Draft

New Jersey Energy Master Plan

April 14, 1989

State of New Jersey
Thomas H. Kean, *Governor*

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This Draft Energy Master Plan was prepared by the Energy Master Plan Committee in accord with the requirements of P.L. 1987, c. 365.

Department of Commerce, Energy and Economic Development
Department of Community Affairs
Department of Environmental Protection
Department of Health
Department of Human Services
Department of Transportation
Department of Treasury

The Division of Energy Planning and Conservation serves as Technical Staff to the Energy Master Plan Committee.

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EXECUTIVE SUMMARY

Introduction

New Jersey can choose its energy future, or let others choose it. The objective of the 1989 Energy Master Plan is to provide the information and framework that the people of New Jersey need for wise decisions. New Jersey needs an energy future that supports economic prosperity, protects the environment, and safeguards it from supply disruptions.

The apparent lesson of the 1970s was that foreign forces could raise energy prices or embargo supplies at will. The real lesson is that America discovered a "new" and very large source of energy: efficiency. Higher levels of insulation, more efficient cars, trucks, and industrial methods have allowed the United States and New Jersey to hold energy use to levels first reached in the early 1970s, while the economy expanded by 40 percent. This response shows that we can indeed choose our energy future. Today's challenge is to preserve and extend efficiency gains.

The 1989 New Jersey Energy Master Plan focuses on the year 2000. It recommends pursuing a high efficiency energy future and identifies actions that the government and the private sector must take to achieve this future.

Today's Situation

Energy Sources

In 1986, New Jersey used over 2,000 trillion Btu (TBtu), an average of 269 million Btu (MMBtu) per capita. The state ranked 39th in per capita use, close to other northeastern industrial states. Petroleum has been the predominant source throughout the period, but its share dropped from 76.2 percent in 1972 just before the first oil crisis to 56 percent in 1986. Since the mid-1970s net electricity purchases have been a significant source of energy used in New Jersey. In 1986 they accounted for 15 percent of energy used, a little less than the 18 percent contribution of natural gas. Coal accounted for 4 percent in 1986, and nuclear energy for 8 percent.

The utilities provided almost 47 percent of the total energy used in 1986, 31 percent attributable to the electric utilities and 16 percent to the gas utilities. In 1987 and 1988 electricity prices went down, and electric sales grew by about 5 percent a year. The state and its electric utilities are facing unprecedented economic and regulatory changes, including increasing marginal costs, generation competition, and demands that utilities adopt least cost planning, including major end-user investments. Traditional regulatory methods may be inappropriate for the new conditions.

The gas utilities need more pipeline capacity to meet peak winter needs and new opportunities, including cogeneration and air conditioning.

Energy Prices

For wholesale gasoline, coal, and electricity, New Jersey pays among the highest prices in the country. For gasoline, the high wholesale price is offset by the competitive environment and by the low state tax on motor fuels, making retail gasoline less expensive than in most states. Coal prices are high throughout the eastern U.S. New Jersey's coal prices are somewhat greater, because stringent air quality standards require use of more costly low sulfur coal. Natural gas prices are in the midrange nationally.

Energy Uses

Residential and commercial buildings used almost half of the total energy consumed in New Jersey in 1986. The energy performance of buildings is much more expensive to affect through retrofit than during construction. Since buildings last for scores of years, building codes and construction practices lock in energy use for a long time.

Transportation accounted for one-third of energy use in the state. Transportation needs depend on vehicle efficiency, mode of travel (e.g., car versus train), and land use. The location of buildings, jobs, shopping, and residences relative to each other helps determine the transportation infrastructure and transportation energy requirements.

Industry was responsible for the remaining quarter of use. Its portion has declined with the loss of manufacturing, and the remaining manufacturers have increased their efficiency using less energy for the amount of goods produced.

Supply Projections

Over the next decade long-term shortages are unlikely in the supply of primary fuels--natural gas, petroleum, coal, or uranium--which together provide over 99 percent of the state's energy. However, the price at which they will be supplied is uncertain. Fuel prices in New Jersey are considerably higher than national averages but are close to prices in other northeastern industrial states.

Domestic oil production continues a gradual decline. New Jersey and the Northeast are heavily reliant on imported petroleum. Until new gas pipelines are installed, New Jersey's winter consumption is limited by the capacity of the pipelines. Coal is readily available but challenging to use in environmentally acceptable ways. In addition to acid rain problems amenable to technical controls, coal combustion produces significantly more CO_2 (a major greenhouse gas) than other fuels, so global warming considerations may limit expanded uses. The nuclear industry is stagnant, and according to the utilities, will provide no new power plants for New Jersey before the year 2000.

Needs

Improving Our Competitive Edge: In spite of great progress, the United States uses more energy per dollar of output than its major foreign trade competitors. In 1984, energy costs accounted for 11.2 percent of gross national product (GNP) of the United States. In Japan, a major foreign trade competitor, energy costs accounted for only 5 percent of GNP. Thus, the U.S. may be more vulnerable to sharp price increases than Japan, which has lower domestic supplies.

Bolstering our Energy Security: New Jersey is entirely dependent on energy imports from foreign and domestic sources. In an energy emergency it lies distant from the Strategic Petroleum Reserve.

Improving Environmental Quality: The increasing use of fossil fuels affects environmental quality. Some environmental problems are inherent to fossil fuel combustion, and the primary means of mitigating them is to use less fuel to accomplish the desired ends.

State Energy Policy Goals

GOAL #1: TO PROVIDE SECURE ENERGY SUPPLIES AND SERVICES TO ENERGY USERS

GOAL #2: TO ENCOURGE ECONOMIC GROWTH THROUGH FOSTERING THE PROVISION OF ENERGY SERVICES AT THE LEAST COST

GOAL #3: TO PROTECT OUR ENVIRONMENT THROUGH WISE AND EFFICIENT ENERGY USE

Scenarios for 2000

To meet these goals, New Jersey must select the optimum energy future for New Jersey. The Master Plan examines three plausible projections of future energy needs:

- historical high growth: increase at the 1960-1973 growth rate (about 4 percent per year),
- historical low growth: rising slowly at the 1981-1986 rate (about 0.2 percent per year),
- best available technology: decrease at a rate determined by incorporation of the best currently available technology and additional initiatives undertaken to meet environmental, economic, and security considerations (1.8 percent per year per capita decline in energy use).

The three scenarios are more fully described in Part VI - New Jersey 2000. The best available technology use scenario requires that the state implement policies to improve efficiency of energy use, including encouraging consumers to replace existing energy-using equipment with the most efficient equipment currently available.

Policies for Implementing the Best Choice

We refer to the choices that will offer New Jersey the greatest benefits as the "Best Available Technology" (BAT) scenario. Achieving BAT will require change and leadership. The policies required center around least cost planning, the concept that energy service needs should be met by the combination of energy supply and energy consumption investments that minimize total cost to society. This concept usually requires more investment on the customer side of the meter to achieve improved end use efficiency and less in central supply technology than has been the case in the past. Significant movement in this direction will require change:

1. The Board of Public Utilities and the legislature will need to direct the marketing, technical, and capital strengths of the utilities toward this strategy and will need to allow the utilities to profit from it.

2. Government will need to maintain a strong planning function and the ability to invest where others cannot. Government will have to stimulate end-use research and development, to help New Jersey become a leader in this area.

3. The utilities will need to change to meet customer needs as efficiently as possible and to find ways to profit as managers and brokers of energy services, instead of as commodity vendors.

4. The private sector will have to become more sensitive to the value and benefits of energy efficiency. Energy efficiency is not "freezing in the dark" but working and living smarter!

We conclude this Executive Summary by stating some of the major Findings and Policies of the New Jersey Energy Master Plan:

Energy Sources

Natural Gas - Findings

- Relative to most other states, New Jersey uses proportionately less natural gas and more oil, but gas utilities are adding customers rapidly.

- During peak winter consumption intervals, the supply to New Jersey is inadequate, forcing curtailment of interruptible customers and threatening economic development. Additional pipeline capacity is needed.

- Natural gas combustion causes less pollution and less greenhouse effect than petroleum or coal.

- Natural gas supplies are more secure than petroleum, though no more than coal.
- The regulatory changes of the past decade have profoundly affected producers and pipeline companies and will also affect change the business environment of local distribution companies (LDCs) and their customers.
- The meaning of least-cost planning is uncertain to many. New Jersey utilities do not yet follow integrated least cost planning principles, including customer side options.

Policies

- The state must encourage pipeline construction from both the Southwest and Canada to relieve capacity constraints, to diversify supply and to foster economic competition.
- The state must encourage gas air conditioning, natural gas motor vehicle fleet demonstrations, and other uses that can replace summer electricity or more polluting fuels.
- The state must more explicitly define its expectations of LDCs for least cost planning in order to assure that needs are met as economically as possible. This strategy includes, but is not limited to, oversight of gas purchasing.
- Investment where cost-effective on the customer's side of the meter and customer gas transportation must be potentially profitable to the gas utilities.

Petroleum - Findings

- New Jersey ranks sixth in the nation in petroleum usage; it is vulnerable to supply disruptions. At present, almost all petroleum used in New Jersey is traceable to foreign sources.
- Transportation consumes 63 percent of the petroleum used in the state, followed by much smaller amounts used in industry (20 percent), residential heating (8 percent), commercial structures (5 percent), and electric utilities (4 percent).
- Becoming less vulnerable requires using less petroleum for transportation through a combination of more efficient vehicles, less congestion, and alternatives to single occupancy vehicle commuting.

Policies

New Jersey must support programs to increase automotive fuel efficiency.

- New Jersey supports increases in the fill rate of the Strategic Petroleum Reserve.
- New Jersey must maintain and regularly test energy emergency procedures.
- New Jersey must aggressively seek ways to meet citizen needs with less use of the automobile, including stimuli for expanded ridesharing and vanpooling, adequate mass transit, and innovative ideas (such as flex-time) that save fuel by decreasing peak hour congestion.

Coal - Findings

- Ninety percent of coal burned in New Jersey is used to generate electricity.
- Utility and industrial applications can switch fuels; coal must compete on price.
- Environmental controls affect New Jersey utility coal combustion only by restricting the sulfur content of the fuel; there are no exhaust treatment requirements other than for particulates.
- Coal combustion contributes more pollution per kwh generated than oil or natural gas.

Policies

- Coal use should continue where environmentally acceptable. When environmental costs are internalized, coal should be allowed to compete freely with other fuels.
- New Jersey supports clean coal technology research and development.

Electricity - Findings

- New Jersey utilities rely on out-of-state facilities for significant amounts of their energy and capacity needs. In 1988, over half the electricity used in New Jersey was generated out of state.
- Load factors for New Jersey utilities are below the national average (60 percent); improvements may be very cost-effective.
- The New Jersey nuclear plants have, on average, performed less well than national averages and have required significant capital additions to continue to meet upgraded licensing requirements.

- New Jersey electricity prices are competitive with downstate New York but almost twice as high as the national average.

- New Jersey's Gross Receipts and Franchise Taxes (GR&FT) are based on sales instead of energy provided. GR&FT is approximately 12.5 percent of revenue and almost twice has high as the national average. This situation affects the competitiveness of New Jersey industry.

- Although the electric utilities can influence customer behavior by tariff design and by marketing, least cost planning is not yet implemented in New Jersey, in part because utilities have inadequate incentives to invest in end-use efficiency.

- The electric utilities receive little pro-active collaboration in facility planning from state officials; improved processes are required.

Policies

- Electric utilities should continue efforts to diversify their fuel and supply technology options.

- Performance standards for nuclear power plants should be continued on a rational basis offering incentives as well as penalties.

- GR&FT should be gradually reduced from the present 12.5 percent to about 7 percent, over a six- to ten-year period. The present sales-based system should be replaced with a proportional energy unit tax.

- Least-cost planning shall be implemented in ways to benefit all stakeholders.

Cogeneration - Findings

- Where cogenerators meet real thermal loads (process, heating, cooling, etc), cogeneration uses fuel more efficiently (up to 84 - 85 percent yield) than traditional central power stations (less than 35 percent).

- By the year 2000, New Jersey could absorb over 2,500 MW of cogeneration, depending on economic and population growth.

- Under current regulatory methods, cogeneration may be attractive to ratepayers, since economic risks are absorbed by the developers instead of the utilities.

- Challenges remain in matching cogeneration with the grid: dispatch and self-wheeling remain to be considered fully.

- The growth of cogeneration is tied to the future of natural gas in New Jersey, since it will be the fuel of choice for most cogenerators and offers reduced environmental impacts.
- Reliable in-state cogeneration can reduce transmission problems by relieving the heavily-loaded east-west system and by providing local generation that is closer to the loads served.

Policies

- Cogeneration continues to offer many benefits to New Jersey and must be promoted.
- DCEED will work to minimize regulatory impediments and assure a stable planning environment.
- DEP shall evaluate the "netted" benefits of cogeneration replacing older combustion sources that produce large amounts of air pollution.
- The BPU shall evaluate experimental tariffs that allow profit from self-wheeling and other "unbundled" services.
- Cogeneration must be explicitly considered in least cost planning processes.

Renewable Energy Sources - Findings

- Few regulatory barriers or government incentives remain for renewable energy sources.
- Building siting and design can allow significant energy benefits when combined with energy efficient building techniques.
- Photovoltaic electricity production has significant promise in the near term (two to five years).

Policies

- Land use planning should consider the benefits of solar orientation of all buildings.
- Building codes should stimulate and credit construction that works with and uses winter solar gain while avoiding summer gain from unshielded glazing.
- The potential of photovoltaic technology warrants continued stimuli to help develop new products and markets. The state shall evaluate the role of demonstration grants, purchases of equipment, etc.

Residential Sector Uses - Findings

- Natural gas accounted for almost half of New Jersey residential fuel use in 1986, and its use is increasing. It is the predominant fuel for cooking and for space and water heating.

- Petroleum accounted for 32 percent of residential fuel use in 1986, but shows a long-term declining trend.

- Electricity accounts for about 19 percent of residential energy use. Major electricity users include refrigerators and freezers and air conditioners.

- Replacing the present appliance mix in the residential sector with the best appliances commercially available would save 30 - 35 percent of the electricity now used in this sector and about 20 percent of the natural gas.

- Improvements to building envelopes will generate substantial additional energy savings. Improved new construction offers potential for economic gain to builders and buyers alike.

Policies

- For environmental and economic reasons, the state should set as its goal achieving residential energy efficiency by the year 2000 represented by the level of the best commercially available technology in 1988.

- Weatherization of existing residences should be aggressively stimulated.

- New Jersey shall regularly evaluate and adopt energy subcodes that approach the maximum cost-effective efficiencies achievable.

- The state should set ventilation standards for buildings and concentration limits for specific pollutants, to assure that efficient buildings are healthful ones.

Nonresidential Energy Uses - Findings

- In the commercial sector, major fuels have roughly equal shares: 38 percent natural gas, 33 percent electricity, and 29 percent petroleum.

- Industrial fuel use in 1986 was dominated by petroleum (66 percent). Nineteen percent of fuel used was natural gas, and 14 percent of the energy was electric.

- Electric energy uses and peaks are rising.

- In the commercial sector, primary electric uses are for cooling and lighting; natural gas and petroleum are primarily used to heat space and water.

- The primary industrial use of electricity is shaft power (motors); natural gas and petroleum are primarily used for process boiler fuels.

Policies

- The state should promote cost-effective replacement of inefficient industrial motors to improve competitiveness of New Jersey industry.

- The state should promote more efficient cooling and lighting for the commercial sector, including the evaluation of natural gas air conditioning and thermal storage to reduce electric peaks. Tariffs that allow utilities to profit from capital invested efficiently on customer premises will encourage these improvements.

Energy Use in Transportation - Findings

- New Jersey has the most crowded roads (vehicles per mile) in the United States because of its economic health, population density, and location in the northeast corridor.

- Auto emissions contribute significantly to New Jersey's air pollution; traffic congestion contributes disproportionately to this problem. New Jersey is not in compliance with Federal requirements.

- Motor fuel use is elastic; it has increased as prices (and expected future prices) have declined.

- One quick and cost-effective solution to some of these problems is increased ridesharing and vanpooling as alternatives to single-occupancy vehicles.

- Significant improvements in vehicle fuel efficiency are possible.

- Per person served, the cost of many road projects may be higher than that of incentives that would obviate the need for the additional construction.

Policies

- All road construction proposals should meet least cost criteria relative to options such as subsidies to alternatives that would eliminate the need for the construction.

- Alternatives to single occupancy vehicles must be stimulated by the state. Measures to consider include differential tolls based on time of day and occupancy, parking restrictions, and restricted use lanes.

- To stimulate the production and sale of more efficient vehicles, the state should adopt bid procedures based on life-cycle cost for passenger cars and buses.

Energy Efficient Buildings - Findings

- For new construction, codes, rating systems, and promotional programs can all stimulate more efficient buildings.

- Current judicial interpretation of the law does not permit amendment of the energy subcode. There is a technical debate as to which national model energy subcode is economically practicable and feasible.

- Although energy use is usually a major cost of building operation, owners rarely have adequate or accurate information before purchase or lease. Home Energy Rating Systems (HERS) can provide useful information to owners and tenants.

- Mechanisms for reporting and evaluating building energy use are inadequate, particularly for retrofit programs.

- The DEPC estimates that expenditures in the Institutional Conservation Program, the state Energy Conservation bond Program, and other nonresidential programs have been cost-effective.

- By 1988, approximately 300,000 households had obtained energy audits by trained inspectors. Evaluation of this program is underway.

- More than 100,000 low-income households have received free weatherization services from utilities, and more than 60,000 have received DCA weatherization. These numbers are not large compared to the housing stock.

Policies

- New Jersey Energy Subode requirements shall minimize life-cycle costs; i.e., prescribe maximum cost effective levels at current energy prices.

- All programs should have funding to generate the data required for program evaluation. With such data, least cost planning can become a reality.

- The state should adopt a voluntary Home Energy Rating System, to be made available by utilities at low cost for all houses put on the market for rental or sale.

- The state, working with utilities and other interested parties, should offer increased support services to the commercial and industrial sector.
- Because a unit saved energy is frequently cheaper and more environmentally benign than a unit of energy produced, government must work to remove barriers to cost-effective investment and to put its own buildings and purchase policies in the best possible order.
- Appropriate incentives should be implemented to reward government entities and personnel that achieve significant energy savings through wiser purchasing or better operations.
- The state should encourage cost-effective cogeneration and district heating for urban revitalization.
- The Board of Public Utilities should evaluate the use of tariff structures to reward new buildings that minimize new capacity requirements and penalize those that only meet code.

Energy Efficient Land Use Patterns - Findings

- Population shifts to the suburbs and formerly rural areas have increased transportation energy use by increasing reliance on the private automobile.

Policies

- The state should continue to encourage revitalization of cities as attractive places to both work and live.
- In nonurban settings, clustered development with residential and occupational uses has energy utilization advantages and warrants encouragement by the state.

Energy Efficiency and the Environment - Findings

- Atmospheric CO_2 has increased by more than 30 percent since the beginning of the industrial revolution. This CO_2 and other "greenhouse gases," largely of industrial technology origin, can cause significant warming of the earth's climate.
- Other pollutants that cause health problems and environmental damage, such as NO_x, SO_2, and O_3, are largely byproducts of energy use, directly or indirectly.
- Improved energy efficiency is the single most effective means of reducing these combustion-derived pollutants and will be necessary to comply with federal air quality standards.

Policies

- State regulatory procedures and laws should consider environmental impacts of energy use in encouraging maximum cost-effective energy efficiency in all sectors.
- New Jersey should stimulate use of renewable and "waste" energy, including technologies as diverse as photovoltaics and landfill methane recovery.
- Economic analyses of major capital investments should require life cycle costing and should explicitly internalize environmental costs.

Energy Education - Findings

- Energy education can make a difference in consumer attitudes and can be implemented in schools.
- DCEED and utility energy education programs have been well received in schools, but DCEED funding from federal programs has been gravely reduced.

Policy

- To insure that future energy decisions will be made by informed citizens, the state should encourage and promote energy education in its schools.

Research and Development - Findings

- Higher efficiency products, services, and systems are now available for many sectors. These are not being installed at rates commensurate with their cost-effectiveness. Research is required on the barriers to these cost-effective improvements.
- In all sectors studied, "hardware" research and development offer opportunities to bring to market new products that would use less energy than present approaches.
- For the last several years, stable to declining energy prices have led to reductions in public and private energy efficiency research and development.

Policies

- Because New Jersey is an energy-consuming state with a large research and manufacturing base, mechanisms shall be developed to foster research and development to build on current strengths in universities and industry to make New Jersey a national leader in energy efficiency products and services.

- New Jersey shall develop tax policies that foster energy efficiency investments to help shield the state from future "price shocks" and to provide a local market for the developers of energy efficiency products and services.

Part I

Introduction

CHAPTER I-1

ENERGY GOALS FOR 2000

Introduction

New Jersey can choose its energy future, or let others choose it. That is the real lesson of the past 20 years. The objective of this Energy Master Plan is to provide the information and framework so that the people of New Jersey can decide on their energy future. The Plan seeks to give a consistent thrust to the policies and actions of state government that will offer New Jersey a coherent and definite direction toward an energy future to support its economic prosperity, protect its environment, and safeguard it from disruptions outside its control.

The 1989 New Jersey Energy Master Plan focuses on the year 2000, just over a decade away. After comparing several alternative futures based on their expected energy, economic, and environmental effects, this 1989 Plan recommends a preferred energy future and identifies actions that the government and the private sector must take to achieve this future.

The conclusion that New Jersey can choose its energy future surprises most citizens. After all, the apparent lesson of the 1970s was that foreign forces, led by the Organization of Petroleum Exporting Countries (OPEC), could raise energy prices or embargo supplies at will, driving the economy into a tailspin. But the real lesson comes from responses to OPEC's actions, responses that minimized the likelihood that history will repeat itself. America and other industrialized countries discovered the virtues of a "new" and very large source of energy: efficiency. Higher levels of insulation, more efficient cars, trucks, and industrial methods have allowed the United States and New Jersey to hold energy use to levels first reached in the early 1970s, while the economy expanded by 40 percent.[1]

Efficiency gains were essential in undermining the leverage of OPEC and led to an era of declining energy prices.[2] This response shows that we can indeed choose our energy future. Today's challenge is to preserve and extend efficiency gains.

Utilities

The utilities form an essential part of the state's energy infrastructure, accounting for over 45 percent of the total energy used in 1986, 30.9 percent attributable to the electric utilities and 15.8 percent to the gas utilities. In 1987 and 1988 electricity prices went down, and electric sales grew by about 5 percent a year, more than expected.

The state and its electric utilities are facing an unprecedented wave of economic and regulatory changes, which will require a radical revision in some of the industry's basic tenets: (1) production of electricity has gone from a decreasing cost to an increasing cost industry; (2) electric utilities are being pushed from their monopoly position as the sole source of power to one of several alternative suppliers; and (3) utilities are providing conservation services as a way to deliver the lowest cost energy services. The emergence of alternative power providers (e.g., cogenerators) and the uncertainty of planning due to volatile rates of growth in peak demand have complicated the adjustment process.[3]

The gas utilities are confronted by the urgency of finding adequate pipeline capacity to meet peak winter needs and by potential new opportunities, including providing fuel for cogenerators and possibly for air conditioning or in transportation.

Environmental Concerns

Environmental concerns have come to the forefront. They involve well-known but difficult problems, such as heat emitted by generating facilities and the direct relationship between automobile use and air pollution. More recently questions of indoor air quality and global weather patterns have emerged as important energy-related environmental issues. (See Table I-1.)

TABLE I-1
Environmental Impact Arising from Energy-Related Contaminants

	Substance or type of environmental impact						
	Carbon Monoxide	Carbon Dioxide	Nitrogen Oxides	Ozone	Sulfur Dioxide	Methane	Heat
GLOBAL		X	X	X	X	X	
NATIONAL		X	X	X	X	X	
REGIONAL		X	X	X	X		
STATE		X	X	X	X		X
LOCAL	X	X	X	X			X
HOME	X	X	X				X

Beyond these concerns, New Jersey's tradition of home rule, combined with the spread of residences into rural areas, has brought on a clash between private interests and public needs for infrastructure. This clash is a critical issue in choosing New Jersey's energy future. Greater use of energy will require expansion of the highway system, more generating stations, transmission and distribution lines, pipelines, and gas storage depots.

This New Jersey Energy Master Plan cannot solve all of these problems. It does, however, advance the discussion by calling attention to needs, comparing alternatives, and adopting a plan for action. The 1980s have brought to New Jersey challenges that demonstrate how important it is to choose rather than drift.

Energy Use

In 1986, New Jersey used 2,050.5 trillion Btu (TBtu), an average of 268.9 million Btu (MMBtu) per capita.[4] The state ranked 39th in per capita use, close to other northeastern industrial states.[5] (See Table I-2.)

Table I-2
PER CAPITA ENERGY USE IN NEW JERSEY AND OTHER NORTHEASTERN STATES
1986
in million British thermal units (MMBtu)

State	Total /capita	Residential /capita	Commercial /capita	Industrial /capita	Transport /capita
New Jersey	*268.9	62.21	62.12	66.36	*88.4
Penn.	275.1	66.94	44.96	102.52	66.0
Maryland	255.5	64.55	35.38	82.97	72.5
New York	*198.3	53.73	53.29	36.01	*55.5
US average	308.0	63.38	48.65	109.80	92.2

* - adjusted for realloaction of jet fuel consumption bewteen NJ and NY.
Source: EIA, Report DOE/EIA-0214(86)

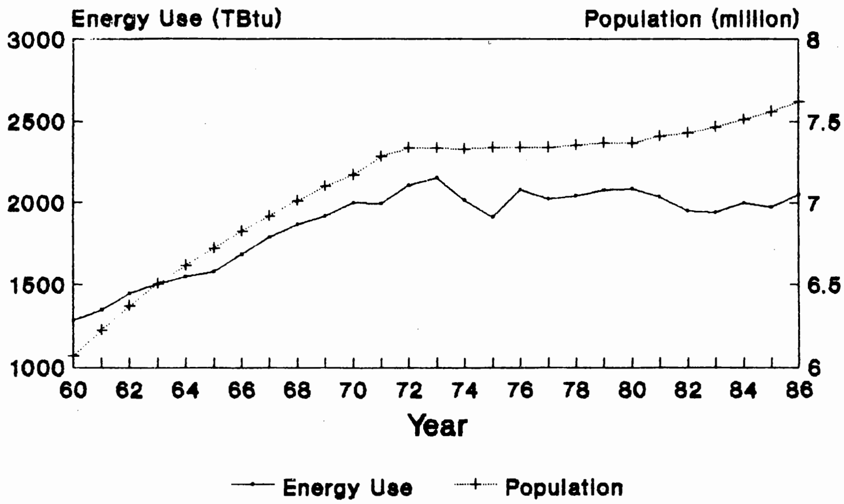
Figure I-1 shows changes in total annual energy use and in population in New Jersey over the past 26 years. From 1960 through 1973 total energy use and population both rose steadily: energy use grew on average more than 4 percent per year and population at an annual rate of 1.47 percent. But following the oil embargo of 1973, energy use dropped sharply, recovered, and then remained within a narrow range for a dozen years. However, population continued to grow, albeit at a somewhat slower rate (0.3 percent per year). As a result, per capita energy use fell by about 11 percent from its peak in 1973, reaching a low of 260.2 MMBtu per capita in 1983.[6]

The precipitous decline in world oil prices in late 1985/early 1986 led to a general fall in energy price levels, which in turn has led to an acceleration in energy use. Data from 1986 and 1987 and preliminary indicators for 1988 all point to energy use growing at rates approaching those prior to 1973.[7]

Figure I-2 shows the major sources of energy used in New Jersey during the period 1960-86. Petroleum has been the predominant source throughout the period, but its share dropped from 76.2 percent in 1972 just before the first oil crisis to 55.6 percent in 1986. Since the

Figure I-1

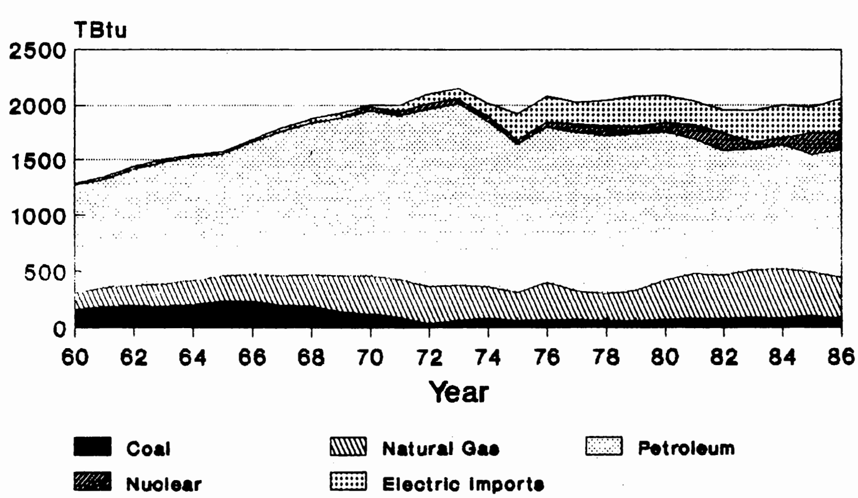
Energy Use and Population in NJ
1960-86



Source: EIA Rpt. DOE/EIA-0214(86)

Figure I-2

Energy Sources in New Jersey
1960-86



Source: EIA adjusted by DCEED

mid-1970s net electricity purchases have been a significant source of energy used in New Jersey. In 1986 they accounted for 15.1 percent of energy used, which was a little less than the 17.7 percent contribution of natural gas. Coal accounted for 3.8 percent in 1986, and nuclear energy for 7.8 percent.[8]

Figure I-3 presents a breakdown for energy used in each sector of the New Jersey economy.

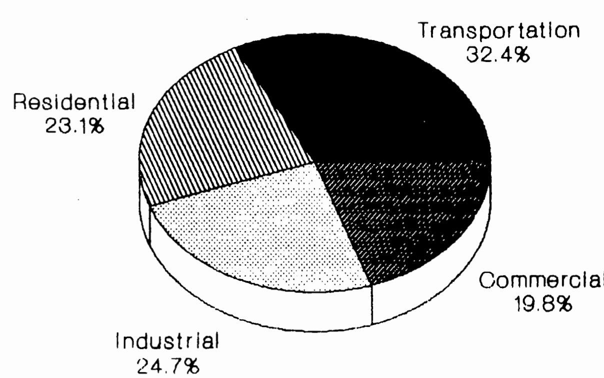
- Residential and commercial buildings used 43.9 percent of the total energy consumed in New Jersey in 1986.[9] The energy performance of buildings is much more expensive to change through retrofit than during construction.[10] Since buildings last for scores of years, building codes and construction practices lock in energy use for a long time.

- Transportation accounted for 32.4 percent of energy use in the state.[11] Transportation needs depend on vehicle efficiency, mode of travel (e.g., car versus train), and land use. The location of buildings, jobs, shopping, and residences relative to each other help determine the transportation infrastructure and transportation energy requirements.[12]

- Industry was responsible for the remaining 24.7 percent of use.[13] Its portion has declined with the loss of manufacturing, and the remaining manufacturers have increased their efficiency using less energy for the amount of goods produced.

Figure I-3

ENERGY USE BY SECTORS
1986



Source: EIA adjusted by DCEED

CHAPTER I-1

Energy Supplies

Over the next decade shortages are unlikely in the supply of primary fuels--natural gas, petroleum, coal, or uranium--which together provide over 99 percent of the state's energy. However, the price at which they will be supplied is highly uncertain. Fuel prices in New Jersey are considerably higher than national averages but are close to prices in other northeastern industrial states. Both national and local prices are subject to fluctuations beyond the state's and even federal control.

Like many northeastern states, New Jersey lacks indigenous fossil fuel resources. The state imports all coal, gas, and petroleum it uses from other states or from abroad. Several refineries have closed or reduced their capacity in recent years, leaving fewer local sources for refined petroleum products. (See Chapter II-1-B.) For the past several years, the state's electric utilities have purchased from power plants outside New Jersey more than 30 percent of the kilowatt hours they distribute. (See Chapter II-2.)

Physical availability of petroleum, natural gas, and coal seems assured for the next decade. Although oil production is falling in the contiguous 48 states, reserves and production capacity in Alaska and outside the United States appear large enough to comfortably supply New Jersey and world requirements over the next decade. Possible natural gas sources include domestic and Canadian producing areas. Coal sources in the continental United States can satisfy present use and expected increases in domestic demand for many years to come.

Natural Gas

Natural gas reserves are sufficient to meet growth projections in all market areas worldwide well past 2000.[14] In Alaska, Canada, and Mexico, large reserves are now available or plans exist for their development before 2000.[15] Several proposals before the Federal Energy Regulatory Commission (FERC) would expand or build interstate pipelines to bring additional natural gas into New Jersey by the end of the century, when projections show it will be needed.[16]

Natural gas imports from outside North America will likely cost more for liquefaction and transport. Liquefied natural gas (LNG) delivered by ship averaged $1.43/Mcf in 1985 and $2.18/Mcf in 1986, more than Canadian natural gas imported via pipeline.[17] But there is no shortage of suppliers. Norway is preparing to market gas[18]; Algeria has resumed deliveries; and Nigeria hopes to sell output from its recently revived LNG project to the United States.[19]

A surplus of natural gas on the market exists today. Future demand for gas will probably be constrained by sensitivity to price compared to oil and coal, rather than limited by the availability of supplies.

Petroleum

In 1986, New Jersey imported 78 percent of the petroleum used in the state from other countries.[20] As domestic production continues to fall, we can expect to import increasing amounts of petroleum from abroad.[21]

As of November 1988, the amount of unused oil-producing capacity worldwide was about 10 million barrels per day.[22] In spite of falling production in the United States, worldwide oil reserves increased by 189 billion barrels, or 27 percent, from 1986 to 1987.[23] In 1988, there were reports of additional large increases in reserves: in excess of 50 billion barrels in Iraq,[24] and substantial finds of light and medium crudes in Venezuela.[25]

Coal

Analysts expect coal to be readily available through the beginning--and probably the end--of the next century.[26] Coal will compete with oil and natural gas for any increase in consumption in the next decade. The United States presently produces considerably more coal than it uses. In 1986, it exported 89 million short tons, about 10 percent of total production. The U.S. Department of Energy forecasts that coal exports will at least remain stable or may increase by as much as a third by the year 2000.[27] Coal supplies for New Jersey should be sufficient throughout the next decade.

The major constraints on coal use are environmental. In addition to the environmental problems related to mining and transportation, coal use impairs air and water quality, leads to acid rain, and probably contributes to global warming.

Nuclear

The nuclear industry has stagnated. Since 1978 utilities in the United States have ordered no nuclear power plants and have cancelled 78 orders.[39] Safety issues, primarily waste disposal and emergency evacuation procedures, await resolution. Costs to improve plant safety and allay fears of environmental contamination have risen dramatically along with insurance costs. The regulatory environment has changed considerably over the years in response to safety concerns and large cost overruns. Utilities have been unwilling to order new nuclear plants, when they cannot accurately evaluate the costs of bringing a plant on line. The costs will not stabilize until most of the underlying health, safety, and waste disposal issues are settled. A 1988 Nuclear Regulatory Commission ruling, requiring Seabrook's owners to demonstrate financial capacity to decommission the plant, burdens utilities with a new and additional cost uncertainty.[40]

Energy Prices

Table I-5 compares New Jersey energy prices to those of neighboring states and the nation. For three of the five fuel types--wholesale gasoline, coal, and electricity--New Jersey pays among the highest prices in the country. For gasoline, the high wholesale price is offset by the very low state tax on motor fuels, making retail gasoline moderate in price.[41] Coal prices are high throughout the Eastern U.S. New Jersey's coal prices are somewhat greater, because stringent air quality standards require use of more costly low sulfur coal.[42] Natural gas prices are in the midrange nationally.

Because New Jersey imports nearly all its commercial energy, the state has no control over price changes decided by other countries or national policy. Price rises will increase the outflow of income from New Jersey's economy to producing countries, while price decreases will reduce that outflow. If energy prices rise faster than the overall cost of living, as many analysts are predicting for the mid- and late 1990s, then New Jersey's economy would be adversely affected.

Table I-5

NEW JERSEY FUEL AND ELECTRIC PRICES COMPARED TO OTHER STATES
1987

	Retail Gasoline $/MM Btu*	Motor Fuel Tax Rates cents/gal	Wholesale Gasoline $/gal**	Natural Gas $/tcf	Coal $/ton	Electric $/kwh***
U.S. highest	11.14	20.9	0.75	6.55	63.45	0.106
U.S. next highest	10.19	20.0	0.73	4.05	52.01	0.103
U.S. lowest	8.59	7.0	0.52	2.38	9.16	0.040
New Jersey	8.97	10.5	0.69	2.98	46.14	0.106
New York	8.82	14.75	0.68	2.92	40.73	0.103
Pennsylvania	9.03	17.4	0.64	3 07	35.97	0.101
Maryland	9.50	18.5	0.67	3.18	40.65	0.079
U.S. Average	9.03	15.72	0.65	2.87	31.12	0.082
New Jersey rank - highest to lowest - among 50 states & D.C.	36	47 tie	8	21	6	1

* - 1985 ** - excluding taxes and resellers margins
*** - based on weighted average of typical monthly residential bill for 500 kWh

Sources: State Energy Price & Expenditure Rpt., 1985, EIA, Table 5, p. 9.
Highway Users Federation, October 1, 1988.
Petroleum Marketing Monthly, June 1988, EIA, Table 28, pp. 57-60.
Natural Gas Monthly, May 1988, EIA, Table 27, p. 57.
Quarterly Coal Report, Jan.-March 1988, EIA, Table 17, p. 37.
Typical Electric Bills, Jan. 1, 1987, EIA, Table 9, p. 20.

CHAPTER I-1

Needs

Need for Improving Our Competitive Edge

In spite of great progress, the United States uses more energy per dollar of output than its major foreign trade competitors. We saved $150 billion in 1986, but we continue to spend $440 billion each year on primary energy. In 1984, energy costs accounted for 11.2 percent of gross national product (GNP) of the United States. In Japan, a major foreign trade competitor, energy costs accounted for only 5 percent of GNP. This nation's continued dependence on a high level of energy leaves it in a poor competitive position relative to more efficient economies. If our economy could produce at Japan's level of efficiency, we would reduce annual U.S. energy cost by an addional $220 billion, 4.5 times the bill for energy imports and more than the U.S. budget or trade deficits. Increasing production efficiency would make our goods and services competitive with other nations now and would give even greater benefits should the price of energy rise.[32]

A competitive position for New Jersey, a consumer state, is more critical than for the nation as a whole. The state is entirely dependent on energy imports from foreign and domestic sources. In an energy emergency it lies distant from the Strategic Petroleum Reserve in the Southwest and at the end of the gas distribution network. It is more dependent than many other states on foreign petroleum imports.[33]

Need for Bolstering Our Energy Security

The United States is again increasing its dependence on imported petroleum. Domestic production is falling, and imports are rising and accounting for a greater portion of the balance of payments deficit.[34] This increasing dependence has major implications for economic development and energy security, which this Plan will address. The import cost is now about $40 billion annually, over a quarter of the nation's trade deficit in 1988.[35] That outflow of dollars could expand to $100 billion annually by the year 2000, if government projections for price and use are correct.[36]

Need for Improving Environmental Quality

The increasing use of fossil fuels has major implications for environmental quality on local, state, national, and global levels. Investigators believe that if present use trends continue, the formation of ozone or the release of carbon dioxide (CO_2), a direct result of the intensive use of fossil fuels, will cause profound climatic changes with far-reaching implications for the earth's biosphere in the future. We cannot change impacts already in progress, only moderate further impacts.[37]

We are increasingly aware of hazardous environmental conditions that arise from inadequately controlled or vented fossil fuel combustion or by internal engine combustion in closed or congested areas. Some environmental problems, such as CO_2 or NO_2 production, are inherent to fossil fuel combustion, and the primary means of mitigating them is to use less fuel to accomplish the desired ends.[38]

State Energy Policy Goals

The energy policy goals established in the 1977 initial legislative mandate and stated as the goals of previous Plans--energy security, economic growth, and environmental quality--remain relevant to today's needs.[39] Goals specific to this 1989 Plan are as follows:

GOAL #1: TO PROVIDE SECURE ENERGY SUPPLIES AND SERVICES TO ENERGY USERS

This Plan recommends policies that improve energy efficiency for all uses to the maximum cost effective limit because increased energy efficiency is the most practical means of decreasing reliance on imported energy. The policies also aim to reduce the state's dependence on imported energy by encouraging the development of alternative sources.

An economy less dependent on energy can remain strong in spite of fluctuating energy prices and supply disruptions resulting from the control of energy supplies by outsiders. Each barrel of oil, ton of coal, or kilowatt hour not needed because of efficiency improvements furthers our energy security goals by reducing our need to import fuel.

GOAL #2: TO ENCOURAGE ECONOMIC GROWTH THROUGH FOSTERING THE PROVISION OF ENERGY SERVICES AT THE LEAST COST

This Plan recommends policies for obtaining energy services from utilities at least cost to users. It also supports the evolution of utilities into competitive providers of energy services other than power generation and distribution. The least-cost approach means that utilities strive to supply the lowest cost energy services, such as heat, light, cooling, and motor power, in contrast to providing low cost energy *per se*.[40] A kilowatt conserved as a result of a home retrofit is equivalent to one delivered by a power plant. Electric power generated from the waste heat of an industrial boiler is as useful as kilowatt hours produced from a utility's thermal power plant.

This Plan shows that energy prices in New Jersey are higher than in other parts of the country. The Plan also identifies policies available to New Jersey government to mitigate price increases and, where possible, to reduce or stabilize energy service costs.

Stable energy prices help promote economic development. The sharp rise in energy prices from 1974-80 was a major factor in the economic problems of that period.[41] Now falling prices could delay the introduction and dissemination of some new energy-saving technologies and encourage a misallocation of resources. Although lower energy prices provide relief, if short-lived, they give consumers false signals about the underlying price trend and can distort economic planning and misdirect capital investment.

GOAL #3: TO PROTECT OUR ENVIRONMENT THROUGH WISE AND EFFICIENT ENERGY USE

This Plan recommends policies that improve both indoor and outdoor air quality through measures that reduce energy use, while maintaining the services that energy provides. Chapter IV-4 describes the major causes of outdoor air quality degradation and auto and power plant emissions. It details measures that the state can take to reduce their harmful effects and the added enforcement effort necessary to gain maximum benefit from federal regulation of air pollution. The state depends mainly on enforcement of federal law to reduce environmental pollution. It can also promote the protection of the environment through education, incentives, and demonstration of less polluting fuels.

Fortunately, reduction and control of harmful emissions correlate directly with increasing energy efficiency and least-cost planning. The main tools for controlling energy costs are equally the main tools for improving environmental quality.

Scenarios for 2000

Several independent organizations have developed national and global energy use scenarios for the year 2000 and beyond. These studies have all shown that increases in energy efficiency are possible and economically justified even at today's low energy prices.

The analyses in Parts III and IV of this Plan consider the use efficiencies developed by the independent organizations and apply that potential to historical state use data. Based on these analyses, and on the different historical rates of growth in energy use before and after 1973, this Energy Master Plan describes three distinct scenarios of future energy use in New Jersey:

- historical high growth: increase at the 1960-1973 growth rate;
- historical low growth: rising slowly at the 1981-1986 rate;
- best available technology: decrease at a rate determined by incorporation of the best currently available technology and additional initiatives undertaken to meet environmental, economic, and security considerations.

The three scenarios, which are more fully described in Part VI - New Jersey 2000, show a wide range of possible future energy use. The best available technology use scenario assumes that, for environmental and security reasons, the state implements policies to improve efficiency of energy use, including encouraging consumers to replace existing energy-using equipment with the most efficient equipment currently available.

The scenarios are neither forecasts nor predictions. They are straight line projections of possible alternative levels of energy use, starting from the 1986 level and based either on an assumption of past rates of growth, or on the effectiveness of new policies to cause the incorporation of efficient technologies. They do not include the effects of other factors such as population growth, employment changes, or personal income.

Table I-4
Scenarios for Energy Use in New Jersey in Year 2000

Scenario*	% change/year	in TBtu 1992	2000
Best available technology	-1.8	1842.2	1593.0
Historical low growth	+0.2	2079.0	2112.6
Historical high growth	+4.0	2599.3	3557.4

* - 1986 use = 2050 TBtu.

Definitions

Resources are the total of the natural occurrences of a mineral or energy source existing in or around the earth.

Reserves are those resources that have been identified as to location and size.

Proven reserves are those reserves that have been precisely located, whose characteristics have been evaluated, and that are producible at present prices and with present technologies.

Potential reserves are those reserves that have been well located and can likely be produced in the future.

Capacity is the physical limit of the equipment and related infrastructure to produce a certain product.

CHAPTER I-1

FOOTNOTES

1. W.U.Chandler, H.S.Geller, and M.R.Ledbetter, Energy Efficiency: A New Agenda (Washington, D.C.: American Council for an Energy-Efficient Economy, 1988), p. 16.

2. Chandler, et al, p. 12.

3. See discussion in Chapter II-2 (Electricity).

4. Annual data from Energy Information Administration, State Energy Data Report, 1960-86, No. DOE/EIA-0214 (86) (Washington, D.C.: U.S. Department of Energy, 1988), hereinafter referred to as EIA, Report DOE-0214(86). State data are available for 1970 through 1988 from the state energy data base maintained by DCEED's Division of Energy Planning and Conservation and from the Energy Information Administration (EIA). EIA, which is a statistical and analytical agency within the U.S. Department of Energy, compiles energy use data on a consistent basis for all states. Its data are available for 1960 through 1986. EIA data have been corrected by reallocating jet fuel use between New York and New Jersey. (See Chapter III-3.) The New Jersey Department of Labor (DOL) provides economic data.

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6. Calculated from EIA, Report DOE/EIA-0214(86), p. 207, and U.S. Census Data 1980 Table 2, Land Area and Population.

7. New York Times, February 27, 1989, pp. A1, D5.

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9. EIA, Report DOE/EIA-0214(86), pp. 208-9.

10. Chandler, et al, p. 55.

11. EIA, Report DOE/EIA-0214(86), p. 211.

12. See Chapter IV-3 (Energy Efficient Land Development).

13. EIA, Report DOE/EIA-0214(86), p. 210.

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15. Wall Street Journal, September 27, 1988.

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21. Energy Information Administration, Petroleum Supply Monthly, January 1988 (Washington, D.C.: US Department of Energy, 1988), p. xxi.

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32. A.R. Rosenfeld, "Energy Conservation, Competition and National Security," in Strategic Planning and Energy Management, Vol. 8, No. 1 (Summer 1988).

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34. See Part VI.

35. Chandler, et al, p.13.

36. Ibid.

37. Mintzer, Irving M., 1987, A Matter of Degrees: The Potential for Controlling the Greenhouse Effect (Washington, D.C.: World Resources Institute, April 1987), Research Report #5, p. 1.

38. Ibid.

39. NJDOE, 1978 Energy Master Plan, p. i, and NJDOE, 1985 Energy Master Plan, p. i. See also Chapter I-2, (History of Energy Policy in New Jersey).

40. R.W. Sant, D.W. Bakke, and R.F. Naill, Creating Abundance: America's Least-Cost Energy Strategy, James Bishop, Jr., ed., (New York: McGraw-Hill, 1984).

41. Real gross domestic product in the United States grew at an annual average rate of 2.1 percent during the years of steeply rising energy prices from the beginning of 1974 through 1980, compared to an annual average rate of 3.2 percent from 1960-85. During this period of rising energy prices, inflation, as measured by the implicit index of consumer prices, rose at an annual average rate of 8.3 percent compared to an annual average rate of 5.0 percent from 1960-85. Historical Statistics, 1960-85, Organization of Economic Cooperation and Development, Paris, 1987. See also Time, July 9, 1979.

CHAPTER I-1

D R A F T

Chapter I-2

HISTORY OF ENERGY POLICY IN NEW JERSEY

Introduction

The history of energy planning in New Jersey begins with the 1974 Task Force on Energy report to the Governor.[1] The report, produced in 30 days in the crisis atmosphere of the oil embargo, set forth several objectives that remain the major themes of energy planning:[2]

- Describe the state's energy supply and consumption flows, and how they fit into national and international patterns.

- Develop an approach to conserving energy that will provide both immediate and long-term economically justified benefits.

- Define adverse environmental effects associated with increasing supplies of energy and a strategy to combat them.

The 1977 legislation establishing the Department of Energy (DOE), N.J.S.A. 52:27F-1 *et seq*., incorporated many recommendations from the 1974 report. The legislation required that DOE prepare an Energy Master Plan (Plan) and update it every three years. The state has adopted two Plans, in 1978 and 1985. A 1981 draft version, prepared during the transition between administrations, went through proposal and public hearings stages but was never adopted. DOE prepared, in addition, several major studies and documents that have provided input to the Plans.

Efforts of the Board of Public Utilities (BPU) have contributed to the evolution of energy policy since 1974. These include a 1979 inquiry into electric public utility construction practices and a study of electric utility plans to convert certain facilities to burn coal. The BPU did not produce a final evaluation in either case, but the dockets are rich in written testimony concerning utility practices.[3]

In 1988 the BPU concluded a stipulation settlement on cogeneration and small power production.[4] This docket implements many of the 1985 Energy Master Plan recommendations on contracting mechanisms between electric utilities and nonutility generators. It also replaces *ad hoc*, prolonged contract negotiations by establishing an auction and bid system for supplying new power capacity for electric utilities. It did not address other concerns, such as wheeling rates and access to natural gas for cogenerators.

Past Energy Master Plans

Two adopted Plans and the draft Plan provide a chronicle of the evolution of energy policy since 1974.

Chapter I-2

The 1978 Plan - Statutory Goals, Strategies, and Issues

The 1978 Plan set forth the statutory goals that each version since has incorporated:[5]

- To assure uninterrupted energy supplies to all residential, commercial, utility, and industrial users in New Jersey.
- To promote economic growth while safeguarding environmental quality; and
- To encourage the lowest possible energy costs consistent with the conservation and efficient use of energy.

The 1978 Plan identified three strategies to meet those goals:[6]

- Establish an independent capability to determine the state's energy needs, including the need for new energy facilities. The Plan identified an energy data base and forecasting capability as tools for this task.
- Promote conservation as a "new source of energy" to meet future demand. The Plan proposed implementing this strategy through integrating energy and environmental planning.
- Use indigenous supplies of energy, solid waste, biomass, solar, wind, and low-head hydro.

The 1978 Plan, developed under the pressures of establishing a new cabinet level agency and the lack of adequate data, did not present a sophisticated economic analysis of the state's energy problems. Subsequently, DOE, with Rutgers and Princeton Universities, developed the New Jersey Energy Data System as a tool to monitor energy use in the state.

This initial Plan dealt with issues rather than planning. The Plan reflected the federal philosophy of the 1970s, that regulatory mechanisms could order energy markets and ensure reliable supplies of energy to the state.

Its major contribution was establishing a process for evaluating energy facility siting proposals. Earlier, state government had reacted to each proposal separately and without formal evaluation procedures. The Plan contained, in addition, a Memorandum of Understanding between the Commissioners of Environmental Protection and Energy establishing a process for joint evaluation of facility siting proposed for the coastal zone.[7]

From 1978 through 1981, proposals for a range of energy facilities reached the state, for floating nuclear power plants, off-shore bases to support Baltimore Canyon exploration, off-shore pipelines to bring oil and gas from Baltimore Canyon wells to interstate pipeline junctions, deepwater oil terminals, and liquefied natural gas storage facilities on Staten Island.

These proposals precipitated a prolonged legislative debate regarding the role state government should play in determining the need for electric generating facilities. The debate ultimately resulted in the enactment of the Certificate of Need Act for Electric Generating Facilities.[8]

The Draft 1981 Plan - in a Period of Change

DOE prepared, proposed, and held hearings on a 1981 Draft Plan but did not adopt it. The document included results from the data base, forecasts of primary fuels, and electricity use. It proposed coal as a major primary fuel option for the industrial sector and for electricity generation.[9]

The USDOE had initiated a mandatory electric utility coal conversion program for power plants. The Port Authority of New York and New Jersey had proposed building a coal import/export terminal in Jersey City that would have created a rail/barge/ocean collier interconnection, and encouraged utilities and industries in New Jersey to use coal.[10]

1981 was a year of economic redirection. Refineries in the state were closing or reducing throughput. Unemployment was increasing. The service sector was beginning a rapid expansion while the manufacturing sector was shrinking. This was the year of highest retail oil prices but the first fall in world crude oil prices.[11]

Falling oil prices upset the economics of coal use and brought about a review of state and federal policies.[12] At the same time, industries and utilities began conversion to gas/oil dual fuel capability, enabling them to respond quickly to competitive price changes. All these events caused a fundamental review of the primary fuels policy in the Plan and delayed its adoption.

The 1981 revisions contained a policy statement that became a cornerstone of the 1985 Plan:

> "Indeed, New Jersey's future economic development is largely dependent on finding a clean, relatively inexpensive alternative to the fuel mix we now employ. Conservation is therefore clearly the fuel of first dependence--the least expensive, quickest, and least polluting of all our fuel options."[13]

1985 Plan

The 1985 Plan, still in force, set forth policies to promote energy efficiency in the production and use of energy, and reorientation of energy regulation to incorporate market forces.

The 1985 Plan recognizes that reducing energy use can moderate environmental impacts of using fossil fuels and nuclear power. As the Plan states:[14]

> "Saved energy converts all New Jersey consumers into energy producers, as plugging leaky attics and managing over-lit and over-heated buildings yield owners the equivalent of high financial returns on their investments in saved energy."

DOE outlined its implementation strategy in a series of regulations mandating energy conservation programs.[15] According to these regulations, the utilities must measure the amount of energy saved and relate the gains to plans for adding new capacity.

A goal of the 1985 Plan was to bring competition to the utility industry through cogeneration, a supplementary means of electric generation, and through least-cost planning.[16] Implementation of least-cost planning is progressing slowly because a generally applicable and accepted formula for calculating utility costs has not yet evolved.

The document was the last Plan of the DOE. The legislation required that, to the extent practical and feasible, the actions of all state agencies must conform to the Plan.[17] Affected state agencies commented on the draft Plan prior to its adoption but had no direct responsibility in preparing and adopting it.

Reorganization of DOE into other Departments

In 1986 Governor Kean realigned functions of DOE, under authority of the Executive Reorganization Act.[18] He merged energy-related functions into the Department of Commerce and Economic Development and recycling functions into the Department of Environmental Protection. Controversy surrounded the reorganization, and a member of the legislature sued to prevent it. Eventually the courts sustained the action. The reorganization, finalized by enactment of P.L. 1987, c.365, changed the preparation and adoption process for Energy Master Plans.

It established a Master Plan Committee of seven cabinet agencies, with the Commissioner of Commerce, Energy and Economic Development serving as chair. Representatives of seven agencies make up the Committee: the Departments of Commerce, Energy and Economic Development, Community Affairs, Environmental Protection, Health, Treasury, Human Services, and Transportation.[19] The Committee as a whole prepares, issues, and adopts the Plans, including this first effort of the Committee, the 1989 Plan.

DRAFT

Chapter I-2

FOOTNOTES

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5. NJDOE, 1978 Energy Master Plan, p. i, and NJDOE, 1985 Energy Master Plan, p. i.

6. Ibid.

7. DOE-DEP Memorandum of Understanding, 1978 New Jersey Energy Master Plan, Attachment II, pp. 1A-40.

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9. NJDOE, Draft Revisions to the New Jersey Energy Master Plan, Sept. 1981, p. D-13.

10. Newark Star Ledger, January 6, 1982, p. 26 and January 22, 1982, p. 25.

11. DCEED, New Jersey Energy Profile: 1987 Edition (Newark: DCEED, 1988), and Shell Briefing Service, Energy in Profile, No. 3, 1988.

12. NJDOE, 1985 Energy Master Plan, p. 39.

13. NJDOE, Draft Revisions to the New Jersey Energy Master Plan, Sept. 1981, p. C-3. See also NJDOE, 1985 Energy Master Plan, p. ii.

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15. N.J.A.C. 14A:20-1, et seq.

16. NJDOE, 1985 Energy Master Plan, p. iv.

17. N.J.S.A. 52:27F-15.

18. P.L.1987, c. 365.

19. Ibid.

Part II

Energy Sources

Chapter II-1-A

PRIMARY ENERGY SOURCES
NATURAL GAS

Introduction

This chapter reviews the history of natural gas production, usage, and regulation nationally and in New Jersey. It presents an 18-year record of consumption statistics by sector and an overview of sweeping changes in federal regulation, followed by a look at the sources of our gas supply and how to provide for increasing demands. The chapter also examines how New Jersey's local distribution companies can provide gas service at the least cost. We conclude with an outlook of supply and consumption in the next decade and with policies concerning adequacy of supply, conservation, and fuel substitution.

The Role of Gas

Natural gas is a clean fuel that consists primarily of methane, a compound of hydrogen and carbon. When burned, the predominant products of combustion are water and carbon dioxide. Natural gas occurs in underground reservoirs of ancient sedimentary rock. Sometimes the gas is found along with crude oil and sometimes in separate gas fields. Gas produced at the well is gathered by pipeline, cleaned, and then transported to points of use via interstate pipelines and local distribution networks to most parts of the United States.

Definitions

For quantifying volumes of natural gas, the industry uses several units interchangeably. This discussion uses British thermal units (Btu) rather than cubic feet (cf) or therms to enable us to make direct comparisons with the energy value of other fuels.

The following are units of measure of natural gas and their equivalents in British thermal units.[1]

1 cf	=* 1,000 Btu		
1 therm	= 100,000 Btu		
10 therms	= 1,000 cf (Mcf)	= 1,000,000 Btu	= 28.32 cubic meters
1,000,000 cf (MMcf)	= 1,000,000,000 Btu		

*Read "=" as "approximates" between volumes (cf) and energy units (Btu) For comparative purposes, 1 barrel of fuel oil equals approximately 6,000,000 Btu.

Chapter II-1-A

Historic Perspective

Initially, natural gas was a by-product of oil extraction operations that was either flared off at the wellhead or used as a fuel near its source. By the 1920s, improvements in pipeline technology allowed producers to ship natural gas to states far removed from the wellhead. Subsequently, wells were drilled specifically to find natural gas. During the 1920s and 1930s, expansion of the interstate pipeline system led to increased use of natural gas.

In 1938, Congress passed the Natural Gas Act, in response to complaints of discriminatory pricing and uncertainty of supply. This law regulated the transportation and sale of natural gas in interstate commerce.

In 1954, a Supreme Court ruling (Phillips Petroleum v. Wisconsin) helped to stimulate the demand for natural gas by setting price ceilings on the previously unregulated wellhead price of natural gas in interstate commerce. That decision created two markets: an unregulated intrastate market and a regulated interstate one. Production and reserves dedicated to the interstate market began to decline in the late 1960s and early 1970s as producers found they could obtain higher prices in the intrastate market.

The Arab oil embargo of 1973 further increased the demand for natural gas, as petroleum consumers sought to switch to a fuel that was cheaper and more reliable in supply. This increased demand was not met by an equivalent increase in supplies, resulting in curtailments and shortages in the interstate market during the mid-1970s. To resolve these problems, the Natural Gas Policy Act (NGPA) was passed on November 9, 1978, as a compromise both to increase supplies and to allow for the gradual decontrol of certain categories of old gas by January 1, 1985. (Old gas is gas committed to interstate commerce prior to passage of the NGPA.)

The NGPA also increased the supply of gas by allowing sales by intrastate pipelines to interstate pipelines and LDCs without subjecting to regulation by the Federal Energy Regulatory Commission (FERC) of these previously non-FERC-regulated intrastate entities.[2]

Recent policy changes of both the U.S. and Canadian governments have made Canadian gas price competitive with domestically produced gas, and thus larger quantities are available for export.

New Jersey Experience

After World War II, natural gas became available in New Jersey to supplement gas produced by burning coal. By the 1960s, natural gas completely replaced manufactured gas due to its lower price and higher heating value. By 1970, natural gas use accounted for approximately 17 percent of the total energy consumed in New Jersey, compared to a 33 percent share nationally. The use of natural gas in New Jersey by all sectors increased throughout the 1960s and registered a 1971 high of 336.3 trillion Btu (Table II-1-A-1). Gas use declined then until additional supplies became available in the late 1970s, which led to the recent peak of 420.3 TBtu in 1984.

At the same time that demand was growing in the late 1960s and early 1970s, natural gas production and the reserves committed to interstate sales were declining. By mid-1972, New Jersey's utilities found it increasingly difficult to obtain the natural gas required to meet demand. In 1975, the Public Utilities Commission (now the Board of Public Utilities, or BPU) issued an executive order requiring gas utilities to obtain PUC approval before making commitments to new customers or increasing service to existing customers. The Governor issued an executive order mandating that, among other requirements, thermostat settings be lowered and all nonessential uses of natural gas be discontinued.

Beginning in 1978, the supply situation dramatically reversed. As a result of conservation, the slow economy, and the Natural Gas Policy Act, adequate gas supplies became available again, but at higher prices.

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Chapter II-1-A

Table II-1-A-1

Natural Gas Consumption in New Jersey (Trillion Btu)*

Year	Res.	Comm.	Ind.	Elec. Util.	Other	Total
1970	145.8	57.0	83.1	35.9	2.8	324.6
%	44.9	17.6	25.6	11.1	0.9	100.0
1971	149.0	61.4	85.5	37.6	2.8	336.3
%	44.3	18.3	25.4	11.2	0.8	100.0
1972	153.8	64.9	82.4	26.1	3.1	330.3
%	46.6	19.6	24.9	7.9	0.9	100.0
1973	146.5	62.2	75.2	26.2	6.3	316.4
%	46.3	19.7	23.8	8.3	2.0	100.0
1974	144.3	61.2	67.9	15.5	2.7	291.6
%	49.5	21.0	23.3	5.3	0.9	100.0
1975	141.6	58.2	53.4	8.9	2.6	264.7
%	53.5	22.0	20.2	3.4	1.0	100.0
1976	151.5	61.2	53.0	10.4	2.6	278.7
%	54.4	22.0	19.0	3.7	0.9	100.0
1977	145.4	57.9	53.4	7.4	2.4	266.5
%	54.6	21.7	20.0	2.8	0.9	100.0
1978	150.0	60.2	53.4	0.8	2.6	267.0
%	56.2	22.5	20.0	0.3	1.0	100.0
1979	145.2	63.4	72.6	31.7	2.8	315.7
%	46.0	20.1	23.0	10.0	0.9	100.0
1980	148.8	69.0	78.9	84.6	5.8	387.1
%	38.4	17.8	20.4	21.9	1.5	100.0
1981	151.7	76.7	87.4	81.9	2.8	400.5
%	37.9	19.2	21.8	20.4	0.7	100.0
1982	152.4	80.5	80.9	67.5	2.7	384.0
%	39.7	21.0	21.1	17.6	0.7	100.0
1983	146.1	79.8	80.3	100.3	2.0	408.5
%	35.8	19.5	19.7	24.6	0.5	100.0
1984	159.4	87.9	81.8	90.8	0.4	420.3
%	37.9	20.9	19.5	21.6	0.1	100.0
1985	152.6	84.3	73.0	57.9	0.0	367.8
%	41.5	22.9	19.9	15.7	0.0	100.0
1986	168.0	90.3	64.3	34.5	0.5	357.6
%	47.0	25.3	18.0	9.7	0.1	100
1987	177.0	95.2	60.1	75.6	1.7	409.6
%	43.2	23.2	14.7	18.5	0.4	100

* 1 trillion Btu equals approximately 1 billion cubic feet
Source: N.J. Energy Data System.

Table II-1-A-2

Natural Gas Consumption in the United States (Trillion Btu)

Year	Res.	Comm.	Ind.	Trans.	Util.	Total
1971	5,092.4	2,586.9	9,850.6	761.5	4,091.8	22,383
%	22.8	11.6	44.0	3.4	18.3	100
1972	5,256.9	2,674.1	9,881.1	785.6	4,084.8	22,682
%	23.2	11.8	43.5	3.5	18.0	100
1973	5,000.5	2,660.0	10,451.9	745.3	3,737.7	22,595
%	22.1	11.8	46.3	3.3	16.5	100
1974	4,898.0	2,614.2	10,022.2	683.7	3,511.5	21,734
%	22.5	12.0	46.1	3.2	16.2	100
1975	5,024.1	2,556.2	8,570.6	594.6	3,231.6	19,977
%	25.2	12.8	42.9	3.0	16.2	100
1976	5,148.7	2,716.8	8,803.6	559.0	3,153.1	20,381
%	25.3	13.3	43.2	2.7	15.5	100
1977	4,914.4	2,546.9	8,685.4	544.2	3,281.9	19,973
%	24.6	12.8	43.5	2.7	16.4	100
1978	4,986.9	2,642.1	8,604.2	541.2	3,293.2	20,068
%	24.9	13.2	42.9	2.7	16.4	100
1979	5,052.4	2,834.0	8,584.0	612.7	3,604.4	20,687
%	24.4	13.7	41.5	3.0	17.4	100
1980	4,855.4	2,665.7	8,409.3	649.9	3,803.6	20,384
%	23.8	13.1	41.2	3.2	18.7	100
1981	4,652.1	2,577.5	8,280.5	659.6	3,758.8	19,927
%	23.4	13.0	41.5	3.3	18.9	100
1982	4,750.7	2,670.8	7,144.8	613.9	3,335.0	18,515
%	25.7	14.4	38.6	3.3	18.0	100
1983	4,514.5	2,504.6	6,831.3	505.2	2,992.1	17,348
%	26.0	14.4	39.4	2.9	17.3	100
1984	4685.4	2593.9	7464.2	544.7	3215.0	18,503
%	25.3	14.0	40.3	2.9	17.4	100
1985	4566.1	2503.3	7096.0	520.7	3156.9	17,843
%	25.6	14.0	39.8	2.9	17.7	100
1986	4432.3	2382.6	6713.9	501.1	26788.5	16,718
%	26.5	14.3	40.2	3.0	16.1	100
1987	n/a	n/a	n/a	n/a	n/a	17,190

Sources: EIA State Energy Data Report, 1960-1986, p. 21-26
EIA Natural Gas Monthly, April 1988, p. 19

Chapter II-1-A

Present Situation

Industry Structure

The natural gas industry has been undergoing rapid and profound changes. New regulatory approaches are significantly restructuring the traditional functions of and relationships among producers, pipelines, distributors, and end-users. The roles of federal and state regulators are also being redefined. A more dynamic and complex gas industry is emerging, which is characterized by decreased regulation and increased competition. These new relationships are now in place and are functioning in parallel with the traditional roles.

The traditional gas industry has separate providers of three essential service components: Producers own gas wells and sell under long-term contracts to interstate pipeline companies, who in turn sell to local distribution companies (LDCs). Sometimes the pipeline company selling to the LDC is not directly connected to it. In those cases, a pipeline that is directly connected transports the gas for a fee. The end-user, i.e., residential, commercial, industrial, or electric utility, purchases only from the LDC. Federal regulations controlled wellhead prices until January 1, 1985, when most wells were deregulated. Pipeline rates are federally regulated while the states set LDC rates. Now, however, alternative arrangements have emerged as a result of various deregulating events of the last 10 years.

LDC Transportation Gas: LDCs now purchase significant portions of their natural gas directly from producers or energy brokers. In 1987, the amount ranged from 26 percent for New Jersey Natural Gas to 52 percent for South Jersey Gas (see Tables III-1-A-7 and II-1-A-11). This gas is bought in the spot market, is interruptible, and usually costs less than the firm gas supplies purchased from interstate pipeline companies under long-term contracts.

End-user transportation gas: The larger end-users now purchase some of their natural gas directly from producers, usually via a new entity in the business--the marketer or broker. This energy marketer can be either an independent or a wholly-owned subsidiary of a pipeline company or of an LDC. The marketer matches end-user requirements with available gas at the wellhead and with pipelines having excess capacity. Under this new arrangement, neither the LDC nor the pipeline owns the gas it carries, and each charges a fee to recover transportation costs. This category represents less than 1 percent of Elizabethtown Gas and Public Service Electric and Gas sales (see Table II-1-A-4).

Interstate Pipelines Serving New Jersey LDCs

Five interstate pipeline companies connect directly to one or more of New Jersey's LDCs to provide delivery of natural gas. They are: Algonquin Gas Transmission Corp. (AGT), Columbia Gas Transmission Corp. (Columbia), Tennessee Gas Pipeline Co. (Tennessee), Texas Eastern Transmission Corp. (Texas Eastern) and Transcontinental Gas Pipe Line Corp. (Transco).

Tennessee and Transco own or contract directly with producers for nearly all their gas supplies, whereas Texas Eastern and Columbia depend mostly on such sources but also buy gas from other pipelines. AGT depends mostly on purchases from other pipeline companies.

Local Distribution Companies

New Jersey's natural gas consumers are supplied by four LDCs--Elizabethtown Gas Company (E'town), New Jersey Natural Gas Company (NJN), Public Service Electric and Gas Company (PSE&G), and South Jersey Gas Company (SJ). Figure II-1-A-1 defines the franchise territories and Tables II-1-A-3 and II-1-A-4 compare selected statistics for each LDC.

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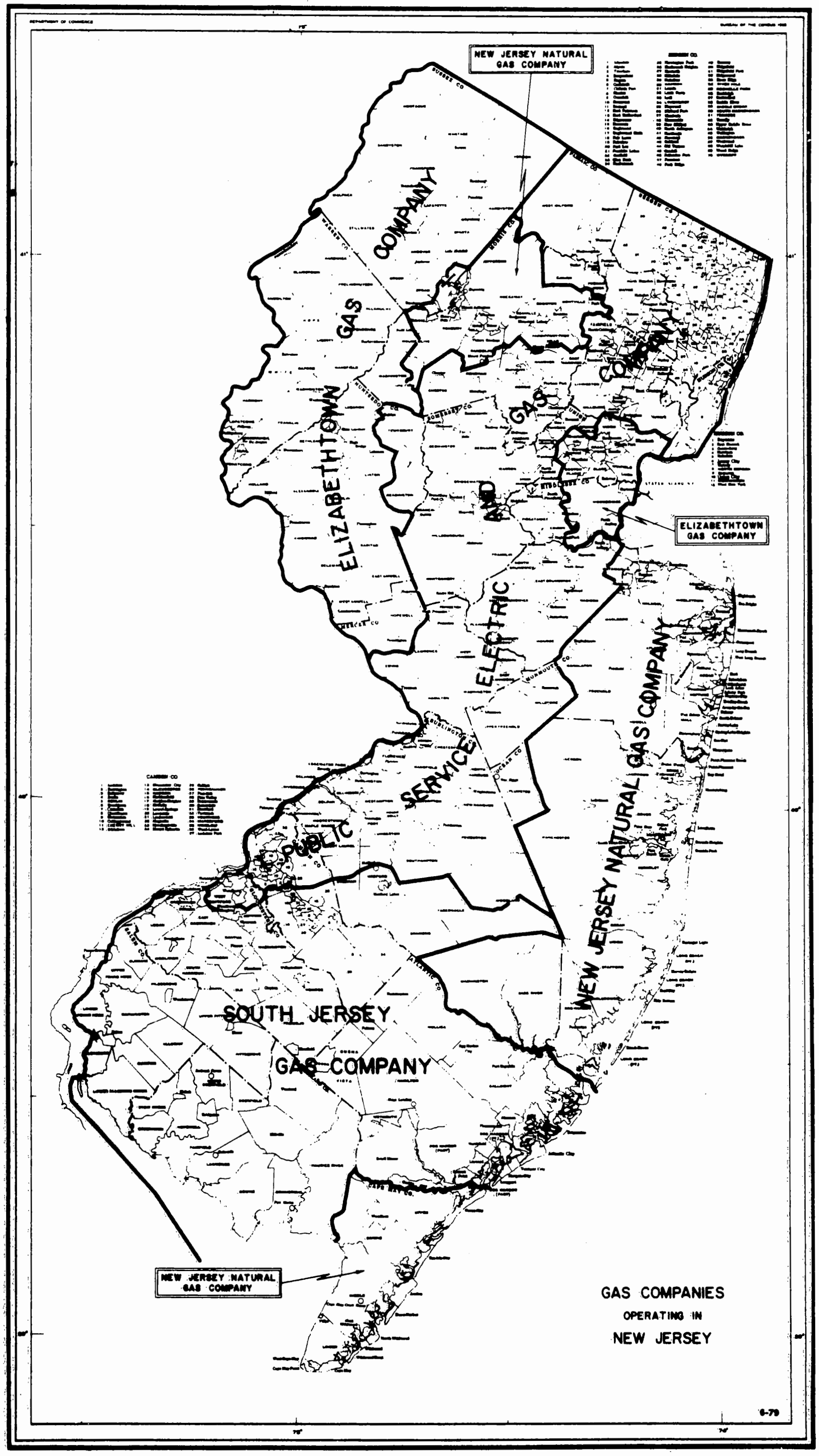
Fig. II-1-A-1

MAP: Gas Companies Operating in New Jersey



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The four LDCs currently receive about half of their natural gas supplies by direct purchase from Transco and Texas Eastern. The balance of direct purchase gas comes from AGT, Columbia, and Tennessee. Gas purchased from other suppliers is transported for a fee via one of these five companies in order to be delivered. Supplies of natural gas that are in excess of the quantity required by those customers who use gas as their sole source of energy (firm customers) make possible sales of gas to commercial and industrial customers whose equipment is capable of using natural gas or other energy sources, such as fuel oil and propane (interruptible customers).

Table II-1-A-3

Local Distribution Companies
Demographic Profiles

LDC	Area Served	Square Miles Served	Munici-palities	Number of Customers 1987	Number of Res Heating Customers 1987
E'town	Northwest plus Union Cty	2300	74	213,000	125,000
NJN	Southeast plus Morris Cty	1436	104	268,000	n/a
PSE&G	Central through Northeast	1150	74	1,398,000	786,000
SJ	Southern	2500	112	185,000	140,000

n/a: not available
Source: LDC 10K annual reports to Securities & Exchange Commission

Table II-1-A-4

Local Distribution Companies
Natural Gas Sales Profiles
(MMcf)

LDC	Year	Industrial Sector Firm	Industrial Sector Interruptible	Total Sales	End-user Transportation	End-user Transport vs. Total Sales (%)
E'town	1986	3,774	1,367	31,990	12	0.04
E'town	1987	3,433	1,317	39,327	12	0.03
NJN	1986	1,005	4,292	45,682	n/a	--
NJN	1987	910	5,172	54,869	n/a	--
PSE&G	1986	16,965	24,627	241,214	n/a	--
PSE&G	1987	14,527	23,249	268,629	9	0.003
SJ	1986	6,433	5,544	38,547	n/a	--
SJ	1987	6,534	4,491	41,774	n/a	--

Sources: N.J. Monthly Profile, December 1987; N.J. Energy Data Base

Elizabethtown Gas Company:[3] E'town serves a franchised territory consisting of 74 municipalities in central and northwestern New Jersey, with an estimated population of 900,000. These areas include a concentration of diversified industry, such as chemicals and allied products, fabricated metal products, assembly plants, and primary metal industries.

To ensure sufficient quantities of gas during the winter months, E'town supplements its supply of pipeline gas purchased pursuant to long-term contracts, with storage gas transported during nonpeak periods for use during peak periods.

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Chapter II-1-A

Table II-1-A-5

Elizabethtown Gas Company
Gas Purchases: Contract vs. Transportation and
Percent of Total Purchases

	CONTRACT FIRM Pipeline Companies														TRANSPORTATION INTERRUPTIBLE Direct Purchase		
	Transco		Texas Eastern		Tennessee		Columbia		Consolidated Gas		Natural Fuel Gas		Union Drilling		Brokers or Producers		Total Purchases
Year	10^6 MMBtu*	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu
1979	18.6	67.7	5.2	15.3	--	--	--	--	--	--	--	--	--	--	--	--	--
1980	24.0	65.4	5.9	16.0	--	--	--	--	---	--	--	--	--	--	--	--	--
1981	27.5	69.7	6.1	15.6	--	--	--	--	--	--	--	--	--	--	--	--	--
1982	25.6	62.0	5.4	13.2	--	--	--	--	--	--	--	--	--	--	--	--	--
1983	29.8	64.4	8.5	18.4	--	--	--	--	--	--	--	--	--	--	--	--	--
1984	21.6	64.5	6.9	20.6	--	--	--	--	--	--	--	--	--	--	--	--	--
1985	18.9	48.3	6.9	17.6	0.3	0.8	1.5	3.8	0.8	2.0	1.2	3.1	--	--	9.5	24.3	39.1
1986	8.8	28.2	9.0	28.7	0.3	1.0	1.1	3.5	0.4	1.3	2.4	7.7	--	--	9.2	29.5	31.2
1987	8.6	21.5	8.6	21.5	0.4	1.0	0.7	1.6	0.3	0.7	3.9	9.7	0.4	1.0	17.1	42.7	40.0

* Trillion Btu or Billion Cf
Source: E'town Annual Reports to the N.J. Board of Public Utilities, p. 327

Table II-1-A-6

Elizabethtown Gas Company
Natural Gas Consumption (Trillion Btu)

Year	Residential	Commercial	Industrial	Electric Utility	Other	Total
1971	13.6	4.8	9.6	6.7	0.0	34.7
%	39.2	13.8	27.7	19.3	0.0	
1972	13.8	4.7	9.2	5.7	0.0	33.4
%	41.3	14.1	27.5	17.1	0.0	
1973	12.9	4.4	9.1	4.3	0.0	30.7
%	42.0	14.3	29.6	14.0	0.0	
1974	12.9	4.2	9.5	4.5	0.0	31.1
%	41.5	13.5	30.5	14.5	0.0	
1975	12.5	4.2	6.6	0.4	0.0	23.7
%	52.7	17.7	27.8	1.7	0.0	
1976	13.5	4.7	7.3	0.6	0.0	26.1
%	51.7	18.0	28.0	2.3	0.0	
1977	13.0	4.4	7.3	1.0	0.0	25.7
%	50.6	17.1	28.4	3.9	0.0	
1978	13.8	4.8	7.6	0.0	0.0	26.2
%	52.7	18.3	29.0	0.0	0.0	
1979	13.3	4.8	8.7	4.5	0.0	31.3
%	42.5	15.3	27.8	14.4	0.0	
1980	13.9	5.6	11.1	5.3	0.0	35.9
%	38.7	15.6	30.9	14.8	0.0	
1981	14.3	6.3	13.3	7.5	0.0	41.4
%	34.5	15.2	32.1	18.1	0.0	
1982	14.7	6.7	11.8	7.9	0.0	41.1
%	35.8	16.3	28.7	19.2	0.0	
1983	14.2	6.7	13.0	11.1	0.0	45.0
%	31.5	14.9	28.9	24.7	0.0	
1984	15.4	7.3	10.9	6.5	0.0	40.1
%	38.4	18.2	27.2	16.2	0.0	
1985	14.9	7.5	8.5	6.2	0.0	37.1
%	40.2	20.2	22.9	16.7	0.0	
1986	16.4	7.8	5.2	2.3	0.0	31.7
%	51.7	24.6	16.4	7.3	0.0	
1987	20.3	8.2	5.0	9.3	0.0	42.8
%	47.4	19.1	11.7	21.7	0.0	

Source: N.J Energy Data System

New Jersey Natural Gas Company:[4] NJN serves more than 274,000 customers in Monmouth and Ocean counties and parts of Morris and Middlesex counties. Its service territory has an estimated population of 1.2 million and is growing rapidly. This growth has resulted in record customer additions in each of the last three years. NJN projects 83,000 new customers over the next five years.

NJN's four suppliers of natural gas are Texas Eastern, AGT, Consolidated, and Boundary. The gas is delivered via the interstate pipelines of Texas Eastern, AGT, Tennessee, and Transco.

To meet the increased demand on the coldest days of the year, NJN purchases storage service from its pipeline suppliers and maintains liquefied natural gas (LNG) and liquefied propane gas (LPG) storage facilities. NJN began receiving deliveries from Keystone, a new storage facility, on November 1, 1986. Under this service, NJN injects its own gas supplies into storage during the summer months and receives deliveries of these supplies during the winter heating season. NJN has also completed negotiations for new storage capacity in southern New York State with start-up on April 1, 1989.

Table II-1-A-7

New Jersey Natural Gas Company
Gas Purchases: Contract vs. Transportation and
Percent of Total Purchases

	CONTRACT FIRM Pipeline Companies				CONTRACT FIRM Canadian Gas		TRANSPORTATION FIRM Director Purchase		TRANSPORTATION INTERRUPTIBLE Direct Purchase		
	Texas Eastern		Algonquin		Boundary		Brokers or Producers		Brokers or Producers		TOTAL PURCHASES
Year	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu
1979	32.6	86.2	--	--	--	--	--	--	--	--	--
1980	34.8	74.0	--	--	--	--	--	--	--	--	--
1981	33.7	70.7	--	--	--	--	--	--	--	--	--
1982	36.9	72.2	--	--	--	--	--	--	--	--	--
1983	41.4	79.3	--	--	--	--	--	--	--	--	--
1984	43.6	82.3	--	--	--	--	--	--	--	--	--
1985	37.6	76.0	0.9	1.8	3.2	6.5	3.7	7.5	4.1	8.3	49.5
1986	34.5	74.8	0.7	1.5	2.7	5.9	2.2	4.8	6.0	13.0	46.1
1987	38.8	66.7	0.7	1.2	3.7	6.4	4.5	7.7	10.5	18.0	58.2

* Trillion Btu or Billion Cf
Source: NJN Annual Reports to the N.J. Board of Public Utilities, p. 327

Table II-1-A-8

New Jersey Natural Gas Company
Natural Gas Consumption (Trillion Btu)

Year	Residential	Commercial	Industrial	Electric Utility	Other	Total
1971	23.7	5.3	5.7	4.1	0.0	38.8
%	61.1	13.6	14.7	10.6	0.0	
1972	25.0	5.3	5.7	1.8	0.0	37.8
%	66.1	14.0	15.1	4.8	0.0	
1973	23.7	5.1	4.7	1.0	0.0	34.5
%	68.7	14.8	13.6	2.9	0.0	
1974	22.3	4.6	4.0	0.7	0.0	31.6
%	70.6	14.6	12.6	2.2	0.0	
1975	22.0	4.6	2.7	0.4	0.0	29.7
%	74.1	15.5	9.1	1.3	0.	
1976	23.6	4.9	3.6	0.0	0.0	32.1
%	73.5	15.3	11.2	0.0	0.0	
1977	22.6	4.6	4.4	0.6	0.0	32.2
%	70.2	14.3	13.7	1.9	0.0	
1978	23.3	5.0	4.6	0.0	0.0	32.9
%	70.8	15.2	14.0	0.0	0.0	
1979	22.4	4.9	7.8	2.1	0.0	37.2
%	60.2	13.2	21.0	5.6	0.0	
1980	23.1	5.3	7.8	7.9	0.0	44.1
%	52.4	12.0	17.7	17.9	0.0	
1981	25.0	5.7	7.2	8.7	0.0	46.6
%	53.6	12.2	15.5	18.7	0.0	
1982	25.5	6.0	7.0	11.4	0.0	49.9
%	51.1	12.0	14.0	22.8	0.0	
1983	23.8	5.8	6.8	13.9	0.0	50.3
%	47.3	11.5	13.5	27.6	0.0	
1984	25.3	6.0	8.0	11.7	0.0	51.0
%	49.7	11.8	15.7	22.9	0.0	
1985	24.9	6.0	6.5	11.0	0.0	48.4
%	51.4	12.4	13.4	22.7	0.0	
1986	28.0	6.7	5.4	5.7	0.0	45.8
%	61.1	14.6	11.8	12.4	0.0	
1987	30.4	7.6	6.3	11.1	0.0	55.4
%	54.9	13.7	11.4	20.0	0.0	

Source: N. J. Energy Data System

Public Service Electric & Gas Company:[5] PSE&G serves a gas territory from central to northeastern New Jersey consisting of 74 municipalities with an approximate population of 1.4 million. (The gas territory is not identical to the electric territory.) The company supplies its customers principally with natural gas, which is supplemented with purchased refinery gas and synthetic natural gas. On the coldest days approximately 16 percent of the gas available to PSE&G's firm customers comes from its supplemental sources.

In 1987 the natural gas was obtained principally from five pipeline suppliers (Transco, Texas Eastern, Tennessee Gas Pipeline Company, National Fuel Gas Supply Corporation, and Consolidated Gas Transmission Corporation) and from one producer (Energy Development Corporation, a wholly-owned subsidiary of Enterprise, which is PSE&G's parent company). In addition, PSE&G delivered spot purchase gas to customers under transportation agreements accounting for 4.2 percent of its annual gas sendout. In warm months, PSE&G stores natural gas under storage contracts with its principal suppliers, to be withdrawn on selected winter days. Underground storage capacity currently approximates a 30-day supply. PSE&G purchased low-cost gas in 1987, amounting to 38 percent of total gas purchased, to displace more costly gas supplies available under long-term pipeline contracts.

On January 1, 1985, the price of a significant portion of the gas under contract to PSE&G's pipeline suppliers was decontrolled. Decontrol has not had a major adverse effect on PSE&G's cost of pipeline natural gas as of year-end 1987. Two of PSE&G's pipeline suppliers, Transco and Tennessee, are expected to incur significant costs to resolve past take-or-pay claims in contracts with producers and to reduce or mitigate future purchase requirements at uneconomic prices. Both of these pipelines have filed with FERC for authorization to charge a portion of these costs to their customers, including PSE&G, in accordance with FERC Order 500 issued on August 7, 1987. The extent of PSE&G's potential exposure to such costs by way of direct billed charges or surcharges in future pipeline rates cannot be quantified at this time.

The regulatory framework established by FERC Orders 436 and 500 has increased competition in the gas market by encouraging pipelines to act as nondiscriminatory transporters of gas. These regulations enabled PSE&G to transport substantial quantities of low-cost spot gas by converting a portion of its pipeline contract volumes to firm transportation, while obtaining gas from producers and marketers.

PSE&G met all of the demands of its firm customers during the 1986-87 and 1987-88 winter seasons. During the 1987-88 heating season through February 29, 1988, PSE&G interrupted service to interruptible customers for 14 days. During the 1986-87 heating season, service to such customers was interrupted for five days. These interruptions were due to lack of capacity on interstate pipelines, not by constraints within PSE&G's distribution network.

Table II-A-1-9

Public Service Electric & Gas Company
Gas Purchases: Contract vs. Transportation and
Percent of Total Purchases

	CONTRACT FIRM Pipeline Companies										CONTRACT FIRM Broker		TRANSPORTATION INTERRUPTIBLE Direct Purchase		
	Transco		Texas Eastern		Tennessee		Consolidated		National Fuel Gas		Energy Development Corp		Brokers or Producers		Total Purchases
Year	10^6 MMBtu*	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu	%.	10^6 MMBtu
1979	115.3	54.3	66.1	31.3	--	--	--	--	--	--	--	--	--	--	--
1980	153.6	58.2	71.8	27.2	--	--	--	--	---	--	--	--	--	--	--
1981	152.4	57.3	72.7	27.3	--	--	--	--	--	--	--	--	--	--	--
1982	147.5	57.8	71.9	28.2	--	--	--	--	--	--	--	--	--	--	--
1983	142.4	50.9	103.9	37.2	--	--	--	--	--	--	--	--	--	--	--
1984	104.1	35.5	122.1	41.7	--	--	--	--	--	--	--	--	--	--	--
1985	63.7	26.0	67.9	27.8	9.9	4.0	5.6	2.3	--	--	23.3	9.5	71.6	29.3	244.6
1986	50.7	21.4	62.9	26.6	8.1	3.4	1.1	0.5	--	--	19.2	8.1	93.0	39.3	236.9
1987	66.0	24.6	68.6	25.6	9.6	3.6	1.8	0.7	4.5	1.7	17.9	6.7	99.8	37.2	268.2

* Trillion Btu or Billion Cf
Source: PSE&G Annual Reports to the N.J. Board of Public Utilities, p. G-327, G-327a

Table II-1-A-10

Public Service Electric & Gas Company
Natural Gas Consumption (Trillion Btu)

Year	Residential	Commercial	Industrial	Electric Utility	Other	Total
1971	101.5	45.4	48.7	23.9	0.3	219.8
%	46.2	20.6	22.2	10.9	0.1	
1972	104.3	48.5	49.4	15.6	0.5	218.3
%	47.8	22.2	22.6	7.1	0.2	
1973	97.9	45.9	45.5	17.7	3.9	210.9
%	46.4	21.8	21.6	8.4	1.8	
1974	97.8	45.8	41.3	8.9	0.4	194.2
%	50.4	23.6	21.3	4.6	0.2	
1975	95.9	44.3	34.2	8.1	0.4	182.9
%	52.4	24.2	18.7	4.4	0.2	
1976	102.8	46.1	31.1	9.8	0.2	190.0
%	54.1	24.3	16.4	5.1	0.1	
1977	98.8	43.7	31.9	5.8	0.2	180.4
%	54.8	24.2	17.7	3.2	0.1	
1978	101.4	44.8	30.2	0.8	0.3	177.5
%	57.1	25.2	17.0	0.5	0.2	
1979	98.5	46.3	41.0	22.1	0.3	208.2
%	47.3	22.2	19.7	10.6	0.1	
1980	100.3	49.7	44.3	66.0	0.3	260.6
%	38.5	19.1	17.0	25.3	0.1	
1981	100.6	55.7	51.3	62.6	0.3	270.5
%	37.2	20.6	19.0	23.1	0.1	
1982	100.8	58.8	47.3	45.8	0.2	252.9
%	39.9	23.3	18.7	18.1	0.1	
1983	96.6	58.1	45.8	73.3	0.2	274.0
%	35.2	21.2	16.7	26.8	0.1	
1984	105.1	64.5	49.9	71.2	0.4	291.1
%	36.1	22.2	17.1	24.5	0.1	
1985	99.5	61.8	46.6	39.2	0.0	247.1
%	40.3	25.0	18.9	15.9	0.0	
1986	108.6	65.5	41.7	24.8	0.5	241.1
%	45.0	27.2	17.3	10.3	0.2	
1987	110.6	67.6	37.8	51.7	1.7	269.4
%	41.0	25.1	14.0	19.2	0.6	

Source: N. J. Energy Data Base

South Jersey Gas Company:[6] SJ, a subsidiary of South Jersey Industries, serves a territory that comprises 112 municipalities in southern New Jersey with an approximate permanent population of 1,048,800. The franchise area to the east is centered on Atlantic City and the neighboring resort communities in Atlantic and Cape May counties, which experience large population increases in the summer months.

South Jersey Energy Company, a wholly-owned subsidiary of South Jersey Industries, provides services for the acquisition and transportation of natural gas for large volume users.

SJ's service territory lies within unregulated parts of the Pinelands region, a largely undeveloped area in the heart of southern New Jersey. Future construction is expected to be limited by statute and by a master plan adopted by the New Jersey Pinelands Commission. However, in terms of potential growth, these limitations do not affect significant portions of SJ's service area.

SJ has natural gas purchase agreements with two interstate pipeline companies, Transco and Columbia. The Transco gas purchase agreement expires in 1990. This agreement can be extended for three additional five-year periods, subject to Transco's having an adequate supply of gas and approval by FERC of a rate acceptable to Transco at the initiation of each extension. SJ began taking deliveries of Columbia-supplied gas in January 1988 under a purchase agreement that expires in 2007. SJ utilizes underground gas storage services to supplement its winter season gas supplies.

In 1987, SJ purchased approximately 23,254 Mcf (23,905 MMBtu) of gas from its affiliate, South Jersey Exploration Company. This gas was produced in Texas and transported to New Jersey by Transco. In addition, SJ purchased 22,440,970 Mcf of natural gas directly from producers and gas marketers for transportation to its service territory. This gas represented 52 percent of its total gas supply in 1987. Usage by interruptible customers amounted to approximately 27 percent of total volume of gas sold.

Table II-A-1-11

South Jersey Electric & Gas Company
Gas Purchases: Contract vs. Transportation
and
Percent of Total Purchases

	CONTRACT FIRM Pipeline Companies		CONTRACT FIRM Broker or Producer		TRANSPORTATION INTERRUPTIBLE Direct Purchase		
	Transco		South Jersey Exploration		Brokers or Producers		Total Purchases
Year	10^6 MMBtu*	%	10^6 MMBtu	%	10^6 MMBtu	%	10^6 MMBtu
1979	34.2	88.0	--	--	--	--	--
1980	39.8	90.2	--	--	--	--	--
1981	40.0	97.2	--	--	--	--	--
1982	38.5	98.5	--	--	--	--	--
1983	38.9	98.9	--	--	--	--	--
1984	37.7	98.4	--	--	--	--	--
1985	26.5	75.9	0.1	0.3	8.3	23.8	34.9
1986	22.1	55.5	0.1	0.3	17.6	44.1	39.9
1987	20.4	48.1	0.08	0.2	22.1	52.1	42.4

* Trillion Btu or Billion Cf

Source: SJ Annual Reports to the N.J. Board of Public Utilities, p. 327

D R A F T

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Table II-1-A-12

South Jersey Gas Company
Natural Gas Consumption (Trillion Btu)

Year	Residential	Commercial	Industrial	Electric Utility	Other	Total
1971	10.2	5.9	21.5	2.9	2.5	43.0
%	23.7	13.7	50.0	6.7	5.8	
1972	10.7	6.4	18.1	3.0	2.6	40.8
%	26.2	15.7	44.4	7.3	6.4	
1973	12.0	6.8	15.9	3.2	2.4	40.3
%	29.8	16.9	39.4	7.9	6.0	
1974	11.3	6.6	13.1	1.4	2.3	34.7
%	32.6	19.0	37.8	4.0	6.6	
1975	11.2	5.1	9.9	0.0	2.2	28.4
%	39.4	18.0	34.9	0.0	7.7	
1976	11.6	5.5	11.0	0.0	2.4	30.5
%	38.0	18.0	36.1	0.0	7.9	
1977	11.0	5.2	9.8	0.0	2.2	28.2
%	39.0	18.4	34.8	0.0	7.8	
1978	11.5	5.6	11.0	0.0	2.3	30.4
%	37.8	18.4	36.2	0.0	7.6	
1979	11.0	7.4	15.1	3.0	2.5	39.0
%	28.2	19.0	38.7	7.7	6.4	
1980	11.5	8.4	15.7	5.4	5.5	46.5
%	24.7	18.1	33.8	11.6	11.8	
1981	11.8	9.0	15.6	3.1	2.5	42.0
%	28.1	21.4	37.1	7.4	5.9	
1982	11.4	9.0	14.8	2.4	2.5	40.1
%	28.4	22.4	36.9	6.0	6.2	
1983	11.5	9.2	14.7	2.0	1.8	39.2
%	29.3	23.5	37.5	5.1	4.6	
1984	13.6	10.1	13.0	1.4	0.0	38.1
%	35.7	26.5	34.1	3.6	0.0	
1985	13.3	9.0	11.4	1.5	0.0	35.2
%	37.8	25.6	32.4	4.3	0.0	
1986	15.0	10.3	12.0	1.7	0.0	39.0
%	38.5	26.4	30.8	4.4	0.0	
1987	15.7	11.8	11.0	3.5	0.0	42.0
%	37.4	28.1	26.2	8.3	0.0	

Source: N. J. Energy Data System

Chapter II-1-A

Price and Availability

In 1986, New Jersey's residential gas market share was 47 percent of total consumption, whereas the U.S. residential market was only 26 percent (see Tables II-1-A-1 and II-1-A-2). In contrast, the industrial sector represented the largest market for gas in the United States with a 40 percent share, while it accounted for a much smaller share--18 percent--in New Jersey. These differences result primarily from differences in price. In 1985, the delivered price of natural gas in New Jersey ranged from 16 percent to 34 percent higher than the national average in all consuming sectors (see Table II-1-A-13). This price difference is due mainly to high transmission and distribution costs.

Because New Jersey obtains its gas by way of interstate pipelines and 95 percent of the supply for these companies comes from the Gulf Coast, New Jersey is literally at the end of the pipeline and pays higher transportation costs than most states.

Since 1978 when more natural gas became available to the pipelines at higher prices, the average domestic wellhead price of natural gas rose dramatically until 1983. It dropped significantly in 1986 and 1987. Retail prices in New Jersey followed a similar pattern (see Table II-1-A-14).

While the retail price of fuel oil has declined in response to decreased demand, the relative price of natural gas has increased (Table II-1-A-15). In New Jersey's industrial sector, the price per MMBtu of natural gas in 1983 and 1984 was nearly the same as that of residual fuel oil. This price trend can result in fuel switching by industrial users from natural gas to residual fuel oil. The extent to which fuel switching in the industrial sector will occur depends in part upon the number of industrial boilers with dual-fuel capability, in part upon the economic feasibility of the conversion of existing boilers, and in part upon the availability and price of the natural gas.

Table II-1-A-13

Comparison of Natural Gas Prices
($/MMBtu)

Sector	New Jersey	United States	Percent Higher N.J.
	1981	1981	
Residential	5.68	4.18	35.9
Commercial	5.30	3.90	35.9
Industrial	4.57	3.05	49.8
Electric Utility	4.00	2.82	41.8
	1982	1982	
Residential	6.82	5.04	35.3
Commercial	6.17	4.69	31.6
Industrial	5.08	3.77	34.7
Electric Utility	4.31	3.39	27.1
	1983	1983	
Residential	7.21	5.88	22.6
Commercial	6.49	5.42	19.7
Industrial	5.28	4.06	30.0
Electric Utility	4.07	3.46	17.6
	1984	1984	
Residential	7.12	5.95	19.7
Commercial	6.37	5.40	18.0
Industrial	5.49	4.09	34.2
Electric Utility	4.39	3.57	23.0
	1985	1985	
Residential	7.30	5.92	23.3
Commercial	6.46	5.32	21.4
Industrial	5.34	3.99	33.8
Electric Utility	4.02	3.47	15.8

Source: EIA Natural Gas Annual, 1986, Table 46

Table II-1-A-14

Domestic Wellhead Price vs.
New Jersey Consumer Price (All Sector Average)
($/MMBtu)

Year	Wellhead Price[1]	New Jersey Consumer Price[2]
1973	$ 0.22	$ 1.51
1974	0.30	1.80
1975	0.45	2.32
1976	0.58	2.88
1977	0.79	3.15
1978	0.91	3.53
1979	1.18	3.77
1980	1.59	4.36
1981	1.98	5.08
1982	2.46	5.91
1983	2.59	6.08
1984	2.66	6.01
1985	2.51	6.17
1986	1.94	5.89
1987	1.71	5.07

Sources: 1. EIA Monthly Energy Review, December 1987, p. 113
2. N.J. Energy Profile 1987, Data Supplement, p. 6

Table II-1-A-15

Natural Gas vs. Fuel Oil Retail Prices ($/MMBtu)

	Residential Heating Sector			Industrial Sector		
Year	Natural Gas	Home Heating Oil	Natural Gas As a % of Heating Oil	(Firm) Natural Gas	Residual Oil	Natural Gas As a % of Residual Oil
1976	2.94	2.93	100.5	2.32	2.45	94.3
1977	3.19	3.40	94.1	2.63	2.64	99.9
1978	3.53	3.59	98.5	2.86	2.58	110.9
1979	3.88	5.25	74.0	3.16	3.85	82.2
1980	4.55	7.12	64.0	3.73	5.44	68.6
1981	5.55	8.86	63.0	4.76	6.20	76.7
1982	6.60	8.53	77.0	5.61	5.89	95.2
1983	7.18	7.78	92.0	5.99	5.29	113.2
1984	6.81	7.89	86.0	5.82	5.54	105.0
1985	7.06	7.60	93.0	5.79	5.24	110.5
1986	6.84	6.10	112.0	5.51	3.58	153.9
1987	6.20	5.97	104.0	4.87	3.62	134.5

Source: N.J. Energy Profile Data Supplement 1987, p. 7, 9, 31

Regulators: Trends Toward Deregulation

Federal Energy Regulatory Commission (FERC)

In 1938 Congress passed the Natural Gas Act (NGA), which regulates wholesale transactions and transportation of natural gas in interstate commerce. This law is the basis for the FERC to regulate interstate pipelines by authorizing construction and operation of their facilities and setting of rates for transportation and sale of gas. Therefore, any interstate pipeline desiring to build facilities, transport natural gas, or sell gas for resale must first seek and obtain prior approval from FERC.[7]

Various regulatory actions have spurred the development of a more market-oriented natural gas industry. The most significant of these have been FERC Order 436 (later replaced by Order 500) and Order 451.

The collective thrust and policy goals of these Orders are clear--natural gas will increasingly be treated as a commodity, and competition will increase among natural gas suppliers and between natural gas and alternative fuels. A much wider range of natural gas supply and transportation services will become available to meet customer needs.

The phased decontrol of new natural gas prices has been implemented in accordance with the Natural Gas Policy Act of 1978 (NGPA). Under the NGPA most new gas supplies (generally those produced from wells drilled after April 20, 1977) were decontrolled on January 1, 1985. In spite of the fears of some analysts, gas prices did not increase following decontrol, but have, in fact, declined. Refer to Table II-1-A-11. While market forces have proven to be the dominant factor influencing gas prices, contract pricing provisions of long-term supplies have slowed adjustments to market conditions.[8]

FERC Order 436

On October 9, 1985 FERC issued Order 436 covering take-or-pay buyouts, transportation policy, and expedited certification of new facilities.

Take-Or-Pay Policy: The take-or-pay provision of long-term contracts between pipelines and producers requires that pipelines pay for contracted volumes of gas, even if they have no need for that gas. Recovery of lump sum payments made to producers to modify existing take-or-pay obligations will be considered by FERC in pipeline company rate cases.

Transportation Policy: A pipeline company can provide self-implementing (that is, without prior FERC approval) transportation service only if it does so on a nondiscriminatory basis for all shippers, and agrees to allow all of its existing firm sales customers either to reduce their purchase obligations by up to 25 percent per year or to convert that amount to transportation service.

Transportation rate guidelines require volumetric rates (a flat charge per unit transported) that reflect variations in cost due to distance and season of use.

FERC's policy is to allocate variable pipeline transportation capacity on a first-come, first-served basis. However, priority for firm transportation is effectively given to existing customers via conversion rights and remains unavailable for new customers. New customers may also find it difficult to access interruptible transportation. FERC must decide what restrictions on open access capacity are acceptable.

Optional Expedited Certificates: FERC will give expedited treatment to proposals for pipeline facilities to provide new services if the sponsor is willing to accept the full risk of the project (i.e., the cost of the project cannot be shifted to nonparticipating customers at any time). If the proposal is for providing transportation service, the applicant must agree to the open transportation policy. Where a bypass situation is involved, parties adversely affected have a right to challenge the application but carry the burden of proof.

The pipeline companies saw Order 436 as pressuring them to relinquish their merchant function and become only transporters, effectively reducing their ability to plan and control how their systems are used.

On June 23, 1987, the DC Circuit Court of Appeals issued its decision on an appeal of Order 436. The court vacated the order, indicating that the various parts of Order 436 are interdependent and that FERC did not adequately consider the effect of contract reduction/conversions on the ability of pipelines to recover take-or-pay obligations. The court upheld specific aspects of the order, including the open access conditions for transportation, the rate requirements, and the optional expedited certificates. The court found that FERC justified contract conversions to transportation but not contract reductions. The court instructed FERC to reconsider the option of conditioning producer access to nondiscriminatory transportation for a producer providing take-or-pay relief.

FERC Order 500

On August 7, 1987 FERC issued Order 500 as an interim rule, to correct the problems identified by the Court of Appeals when it vacated Order 436. Order 500 readopts the regulations originally formulated by Order 436 and adds the following:

1. Producers must offer to credit gas transported by a pipeline against that pipeline's take-or-pay liability.

2. A pass-through mechanism provides for equitable sharing between pipelines and their customers of the cost of settling already accrued take-or-pay obligations.

3. Principles are adopted on which pipelines may base future gas supply charges.

4. Contract Demand (CD) Adjustments: The objectives of the CD reduction right granted in Order 436 remain valid, but now FERC cannot justify this option on a generic basis. FERC believes that in the short-term the goals it hoped to accomplish with this option may largely be achieved through other means.

FERC Order 451

The NGPA had established 16 categories of old gas with price ceilings ranging from about $0.23/Mcf to $2.57/Mcf. According to the federal Department of Energy (DOE), that pricing system, which was based on contract vintage, distorted price signals in natural gas markets, raised consumer prices above market clearing levels, and inhibited efficient production of least-cost supplies.[9]

On June 6, 1986 FERC issued Order 451, which eliminated old gas price vintaging and replaced it with a single new ceiling price of $2.57 per Mcf for all vintages of old gas. The $2.57 price was effective June 1986 and was subject to an inflation factor adjustment for each month thereafter. Order 451 also provides for a "good faith negotiation process" by which a higher price, up to the new maximum lawful price, may be collected by producers from purchasers under certain eligible contracts for old gas.

Marketing Affiliates

In November, 1986 FERC initiated an inquiry into whether pipeline marketing affiliates have an unfair competitive advantage in acquiring and using the pipeline's transportation services. FERC also established an internal task force and procedure for dealing with complaints of discriminatory and anticompetitive practices by pipelines and their affiliates.

Full implementation of the spirit of the new federal policies, including participation by all major pipeline companies in the open transportation program, will create many new choices and opportunities for LDCs and their customers. Such fundamental changes will complicate LDC purchasing and marketing strategies and state regulatory policies. Planning to meet the needs of a market that can exercise its own supply options will become more difficult.

New Jersey Board of Public Utilities (BPU)

The BPU evaluates the LDCs' operating and capital requirements and recommends a level of revenue that will enable an LDC to provide safe and reliable service. The BPU is also responsible for setting rates and recommending how the additional revenues should be allocated to each class of customer. Participating in and developing positions on gas matters before FERC, reviewing and analyzing future gas costs through the level purchased gas adjustment clauses, and development of conservation programs are also BPU functions.

Environmental Considerations

In January 1989 the U. S. Environmental Protection Agency (USEPA) set a deadline of October 1991 for New Jersey to devise a new strategy for bringing the state into compliance with national air quality standards for ozone.[10]

The combustion of natural gas generally produces far lower emissions of pollution that cause ozone than the combustion of other fossil fuels. In fact, natural gas offers the opportunity to reduce simultaneously emissions of all of the major contributors to ozone formation--nitrogen oxides, reactive hydrocarbons, and carbon monoxide. The two largest sources of hydrocarbon emissions are transportation and industrial processes, which contribute about equal quantities of pollution. Carbon monoxide is the second most pervasive urban air pollutant. Vehicles are the source of over two-thirds of carbon emissions and a substantial amount of nitrogen oxide emissions.[11]

Therefore, reducing the use of gasoline-powered vehicles by switching to alternative fuels, such as methanol or natural gas, can significantly improve air quality (see Chapter IV-4, Energy Efficiency and the Environment).

Sources of Supply and Reserves

The lower 48 states supply about 95 percent of the natural gas consumed in the United States. Canada supplies the remainder. The most prolific United States production area is the Gulf Coast--onshore and offshore Texas and Louisiana. In 1985 these two states produced about 11 trillion cubic feet (Tcf) or 67 percent of total United States marketed production of 16.4 Tcf. A surplus of domestic natural gas production capability first appeared in 1981, grew substantially, and still persists.[12]

Since enactment of the NGPA, Lower 48 proved reserves have declined from 169 Tcf in 1978 to 159 Tcf in 1986. (At current consumption levels we have nine years of reserve gas.) During this period annual marketed gas production averaged 17.4 Tcf, while reserves additions averaged approximately 14.7 Tcf (about an 85 percent replacement level).[13]

In 1986, Canada exported about .75 Tcf to the United States. On November 1, 1986, the Canadian National Energy Board (NEB) deregulated gas and replaced its system of prior approval of specific prices with quarterly monitoring of domestic and export prices. However, the price for exported gas cannot be less than the price charged to Canadians for similar service in the area adjacent to the export point.[14]

Canadian natural gas reserves are estimated at 89.6 Tcf for 1985. Of this amount, 72.9 Tcf is in conventional areas, while the remainder is located in frontier areas. This reserve base is large relative to Canada's domestic consumption of approximately 1.8 Tcf/yr--a 40 year reserve, without the frontier gas.[15]

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Canadian imports offer New Jersey an opportunity both to increase and to diversify its supply of natural gas with several advantages over Gulf Coast supplies. Canada, with little demand in its eastern provinces for the gas, has expressed an interest in exporting large volumes to the Northeast on a long-term basis. The price of the gas will reflect market conditions and will be competitive with alternative fuel sources.

Pipeline Projects for Increasing Supplies to the Northeast

Many gas utilities in the Northeast are experiencing increases in customer growth. At present, the interstate pipelines can barely meet gas demand during peak winter periods, forcing interruptible customers to switch to fuel oil as a direct result of constraints in pipeline capacity. In response to this need, 72 proposals for expanding pipeline capacity were filed with FERC, mostly in FERC's "open season" from July 1987 to January 15, 1988.

On March 17, 1988 FERC issued an order in Docket No. CP87-451-004, which consolidated the 72 applications by grouping together those that composed a single project, thereby identifying 31. The discrete proposals involve projects that no one else has proposed for the same type service to the same customer. One proposal with major significance to New Jersey is the PennEast Sales Project. (PennEast is a partnership of Consolidated Gas Corporation [Con Gas] and Texas Eastern.) This project would serve two New York and three New Jersey LDCs, including E'town, NJN, and PSE&G.

On July 27, 1988, FERC ruled on the PennEast Sales project and found that the three New Jersey LDCs had all shown a need for additional gas supplies in the 1989-1990 winter season. Furthermore, FERC granted certificates to Con Gas and Texas Eastern authorizing sale of gas at Leidy, Pennsylvania, to the three New Jersey gas companies and authorizing firm transportation of the gas by Texas Eastern to interconnections with them. Finally, FERC granted Texas Eastern and Con Gas the authority to perform these services rather than PennEast, in order to unbundle sales and transportation services. This ruling was a major step towards preventing a possible gas shortage in New Jersey in the 1989-90 heating season.

In July 1988 FERC appointed an administrative law judge to conduct hearings among the remaining competing sponsors and reach negotiated settlements. On November 30, 1988, the judge issued a certification of settlement approving construction of three projects: two new pipeline systems from the Canadian border--Iroquois and Champlain--and a 90-mile extension of the ANR pipeline from Muncie, Indiana, to a junction in Lebanon, Ohio, with Texas Eastern and Transco pipelines. These projects will provide additional U.S. and Canadian gas for the needs of New Jersey, New York, and the New England states. TransCanada Pipelines assured the judge that if FERC approves both Champlain and Iroquois, it will build pipelines to both export points. Alberta producers and Canadian brokers have also assured the judge that supplies are ample to meet the requirements of both pipelines' customers. Iroquois expects to be flowing natural gas from Canada sometime between November 1, 1990, and October 31, 1991.

Least Cost Planning Strategies for LDC

Least cost planning is the integration of supply-side and demand-side options into a resource plan that provides adequate and reliable service at least cost to a utility's customers. Sound energy policy for natural gas demands that New Jersey LDCs provide gas service at least cost. A successful plan would conserve energy, create opportunities for customers to reduce their gas bills, maximize the utilities' planning flexibility, and curtail their need for more capital expenditures.

Least cost gas service will balance supply-side planning with demand-side management options. Gas purchasing plans for short-term and long-term service to customers will seek to achieve the lowest cost mix of gas supplies. These purchasing plans may include alternatives such as gas storage, seasonal purchases, and utilizing local peaking supplies (e.g., liquefied natural gas). These supply-side efforts can then be compared to the cost savings achievable from demand-side management efforts. Demand-side measures involve the planning, implementation, and monitoring of utility efforts to influence customer use of gas and produce desired changes in the utility load shape. These measures are generally pursued via conservation, load valley-filling, and load growth.

Traditionally, gas utility supply planning has consisted primarily of matching load requirements with the right kind of gas purchase strategies. An integrated least cost strategy, on the other hand, evaluates alternative ways for meeting these load requirements. The costs of building and financing new gas supply pipelines and distribution and transmission systems are ultimately borne by the utilities' customers. These costs can be reduced and sometimes avoided altogether by reducing demand with conservation and other demand side management measures. Demand-side management and least cost supply planning must therefore aim to reduce the LDCs' revenue requirements by selecting the least expensive gas purchase plans and reducing the need for capital expenditures.

To determine that the policy implemented by the LDC is least cost, planning models (mathematical, heuristic, or otherwise) as well as managerial judgment can be developed that evaluate demand-side and supply-side options simultaneously and indicate which approach minimizes the present value of revenue requirements.

Issues Affecting Supply Planning

The LDC is the third and final link in the delivery of gas to the customer. Industrial customers who need gas to generate electricity and fuel manufacturing processes are able to switch to alternative fuel sources and take advantage of the spot gas market and other sources to meet their energy needs. Residential and commercial customers generally do not have this option.

The LDC must provide sufficient capacity to serve its firm customers while providing a marketing policy (such as an option for interruptible gas sales) that is attractive to large industrial customers. The pricing of LDC gas service is dependent on retaining large customers and on sources that assure long-term firm supplies as well as the ability to deliver gas when needed.

Spot Purchases versus Long Term Supplies: LDCs sometimes purchase gas in the spot market. Spot market gas is gas bought and sold for delivery "on the spot" or soon after purchase. Spot gas in the short run serves as a cheap supply source, but it may not provide adequate supply security. Spot gas supply and cost fluctuate depending on the exigencies of the energy market and, especially, the effect of availability and price of oil. To moderate the impact of the uncertainty of gas supply in the spot market while minimizing the cost of gas, LDCs have signed long-term pipeline supply contracts and made long-term purchases from producers. Other sources of supply have included the exploration for and development of gas reserves and purchases of reserves in place.

Long-term pipeline contracts have been the predominant source of gas for LDCs because of the efficiency, reliability, and deliverability they provide. Long-term contracts also involve lower transaction costs and help reduce an LDC's financial risk. Transaction costs include the costs of negotiating, monitoring, and enforcing contracts. Short-term contracting tends to increase transaction costs by increasing the frequency of these activities. In addition, long-term contracting provides certainty of demand and cash flow, thereby reducing volatility in earnings and, by extension, financial risk.

Today, the benefits of long-term contracting are changing. In the current partially deregulated market, supply security may increasingly be dependent on the willingness of the LDC to pay the market price for gas rather than on the use of long-term supply contracts. Though there is a lag between exploration for gas reserves and delivery to the marketplace, in the short run higher market prices may induce higher rates of production from existing wells and therefore increase supplies. These supplies may also be supplemented by certain end-users who switch to other fuels (to avoid market prices), thus providing another source of increased supplies. Therefore, with market-priced gas, the need to depend on long-term contracting to ensure security of supplies may be reduced.

Determining the Best Mix of Supply Contracts: Wellhead prices are largely deregulated; there are proposals for establishing a gas futures exchange and spot markets for gas. Open access to transportation is becoming more available. The LDC therefore has choices in contracting for gas and, if pipeline capacity is available, can bargain for gas transportation capacity.

Business and regulatory risks are inherent to both short- and long-term gas supply contracting. Sales may fluctuate as a result of demand volatility, competition, and managerial performance. Gas purchased on long-term, fixed-price contracts may not be sold, causing revenue shortfalls. Also, when spot gas prices are low compared to long-term contract prices, a utility risks the loss of customers who are able to bargain in the spot gas market or to switch to alternative fuels. The loss of customers with alternative energy sources exposes a utility to the risk of convincing regulators of the necessity of rate increases for core customers. With spot gas and/or short-term contracting, an LDC will contract only for gas volumes it can sell in the near-term when customer demand and selling price are more predictable.

However, if the utility depends on short-term contracts, it risks having to justify frequent price changes to its customers and regulators. Also, until pipeline capacity becomes abundant and excess capacity is available, long-term supply contracts help the LDCs assure supplies to their core customers. Long-term contracts, therefore, may favor the utility when it seeks rate approval from the BPU.

The LDCs' risks can be reduced if they provide the lowest cost mix of both spot gas and long-term contract gas. The former reduces the business risk of long-term fixed price contracts while the latter provides price stability, which an LDC seeks.

Capacity Contracting:[16] The LDC also needs to manage its pipeline capacity contracts. Contracting for too much capacity or for capacity at a high price are both undesirable.

Short-term capacity contracting may lower capacity costs in several ways. Short-term capacity will by its nature lower costs initially because smaller amounts of capacity are contracted for. Secondly, if excess capacity develops and interpipeline competition ensues, an LDC unencumbered by long-term capacity contracts will have the flexibility to take advantage of the discounting of pipeline transportation capacity charges when available. In the future, excess capacity may result from changes in pipeline rate design, the entry of interconnecting legs that improve efficiency, and more backhaul and exchanges.

The LDC lowers its business risk through long-term capacity contracting only to the extent that it needs assurance of adequate capacity to meet its service obligation. But this assurance has its price. If the LDC loses customers as a result of bypass, fuel switching, or plant closings, the core customers are left to bear the increased unit cost of long-term pipeline capacity costs. Also, the LDC with long-term capacity contracts is vulnerable to FERC permitting a pipeline to charge higher rates on existing contracts when and if the pipeline loses some of its other customers. If excess pipeline capacity is available, an LDC unburdened by long-term contracts and with sufficient storage capacity can sometimes use interruptible transportation to accept gas at odd times, at a discounted capacity price.

If future capacity is expected to be scarce, the LDC will favor long-term capacity contracting. Short-term contracting will benefit LDCs that are flexible in their capacity acquisition in an environment of interpipeline competition and capacity abundance.

The Raw Materials Adjustment Clause: The Raw Materials Adjustment Clause (RMA) allows an LDC to pass on the commodity cost of gas to the ratepayer. This raises some questions: Are LDCs slow to switch supply sources and capacity to avoid the costs of acquiring new interconnections? Could an LDC overspend on input costs covered by an RMA to minimize those input costs not covered? (Any such cost not covered by the RMA can be recovered only after a rate proceeding, while RMA costs are recovered on a yearly basis.)

In traditional test-year ratemaking, the gas utility would bear the full risk of actual gas service costs being different from costs based on forecasted demand. This condition may have induced the utility in the past to minimize risk by contracting for long-term, fixed-price gas supply. If all gas costs are passed on to customers through the RMA mechanism, the utility may lack the incentive to seek the cheapest gas.

One solution may involve tying the recovery of gas costs to an external index of gas prices that reflects market conditions. The index can be based on a market that has enough participants (including private sector firms that have strong incentives to minimize costs) to ensure a competitive market price. Currently, the spot gas market can serve as a viable index.

A possible scenario is that the ratepayer is initially charged an average spot gas rate. Then, any differences between this index and the actual cost of gas to the LDC are shared between the LDC's stockholders and the ratepayers through a future adjustment.

This procedure has major advantages. It reduces the LDC's need to forecast gas prices. The LDC has the incentive to minimize gas costs while reducing risk through its sharing of gains and losses when gas costs fluctuate. In addition, the ratepayer is assured of a reasonably least cost gas.

Demand Side Measures

Demand side measures include increased end-use efficiencies to reduce gas demand and the exploration of other gas services to improve the management of the LDC's load.

Conservation efforts are aimed at increasing customer awareness of energy efficient options supplemented by specific programs such as energy audits and incentives for installation of energy efficient equipment (see Chapter III-1 and III-2). If properly targeted, such a program will motivate consumers to take specific action with measurable energy use impacts.

LDCs may further reduce average gas rates to its customers through the pursuit of markets in the areas of cogeneration, gas air conditioning, and the unbundling of available gas utility services. Achieving additional sales allows the LDC to spread its fixed cost over larger gas volumes and hence reduces the average cost of gas to its customers as a whole.

<u>Cogeneration</u>: Cogeneration provides an avenue for LDCs to lower unit costs of providing gas service. Increased use of natural gas for cogeneration benefits an LDC's other gas customers directly by spreading the fixed costs of the gas system over greater sales volumes. In addition, affordable supplies of natural gas for cogeneration benefit the state by reducing overall energy costs for industry in general, thereby creating a better economic climate. Cogeneration, both for self-consumption and for resale to electric utilities, helps New Jersey electric ratepayers by providing a more competitive environment for the production of electricity. Cogeneration may also lead to the elimination or reduction of new, expensive capacity that regulated electric companies build to serve their customers.

<u>Gas Air Conditioning</u>: A potential market exists in the commercial sector for gas air conditioning. Use of gas for air conditioning will tend to relieve the growing demand for electricity that would normally accompany the continuing growth in energy consumption in New Jersey. Substantial markets for gas air conditioning may exist in the casino industry, hotel industry, other commercial enterprises, and multifamily housing. Gas cooling may be marketable to supermarkets for use in refrigeration. The growth of office automation and use of computers created an increased cooling load to which gas air conditioning can be applied. The replacement of existing conventional air conditioners also provides an additional avenue for developing this market.

The growth of gas air conditioning can reduce the (summer) peak load of electric utilities in New Jersey, delay or reduce the need for capital addition to the state's electric systems, and fill the valley in LDCs' load profiles (see Chapters III-1 and III-2).

<u>Unbundling of Gas Service</u>: Unbundling is the provision of distinct types of utility service, such as transportation, storage, interruptible service, and peaking service, either individually or in combination at rates uncluttered by costs of unneeded services. Unbundling of services provided by LDCs could forestall a decrease in demand for their services as oil competes with gas as an alternative fuel, pipelines compete with gas utilities to supply gas, and producers, marketers, and brokers compete with the utilities to sell natural gas.

In addition, the unbundling of services enhances the ability of industrial customers, and specifically cogenerators, to secure their own fuel sources and to receive services that supplement transportation, such as peaking, storage, and standby service. Peaking service provides gas to sales customers who know with certainty that they will need supplemental gas service in the winter; storage service meets the needs of customers who want to store their transport gas on the utility's system. Standby service makes gas available to customers with unanticipated needs.

The unbundling of services may have adverse effects on an LDC's firm or core customers, both residential and nonresidential. A gradual phase-in of unbundling may be necessary to prevent a sudden massive defection of large customers from firm service and the likelihood of sudden large increases in rates charged to smaller firm customers.

LDC Transportation Tariffs

The price for firm gas purchases from New Jersey LDCs is based on fixed costs associated with the distribution plant and variable costs of gas purchases and operations. However, the price of gas for interruptible customers generally does not include costs associated with the distribution plant. Instead, a small contribution--a transportation charge--is made toward these fixed costs and added to the gas purchase cost to benefit firm customers who pay the bulk of the fixed costs.

Transportation tariffs are required as a result of direct sales of gas from producers to end users when a pipeline or LDC contracts to move the gas for the final consumer at off-peak times. How much should this consumer, usually an industrial user, pay for the use of the LDC's distribution network? The higher the contribution, the higher the price of gas becomes for New Jersey's industrial consumers. The lower the contribution, the larger the proportional cost of the pipeline becomes for all firm customers.

Low transportation tariffs will result in a more competitive market. Increased competition can create a net benefit for consumers by forcing the pipelines and producers to operate more efficiently and to charge rates more closely tied to the value of their services and products. This represents a transition from cost-of-service monopoly pricing to value-of-service competitive pricing. The long-term benefits of a healthy, largely self-correcting marketplace of willing buyers and sellers can result only from working with the market forces in the natural gas industry.

Outlook

In the short-term, natural gas markets will continue to cope with excess production capacity--the so-called gas bubble. Therefore gas supplies are expected to be relatively abundant at low prices, leading to increased consumption. According to the U.S. Energy Information Administration, 1987 consumption in the U.S. was 16.7 Tcf. The EIA expects consumption to rise to about 19.7 Tcf in the year 2000. Wellhead prices averaged $1.71 in 1987 and are expected to rise to about $4.00 by 2000, following increases in oil prices.[17]

Most of this rise in consumption is expected to come from increased use by electric utilities, when low capital cost combined-cycle units burning natural gas are introduced. An annual increase of about .6 Tcf is expected in the industrial sector by the end of the century, due mainly to higher industrial output and an increase in cogeneration. In the residential and commercial sectors, consumption should grow at roughly the same rates as the housing stock and the square footage of commercial buildings, respectively.[18]

The outlook for natural gas markets reflects heightened competition among gas suppliers, and also between them and the suppliers of alternative fuels. More and more gas is free of price controls, and FERC policy is facilitating open access to interstate pipelines. Today's market is also characterized increasingly by spot sales and supply agreements in which prices are flexible. As gas becomes more competitive, its price should track the energy-equivalent prices for alternative fuels.

The number of new gas well completions is expected to grow steadily as gas prices increase. However, reserve additions are expected to decline markedly in the near-term and remain at a level of about 7 to 8 Tcf in the late 1990s. Production is expected to decline gradually, reaching a low of about 11 Tcf also in the late 1990s.[19]

Over the long term, U.S. annual consumption of natural gas will exceed domestic production by an estimated 1.5 Tcf. This difference will probably be made up from an increase in net imports, mainly from Canada, facilitated by the U.S. - Canada Free Trade Agreement.

Canadian reserves include the Sable Island field in Nova Scotia, which is estimated to contain 3 Tcf of natural gas with a potential production rate of 300 MMcf per day. However, this off-shore source, which would require an undersea pipeline, is too expensive to bring to market at current price levels.

Findings

- Profound regulatory changes by FERC have caused the restructuring of traditional functions among producers, pipelines, LDCs, and end-users.
- These changes have created many uncertainties in natural gas planning.
- New Jersey and the other northeastern states need increasing supplies of natural gas to meet their growth-induced requirements.
- Existing pipelines flowing gas to the region are operating at capacity during portions of the winter peak season.
- Natural gas supplies, which are from domestic or Canadian sources, are secure compared to crude oil and petroleum product supplies, which are predominantly imported.
- The combustion of natural gas produces significantly smaller quantities of polluting gases compared to petroleum products, thereby helping to improve New Jersey's air quality, which currently is in violation of federal standards.
- Current New Jersey LDC planning strategies are not least cost, as defined herein.

Chapter II-1-A

Policy

- For environmental reasons, New Jersey shall encourage competition among natural gas suppliers and between natural gas and other fossil fuels.

- The state shall encourage the establishment of government and commercial auto fleets using motor vehicles powered by natural gas or a combination of natural gas and gasoline.

- The DCEED and the BPU support the completion of new pipeline projects approved by the FERC--Iroquois, Champlain and ANR--which are urgently needed to assure the Northeast an adequate, dependable, and diversified supply of natural gas.

- The BPU shall require each gas LDC to demonstrate that it provides least cost gas service without jeopardizing a secure supply for firm customers.

- LDCs must employ a planning model that integrates supply-side and demand-side options.

- The BPU shall set transportation tariffs that have the flexibility to meet the rapid changes in the gas market. They must be low enough to allow natural gas to compete with oil for industrial consumers, while enabling captive residential consumers to reap some of the benefits of increased competition. The advantages of price cuts, the spot market, and conservation alternatives should be made available to as many consumers as possible.

Implementation

- The state will continue to promote promote conservation by the methods described in Chapter IV-1, including energy subcode improvements for new construction and weatherization programs in existing homes. DCEED will also promote the replacement of older gas furnaces with new, energy efficient units.

- The BPU shall ensure that transportation tariffs are low enough to discourage industrial customers from switching to oil, while shifting as little of the financial burden to firm customers as possible. The BPU shall also determine whether to use "cost of service" or "value of service" with respect to firm and interruptible customers.

- DCEED will require that each gas LDC present data and other supporting evidence regarding its least cost plan, as described in Chapter V-1.

- The state shall initiate demonstration projects of natural gas-powered vehicles at selected motor pools and encourage similar projects in fleets owned by the gas, electric, and telephone utilities.

DRAFT

Chapter II-1-A

FOOTNOTES

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3. Form 10K filed by E'Town with the Securities & Exchange Commission for fiscal year ended 12/31/87.

4. Form 10K for New Jersey Resources Corporation, parent of NJN, filed with the Securities & Exchange Commission for fiscal year ended 9/30/87.

5. Form 10K for Enterprise filed with the Securities & Exchange Commission for fiscal year ended 12-31-87, p. 21-23.

6. Form 10K for South Jersey Industries for fiscal year ended 12/31/87, filed with the Securities & Exchange Commission.

7. New York State Energy Office, Natural Gas Supply Assessment, August 1987, p. 2-7.

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12. Natural Gas Supply Assessment-1987, p. 9-14.

13. American Gas Association, Gas Energy Supply Outlook 1987-2010, p. 50.

14. Natural Gas Supply Assessment 1987.

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16. The National Regulatory Research Institute, National Gas Industry Restructuring Issues, September 1986, p. 120-126.

17. Energy Information Administration, Annual Energy Outlook 1987, p. 1, 11-13.

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D R A F T

CHAPTER II-1-B

PRIMARY ENERGY SOURCES
PETROLEUM

Introduction

New Jersey is a major consumer of petroleum in the United States, but produces no crude oil at all. In 1986, our state ranked sixth among the states in petroleum usage. New Jersey is also a large user of all types of energy, ranking 11th highest nationwide.[1]

The transportation sector is by far New Jersey's biggest user of petroleum, accounting for 59 percent of total state use in 1986. Refer to Table II-1-B-1 and B-2 for New Jersey usage by sector. Gasoline consumption was 66 percent of transportation usage.[2]

New Jersey and the other northeastern states rely heavily upon foreign sources for their petroleum and are particularly vulnerable to supply disruptions. Sixty-seven percent of our refined products are either imported directly or derived from imported crude refined locally, and another 10 percent is refined products derived from imported crude transferred here from other U.S. regions.[3]

This chapter will:

- document existing petroleum supplies;
- map out alternative evolutionary paths toward the year 2000; and
- examine the environmental, economic, and security implications of our present pattern of high dependence on imported petroleum and petroleum products.

The chapter provides an historical perspective of consumption by sector and reviews pertinent trends, followed by supply statistics that show the extent to which New Jersey relies upon imports for its petroleum needs. Refineries are discussed, including the diminished but important role they play in our state. We provide excerpts from the U.S. Energy Information Administration (EIA) short-term and annual energy outlooks of consumption, crude pricing, and domestic production, and conclude with a statement of New Jersey policy for reducing petroleum consumption, including implementation methods.

Consumption Trends

New Jersey has been and still is heavily dependent upon petroleum to meet its energy needs. However, the Arab oil embargo of 1973-74 had a significant effect on petroleum use in the state. In reaction to price increases and the potential for future supply disruptions, oil demand fell dramatically from 76 percent of total energy used in 1972 to 58 percent in 1986. Nationwide, petroleum accounted for 43 percent of the total energy consumed in 1986.[4]

Estimated consumption of fuel oil in New Jersey residences is the lowest since data have been kept (1960). Residential consumers used about 18.7 millions of barrels (MMbbl) of oil in 1986, which is half of what they used in the peak year of 1973. The decrease has resulted from customer conversions (largely to natural gas) and to customer investment in improved fuel efficiencies through new heating units and other measures, such as upgraded insulation and set-back thermostats.

In the commercial and industrial sectors, consumption has been reduced by 50 percent and 40 percent, respectively, over a 13-year period. Much of the reduction in the industrial sector has paralleled the decline of energy-intensive "smokestack industries." Fuel switching has also played a major role. Nevertheless, the industrial sector is the state's second largest user of petroleum and is responsible for about 20 percent of total usage. Within this sector, petroleum accounts for about 50 percent of total energy consumed.

The reductions have been even more dramatic among electric utilities. In 1973, power companies burned 49 MMbbl, which plummeted to 9.2 MMbbl in 1986--a drop of over 80 percent. (Refer to Table II-1-B-1.) Fuel switching explains this drop, since nuclear and natural gas-generated electrical capacity have replaced oil-generated capacity and also handled growth.[5]. Refer to Chapter II-2 on electricity for a more detailed discussion.

Historically, the major user of petroleum has been the transportation sector. Although total petroleum consumption for all sectors in New Jersey peaked in 1973 at 285 MMbbl, within the transportation sector consumption has been rising dramatically in the 1980s. Motor gasoline consumption began rising in 1982 after declining to its lowest point since the shortages of the 1970s. This trend can be attributed to declining prices for gasoline, increasing traffic due to casino expansion in Atlantic City, population shifts from urban to suburban locations, and strong sales of larger cars that are less fuel efficient than the overall average for new cars. These factors are not listed in any priority order, nor are we able to find such a ranking.

Table II-1-B-1
Petroleum Consumption Estimates in New Jersey
(Million Barrels)

Year	Res.	Comm.	Ind.	Trans.*	Elec. Utility	Total
1970	34.5	23.6	71.3	90.4	38.9	258.7
%	13.3	9.1	27.6	34.9	15.0	100.0
1971	34.3	22.0	66.4	93.5	38.9	255.1
%	13.4	8.6	26.0	36.7	15.2	100.0
1972	37.0	22.5	69.6	101.9	48.5	279.5
%	13.2	8.1	24.9	36.5	17.4	100.0
1973	37.2	22.8	73.7	102.6	49.0	285.3
%	13.0	8.0	25.8	36.0	17.2	100.0
1974	32.6	19.8	68.0	97.7	41.5	259.6
%	12.6	7.6	26.2	37.6	16.0	100.0
1975	32.1	17.8	62.1	96.5	26.2	234.7
%	13.7	7.6	26.5	41.1	11.2	100.0
1976	33.3	20.9	63.3	101.5	25.9	244.9
%	13.6	8.5	25.8	41.4	10.6	100.0
1977	31.9	19.5	66.5	101.4	30.0	249.3
%	12.8	7.8	26.7	40.7	12.0	100.0
1978	30.2	18.3	67.3	104.9	29.5	250.2
%	12.1	7.3	26.9	41.9	11.8	100.0
1979	22.5	19.0	82.1	101.6	21.0	246.2
%	9.1	7.7	33.3	41.3	8.5	100.0
1980	25.0	20.6	70.0	103.5	15.7	234.8
%	10.6	8.8	29.8	44.1	6.7	100.0
1981	24.3	14.6	61.0	103.6	11.2	214.7
%	11.3	6.8	28.4	48.3	5.2	100.0
1982	20.5	12.2	53.2	104.1	8.8	198.8
%	10.3	6.1	26.8	52.4	4.4	100.0
1983	17.4	10.8	43.6	112.7	8.6	193.1
%	9.0	5.6	22.6	58.4	4.5	100.0
1984	17.9	10.8	46.6	116.2	9.3	200.8
%	8.9	5.4	23.2	57.9	4.6	100.0
1985	19.4	8.7	39.6	142.9	5.7	189.9
%	10.2	4.6	20.9	61.3	3.0	100.0
1986	18.7	11.5	44.4	121.0	9.2	204.7
%	9.1	5.6	21.7	59.1	4.5	100.0

Source: EIA State Energy Data Report 1960 - 1986, p.207-212.
* Refer to footnote 27 for explanation of adjustments to EIA Transportation sector data for 1981-1986.

Table II-1-B-2
Petroleum Consumption Estimates in New Jersey
(Trillion Btu)

Year	Res.	Comm.	Ind.	Trans.	Elec. Utility	Total
1970	199.3	142.0	414.7	491.6	243.9	1491.5
1971	198.0	132.1	385.5	508.9	243.3	1467.8
1972	213.5	134.6	401.6	555.1	301.5	1606.3
1973	214.9	136.7	426.9	557.8	303.6	1639.9
1974	188.0	118.3	391.4	527.8	256.7	1482.2
1975	184.6	106.0	356.9	518.6	163.4	1329.5
1976	191.1	125.3	365.6	548.8	161.4	1392.2
1977	183.4	116.7	384.3	548.7	186.5	1419.6
1978	173.3	109.1	388.1	567.4	183.7	1421.6
1979	129.5	114.7	476.0	551.2	131.2	1402.6
1980	144.0	124.5	400.3	565.5	97.5	1331.8
1981	139.5	87.4	347.1	613.3	69.7	1257.0
1982	117.4	72.8	302.5	713.3	5 .9	1260.9
1983	98.8	63.2	247.9	763.4	53.6	1226.9
1984	101.9	63.2	260.4	792.2	58.1	1275.8
1985	111.0	50.8	221.5	787.1	35.3	1205.7
1986	106.3	67.0	250.8	791.7	57.4	1273.2

Source: EIA State Energy Data Report 1960 - 1986, p. 207-212.

Table II-1-B-3

Petroleum Products Consumption Estimates in New Jersey (Thousand Barrels)

Year	Asphalt & Road Oil	Aviation Gasoline	Distillate Fuel	Jet Fuel	Kerosene	LPG	Lubricants	Motor Gasoline	Residual Fuel	Other Petroleum	Total Petroleum
1970	5828	150	63391	6734	1829	6748	1952	66231	80770	25026	258659
1971	6029	116	64551	6742	1842	6834	1993	68308	75446	23255	255116
1972	6310	112	71884	8549	1975	7961	2134	74054	80262	26171	279412
1973	7355	102	74951	8170	1544	8110	2278	75830	79176	27844	285360
1974	6308	129	68360	7093	1267	7840	2182	75512	63532	27409	259632
1975	5012	88	59630	6291	1211	7328	1741	77617	49463	26246	234627
1976	4452	88	61119	6787	1740	7668	1934	79469	57772	23780	244809
1977	5489	104	59302	8420	2519	7940	2369	77535	59682	26014	249374
1978	6017	111	56692	7849	2379	8149	2545	80604	58167	27668	250181
1979	6340	92	50687	8498	1961	7913	2663	75640	61030	31545	246369
1980	4369	83	52854	8781	1694	7383	2371	72740	53617	30947	234839
1981	4931	75	50660	9669	1461	6243	2274	72379	37777	29122	214591
1982	4835	141	45479	8544	1406	6257	2074	73334	33415	21974	197459
1983	6112	155	39307	11095	1793	6292	2171	77650	26578	24997	196150
1984	6242	135	40820	14811	948	7005	2315	77257	26361	24997	200891
1985	4732	184	40389	17482	636	5670	2158	75391	20810	22424	189876
1986	5565	159	44963	16036	620	5643	2110	80694	23326	25559	204675

Source: EIA State Energy Data Report 1960 - 1986, p.207.

* Refer to footnote 27 for explanation of adjustment to EIA Jet Fuel data for 1981 to 1986

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Retail prices for gasoline in New Jersey were stable in 1986 and 1987, with regular unleaded gasoline averaging about $.89 per gallon.[6] Nationwide, drivers today are actually paying less for a gallon of gas, adjusted for inflation, than they paid in 1967.[7] New Jersey motorists used a record 3.6 billion gallons of gasoline in 1987, which is an increase of 200 million gallons above 1986 consumption.[8]

New Jersey's electric utilities have been the most responsive to the changing economics of oil. The electric industry increased its oil use from 1970 to 1973 to comply with the Federal Clean Air Act. When oil prices increased, the utilities replaced oil with planned nuclear generation and the purchase of electricity from out-of-state coal-fired plants. With the increased availability of natural gas in the 1980s and a relaxation of the Fuel Use Act, even greater amounts of oil were displaced. Oil used by electric utilities dropped from 17.4 percent of petroleum consumed within the state in 1972 to 4.0 percent in 1986. (Refer to Table II-1-B-1.)

At the national level, overall petroleum consumption has shown an upward trend, increasing by about 7 percent between 1982 and 1986. Significant reductions in usage in the residential, industrial, commercial and electric utility sectors have been offset by increases in the transportation sector.[9]

In New Jersey, products derived from petroleum currently represent 58 percent of energy consumed, compared to the national average of 43 percent. Statewide, 63 percent of these products are consumed within the transportation sector, which is virtually identical to national usage. The industrial sector is New Jersey's second largest sector for petroleum use, accounting for about 20 percent, but less than the 25 percent industrial share at the national level.[10]

Present Situation

Supply

A detailed analysis of regional petroleum supply is contained in the EIA report, "The Northeast Distillate Fuel Oil Supply (1986)."[11] The following statistics derived from that report are generally applicable to New Jersey.

The Northeast (11 states from Maryland to Maine) is the region of the United States that is the most dependent upon imported petroleum. It has limited refinery capacity, negligible crude production, and high product demand. About two-thirds of the product supplied is derived from non-U.S. crude oil and refined products imported directly into the region. The remaining one-third is transferred from two other U.S. regions; 15 percent from PADD II (Midwest) and 86 percent from PADD III (Gulf Coast)[12]. However, PADD II imports about 15 percent of the crude oil it refines into product, and PADD III imports about 42 percent of its crude.[13] Therefore, approximately 38 percent of the product transferred into the Northeast is derived from imported crude. When we add these "indirect" imports to the 67 percent of the Northeast's consumption directly imported, we conclude that 78 percent of the oil currently supplying regional needs is imported. Refer to Table II-1-B-4 and Figures II-1-B-1 and 2.

Petroleum product sources for New Jersey are production by regional refineries; movement from other U.S. regions via pipelines, tankers, and barges; and imports.

New Jersey met its petroleum needs in 1986 by bringing in a substantial amount--about 75 percent--as product and obtaining the balance by refining crude oil. Interregional transfers accounted for 31 percent of the products supplied, 72 percent of which arrived via pipeline from the Gulf Coast states. Colonial Pipeline, which terminates in Linden, is the only pipeline for petroleum products serving New Jersey. Tanker and barge shipments from the Gulf Coast accounted for another 14 percent. The Midwest was the source of the remaining product movement. Refer to Table II-1-B-4. While Gulf Coast refineries have the capacity to meet surges in demand, limitations of pipeline, tanker, and barge transportation may restrict the availability of distillates from this source.[14]

Table II-1-B-4

Sources of Crude Oil and Petroleum Product
Northeast United States--1986
(Million Barrels per Day)

Crude Oil			Petroleum Products				
Source	Volume	%	Source	Volume	%	Imported Volume	%
Imported	1.01	91.8	Imported	1.20	35	1.2	100
Domestic	0.09	8.2	Other U.S. regions	1.06	31	0.4	38
			Northeast refineries	1.15	34	1.05	91
Total	1.10	100	Total	3.41	100	2.66	78.0

$$\frac{2.66}{3.41} = 78\%\text{ of petroleum products from imported sources}$$

Source: EIA Petroleum Supply Monthly, November 1987, p. xix, table FE-1 & p. xxii

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The state receives petroleum products that are processed in New Jersey, Pennsylvania, and Delaware refineries from both imported and domestic crude oil. Shipments of refined products from other regions of the U.S. and foreign sources supplement these supplies. As shown in Table II-1-B-5, 97 percent of the crude oil received at regional refineries in 1977 was imported. Since then, increased volumes of crude from Mexico, Canada, the North Sea, and Venezuela have displaced huge amounts of crude oil from the Middle East. (See Tables II-1-B-6 and II-1-B-7.) Imports currently provide 91 percent of the crude oil processed at refineries in the Northeast. Most of this crude arrives by tanker at eastern ports. Domestic crude for the Northeast comes mainly from Alaska and California, also via tanker.[15]

Table II-1-B-5

Imported Crude Oil Receipts for the Ten Refineries in New Jersey, Delaware and Eastern Pennsylvania (MMbbl/day)

Year	Total	Imported	Imported as % of Total
1976	1.33	1.28	96
1977	1.40	1.36	97
1978	1.43	1.34	94
1979	1.38	1.31	95
1980	1.19	1.08	91

Source: Adapted from Deepwater Port Alternatives for New Jersey, New Jersey Department of Energy and the Port Authority of New York and New Jersey, 1982

Table II-1-B-6

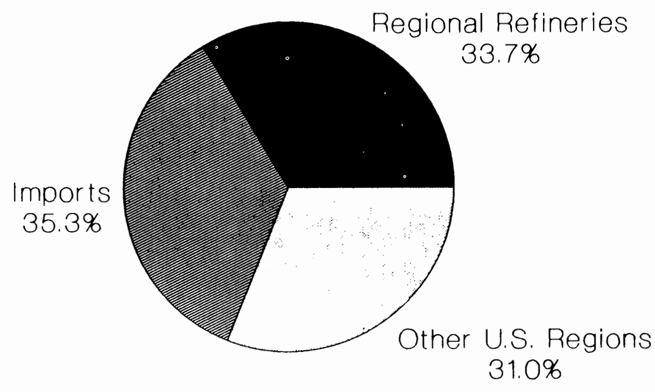
Imports of Crude Oil by Source, 1986
Comparison of Total U.S. with PADD 1 (bbl/day)

	Total U.S.			PAD District 1		
Source	Rank	Amount	%	Rank	Amount	%
Saudi Arabia	1	620,000	15	5	80,000	8
Mexico	1	620,000	15	4	110,000	10
Canada	3	570,000	14	6	60,000	6
Nigeria	4	440,000	10	1	220,000	20
Venezuela	5	420,000	10	3	120,000	11
United Kingdom	6	320,000	8	2	180,000	16

Source: EIA Petroleum Supply Annual 1986, Table 15

Figure II-1-B-1

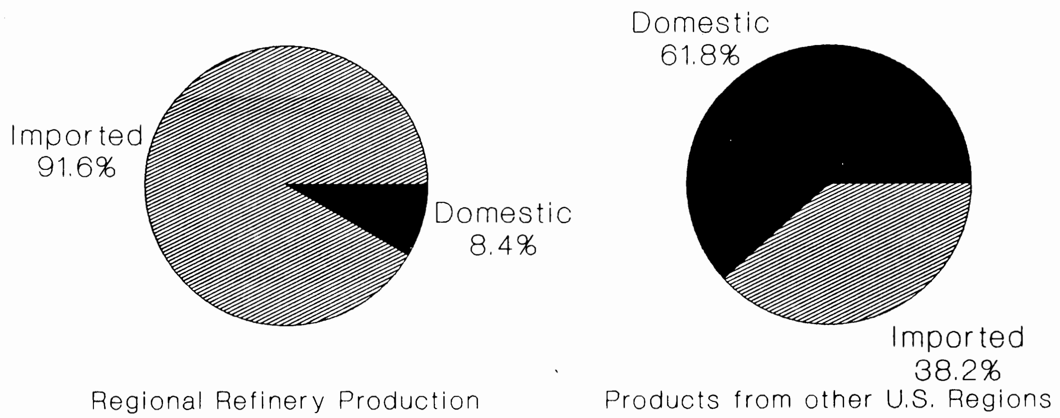
SOURCES OF PETROLEUM PRODUCTS
Northeast United States-1986



**Source: EIA Petroleum Supply Monthly
November 1987**

Figure II-1-B-2

SOURCES OF CRUDE OIL
Imports vs Domestic
Northeast United States-1986



**Source: EIA Petroleum Supply Monthly,
November 1987**

Table II-1-B-7

United States
Gross Imports of Crude Oil by Source, 1977-1986
(Million Barrels per Day)

Source	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Arab OPEC										
Algeria	0.54	0.63	0.61	0.46	0.26	0.09	0.18	0.19	0.08	0.08
Iraq	.07	.06	.09	.03	.00	s	.01	.01	.05	.08
Kuwait	.04	.01	.01	.03	.00	s	.01	.02	s	.03
Qatar	.07	.06	.03	.02	.01	.01	.00	s	.00	.01
Saudi Arabia	1.37	1.14	1.35	1.25	1.11	.53	.32	.31	.13	.62
United Arab Emirates	.33	.39	.28	.17	.08	.08	.02	.09	.04	.04
Libya	.70	.64	.64	.55	.32	.02	.00	.00	.00	.00
Subtotal Arab OPEC	3.14	2.93	3.00	2.50	1.77	.74	.53	.63	.30	.85
Other OPEC										
Ecuador	.06	.04	.03	.02	.04	.03	.06	.05	.06	.06
Gabon	.04	.04	.04	.03	.04	.04	.06	.06	.05	.02
Indonesia	.51	.53	.38	.31	.32	.23	.32	.30	.29	.30
Nigeria	1.13	.91	1.07	.84	.61	.51	.30	.21	.28	.44
Venezuela	.25	.18	.29	.16	.15	.16	.16	.25	.31	.42
Iran	.53	.55	.30	.01	.00	.04	.05	.01	.03	.02
Subtotal Other OPEC	2.51	2.25	2.11	1.36	1.15	1.00	.94	.88	1.01	1.26
Total OPEC	5.64	5.18	5.11	3.86	2.92	1.73	1.48	1.51	1.31	2.11
Non-OPEC										
Mexico	.18	.32	.44	.51	.47	.65	.77	.66	.72	.62
Canada	.28	.25	.27	.20	.16	.21	.27	.34	.47	.57
United Kingdom	.10	.17	.20	.17	.37	.44	.37	.38	.28	.32
Trinidad & Tobago	.13	.14	.12	.12	.10	.09	.08	.09	.10	.09
Angola	.02	.01	.04	.04	.05	.04	.07	.09	.10	.10
Norway	.05	.10	.08	.14	.11	.10	.07	.11	.03	.05
Columbia	.00	.00	.00	.00	.00	.00	.00	.00	.00	.06
All Other	.22	.19	.26	.22	.21	.22	.23	.25	.20	.25
Subtotal Non-OPEC	.97	1.17	1.41	1.40	1.47	1.76	1.85	1.91	1.89	2.07
Total Imports	6.62	6.36	6.52	5.26	4.40	3.49	3.33	3.43	3.20	4.18

s. Less than 0.01 million barrels per day
Note: Total may not equal sum of components due to independent rounding

Source: EIA, Petroleum Supply Annual 1986, Table FE-5

Refinery Capacity

U.S. refineries have reacted to price and supply changes in the market. As shown in Table II-1-B-8, U.S. refinery capacity dropped by 17 percent, or over 3.1 million barrels per day since 1981. However, capacity has remained fairly level for the past four years.

Table II-1-B-8

U.S. Refinery Crude Capacity
(as of January 1)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Number of Plants	289	297	303	273	225	220	191	189	187	182
Capacity	17.2	17.8	18.5	17.7	16.2	15.9	15.1	15.3	15.3	15.3

Source: The Oil and Gas Journal, Annual Refining Issues, March 1979-1988

The basic reasons behind the changes in the refinery industry include:

Overcapacity: The demand for oil was expected to continue to grow through the year 2000. As a result, refineries were built or expanded to meet these projections during the 1970s. Much of this expansion in the U.S. took place in the traditional producing and refining areas of Texas and Louisiana as well as in California. When demand fell, the newer, more efficient refineries remained open while smaller, older and less efficient refineries closed.

Changes in the crude stream: As political events shaped the price and availability of crude supplies, refiners began switching from politically unstable sources to stable sources. Many of the OPEC crudes are sweet (low sulfur content) and light.[16] U.S. refiners began importing larger quantities of predominantly sour (high sulfur content) and heavier crudes from Canada, Mexico, and Venezuela. New Jersey refineries were incapable of processing these sour and heavier crudes.

Change in product demand: The market was "demanding" more light distillates, including gasoline and jet fuel, while decreasing its demand for No. 4 and No. 6 residual fuel oils. In addition, the use of leaded gasoline declined as the use of unleaded gasoline increased. As a result, refineries were modified to extract more light products. Special units, called catalytic crackers, were constructed to upgrade petroleum fractions to higher quality products.

Mergers in the industry: In the last few years a number of mergers/buy-outs of oil companies have occurred. Companies have consolidated their refining operations in large, new, efficient refineries while retiring older units. These mergers have caused companies to re-examine their market strengths and weaknesses and have resulted in companies withdrawing totally from some market areas.

New foreign refineries: Many of the exporting nations have constructed large modern refineries that are cost-competitive with western refineries because of lower labor costs and different environmental regulations. In 1986, the 11 northeastern states met 35 percent of their petroleum product needs by direct import of product. (Refer to Figure II-1-B-1.)

Foreign ownership of U.S. refineries: In June 1988 Texaco announced an $800 million deal to refine and market oil in a joint venture with a company owned by the Saudi Arabian government. Texaco is to sell a half-interest in its southeastern refining and marketing system to the Saudis. This arrangement marks the first time a foreign oil-producing country has acquired a major stake in a U.S. distribution network. In 1986 the Venezuelan National Oil Company bought a one-half interest in Southland Corporation's refining and distribution network. The Venezuelan acquisition has caused no negative impacts on New Jersey, and it is too early to assess the impact of the Saudi-Texaco deal on New Jersey's petroleum consumption needs.

New Jersey Refineries

All 15 operating refineries in the Northeast are located in the Mid-Atlantic states. There are seven large refineries along the Delaware River: four in Pennsylvania, two in New Jersey, and one in Delaware. Three others are in northeastern New Jersey near the New York harbor. In addition, there are four smaller refineries in western Pennsylvania. New York or New England have no operating refineries. The Mid-Atlantic refineries distribute petroleum products primarily to the nearby population centers.

Within New Jersey the refining industry has undergone significant changes. Tables II-1-B-9 and B-10 show how refinery capacity has dropped from 644,000 barrels per day (b/d) in 1979 to 435,000 b/d as of January 1, 1988.

The industry began changing with the shutdown of the Amerada Hess refinery in 1974. The Exxon Bayway refinery, the largest facility in PADD I during the 1970s, reduced its capacity in 1982 from 290,000 b/d to 120,000 currently, partly because the refinery was old and product demand had changed.

Chevron announced in 1983 that it would be cutting production at its Perth Amboy refinery. The plant is not handling any distillates at this time and is producing only asphalt, up to 35,000 b/d, when operating. Statistics on refinery capacity by the American Petroleum Institute overstate the refinery's capacity as 80,000 b/d. It would take the refinery some four to six months to operate at that capacity again, since much of the equipment is mothballed.[17]

The Seaview facility in Thorofare is a relatively new refinery built in the late 1970s. It specializes in lubricating oils and asphalt. Its sweet crude unit is presently mothballed, so the refinery has a 25,000 b/d capacity for specialty products.[18]

As part of the Texaco-Getty merger, the Federal Trade Commission directed Texaco either to sell or to close its Westville refinery. In December 1984, Coastal Corporation agreed to acquire Texaco's Eagle Point refinery for $42.5 million. The purchase included the refinery, 9.6 million barrels of crude and product storage capability, and deepwater port facilities.

Table II-1-B-9

Refinery Operating Capacity
(Million Barrels per Day)
(as of January 1)

	1977	1980	1982	1985	1986	1987	1988
N.J.	.71	.69	.60	.50	.42	.42	.44
PADD I*	1.9	2.0	1.8	1.5	1.5	n/a	n/a
U.S.	16.4	17.9	17.9	15.0	15.3	15.3	15.3

* PADD stands for Petroleum Administration for Defense District. PADD I includes all Atlantic coastal states plus Vermont and parts of Pennsylvania and West Virginia.

Sources: N.J. and U.S. data; Oil and Gas Journal, Annual Refining Issues, March 1977-1988

PADD I data; EIA Petroleum Supply Annual 1986

Table II-1-B-10

New Jersey Crude Oil Refining Capacity
(Thousand barrels per day)
(as of January 1)

Year	Exxon	Chevron	Mobil	Texaco	Coastal	Amerada[1] Hess	Seaview	Total
1979	290	168	98	88	(--)	68	N.A.	644
1984	100	80	100	90	(--)	(--)	44	414
1986	100	80	100	(--)	90	(--)	44	414
1987	100	80	100	(--)	90	(--)	45	415
1988	120	80	100	(--)	90	(--)	45	435

1. This refinery was mothballed in 1974. In early 1985 it resumed operating at a 48,000 b/d rate, processing low sulfur vacuum gas oil shipped from its Virgin Islands refinery. More than 80 percent of the product coming off the line is unleaded gasoline. The company's crude oil distillation capacity at the refinery remains shut down.

Source: EIA Petroleum Supply Annual, 1984-1986, U.S. Refineries and Capacities by State;
Oil and Gas Journal, Annual refining issue, March, 1988, p. 60

Reducing Vulnerability To Supply Disruptions

While we recognize that New Jersey has a limited ability to increase singlehandedly the reliability of its oil supplies, we should not completely overlook this area. Policies and programs must be directed toward reducing oil use through conservation and by shifting to less polluting alternative fuels, such as natural gas, wherever practicable. Conservation has shown itself to be a reliable, economic, and flexible energy source. No other source can be brought to market as quickly.

Petroleum usage can be reduced by discouraging single-occupant motor vehicle use for commuting, while encouraging greater use of vanpooling and carpooling. DOT is already active in this area as a means of reducing traffic congestion in busy corridors. Employers should publish address listings of employees by work location, sorted by municipality by county, and promote the concept of ridesharing. Furthermore, "free" parking for workers at corporate facilities should be counterbalanced with an equal value subsidy for those employees who use public transportation.

Another conservation measure is based upon employer-provided shuttle van service from rail stations and selected bus stops to company locations to enable substantial numbers of workers to shift from individual auto use to mass transit. This service is already being offered by Mutual Benefit Life and First Fidelity Bank at Penn Station in Newark, by the Carnegie Center at Princeton, and by other employers.

Reduction in vulnerability to supply disruptions can be achieved by filling the Strategic Petroleum Reserve (SPR) to a level of 750 million barrels (MMBbl). Increased SPR levels would provide the insurance of a continuing flow of crude for a limited time, should there be a disruption in the supply of imported crude. Congressman Philip R. Sharp, chairman of the subcommittee on energy and power, recently stated that a major component of a feasible energy policy is to "provide secure funding for the Strategic Petroleum Reserve and fill it rapidly".[19] With oil prices currently low and projected to increase in the near future,[20] it also makes sense to significantly increase the fill rate, which was only 18 MMbbl (50,000 barrels per day) in fiscal year 1988.[21] This compares most unfavorably with the fill-rate of 122 MMbbl in calendar 1981. The SPR contained 541 MMbbl at year end 1987.[22]

The most effective petroleum conservation program centers on the Corporate Auto Fleet Efficiency (CAFE) program. Initially, New Jersey should urge the U.S. National Highway Traffic Safety Administration (NHSTA) to restore the CAFE standard of 27.5 miles per gallon (mpg) intended by Congress, from the currently reduced level of 26.5 mpg. When that level is reached, we should actively promote technically and economically achievable increases above 27.5 mpg, in coordination with the New Jersey congressional delegation.

Recent experience demonstrates that significant gasoline savings were achieved by the stricter application of CAFE standards that were legislated in 1975. Increasing auto fuel efficiency is imperative if petroleum use is to be reduced significantly because gasoline accounts for 66 percent of transportation sector petroleum consumption in New Jersey.[23] U.S. gasoline consumption amounted to 2.5 billion barrels in 1986. Although Congress set a level of 27.5 mpg, NHTSA used its authority to lower this level to 26 mpg for 1986 and 1987. In 1987, cars manufactured in the U.S. (including foreign makes) were required to have an average CAFE rating of only 26.5. Since imported autos averaged 31 mpg in the same year, it is clear that CAFE standards can and should be tightened.[24]

In mid-September 1988, the NHSTA conducted a hearing on a proposal to lower the CAFE level from 27.5 to 26.5 for model years 1989 and 1990.[25] Both Ford and General Motors lobbied NHSTA for a relaxation of CAFE standards. Chrysler, however, projected that it would meet or exceed the 27.5 mpg standard for 1989 and did not speak at the hearing.[26] On October 3, NHSTA yielded to Ford's and GM's position and set the CAFE standard for 1989 models at 26.5 mpg.[27]

Application of several fuel-saving technologies could double auto fuel economy. Multi-point fuel injection, four valves per cylinder, and improved tires are examples. However, cars twice as efficient as current models will cost $200 to $800 more. Since this cost increase will produce some resistance from both manufacturers and consumers, bold policy initiatives such as higher fuel tax, oil import fee or a gas-guzzler tax will be required to accomplish the fuel economy goal.[28] It is important to note that gasoline tax in the United States is only about $.30 per gallon, compared to $1.48 in West Germany and $1.61 in Japan.[29]

Future Outlook

Short Term Outlook[30]

Excess crude oil stocks and continuing overproduction by OPEC have resulted in declining oil prices in the first half of 1988, and there are good prospects for continued price weakness over the next two years. For 1989, EIA anticipates, in its base case forecast, that oil prices will be around $15 per barrel. Ultimately, the ability or inability of OPEC producers to bring supply in line with demand will determine world oil prices.

United States petroleum demand has been increasing steadily since 1985 and is expected to continue in that direction in 1988 and 1989. Demand may rise by 340,000 barrels per day (b/d) in 1988 to 17 million b/d (6,205 MMbbl annually)--about a 2 percent increase. In 1989, demand is expected to increase by an additional 200,000 b/d. High transportation activity and petrochemical feedstocks are the primary contributing factors.

Expanding demand coupled with falling domestic production is leading to an increase in crude oil imports of 7 percent in 1988 to 6.3 million b/d (including imports for the Strategic Petroleum Reserve), or about 400,000 b/d above 1987 import levels. Further declines in domestic production and advances in demand could stimulate an additional increase in imports to a level of 6.8 million b/d in 1989.

Domestic crude oil production is expected to slacken by 160,000 b/d in 1988 and 200,000 b/d in 1989. Alaskan Prudhoe Bay production is expected to begin its decline in 1989.[31]

Table II-1-B-11

Petroleum Supply, Demand, and Imports
(Base Case Assumption)
(Million Barrels per Day)

Supply, Demand & Imports	1985	1986	1987	1995	2000
World Oil Price (1987 dollars per barrel)	28.50	14.40	18.10	22.40	30.80
Real GNP Growth, 1987--2000 (average annual percent)	n/a	n/a	n/a	n/a	2.2
Production					
Crude Oil	9.0	8.7	8.3	6.5	6.0
Other Liquids[a]	2.2	2.2	2.3	2.3	2.4
Total	11.2	10.9	10.6	8.8	8.4
Consumption	15.7	16.3	16.5	17.7	18.3
Net Imports	4.3	5.4	5.8	9.0	10.0

n/a = Not applicable.

[a]Includes natural gas liquids, processing gain and other domestic production
Source: EIA, Annual Energy Outlook 1987, p. 2, Table 1

Year 2000[32]

According to the EIA's base case projection, the economy is assumed to grow at an average rate of 2.2 percent per year from 1987 through 2000, and real oil prices on the world market (expressed in 1987 dollars) remain below $20 per barrel until 1994. Thereafter, increasing world oil demand is expected to begin absorbing excess supply, so that oil prices should then increase more rapidly, reaching $31 by the year 2000.

In the near term, the oil industry has excess production capacity. In the longer term, as this excess capacity diminishes, prices are expected to rise moderately.

U.S. petroleum demand, estimated at 16.5 million b/d in 1987, is projected to rise to 17.7 million b/d by 1995 and 18.3 by the year 2000. Petroleum production (including natural gas liquids as well as oil), which was estimated at 10.6 million b/d in 1987, is seen falling to 8.8 million b/d by 1995 and 8.4 by 2000. As a result, net imports (estimated at 5.8 million b/d for 1987) should rise steadily to 9 million b/d by 1995 and 20 million by the year 2000 (refer to Table II-1-B-11). Consequently, U.S. dependence on imports is projected to rise from 35 percent in 1987 to 55 percent by the year 2000.

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Total U.S. crude oil production in 2000 is expected to drop from the 1987 level of about 8.3 million b/d to around 6.0 b/d. This decrease reflects an optimistic assessment of the potential for older producing regions within the Lower 48 states.

Despite the relative stability of oil prices in 1987, the world oil market could easily experience large swings in prices over the next several years. Excess capacity and international tensions will exert conflicting market pressures.

Overall, significant excess production capacity within OPEC is expected to persist well into the 1990s, until an anticipated increase in worldwide demand (particularly in the developing countries) and a falloff in oil output from outside that organization combine to bring OPEC production to levels that are closer to capacity. Past experience suggests that projections like these involve uncertainties. However, since most of the free world's oil reserves are located in the Middle East, it seems inevitable that the world will become more dependent on OPEC supplies.

One factor that tends to moderate oil vulnerability is the U.S. Strategic Petroleum Reserve. The SPR contained more than 540 million barrels at year end 1987, and with moderate federal funding will reach 750 million barrels by the mid-1990s. These stocks are large enough to provide a cushion in the event of a short-term supply disruption, significantly reducing the adverse effects that might otherwise occur.[33]

Findings

- New Jersey has no natural resources of petroleum; all supplies of crude oil and petroleum product must be brought into the state.
- New Jersey ranks sixth highest nationally in petroleum usage and is extremely vulnerable to supply disruption.
- In New Jersey the ratio of petroleum consumption by sector to total petroleum consumption is: transportation, 59 percent; industrial, 22 percent; residential, 9 percent; commercial, 6 percent; and electric utilities, 4 percent.
- Opportunities for reducing vulnerability to supply disruptions lie in improving efficiencies in gasoline and distillate fuel usage, thereby reducing consumption.
- Becoming significantly less dependent upon imported oil will require a reduction in gasoline consumption.

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Policy

- New Jersey shall promote significantly increasing the fuel economy of cars and light trucks.
- New Jersey shall encourage Congress to triple the fill rate of the Strategic Petroleum Reserve to provide increased protection against the possibility of an interruption in imported supplies.
- Individual auto use in commuting to work should be reduced by expanding ridesharing, vanpooling and corporate shuttle busing from mass transit points to nearby work locations.
- In the event of a petroleum supply crisis, DCEED shall implement the Petroleum Emergency Energy Response Plan. (See Chapter IV-5.)

Implementation

- Several programs will be effective in reducing petroleum consumption and in improving the security of petroleum supplies. Many are related to motor vehicle use and coordinate with policies in Chapter III-3, Transportation.
- New Jersey shall urge the U.S. National Highway Traffic Safety Administration to restore the Corporate Auto Fleet Efficiency standard of 27.5 miles per gallon.
- The DCEED shall seek the support of the New Jersey Congressional delegation to fill the Strategic Petroleum Reserve to a level of 750 million barrels (MMBbl) at an increased rate.
- New Jersey shall encourage the establishment of commercial fleets using motor vehicles powered by natural gas or a combination of natural gas and gasoline. (Refer to Natural Gas in Chapter II-1-A.)
- The DOT shall discourage single-occupant motor vehicle use for commuting while encouraging greater use of van and carpooling.

DRAFT

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FOOTNOTES

1. Energy Information Administration, State Energy Data Report, 1960-1986, p. 4.

2. Ibid., p. 207,211.

3. EIA, Monthly Petroleum Supply, November 1987, pp. xvii-xxix.

4. State Energy Data Report 1960-1986, p. 21.

5. New Jersey Energy Profile Data Supplement, 1987, pp. 26-28.

6. New Jersey Energy Profile, 1987, p.30.

7. Forbes, 4/18/88.

8. New Jersey Petroleum Council, per Wall Street Journal, 3-25-88.

9. State Energy Data Report, 1960-1986, pp. 21-26.

10. State Energy Data Report 1960-1986, pp. 21, 24, 25, 207, 210, 211.

11. Monthly Petroleum Supply, November 1987, pp. xvii-xxix.

12. PADD stands for Petroleum Administration for Defense District. PAD district 1 is the East Coast from Florida to Maine plus West Virginia and all of New England. PADD II is northcentral U.S. from North Dakota to Tennessee. PADD III is the Gulf Coast from Texas to Alabama plus New Mexico and Arkansas.

13. EIA, Petroleum Supply Annual, 1986, Vol. 1, pp. 27-28.

14. Monthly Petroleum Supply, November 1987, pp. xvii-xxix.

15. Ibid., pp. xxi-xxii.

16. Light crude oil: Density value greater than 30 degrees on American Petroleum Institute (API) scale
Heavy crude oil: Density value less than 20 degrees on API scale.

17. New Jersey Petroleum Council, John Holtz, December 1988.

18. Ibid.

19. "A Practical Energy Policy for the 1990s," Speech by Congressman Philip Sharp, 10-15-87

20. On September 30, 1988 the price of the benchmark crude oil, West Texas Intermediate November contracts, closed at $13.35 on the New York Mercantile Exchange. This was the lowest price in over two years and down $5.50 from the price one year earlier. Wall Street Journal, 10/3/88.

21. Letter dated 2-18-88 from Congressman Philip Sharp, Chairman of Subcommittee on Energy and Power.

22. EIA, Petroleum Supply Annual 1987, volume 1, Table FE-2, p. xiv, xxii.

23. EIA, State Energy Data Report, 1960-1986, p. 25, 207.
NOTE: The 66 percent ratio of gasoline consumption to total transportation sector use is calculated from EIA New Jersey data. EIA has acknowledged to DCEED staff that their jet fuel consumption estimate of 39,197,000 barrels in 1986 is significantly overstated; DCEED estimates the 1986 overstatement at about 23 million barrels. Since this adjustment reduces total transportation sector consumption by a like amount, it increases gasoline's share from 55 to about 66 percent. Refer to Chapter III-3, Transportation, for a detailed explanation.

24. Car fuel economy in U.S. rose to 28.2 mpg in 1987, Wall Street Journal, 3-23-88.

25. "Here's What's at Stake in the Auto Mileage Debate," Oil Daily, 9-19-88, p. 7.

26. Star-Ledger, 9-19-88.

27. "DOT Eases Standard for Motor Fuel Economy," Oil Daily, 10-4-88, p. 3.

28. W. W. Chandler, H. S. Geller, and M. R. Ledbetter, Energy Efficiency: A New Agenda, (Washington, D.C.: American Council for an Efficient Economy, 1988), pp. 28-30.

29. Economic Intelligence Unit Yearbook, 1987.

30. EIA, Short Term Energy Outlook, October 1988, pp. 1, 3, 9.

31. EIA, Short Term Energy Outlook, April 1988, pp. 1, 7.

32. EIA, Annual Energy Outlook 1987, pp. 1-4.

33. Ibid.

CHAPTER II-1-B

Chapter II-1-C

PRIMARY ENERGY SOURCES
COAL

Introduction

Coal developed from the remains of plants that died millions of years ago. As they died, the plants formed a thick layer of matter, which eventually hardened into peat. These peat deposits became buried under sand or other mineral matter whose increasing weight changed the peat to lignite. As the pressure continued to increase, the lignite turned first into subbituminous coal, and then into still harder bituminous coal. Intense pressure in some regions converted the bituminous into anthracite, the hardest of all coals.[1]

Coal, America's most abundant fossil fuel, went from the nation's leading energy source in the late 19th and early 20th centuries to one that supplied 18 percent of total U.S. energy consumption in 1980. However, by 1986, coal's share moved upward again to 23 percent, which is approximately equal to the share for natural gas.[2]

The availability of cheap and convenient oil and natural gas shortly after World War II brought a dramatic decline in coal use in key industries. The relaxation of import controls on oil in the 1950s allowed heavy fuel oil to be used in boilers. These controls were eventually abandoned altogether in early 1973. Stricter clean air standards were passed in the 1960s, which tended to favor oil and natural gas over coal. Periodic labor strikes disrupted the flow of coal to the market, further undermining its position. Finally, by the end of the 1960s, large nuclear reactors came on line. All these factors combined to reduce significantly coal's importance in the nation's energy picture.

Consumption

At the national level coal initially lost its hold on the residential and commercial markets as oil and then natural gas usage grew. Consumption in each sector has been less than 2 percent since 1970. Coal had been gradually but continuously losing market share in the industrial sector from 1965 to 1983. However, the next four years experienced a levelling at around 14 percent of total coal consumption. But in the electric utility sector, coal doubled its share of total consumption to 86 percent as demand quadrupled between 1960 and 1987, reaching record levels.[3] (Shown in trillions of Btu in Table II-1-C-1 and millions of tons in Table II-1-C-2.)

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Chapter II-1-C

Table II-1-C-1

Coal Consumption in the United States (Trillions of Btus)

Year	Res.	Comm.	Ind.	Trans	Util.	Total
1970	153.4	217.1	4663.5	6.9	7228.0	12268.9
%	1.3	1.8	38.0	0.1	58.9	100.0
1971	144.5	203.6	3951.1	4.7	7299.2	11603.1
%	1.2	1.8	34.1	0.0	62.9	100.0
1972	111.0	156.6	3995.7	3.7	7842.5	12109.5
%	0.9	1.3	33.0	0.0	64.8	100.0
1973	105.2	148.1	4044.3	2.6	8659.9	12960.1
%	0.8	1.1	31.2	0.0	66.8	100.0
1974	103.8	151.7	3855.0	1.8	8538.7	12651.0
%	0.8	1.2	30.5	0.0	67.5	100.0
1975	84.7	123.4	3657.6	0.5	8789.3	12655.5
%	0.7	1.0	28.9	0.0	69.5	100.0
1976	82.4	120.4	3642.1	0.3	9730.7	13575.9
%	0.6	0.9	26.8	0.0	71.7	100.0
1977	83.5	121.8	3442.9	0.2	10258.7	13907.1
%	0.6	0.9	24.8	0.0	73.8	100.0
1978	84.6	129.2	3302.4	0.0	10253.4	13769.6
%	0.6	0.9	24.0	0.0	74.5	100.0
1979	73.6	114.9	3582.9	0.0	11270.3	15041.7
%	0.5	0.8	23.8	0.0	74.9	100.0
1980	60.4	87.3	3155.4	0.0	12157.9	15461.0
%	0.4	0.6	20.4	0.0	78.6	100.0
1981	70.3	96.9	3147.7	0.0	12622.9	15937.8
%	0.4	0.6	19.7	0.0	79.2	100.0
1982	75.7	111.7	2544.0	0.0	12537.8	15269.2
%	0.5	0.7	16.7	0.0	82.1	100.0
1983	75.8	117.0	2489.3	0.0	13185.0	15867.1
%	0.5	0.7	15.7	0.0	83.1	100.0
1984	82.3	126.5	2843.1	0.0	13961.6	17013.5
%	0.5	0.7	16.7	0.0	82.1	100.0
1985	69.3	107.2	2777.2	0.0	14586.4	17540.1
%	0.4	0.6	15.8	0.0	83.2	100.0
1986	69.2	107.0	2650.1	0.0	14414.4	17240.7
%	0.4	0.6	15.4	0.0	83.6	100.0

Source: EIA State Energy Data Report 1960-1986, p. 21-26

Table II-1-C-2

Coal Consumption in the United States (Millions of Tons)

Year	Res.	Comm.	Ind.	Trans.	Util.	Total
1960	17.0	24.0	177.0	3.0	177.0	398.0
%	4.3	6.0	44.5	0.8	44.5	100.0
1970	7.0	9.0	187.0	**	320.0	523.0
%	1.3	1.7	35.8	**	61.2	100.0
1971	6.0	9.0	159.0	**	327.0	501.0
%	1.2	1.8	31.7	**	65.3	100.0
1972	5.0	7.0	161.0	**	352.0	525.0
%	1.0	1.3	30.7	**	67.0	100.0
1973	5.0	6.0	162.0	**	389.0	562.0
%	0.9	1.1	28.8	**	69.2	100.0
1974	5.0	7.0	155.0	**	392.0	559.0
%	0.9	1.3	27.7	**	70.1	100.0
1975	4.0	6.0	147.0	**	406.0	563.0
%	0.7	1.1	26.1	**	72.1	100.0
1976	4.0	5.0	146.0	**	448.0	603.0
%	0.7	0.8	24.2	**	74.3	100.0
1977	4.0	5.0	139.0	**	477.0	625.0
%	0.6	0.8	22.2	**	76.3	100.0
1978	4.0	6.0	134.0	0.0	481.0	625.0
%	0.6	1.0	21.4	0.0	77.0	100.0
1979	3.0	5.0	145.0	0.0	527.0	680.0
%	0.4	0.7	21.3	0.0	77.5	100.0
1980	3.0	4.0	127.0	0.0	569.0	703.0
%	0.4	0.6	18.1	0.0	80.9	100.0
1981	3.0	4.0	128.0	0.0	597.0	732.0
%	0.4	0.5	17.5	0.0	81.6	100.0
1982	3.0	5.0	105.0	0.0	594.0	707.0
%	0.4	0.7	14.9	0.0	84.0	100.0
1983	3.0	5.0	103.0	0.0	624.0	735.0
%	0.4	0.7	14.0	0.0	84.9	100.0
1984	4.0	6.0	118.0	0.0	664.0	792.0
%	0.5	0.8	14.9	0.0	83.8	100.0
1985	3.0	5.0	115.0	0.0	694.0	817.0
%	0.4	0.6	14.1	0.0	84.9	100.0
1986	3.0	5.0	112.0	0.0	685.0	805.0
%	0.4	0.6	13.9	0.0	85.1	100.0
1987	n/a	n/a	112.0	n/a	717.9	836.9
%	-	-	13.4	-	85.8	-

Source: EIA State Energy Data Report 1960-1986, p. 21-26
EIA Quarterly Coal Report, October-December 1987, p. 47, 49
n/a not available
**Small, non-zero value

Federal legislation, regulations, and administrative orders attempted to enhance coal's position through the late 1970s. A concerted effort was made to encourage oil-burning electric generating plants to switch to coal, in order to relieve the nation's dependence on oil imports. However, a reversal of federal policy has again caused problems for the coal industry, as Washington now encourages the short-term use of natural gas, instead of coal, for electric power generation.

In New Jersey, coal consumption in the residential and commercial sectors declined from 452,000 tons in 1960 to a low of 56,000 tons in 1980, but has fluctuated since then. Coal was displaced for several reasons: fuel oil was cheap; storage and transportation options allowed fuel oil to be utilized easily; boilers were more easily maintained with fuel oil; and air pollutants were reduced. Virtually all of the coal consumed in these sectors is anthracite from eastern Pennsylvania.

Trends in the electric utilities sector differ from national statistics, with New Jersey experiencing a fluctuating but virtually unchanged consumption pattern since 1982, compared to a quadrupling of use at the national level. Most of the coal consumed the state is bituminous coal burned by the utilities to generate electricity. The utilities' share of total coal consumption rose from 55 percent in 1960 to 91 percent in 1973 and has remained in the 90 to 97 percent range since. Consumption in this sector peaked in 1966 at over 7 million tons, declined to about 1 million tons by 1972, and has generally ranged from 2 to 3 million tons annually for the last 15 years.

Coal consumption in the industrial sector has fluctuated greatly since 1970. After peaking in 1960 at 2.4 million tons, usage fell to its lowest point in 1979 at 18,000 tons. Industrial use rose dramatically in 1982 to 148,000 tons and continued to increase through 1985 when 359,000 tons were consumed.

A comparison of coal consumption in New Jersey by sector is shown in trillions of Btu's in Table II-1-C-3 and in thousands of tons in Table II-1-C-4.

Although anthracite is virtually the only type coal burned in the residential and commercial sectors, bituminous coal still accounts for over 97 percent of the total coal consumed because coal burning by electric utilities dominates total consumption. In 1987, electrical generating plants in five geographical locations burned coal. They were Atlantic Electric's (AE) B.L. England plants in Beesley's Point and its Deepwater plant near the Delaware River; the City of Vineland's (Vinel) H.M. Down plant; Public Service Electric & Gas Company's (PSE&G) Hudson facility in Jersey City and its Mercer facility in Hamilton Township.[4] PSE&G accounted for 69 percent of the 2.8 million tons of coal burned to generate electricity in 1987.[5]

Table II-1-C-3

Coal Consumption in New Jersey (Trillions of Btus)

Year	Res.	Comm.	Ind.	Trans	Util.	Total
1970	2.1	1.4	18.6	0.0	101.1	123.2
%	1.7	1.1	13.4	0.0	81.9	100.0
1971	2.0	1.4	3.4	0.0	84.7	91.5
%	2.2	1.9	3.7	0.0	92.6	100.0
1972	1.5	1.0	1.4	0.0	28.0	31.9
%	4.7	3.1	4.4	0.0	87.8	100.0
1973	1.6	1.3	2.3	0.0	60.9	66.1
%	2.4	2.0	3.5	0.0	92.1	100.0
1974	1.3	1.0	3.7	0.0	76.5	82.5
%	1.6	1.2	4.5	0.0	92.7	100.0
1975	1.1	0.7	1.6	0.0	57.2	60.6
%	1.8	1.2	2.6	0.0	94.4	100.0
1976	1.0	0.7	0.9	0.0	68.0	70.6
%	1.4	1.0	1.3	0.0	96.3	100.0
1977	1.0	0.7	2.3	0.0	67.0	71.0
%	1.4	1.0	3.2	0.0	94.4	100.0
1978	0.9	0.6	1.4	0.0	58.0	60.9
%	1.5	1.0	2.3	0.0	95.2	100.0
1979	0.7	0.4	0.4	0.0	57.6	59.1
%	1.2	0.7	0.7	0.0	97.5	100.0
1980	1.8	0.5	0.8	0.0	66.6	69.7
%	2.6	0.7	1.1	0.0	95.6	100.0
1981	1.4	1.0	0.5	0.0	72.6	75.5
%	1.9	1.3	0.7	0.0	96.2	100.0
1982	1.4	0.9	3.6	0.0	72.4	78.3
%	1.8	1.1	4.6	0.0	92.5	100.0
1983	1.2	0.8	6.8	0.0	82.8	91.6
%	1.3	0.9	7.4	0.0	90.4	100.0
1984	0.5	0.4	7.7	0.0	75.4	84.0
%	0.6	0.5	9.2	0.0	89.8	100.0
1985	1.4	1.1	8.8	0.0	92.0	103.3
%	1.4	1.1	8.5	0.0	89.1	100.0
1986	0.9	0.6	6.6	0.0	69.8	77.9
%	1.2	0.8	8.5	0.0	89.6	100.0

Source: EIA State Energy Data Report 1960-1986, p. 207-212

Table II-1-C-4

Coal Consumption in New Jersey (Thousands of Tons)

Year	Res.	Comm.	Ind.	Trans.	Util.	Total
1960	255.0	197.0	2368.0	40.0	3565.0	6425.0
%	4.0	3.1	36.9	0.6	55.5	100.0
1970	90.0	61.0	740.0	1.0	4054.0	4946.0
%	1.8	1.2	5.0	0.0	82.0	100.0
1971	85.0	58.0	145.0	0.0	3442.0	3730.0
%	2.3	1.6	3.9	0.0	92.3	100.0
1972	66.0	45.0	62.0	0.0	1107.0	1280.0
%	5.2	3.5	4.8	0.0	86.5	100.0
1973	72.0	57.0	100.0	0.0	2380.0	2609.0
%	2.8	2.2	3.8	0.0	91.2	100.0
1974	60.0	44.0	159.0	0.0	3117.0	3380.0
%	1.8	1.3	4.7	0.0	92.2	100.0
1975	47.0	32.0	67.0	0.0	2250.0	2396.0
%	2.0	1.3	2.8	0.0	93.9	100.0
1976	44.0	30.0	39.0	0.0	2604.0	2717.0
%	1.6	1.1	1.4	0.0	95.8	100.0
1977	43.0	28.0	94.0	0.0	2581.0	2746.0
%	1.6	1.0	3.4	0.0	94.0	100.0
1978	35.0	23.0	56.0	0.0	2222.0	2336.0
%	1.5	1.0	2.4	0.0	95.1	100.0
1979	28.0	18.0	18.0	0.0	2209.0	2273.0
%	1.2	0.8	0.8	0.0	97.2	100.0
1980	34.0	22.0	33.0	0.0	2545.0	2634.0
%	1.3	0.8	1.3	0.0	96.6	100.0
1981	58.0	41.0	22.0	0.0	2768.0	2889.0
%	2.0	1.4	0.8	0.0	95.8	100.0
1982	56.0	38.0	148.0	0.0	2744.0	2986.0
%	1.9	1.3	5.0	0.0	91.9	100.0
1983	50.0	34.0	269.0	0.0	3132.0	3485.0
%	1.4	1.0	7.7	0.0	89.9	100.0
1984	20.0	15.0	308.0	0.0	2853.0	3196.0
%	0.6	0.5	9.6	0.0	89.3	100.0
1985	62.0	46.0	359.0	0.0	3476.0	3943.0
%	1.6	1.2	9.1	0.0	88.2	100.0
1986	36.0	25.0	263.0	0.0	2637.0	2961.0
%	1.2	0.8	8.9	0.0	89.1	100.0
1987	n/a	n/a	n/a	n/a	3081.0	3434.0
%	-	-	-	-	89.7	-

Source: EIA State Energy Data Report 1960-1986, p. 207-212
EIA Quarterly Coal Report, October-December 1987, p. 47, 49

D R A F T

Chapter II-1-C

Challenges to use of coal

Significantly increased use of coal in New Jersey would face major challenges on two fronts: chronic and acute air pollution problems and required infrastructure improvements.

Air Pollution, Acid Deposition, and Clean Air[6]

Burning coal causes production of pollutants, including sulfur oxides (chiefly SO_2) and nitrogen oxides (generally referred to as NO_x). The former can be controlled by using low-sulphur coal, precombustion separation, and exhaust "scrubbing." The latter is controlled by temperature of combustion. As noted in Chapter IV-4, utility boilers are significant NO_x and SO_2 sources in New Jersey and elsewhere.

Coal burning affects air quality. The majority of coal burned in New Jersey in recent years has been low sulfur bituminous coal because of the state's air pollution control regulations. PSE&G, the major consumer of coal in New Jersey, burns 1 percent sulfur coal: AE burns 3 percent sulfur coal; Vinel burns 1.5 percent sulfur coal. The anthracite coal, which makes up the remaining consumption, is generally less than 1 percent sulfur. In 1980, utility emissions of sulfur dioxide (SO_2) were estimated at 110,000 tons, half of which resulted from the burning of coal.

Legislation proposed by the 100th Congress in 1987 would have affected the coal mining industry by requiring the reduction of emissions of sulfur dioxide and nitrogen oxide from the burning of fossil fuels. This legislation did not pass. However, the House and Senate approved funding for fiscal years 1988 and 1989 for the Clean Coal Technology Program.

The exact effects of acid rain and methods to cure these problems have continued to be debated in the 100th Congress. The term "acid rain" encompasses a variety of air pollutants and their effects. Acid rain, also called acid precipitation or acid deposition, is precipitation containing harmful amounts of nitric and sulfuric acid that form when sulfur and nitrogen oxides are released into the atmosphere as a result of fossil fuels being burned. Other components include dry deposition, gaseous forms of sulfur dioxide (SO_2) and nitrogen oxides (NO_x), ozone, and trace metals. Therefore, acid rain is potentially a multiple pollutant problem, and policy issues are sometimes divided on whether to address SO_2 and NO_x first or to address all airborne pollutants as a package.

Many of the amendments to the Clean Air Act introduced by the 100th Congress have been of a regulatory nature and usually target utility emissions and emissions from certain boilers. Senate Bill S. 95, a typical proposal, would require reduction in SO_2 of 12 million tons per year below the actual 1980 emission levels, of which 10 million tons would be from utilities. This bill would also require a 3 million ton reduction in NO_x levels by the mid-1990s, including emissions from mobile sources. Most of the bills of a regulatory nature differ mainly in the amount of the sulfur dioxide reduction and in the time frame allowed for compliance.

Some in Congress have focused their attentions on the development and demonstration of more cost-effective technologies to burn coal more cleanly. House bill H.R. 3632 would require an annual reduction in SO_2 of 8 to 10 million tons below the 1980 level and a 3 million ton reduction in NO_x.

Acid deposition is a major international concern and has continually been an issue between the United States and Canada. In January 1986, Special Envoys Drew Lewis (United States) and William Davis (Canada) issued a joint report on their efforts to assess the acid rain problem affecting the United States and Canada. Their report recognized acid rain as a serious environmental problem for both nations and acknowledged that only a limited number of potential avenues exist for achieving major reduction in acidic air emissions, all carrying high socioeconomic costs.

The White House announced on March 18, 1987, a three-point program to carry out the envoys' recommendations. The three steps include: (1) a request for $2.5 billion, to be matched by industry, for Clean Coal Technology and Innovative Control Technology programs over the next five years; (2) an advisory panel to help the Secretary of Energy select innovative control technology projects for funding; and (3) a Presidential Task Force on Regulatory Relief to review federal and state economic regulatory programs.

In the long term (5-20 years) increased concern about "greenhouse gases" may limit utilization of coal; carbon dioxide, a major product of combustion, is increasing steadily in the atmosphere. Because CO_2 absorbs infrared radiation from the earth, its accumulation may cause global warming. The ratio of carbon to hydrogen is very high in coal (relative to petroleum and natural gas) and much more CO_2 per Btu of energy is produced from coal than from alternative fuels.

Emerging Technologies

Clean Coal Technologies

The acid rain debate in the past several years provided an impetus for the development of new clean coal technologies, which should contribute eventually to increased coal use and environmental quality. Public Law 98-473 established the clean coal technology program in 1984. In late 1986, the U.S. Department of Energy (USDOE) issued a second round of solicitation for proposals using new clean coal technologies primarily to retrofit or repower existing facilities. Congress appropriated $50 million and $525 million for fiscal years 1988 and 1989, respectively, to fund the second round of clean coal projects.[7]

The USDOE was asked to submit two reports to Congress. The first report, submitted on March 6, 1987 summarized the number, nature and content of the responses. The second report provided analyses of the commercial viability of the proposed technologies.[8] We infer from these reports that emerging technologies can overcome the environmental problems which have limited coal's use in the past.

Fluidized-bed Combustion Technology[9]

Because of their ability to capture SO_2 and their economic advantage in low-grade fuel usage, fluidized-bed combustors (FBCs) are making significant contributions to the U.S. industrial energy picture. This technology, though not new, is gaining prominence in the United States as a possible answer to some of the environmental problems of coal combustion.

During combustion, FBCs capture the sulfur dioxide by forming calcium sulfate, a dry material that is easier to dispose of than wet scrubber sludge. In addition, because of lower combustion temperatures and *in situ* chemical reactions, nitrogen oxide formation is minimized.

Fluidized-bed combustion simply means burning fuel on a fluidized bed. In the firebox of a conventional boiler, fuel burns either on a grate or in midair in a cloud of flame. In a fluidized-bed combustor, the bottom of the firebox is filled with inert granular particles of sand, limestone, or ash. Air blown up through orifices in the floor of the firebox makes the particles into a fluidized bed. As it burns, the fuel, although it may be less than 1 percent of the material in the bed, can nevertheless make all the inert particles red hot. The surface of the bed looks like bubbling molten lava. Because the turbulence of the churning bed stabilizes the temperature, the bed does not heat up or cool down suddenly. The direct contact of the flowing particles transfers heat within the bed, and from the bed to the surrounding walls or boiler tubes. This direct contact allows a higher rate of heat transfer than possible in a conventional boiler, due to the presence of a large body of hot, solid material. Even very low-quality fuel can be burned, such as low-grade coal, urban refuse, or even wet sludge, which could not be burned in conventional fireboxes.

The FBC method can produce usable energy from coal with reduced atmospheric pollution and acceptable costs. FBCs offer a greater versatility in design than conventional boilers. They also operate at lower temperatures (1,500 to 1,650 degrees Fahrenheit for FBCs versus 2,500 to 3,000 degrees for conventional boilers), which tends to alleviate the problems of NO_x formation and ash slagging that occur at higher temperatures.

Sulfur oxides formed during coal combustion contribute to an increasing environmental problem. Historically, these noxious compounds (sulfur dioxide and sulfur trioxide) were discharged through the boiler stack to the atmosphere. In recent years, however, federal and state regulations require the control of these emissions to acceptable levels.

FBCs achieve this level of control by chemically capturing these compounds before they exit the boiler. Crushed limestone or dolomite is injected into the combustor along with the coal to be burned. As the coal is burned, the sulfur oxides combine with the calcium from the limestone or dolomite to form an environmentally acceptable compound called gypsum (calcium sulfate). As much as 90 percent of the sulfur present in the coal can be captured in this way. Thus, a bituminous coal containing 3 percent sulfur can be burned in an FBC with atmospheric emission of 0.6 pounds of SO_2 per million Btu, which is within the requirements of the EPA New Source Performance Standards (NSPS) for utility applications. This cleanup can be achieved without scrubbers. Similarly, FBCs have been demonstrated to operate with NO_x emissions below 0.6 pounds per million Btu, also within the NSPS for utility applications.

In 1977, the newly created USDOE assumed the responsibility for the fluidized-bed combustion program. In the 1980s, while USDOE continues to sponsor development, the emphasis is no longer on funding demonstration plants but on technology transfer and commercialization.

Atmospheric Fluidized-Bed Combustion: There are two major types of atmospheric fluidized-bed combustion (AFBC) systems, bubbling-bed and circulating-bed systems. The bubbling bed consists of a boiler coupled to a combustion chamber that is modified to accommodate the fluidized bed.

The circulating-system fluidized-bed design goes a step further. This design actually induces solids to escape the combustion area and recycles them into the combustion chamber.

Pressurized Fluidized-Bed Combustion: The pressurized fluidized-bed combustion (PFBC) system also contains in-bed boiler tubes to generate steam, which turns a turbine. In contrast to the AFBC, the combustion gases are at higher temperature and pressure (in excess of 10 atmospheres). The PFBC system uses those pressurized, high-temperature combustion gases not only to generate steam but to drive a gas turbine to generate additional power. The merger of a gas turbine with the steam turbine results in a combined cycle arrangement.

Combustion gases, cleaned by a series of high temperature dust separators (usually cyclones), drive the gas turbine. The turbine in turn drives both an air compressor (to pressurize combustion air for the fluidized bed) and a generator (to produce electric power). Gases exhausted from the gas turbine contain considerable heat, and this heat preheats feedwater for the steam-turbine cycle. The preheated feedwater is then sent to tubes within the fluidized bed where it evaporates to steam.

Typically, one-quarter of the electric generation in PFBC comes from the gas turbine, with the balance coming from the steam turbine. The combined-cycle feature of PFBC yields more efficient generation of electricity than with either an AFBC system or a conventional coal-fired unit.

PFBCs are inherently modular, so new capacity can be built in increments as demand grows; thus, they can reduce capital costs without the economic risks of building larger conventional coal-fired plants. Some manufacturers, architects, and engineers claim that the modular feature and the smaller size of the PFBC plants allow a 25 percent shorter construction period than for conventional coal-fired units.

Atmospheric fluidized-bed combustion systems are widely used. Of the two types of AFBC's, bubbling-bed systems are widely used in smaller plants; circulating systems prevail in larger industrial applications, where they are more economical than bubbling-bed systems. The pressurized fluidized-bed system is complex to build and too costly for all but the largest companies.

In the past, utilities showed little interest in fluidized-bed systems, because the technology had not been demonstrated on a large (i.e., utility) scale. FBCs must compete with traditional combustors in the utilities' boiler market. However, this trend could change in the next five to ten years, as experience is gained from projects recently begun.

Of all the coal, oil, gas, and nuclear units in the United States, 18.5 percent are more than 30 years old and 10.6 percent are more than 40 years old. In view of this situation, FBC boilers could soon come into widespread use. The future for FBCs in the United States looks promising in the large industrial boiler sector, where FBCs currently account for 25 percent of its coal burning capacity, or about 20 million short tons of coal per year. In the small industrial boiler sector, however, FBCs are usually not as economically attractive.

Outlook[10]

According to the U.S. Energy Information Administration (EIA), coal production is expected to continue its growth for the rest of this century. By the year 2000, coal's share of total U.S. energy production may exceed 37 percent--up from 31 percent in 1987. In addition, coal will account for a slightly larger share of domestic consumption, up from 24 percent in 1987 to more than 25 percent, if the fraction of energy needs met by electricity continues to grow. Nevertheless, several factors might impede future growth.

If some current proposals to control acid rain are implemented, the cost of generating electricity from coal would rise--particularly in the industrial Midwest, which is most dependent upon coal for its power requirements. Whether the controls take the form of a tax on sulfur dioxide emissions, a ban on emissions beyond certain levels, or some combination of these and other measures, the coal market is likely to be affected adversely. However, clean coal technology could emerge as an economically attractive alternative to current generating technologies, thus helping to solve the emissions problem in a way that permits this country to rely more heavily on coal.

No new orders for nuclear plants are expected within the forecast horizon. Nevertheless, the additions to nuclear capacity that are now scheduled to come on line over the next five years are expected to reduce the share of coal in supplying baseload electricity during that time. Coal will continue to be a major supplier of baseload electricity demand. However, as the planned additions to nuclear capacity end after 1995, coal's chief competition will begin to come from natural gas in combined-cycle units. Even though gas units are expected to provide the majority of new capacity in the post-1995 period, existing coal plants are expected to be utilized even more fully as demand for electricity increases to the year 2000.

Lack of growth in U.S. heavy industry (such as steel and automobile manufacturing) is expected to have a depressing effect on the growth rate for coal.

Industrial demand for energy in general is likely to fall as energy-intensive industries move abroad and the domestic economy continues its transformation from one based on heavy manufacturing to one that is oriented more toward service and light industry. There seems to be no reason why residential and commercial demand for coal will not continue its slow decline.

The minemouth price of coal is expected to increase modestly between 1987 and 2000, at an annual rate of 1.4 percent. This increase contrasts with the sharp declines between 1980 and 1986, when excess production capacity caused real prices to drop at an annual rate of more than 5 percent. The prices of coal to end-users (especially electric utilities) are expected to climb somewhat more rapidly than minemouth price. End-use prices will increase primarily because of higher transportation costs, which are fueled in turn by higher world oil prices. Nevertheless, coal prices should rise less than those of any other major fuel between 1987 and 2000, widening the cost advantage of coal over petroleum and natural gas, especially for electric utilities.

Findings

- Ninety percent of coal use in New Jersey is in the electric utilities sector; almost all other use is in the industrial sector.
- Coal use is highly concentrated in applications generally amenable to fuel-switching.
- Coal use could increase inexpensively if other fuels were unavailable.
- The cost of coal is competitive with other fuels.

- New Jersey's utility plants that burn coal have limited environmental controls and therefore adversely affect air quality.

- Coal use faces other environmental challenges; greater CO_2 production relative to energy output, ash disposal, etc.

Policy

- The use of coal in New Jersey shall continue but in an environmentally acceptable manner.

- New Jersey shall support clean coal technology research and development.

- Coal shall be allowed to compete unhandicapped with other fuels, including natural gas. The market shall decide the relative values of the attributes of coal and gas, with the environmental costs fully internalized.

- DEP, BPU, and DCEED shall explore means to internalize and thereby allocate to users the environmental cost of producing electricity from coal and should rate these policies treating electricity from out of state on the same terms as New Jersey generation.

Implementation

- DEP should develop an effective coal waste disposal program to enable continued coal use by the electric utilities.

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Chapter II-1-C

FOOTNOTES

1. V.K. Mathur, Coal Power, Its Promises and Problems, in Energy Sources, Ed. by Louis Klotz, (Durham, NH: University of New Hampshire, 1980), p. 3.

2. Energy Information Administration, State Energy Data Report, 1960-1986, p. 21.

3. Ibid.

4. Mid-Atlantic Area Council (MAAC), Bulk Power Supply Program, 4/1/88, Section II-A.

5. New Jersey Monthly Energy Profile, 12/87, pp. 22, 25.

6. EIA, Quarterly Coal Report, October-December 1987, p. 5.

7. EIA, Annual Outlook for U.S. Coal 1988, September 1988, p. 22.

8. EIA, Annual Outlook for U.S. Coal 1987, May 1987, p. 22.

9. Ibid., pp. 25-31.

10. EIA, Annual Energy Outlook 1987, March 1988, p.14.

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Chapter II-2

ELECTRICITY

Introduction

Historical Perspective

The United States electric power industry had its beginning in the late 1800s when Thomas Edison formed the Edison Electric Illuminating Company in New York City with a power load of about 10 KW serving 85 customers. From this small plant, the industry has grown to where it now has a generating capacity of over 650,000 MW. The electric industry forecasts the need to add over 75,000 MW of additional capacity between 1988 and 1997.[1]

The electric industry has grown to a system comprising about 3,400 utility companies that furnish electric power to more than 80 million households, commercial establishments, and industrial operations. While electricity heats about 30 percent of the nation's households, other more diversified uses of electricity have also been developed such as mass transit railways, complex computer systems that perform vital functions, and sophisticated communication systems.

To meet the demand of consumers, in 1988 the electricity suppliers used the following fuels (percent total): nuclear (20.2 percent), coal (54.3 percent), hydro (9.5 percent), oil/gas (12.8 percent), nonutility generation (2.1 percent) and other (1.1 percent). The projected use in electric energy production by fuel for 1997 is: nuclear (20.8 percent), coal (52.1 percent), hydro (8 percent), oil/gas (12.2 percent), nonutility generation (5 percent), other (1.9 percent) (Figure II-2-1).[2]

Historically, the growth in electric energy paralleled the growth in gross national product (GNP) until about 1970 (Figure II-2-2). This growth in energy use was primarily influenced by the electrification of the country, which began in earnest after 1945. As the price of other fuels increased, the cost of electricity remained relatively low (Figure II-2-3). This economic competitiveness was further improved by the increase in the heat rate at which power plants generated electricity and by the advantage gained in building large generating facilities (Figure II-2-4).

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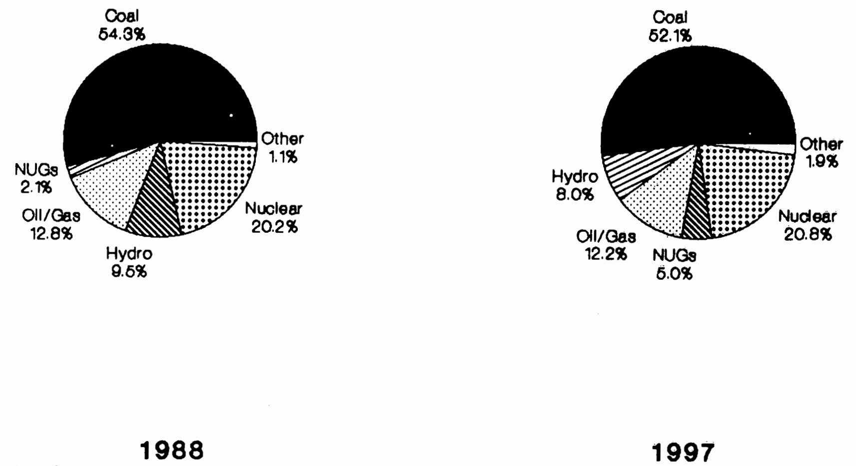
Chapter II-2

Figure II-2-1

ELECTRICAL ENERGY PRODUCTION BY FUEL



SOURCE: National Electric Reliability Council
1988 Electricity Supply and Demand for 1988-1997

Figure II-2-2

ENERGY CONSUMPTION vs GNP

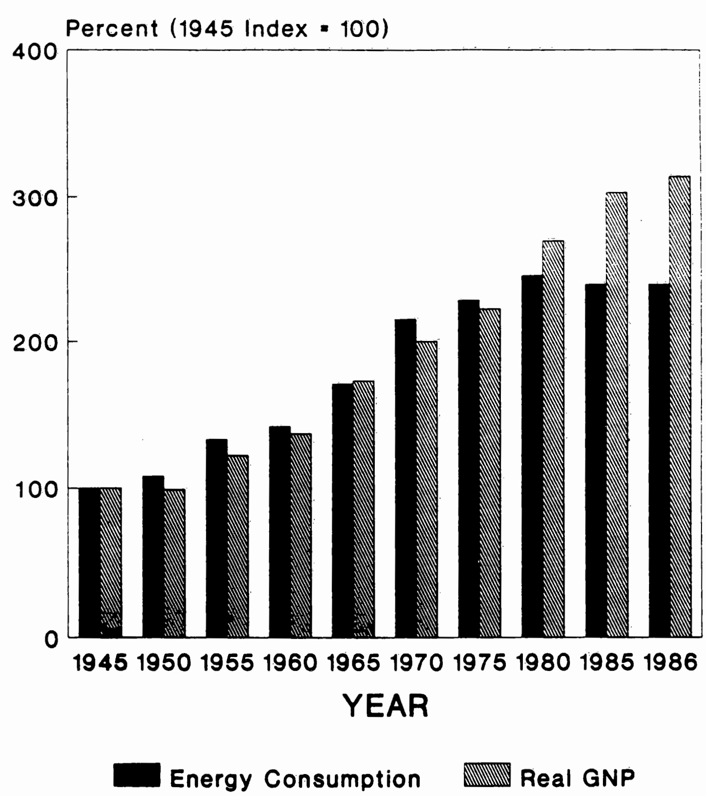


Figure II-2-3

ENERGY PRICES
1945 Index = 100

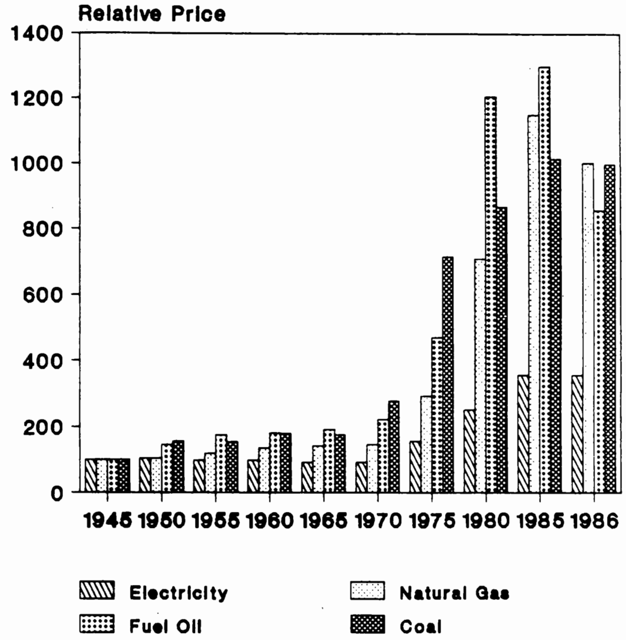
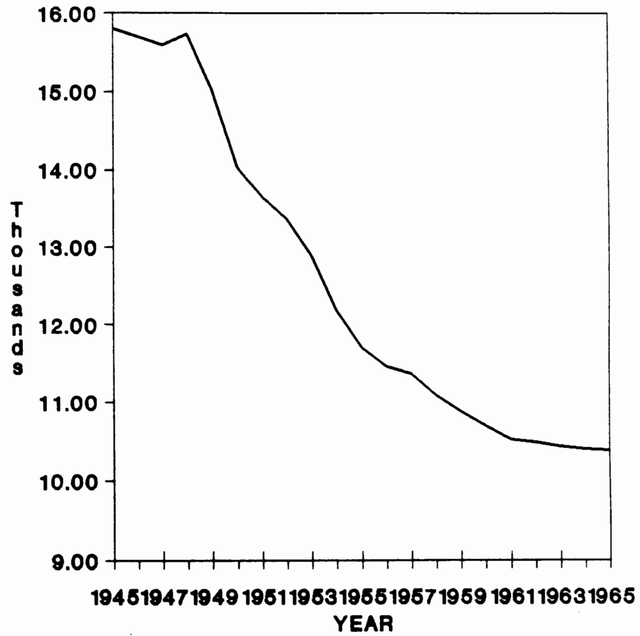


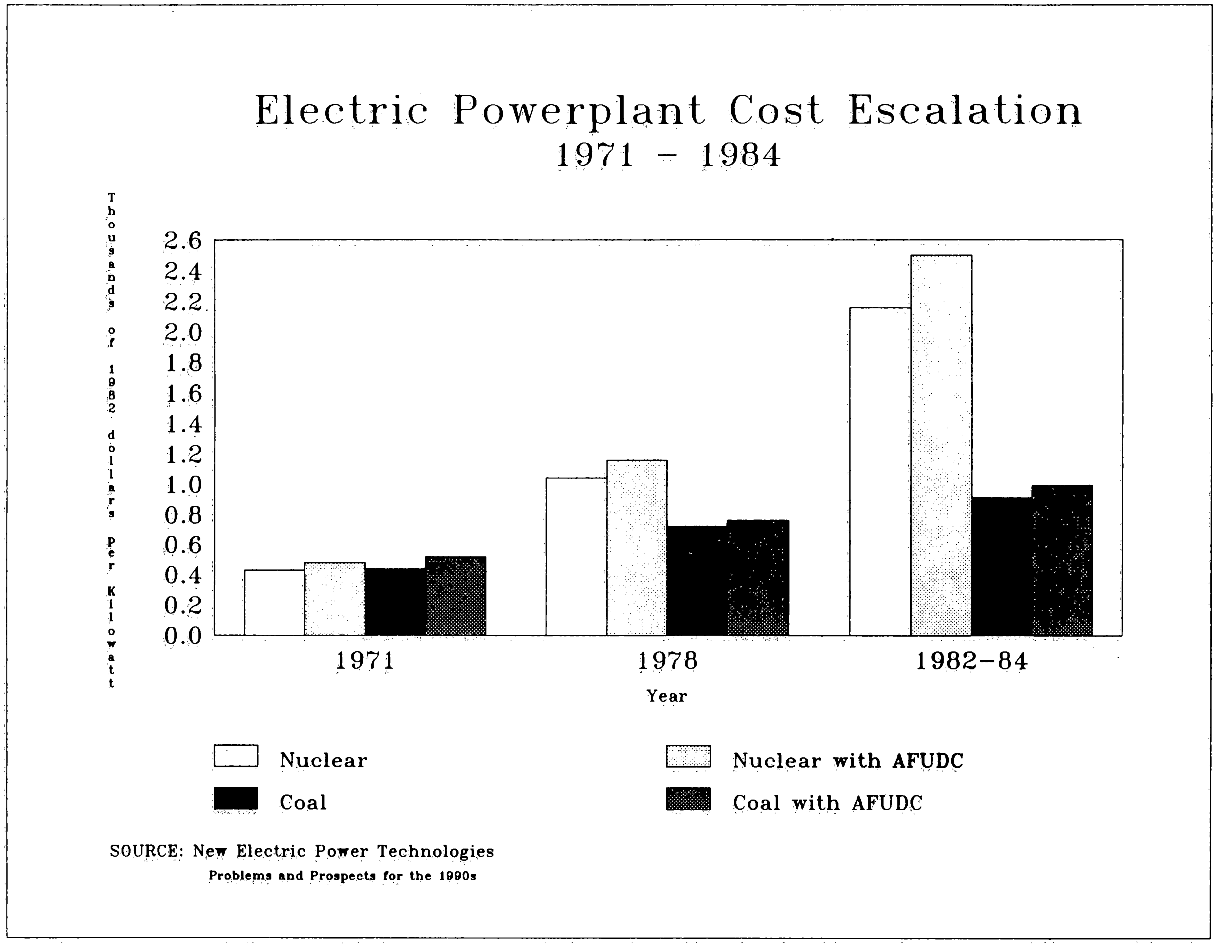
Figure II-2-4

HEAT RATE
btu/kWh



During the 1960s the peak demand grew at a compounded growth rate of over 7 percent. In order to meet the continually increasing peak demand, utilities began to plan and construct large baseload plants. In 1971 the full cost of both coal and nuclear plants ranged between $400 and $500 per KW (Figure II-2-5).

Figure II-2-5



However, due to the passage of the Clean Air Act of 1970, utilities relied more on building nuclear plants than coal-fired plants in the belief that nuclear plants could be operated in a safe and environmentally acceptable way.

The 1973-1974 Arab oil embargo caused an unprecedented change in the operation of the electric power industry. Forecasts of electric demand growth and costs, based solely on past trends, proved virtually useless.

Utility executives found themselves caught in a complicated and uncertain maze of financial, regulatory, and technological considerations.

On average, utilities paid 240 percent more for oil and 385 percent more for natural gas in real dollars in 1984 than in 1972. Due to these price escalations, the utilities began to "back out" oil and gas use and intensified development of coal and nuclear plants. On a nationwide basis oil dropped from 16 to 5 percent in the utility fuel mix and gas from 22 to 12 percent between 1972 and 1984.

Meanwhile construction costs of new power plants, particularly nuclear, rose dramatically during this period due to increased attention to environmental and safety issues that extended construction lead times and added equipment costs, the changing regulatory environment, inflation-driven doubling of the cost of capital, and poor management.[3]

In 1979, the accident at Three Mile Island Unit 2 essentially sounded the death knell for nuclear power in this country. Following the accident, the Nuclear Regulatory Commission imposed a moratorium on the licensing of nuclear reactors. In addition, the NRC required retrofitting commercially operating reactors to take into account the lessons learned at TMI. As a result, utility costs started to escalate in the late 1970s.

While in the late 1940s and 1950s utilities were seeking reductions in rates, for the first time in the 1970s utilities sought higher rates. Additionally, most utilities seriously misinterpreted the price elasticity of electric demand, the relationship between a change in price and change in use. Growth in demand dropped from 7 percent a year to less than 2.5 percent by the end of the decade, as consumers used electricity more efficiently. As shown in Figure II-2-2, the ratio of electric use to GNP started to drop after the 1979 Iranian crisis. Between 1975 and 1986, electric use per customer grew almost 7 percent (Table II-2-1) while real GNP grew at slightly more than 41 percent (Figure II-2-2), signifying that the economy produced more goods and services with fewer kilowatt hours.

These lower growth rates in peak and energy brought some electric utilities to the brink of bankruptcy when forced to cancel large, unneeded power plants. The combined effects of erosion in revenue base and declining demand growth, coupled with the increasingly costly construction programs already underway, left the industry struggling financially as bond ratings and stock prices fell precipitously. Since 1972, 117 United States nuclear power plant orders have been cancelled, and every project on which construction started after 1973 was eventually cancelled.[4]

Table II-2-1

Price & Usage Total Electric Utility Industry
1965-1986

Year	GNP Deflator	Electric Usage Per Customer (kwh)
1965	81.3	14694
1966	84.0	15678
1967	86.5	16384
1968	90.4	17445
1969	94.9	18563
1970	100.0	19380
1971	105.1	19956
1972	109.5	20964
1973	115.8	21955
1974	127.4	21488
1975	139.3	21417
1976	146.4	22361
1977	155.0	23052
1978	165.3	23315
1979	179.4	23481
1980	196.1	23067
1981	214.5	23026
1982	227.4	22197
1983	236.3	22479
1984	245.3	23152
1985	253.4	22903
1986	260.0	22925

After the accident at Chernobyl in 1986, public concern about nuclear power safety increased. While many countries continue to pursue aggressive nuclear power plant construction programs, here in the United States there have been no new orders since 1978.[5]

At the inception, nuclear power was thought to have indisputable advantages over other forms of energy in its production cost. Today even nuclear power supporters are beginning to question its economic viability. The capital cost of constructing new nuclear power plants has skyrocketed since the early 1970s. The installed cost of nuclear generation per KW has increased from $388 in 1971 to $2,693 in 1985. With inflation factored out, the real increase is approximately sixfold.[6] Utility executives are now following a path of capital minimization. The Data Research Institute (DRI) has forecast utility spending to decline from $26.4 billion in 1988 to $24.3 billion in 1990.[7] This decrease in spending extends even to those utilities that are experiencing growth in their service areas and have excess cash relative to their capital expenditure programs.

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During the late 1960s in response to the increasing growth in peak load and energy, New Jersey electric utilities followed the national trend--construction of nuclear power plants. At one time, New Jersey utilities planned to build more than 10 nuclear reactors. Siting plants offshore or on an artificial island were among the proposals. However, most of these projects never reached fruition.

As a result of the TMI accident, which threatened bankruptcy, JCP&L cancelled its Forked River unit after an expenditure of $384 million. PSE&G's Hope Creek 1067 MW Unit No. 1 came on line at the end of 1987 with a price tag of $4.5 billion or $4,200/KW. Over $1.2 billion of this cost was due to interest during construction. Originally conceived in 1968 when growth in electricity had averaged 7 percent per year, Hope Creek was to have included two 1,000 MW units and cost $500 million total. Faced with the cash demands of building both units, PSE&G cancelled Unit No. 2 in 1983 after spending $300 million. At the time the decision to cancel was made, electricity growth rates had dropped closer to 2 percent, with little increase forecast for the next decade. Presently, only 4 reactors are operating in New Jersey, although the state's utilities have part ownership in three reactors out of state (TMI-1 and Peach Bottom 2 & 3).

In 1987 and 1988, however, electricity use and peak demand increased. Forecasters did not expect the peaks experienced in 1988 until at least the year 2000.[8] Two separate stretches of extremely hot, humid weather caused voltage reductions on June 22 and August 15 as the state's utilities were unable to obtain relief normally available from other power pools.

Regulatory Overview

Structure

Electric utilities across the country have a similar structure. A single entity--the electric utility company--owns and operates generation, transmission, distribution, and customer service facilities.

This vertical integration has characterized investor-owned electric utilities but is not the only model extant. In some regions much power is generated by public agencies (e.g., Tennessee Valley Authority, Bonneville Power Authority, Power Authority of the State of New York) for sale by other public agencies (e.g., rural electrification co-ops, municipal power companies) or private companies.

In contrast, the gas industry (Chapter II-1-A) is traditionally less integrated, with producers, transporters (pipeline companies), and local distribution companies. Parenthetically, the divestiture of AT&T represents a shift of telecommunications from electric-like vertical integration to gas-like layering, in response to pressures to allow more competition. The current regulatory framework under which New Jersey's utilities operate evolved between 1907 and 1920, paralleling developments in other states. Enabling legislation was enacted in New Jersey in 1911.

Chapter II-2

Federal

In 1935, the federal Public Utility Holding Company Act (PUHCA) modified the entire regulatory system. The act was designed to end abuses and subsequent collapses associated with the labyrinth-like utility holding companies of that era. Evolution in the regulatory arena resulted in a reliable electric utility industry whose capital base was rivaled only by the real estate industry.

In addition to the constraints imposed by PUHCA, several federal agencies also have regulatory responsibilities. These include the Federal Energy Regulatory Commission (FERC), the Securities and Exchange Commission (SEC), and the Nuclear Regulatory Commission (NRC).

The 1935 PUHCA requires that electric utilities classified as holding companies register with and follow the anti-trust and regulatory rules of the SEC. The holding company must therefore operate a single integrated utility system and maintain relatively simple corporate and financial structures. The acquisition and sale of securities and assets are governed by SEC rules. In addition, the SEC regulates internal operating practices, proxy solicitations, contracts for services, sales, and construction. While not a direct regulator, the Financial Accounting Standards Board (FASB) has accounting representation and presentation oversight over the public accounting profession, and thereby influences reporting requirements.

The FERC approves and sets standards of sale for interstate transactions (usually wholesale); administers the Public Utilities Regulatory Policies Act (PURPA), which concerns small power producers and cogenerators; and approves rates related to the Federal Power Marketing Administration.

The regulatory system tries to balance economic efficiency with the need for adequate and reliable service for ratepayers and equity for shareholders. The regulatory mechanism attempts to approximate what would occur in a competitive market.

New Jersey

The Department of Commerce, Energy and Economic Development, Division of Energy Planning and Conservation, is by law the state's lead energy planning and policy agency with three primary responsibilities: 1) energy emergency planning for all forms of energy including electricity; 2) coextensive energy policy responsibility throughout all state agencies; and 3) explicit statutory authority to issue certificates of need for electric power facilities larger than 100 MW.

In New Jersey, the Board of Public Utilities (BPU) is the agency charged with economic regulation of the state's utilities. Under the theory of ratemaking, the BPU uses four criteria to determine the fair rate of return on utility investment. First, the BPU determines what utility assets provide the service for which rates are charged, generally applying the "used and useful" criterion. These assets make up the rate base, upon which the fair rate of return will be earned. Second, the BPU determines the ratio of debt and equity that will permit the utility to earn a fair return on its rate base. Third, the BPU calculates the operating expenses that consist of maintenance, taxes, wages, fuel, depreciation, and insurance. Finally, the BPU calculates the gross revenue requirements, which is the sum of the first three items. It also determines the prudency and extent of all utility investment, relying upon rate regulation as a proxy for competition in a regulated market.

Until the 1985 PSE&G rate case (BPU Dkt. No. ER8512-1163), ratemaking or rate design generally was based upon the tenets of "full rate base treatment" of traditional regulation. However, with the company seeking to include Hope Creek in its rate base, the BPU was forced to consider alternatives to full rate base treatment. For new facilities, today's options for ratemaking are as follows:[9]

1. Under full rate base treatment or traditional regulation, the full, prudently-incurred cost of a new facility is placed into rate base while operating income reflects the operating, maintenance, depreciation, and fuel costs. With this method of ratemaking ratepayers see an immediate large rate increase with the largest amount of the facility paid for in the first year of operation.

2. Under phase-in, the rate impact or increase is lower, as the rate impact is "phased-in" over a specified time period.

3. Avoided cost treatment is yet another proxy for competition in a regulated environment. In economics, avoided cost is the cost of producing or purchasing an additional unit of any commodity. In the electric industry, that commodity could be additional electricity necessary to meet customer requirements. The utility can either construct a new facility or purchase power/energy from some other source, including a nonutility.

   Note: Each utility's avoided cost is determined through a system planning process and calculated by differential revenue requirement method. The avoided cost, also known as the cap, is the highest cost a utility is willing to pay for new capacity from any qualifying facility.[10]

4. Variable avoided cost is the riskiest method of ratemaking since actual avoided costs are determined after the electricity has been supplied and, therefore, revenues cannot be guaranteed.

5. Another approach is the levelized (fixed) avoided cost, which guarantees a fixed cost per kwh for a predetermined amount of electricity, independent of the actual avoided costs. A single ¢/kwh value is calculated by "levelizing" the projected avoided costs over the length of a contract with the same "present value" if paid over the contract period. Levelization

effectively shifts some of the higher, later avoided costs to earlier time frames. Above the fixed energy threshold, the cost of electricity supplied is variable to track actual avoided cost changes.

Levelized avoided cost with minimum payment is a rate treatment that guarantees a certain revenue level, the minimum payment, regardless of the amount of electricity produced. The minimum payment is calculated as the value of the electricity produced at a facility operating at a specified capacity factor (electricity produced divided by installed capacity times 8760 hours). The minimum payment applies even if the facility operates below the specified capacity. The minimum payment can be "indexed" to track changes in operation and production costs, while the variable energy payment can be adjusted for changes in an index such as the PJM billing rate.

6. <u>Avoided cost with planning assumptions</u> is simply a method by which avoided, basically energy, costs are shifted to the time period the facility actually begins commercial operation.

Prudency review and performance standards have fundamentally changed the New Jersey regulatory environment, without discarding the underlying rate-base, rate-of-return regulatory structure. The combined effects have helped make utilities more cautious about large-scale capital expenditures and independent power production more acceptable to meet customers' needs with lower risk, albeit with lower profit opportunities.

Today's changing regulatory climate in New Jersey was accelerated by Governor Kean's Executive Order of March 9, 1987, which established a task force charged with analyzing electricity prices and exploring methods to introduce market-based incentives to encourage least-cost, reliable electric service. The Task Force on Market-based Pricing of Electricity has recommended for further consideration and study a new approach based on a system of caps on retail rates. However, not yet ruled out are other approaches being considered across the country, such as structured competitive bidding and unbundling of generation from distribution.[11]

In addition, alternative power producers, which include cogenerators, independent power producers, QFs, and self-generators, continue to make inroads into the formerly traditional area of electricity generation. Electric utilities now find themselves competing with the independents, a situation that only a few short years ago did not exist.

Commentary

According to Edward Kahn,[12] prior to 1970 the electric utility industry experienced tremendous growth resulting from the economies of scale in supply as well as demand. As the markets for electricity increased, plants became larger and more efficient, which lowered cost and resulted in more growth. The larger plant sizes require transmission and substation facilities and, therefore, capital costs not necessary for the smaller, localized plants. This capital or fixed cost, when spread over the amount of electricity generated, is essentially the same for large and small plants. However, overall operating, or variable, costs are reduced dramatically. These reductions are associated with improved combustion efficiency, lower fuel costs for larger quantities purchased, and decreased labor requirements for maintenance and operation at the larger, centralized plants.

In general, electric utilities are allowed to operate as monopolies, based on the theory that it is more efficient (and in the public interest) for one company to serve a designated area than several competitors. A single utility thus avoids redundant facilities while regulation is intended to guarantee ratepayers reasonable rates and reliable service.

In order for this utility concept to work, a "franchise" to serve all customers within the designated area is granted. The utility can neither discriminate between like customers nor charge different rates for identical service. The utility is allowed to install its equipment, using local streets and existing and/or new rights-of-way. While its facilities are exempted from real estate taxes, the utility pays a franchise tax and is required to provide a certain level of service and to set prices at a reasonable level.

Current Electric System

PJM

Pennsylvania-New Jersey-Maryland Interconnection (PJM), is the country's oldest integrated power pool. PJM comprises eight investor-owned utility systems and operates as a single system to meet the needs of the Mid-Atlantic area, which includes most of Pennsylvania, almost all of New Jersey, Delaware, the District of Columbia, more than half of Maryland and a portion of Virginia (see Figure II-2-6). PJM serves some 21 million people in an area of just under 49,000 square miles, utilizing over 6,300 miles of bulk power transmission lines.

PJM, from its control center in Valley Forge, Pennsylvania, coordinates the operation of the entire system and dispatches the lowest cost electricity to wherever it is needed. The most economical units required to meet PJM loads are selected on the basis of information provided by the member companies on unit cost and availability of generating units. The electricity produced by the generating units is transported over the bulk power transmission system. Real time monitoring and security analysis programs prevent unsafe conditions that could result as PJM-scheduled generation and interchange with other power pools vary with load.

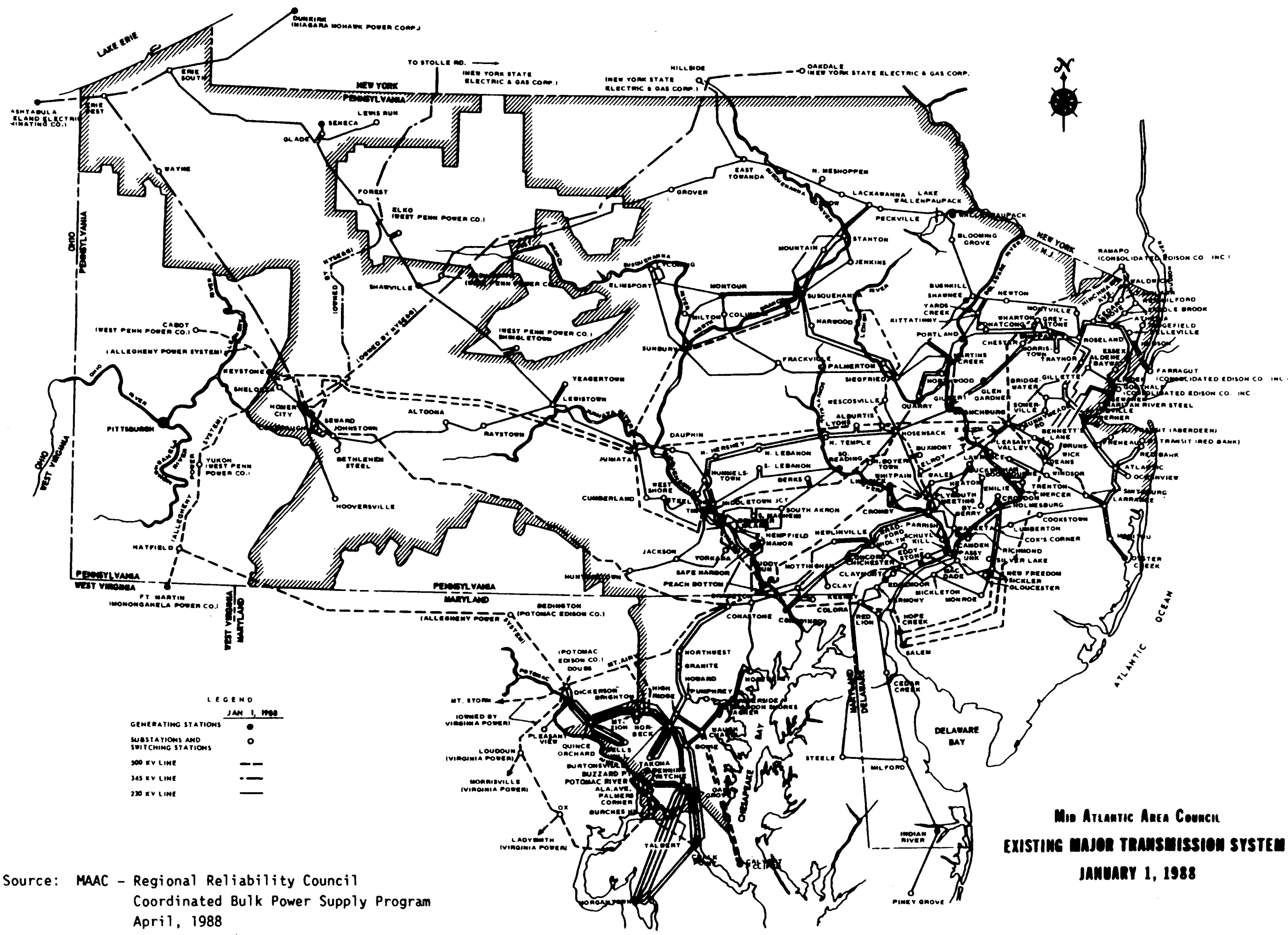
Electricity is produced by the most economical units operating at all times, irrespective of their location or ownership, and transmitted to the demand centers using all available transmission paths. The PJM

Interconnection Office is responsible for providing overall reliability and economy of service as well as accounting for the hourly energy interchange among member systems and scheduled transactions between PJM and neighboring power systems.

If each member were required to have sufficient reserve to meet its own peak demand, each utility's generating capacity would have to be higher than it is with access to PJM power. Operating as a single system, members can rely on the capacity of transmission ties between each other and neighboring systems and pools to meet demand. Therefore, a member incurring a loss of a generator can have its needs met by another unit or an interconnected system without affecting service. In addition, the entire system avoids the necessity of any single company running expensive marginal units for its own security.

New Jersey's utilities rely upon almost 300 circuit miles of 500,000 volt transmission lines to import power from outside of the state. This system is fully integrated into the 500,000 volt grid operated by PJM. New Jersey utilities also have several links with New York utilities. In addition, nearly 1,000 miles of 230,000 volt transmission deliver power within the state.[13]

Figure II-2-6



Source: MAAC - Regional Reliability Council
Coordinated Bulk Power Supply Program
April, 1988

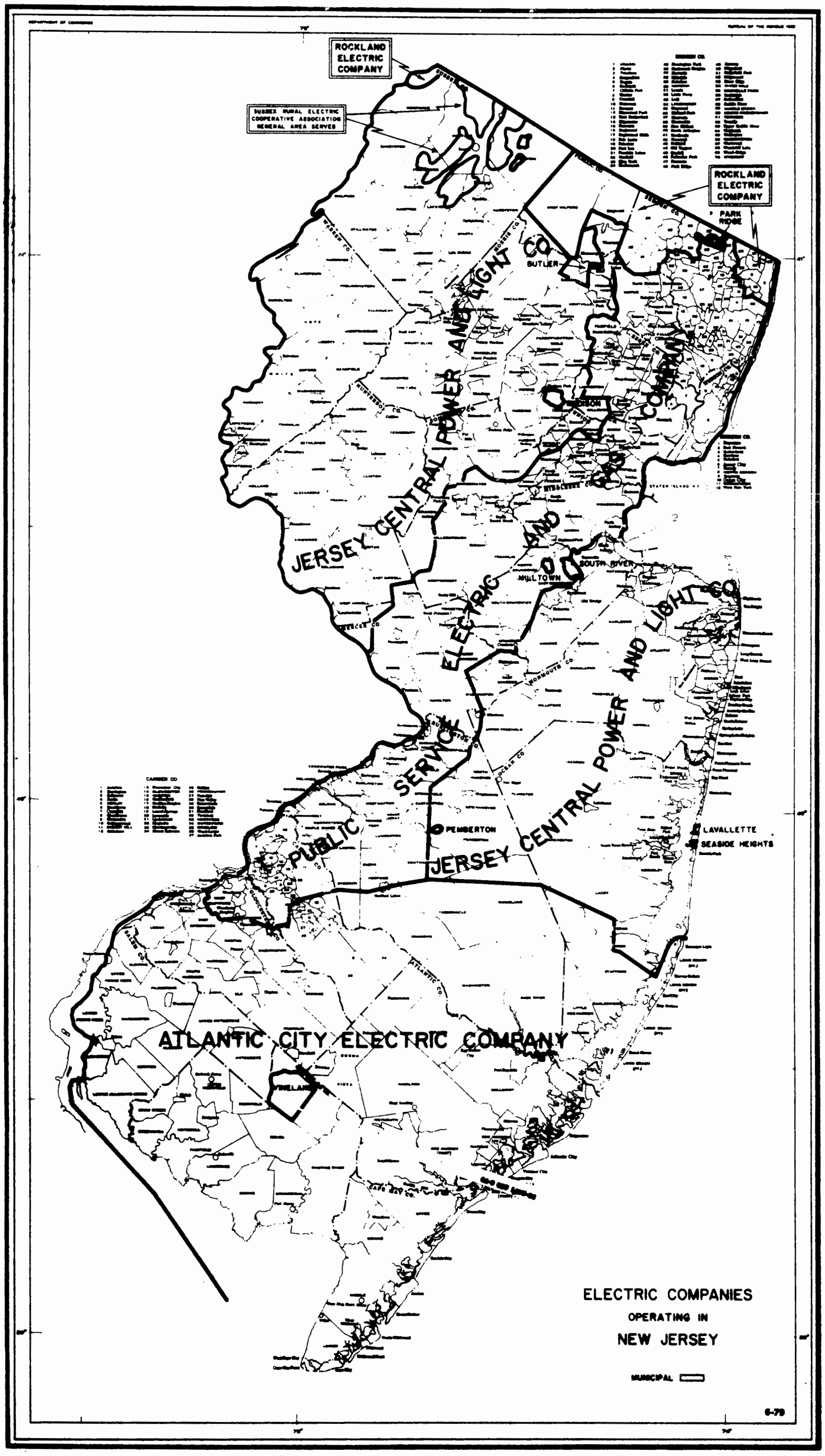
Source: Journal of Commerce article, June 27, 1988

New Jersey Electric Utilities

Three major electric utilities supply more than 90 percent of New Jersey's electricity: Atlantic Electric (AE), Jersey Central Power and Light Company (JCP&L), and Public Service Electric and Gas Company (PSE&G).

Other companies divide the remaining 10 percent. These include Rockland Electric Company, a subsidiary of the New York-based Orange and Rockland Utilities. In 1987, Rockland Electric had annual revenues in New Jersey of just under $100 million and served approximately 58,000 customers, about 51,000 of which are residential, in parts of Bergen, Passaic, and Sussex counties.[14] Vineland Electric, serving the City of Vineland, is the largest of ten municipally-owned systems. A number of rural electric cooperatives and small public systems supply less than 1 percent of New Jersey's electricity (see Figure II-2-7).

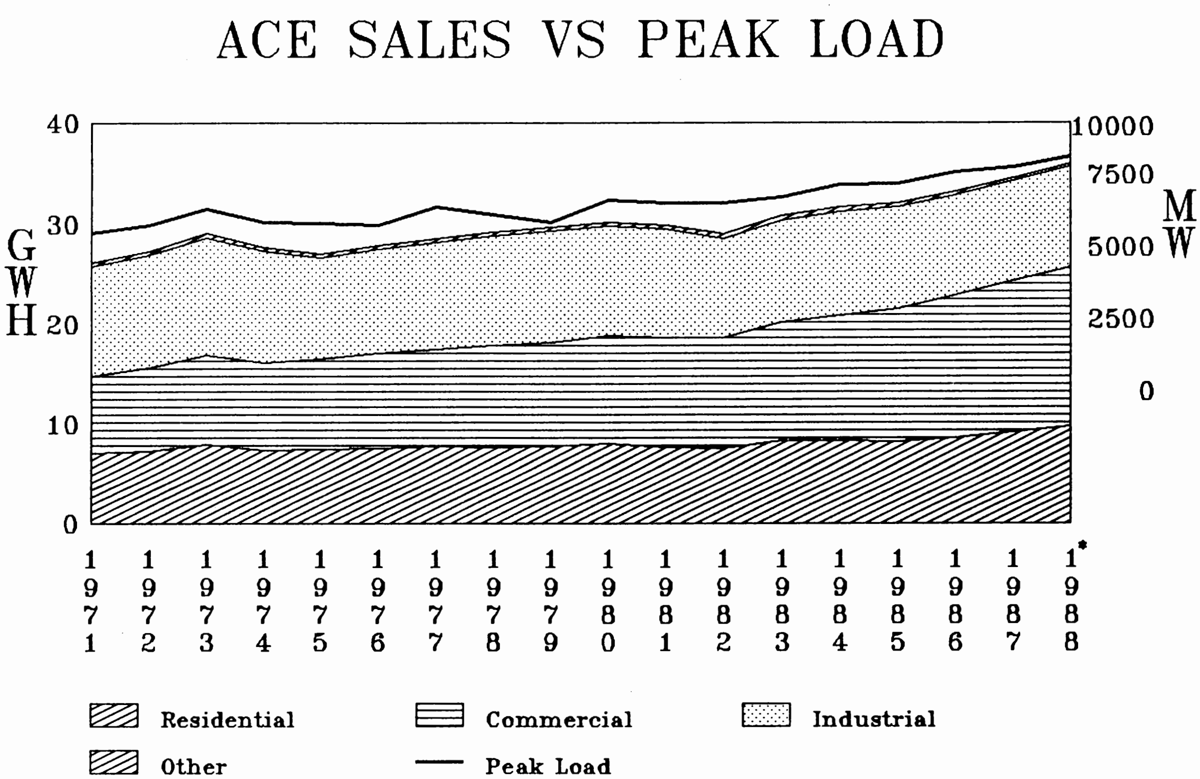
Figure II-2-7


ROCKLAND ELECTRIC COMPANY
SUSSEX RURAL ELECTRIC COOPERATIVE ASSOCIATION GENERAL AREA SERVED
ROCKLAND ELECTRIC COMPANY
PARK RIDGE
BUTLER
JERSEY CENTRAL POWER AND LIGHT CO
PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SOUTH RIVER
MILLTOWN
JERSEY CENTRAL POWER AND LIGHT CO
PEMBERTON
LAVALLETTE
SEASIDE HEIGHTS
ATLANTIC CITY ELECTRIC COMPANY
VINELAND
ELECTRIC COMPANIES
OPERATING IN
NEW JERSEY
MUNICIPAL
6-79

Atlantic Electric: AE serves the southern third of New Jersey and is the fastest growing company, with 1987 revenues of $648 million, about 7,000 gwh and 415,000 customers.[15] Historical energy sales (gwh), peak load (MW), net system requirements (gwh), and installed capacity (MW) are shown in Figures II-2-8 through II-2-10.

The residential sector accounts for about 44 percent of the company's energy sales and almost half of the revenues. While the commercial sector has exhibited the fastest growth, the industrial sector has shown a corresponding steady decline. Since 1980, the company has increased its reliance upon coal, nuclear, and economy purchases while decreasing its dependence upon oil.

Figure II-2-8

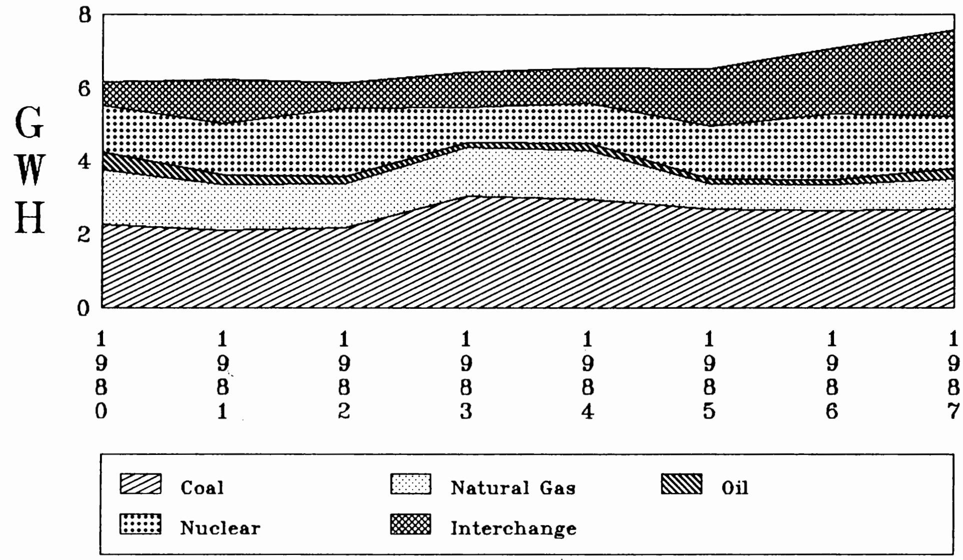


* estimate based on Oct 1987 thru Sep 1988

SOURCE: NJEDS / ELESALES, ELECFUEL

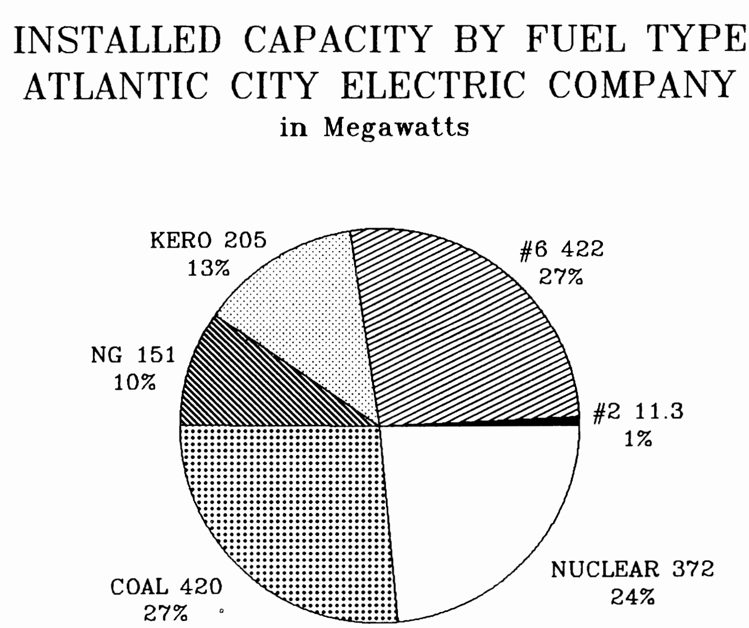
Figure II-2-9

ACE NET SYSTEM REQUIREMENT



SOURCE: NJEDS / ELECFUEL

Figure II-2-10



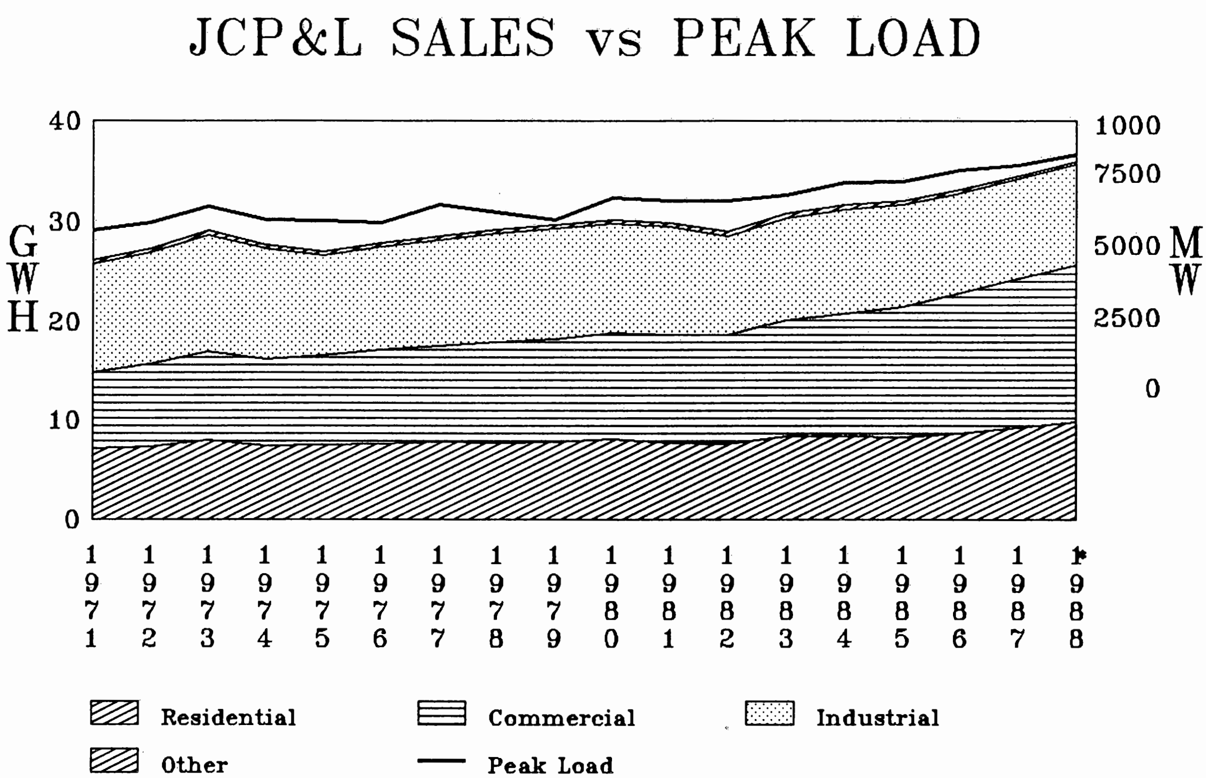
SOURCES: AE 1987 FERC Form No. 1
MAAC Regional Reliability Council Coordinated
Bulk Power Supply Program April 1, 1988

Jersey Central Power and Light Company: JCP&L serves the east-central and northwestern portions of New Jersey, split by PSE&G. In calendar year 1987, JCP&L had revenues of $1.3 billion, 15,550 gwh and about 830,000 customers.[16] Historical energy sales (gwh), peak load (MW), net system requirements (gwh) and installed capacity (MW) are shown in Figures II-2-11 through II-2-13.

Increasing sales to the residential sector reflect the population growth and the rapid expansion of the commercial sector occurring within JCP&L's service territory.

Since the TMI-2 accident in 1979, JCP&L has relied heavily upon "economy" energy purchases from companies with excess capacity to meet its net system requirements. Energy purchases have increased from almost 60 percent to about 70 percent in both 1983 and 1984. However, with excess capacity situated primarily in the Midwest, JCP&L has been able to enter into contracts for both capacity and energy at attractive rates for the near term at least.

Figure II-2-11

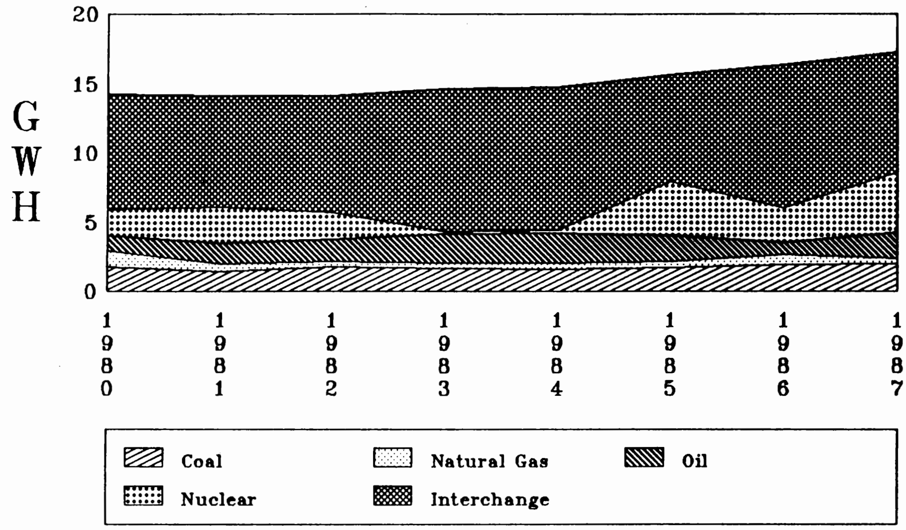


* estimate based on OCT 1987 thru SEP 1988

SOURCE: NJEDS / ELSALES, ELECFUEL

Figure II-2-12

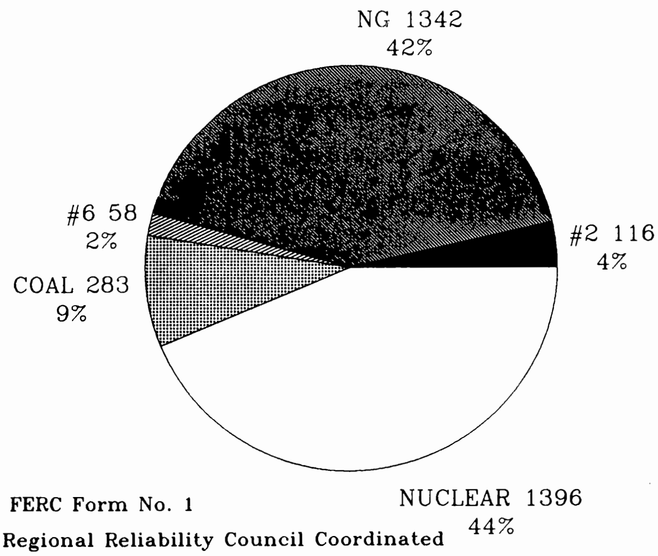
JCP&L NET SYSTEM REQUIREMENT



SOURCE: NJEDS / ELECFUEL

Figure II-2-13

FIG II.2.13
INSTALLED CAPACITY BY FUEL TYPE
JERSEY CENTRAL POWER & LIGHT COMPANY
in Megawatts

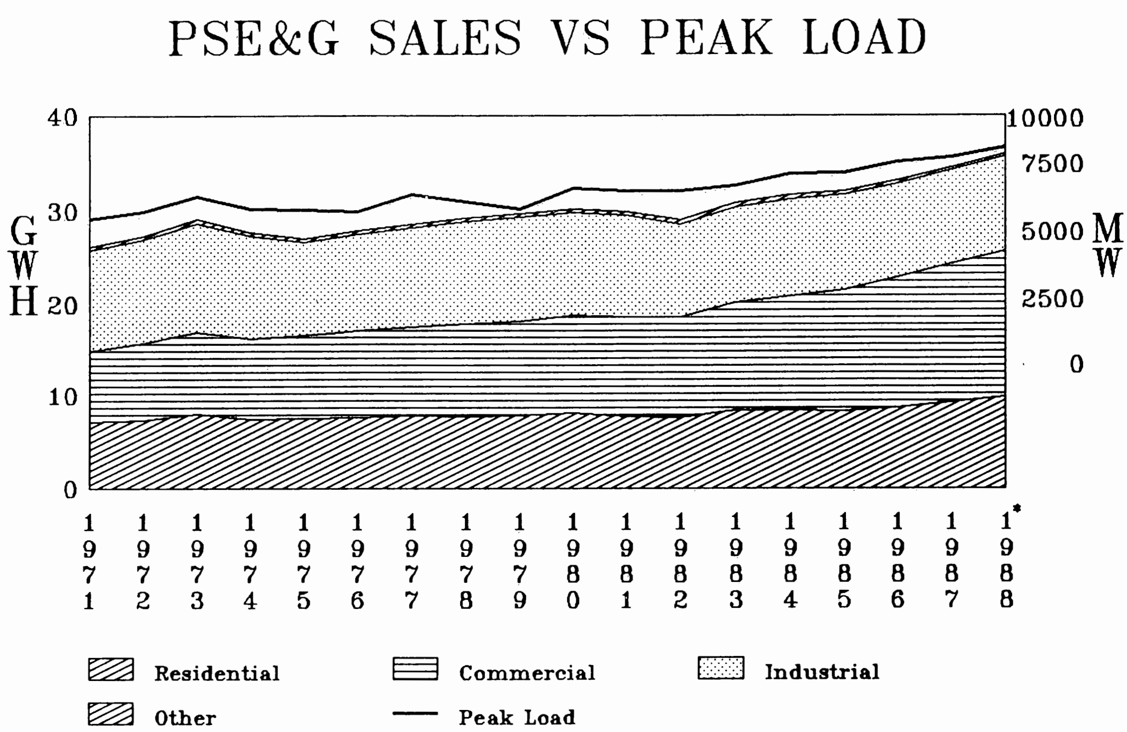


SOURCES: JCP&L FERC Form No. 1
MAAC Regional Reliability Council Coordinated
Bulk Power Supply Program April 1, 1988

Public Service Electric and Gas Company: PSE&G serves a diagonal east-west central portion of New Jersey. The service territory includes many older, fully developed areas. PSE&G is the largest electric utility in the state, supplying over 60 percent of all the electricity sold in New Jersey. In 1987, PSE&G had electric operating revenues just under $3 billion, 34,700 gwh and almost 1,800,000 customers.[17] Historical energy sales (gwh), peak load (MW), net system requirements (gwh) and installed capacity (MW) are shown in Figures II-2-14 through II-2-16.

Only the commercial sector has shown continuous growth, while the industrial sector has steadily declined and the residential sector has been almost constant over the same time period. While generation from coal has remained constant at just under 30 percent, the electricity generated from oil has dropped from about 18 percent to less than 10 percent due to its rapidly escalating price in the late 1970s to early 1980s. Some of the reduction in oil-fired generation can be accounted for by conservation, increased nuclear generation, and displacement by natural gas, which became available and economic for electric generation.

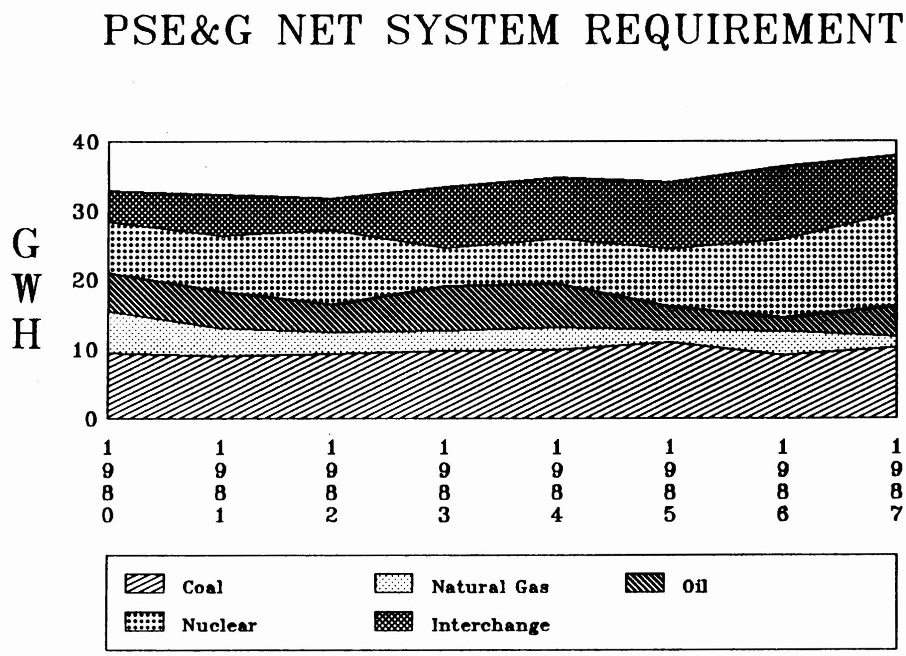
Figure II-2-14



* estimate based on Oct 1987 thru Sep 1988

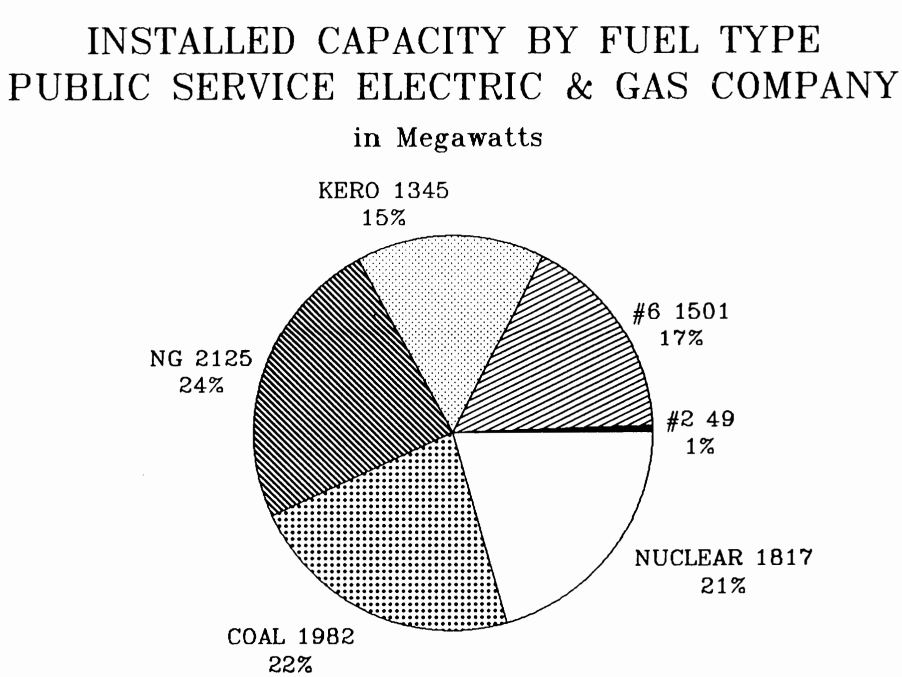
SOURCE: NJEDS / ELSALES, ELECFUEL

Figure II-2-15



SOURCE: NJEDS / ELECFUEL

Figure II-2-16



SOURCES: PSE&G FERC Form No. 1

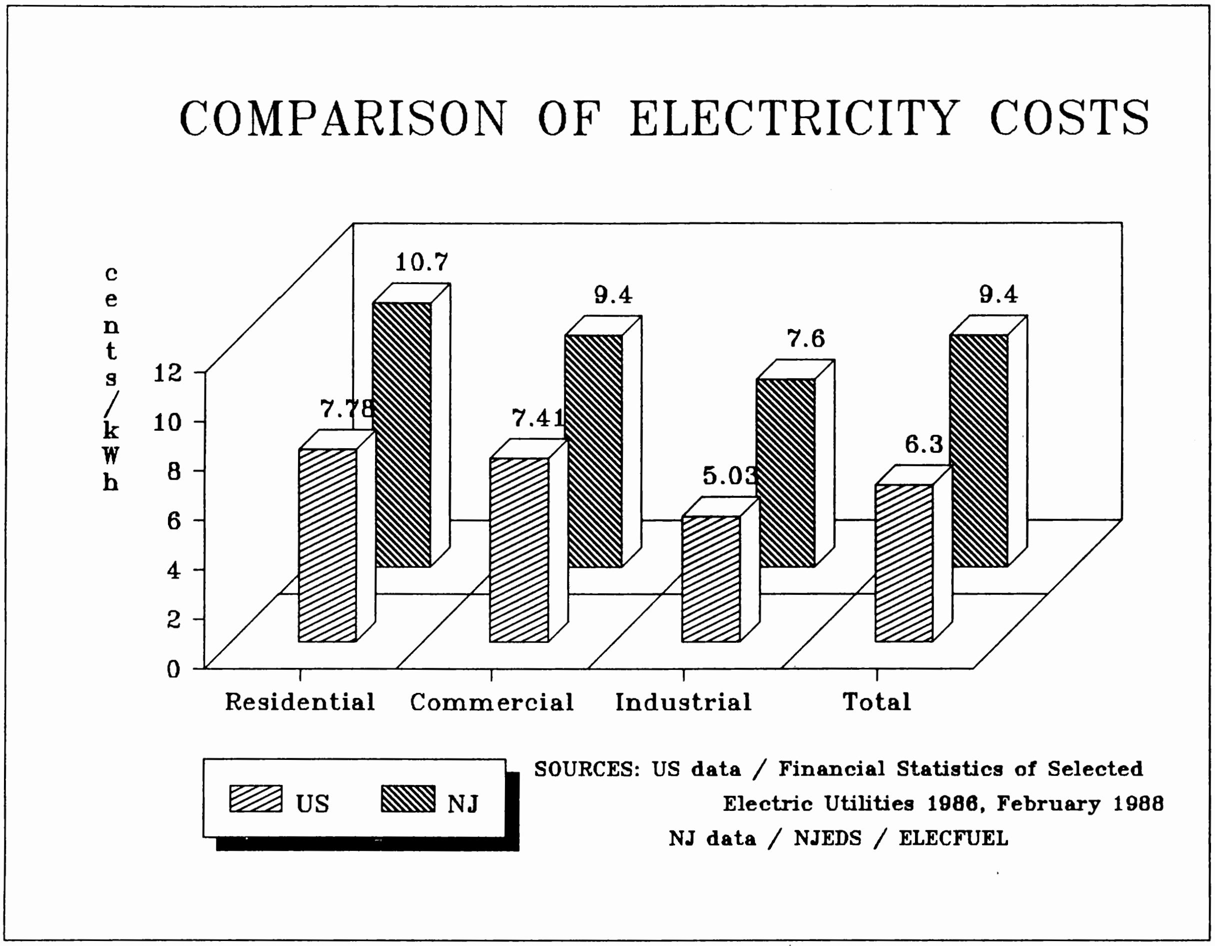
MAAC Regional Reliability Council Coordinated Bulk Power Supply Program April 1, 1988

Analysis

Prices and Taxes

New Jersey electricity prices, while among the highest in the country, paradoxically do not send a strong market signal regarding efficiency. As shown in Figure II-2-17, New Jersey prices are significantly higher than the national average in 1986.[18]

Figure II-2-17



The 1986 Grant Thornton Study of Manufacturing Climate indicated that New Jersey's relative position in energy cost was the worst of all but one of the indicators analyzed in the study[19]. Between 1962 and 1985, every 10 percent increase in the real price of electricity resulted in a 1 percent decline in employment in the paper, primary metals, rubber and plastics, clay, and glass industries with a three-year lag.[20]

A DCEED report[21] identified the gross receipts and franchise taxes (GR&FT) imposed on electric utility revenues as one of the contributing factors in this price disparity. The GR&FT burden is assessed at the rate of approximately 12.5 percent of revenues -- much higher than the national average tax rate of 7 percent. The DCEED proposal would shift the GR&FT from a tax on the value of energy to a proportional tax on a unit of energy for electric and natural gas sales to prevent the tax from climbing rapidly during periods of high inflation or price shock as occurred during the 1970s. The proposal includes imposing different unit taxes for each class of user based upon the proportional contribution made by each class to the total tax, so each class of user gains equally from the proposed change. The ultimate impact would be to reduce the tax burden from 12.5 percent to 7 percent over a five- or six-year timeframe, thereby improving economic competitiveness of New Jersey's commercial and industrial sectors.

The State and Local Expenditure and Revenue Policy Commission was established by the Legislature in December 1984. The SLERP Commission performed a systematic and comprehensive analysis of the existing state and local tax and expenditure structures and mandated spending formulae. With respect to public utility taxes, the SLERP Commission recommended that corporate business tax be imposed upon all public utilities, effectively reducing the tax rate from 13 percent to about 8 percent, and that public utility tax revenues no longer be earmarked for distribution to municipalities[22].

However, GR&FT accounts for only a portion of the difference between New Jersey's electricity prices and the national average. The Task Force on Market Based Pricing of Electricity may be able to ascertain what makes up the differential.

Net System Requirement (NSR)

Figures II-2-18 and II-2-19 and Table II-2-2 present data on the New Jersey electric net system requirements, the amount of electricity sold to New Jersey customers, plus losses, and installed capacity respectively. NSR consists of electricity generated by New Jersey electric utilities and electricity purchased from out-of-state utilities.

Figure II-2-18

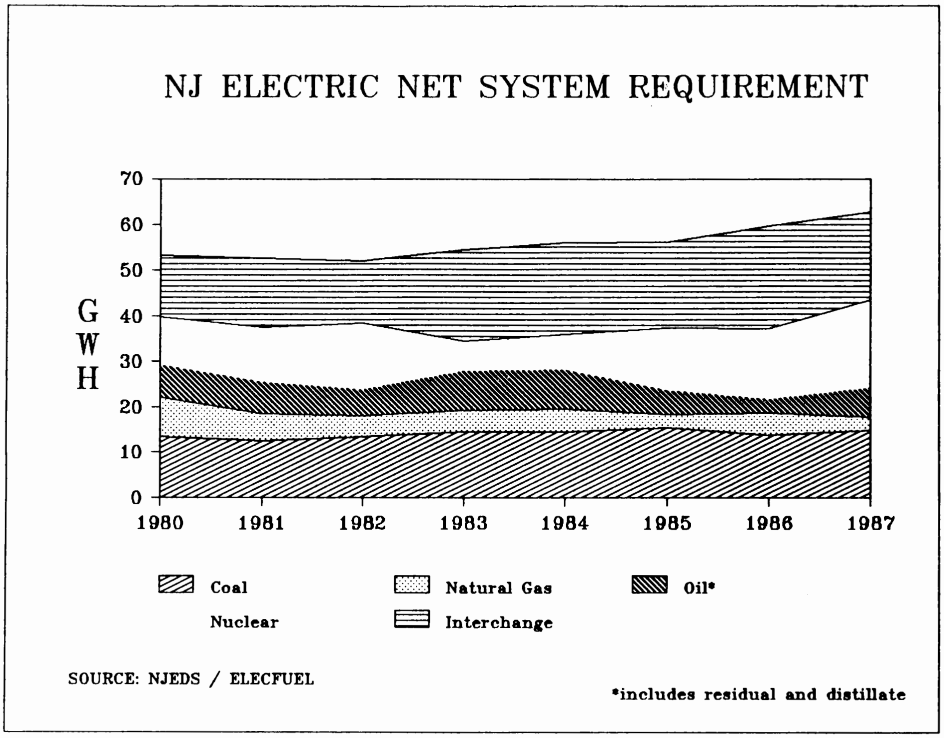


Figure II-2-19

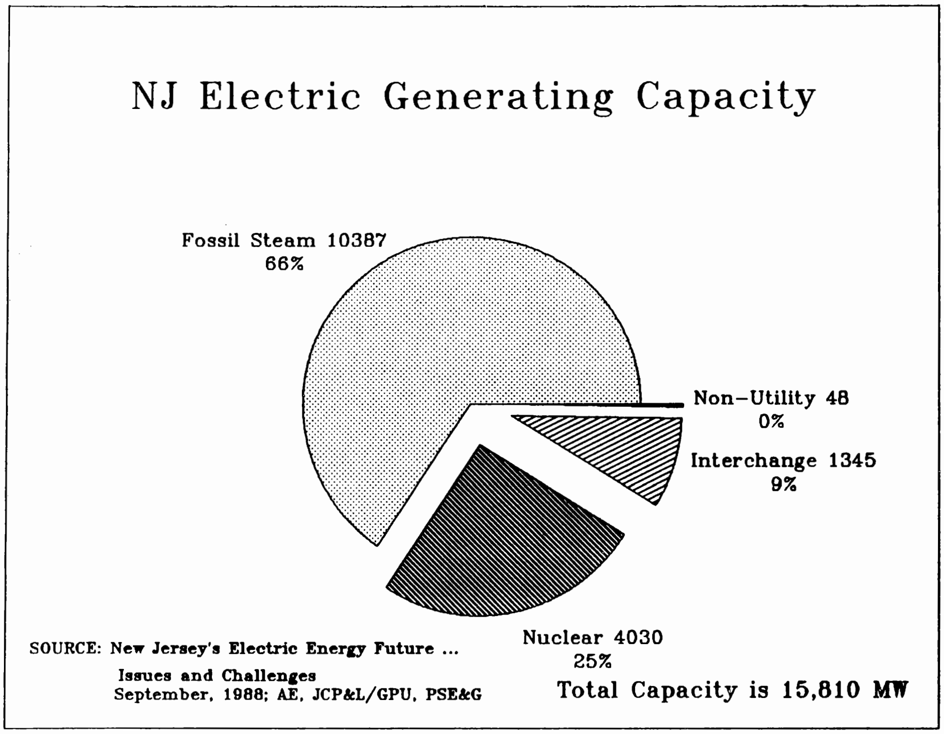


Table II-2-2

New Jersey
Net System Requirement (GW)

Year	Coal	Oil	Natural Gas	Nuclear	Hydro	Net Gen	Purch & Interch	Net System Req
1980	13473	8709	7183	10518	-288	39595	13417	53012
1981	12526	5848	7161	11976	-194	37317	15147	52464
1982	13342	4687	5791	14587	-203	38184	13574	51758
1983	14534	4632	8694	6641	-229	34272	20052	54324
1984	14438	5066	8692	7788	-252	35732	20096	55828
1985	15401	2918	5367	13726	-186	37226	18813	56039
1986	13741	4826	3082	15577	-288	36938	22526	59464
1987	14839	2833	6587	19223	-326	43156	19249	62405

Source: NJEDS/ELECFUEL

New Jersey generation is further broken down into generation by fuel type: coal, natural gas, residual oil, distillate oil, and nuclear. Pumped storage accounts for less than 1 percent of net system requirement. The percentage of net system requirement met by in-state generation (by fuel type) and by interchange or purchased power is shown for each year.

The percentage of electricity produced from oil decreased dramatically between 1973 and 1987. While oil accounted for over 50 percent of electric generation in 1973, it accounted for only 4.6 percent in 1987. This trend was due in part to the rise in oil prices over the last 15 years, but regulatory changes also were important. In 1978, the Natural Gas Policy Act (NPGA) became effective, which made natural gas prices in New Jersey competitive with oil prices. Beginning in 1979, natural gas became a noticeable fuel component for New Jersey electric generation. In that year, natural gas accounted for approximately 5 percent of generation, while oil accounted for approximately 22 percent. By 1980, generation by natural gas was up to about 13 percent, with oil at roughly 16 percent.

Also in 1978, the Power Plant and Industrial Fuel Use Act (FUA) encouraged utilities to switch from oil and natural gas to coal generation, which probably played a part in driving down oil generation as well. Notably, purchased power, which jumped from 0.18 percent to 25.2 percent of New Jersey generation between 1978-79, consisted primarily of out-of-state coal generation. Additional impetus for increased purchased power in New Jersey came from the 1979 Three Mile

Island nuclear accident. Following the accident, JCP&L, a part owner, was forced to purchase large amounts of power to meet its electric load.

Between 1982 and 1983, New Jersey nuclear generation decreased from approximately 27 percent to 12 percent of net system requirement. By 1985, nuclear generation returned to 24 percent. These fluctuations were probably attributable to the Salem nuclear power plant outages in 1983 and 1984. Purchased power, which rose from 26 percent to 37 percent between 1982 and 1983, compensated for the nuclear shortfall. Generation from oil rose from approximately 5 percent to 8 percent between 1985 and 1986, most likely due to the concurrent drop in oil prices.

In order to meet the peak demand and energy requirements of New Jersey residents, electric utilities rely on a combination of power plants owned by them located in New Jersey, partially-owned power plants located in Pennsylvania, firm purchases of power from utilities outside New Jersey, and nonutility generation. Figure II-2-19 provides the breakdown of electric capacity owned or available to New Jersey utilities. Tables II-2-3, II-2-4, and II-2-5 list the various generating plants owned by the utilities with capacity, in-service date, and their installed cost and operating expenses.

By the year 2000 the average age of the majority of these facilities will be over 30 years, an age at which they may have to be replaced.

Table II-2-3

Atlantic City Electric Company
(Existing Plants)*

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
B.L. England	1	Steam	129	Bit.	#6	1962		
Beesley's Pt., NJ	2	Steam	160	Bit.	#6	1964		
	3	Steam	160	#6	x	1974		
Type Total			449				358	3.04
Type Total		I.C./D	8	#2		1962	105	22.29
Station Total			457					
Carlls' Corner	1	G.T.	36	N.G.	Ker.	1973		
Bridgeton, NJ	2	G.T.	37	N.G.	Ker.	1973		
Station Total			73				8	13.22
Cedar	1	G.T.	46	Ker.	x	1972		
Manahawkin, NJ	2	G.T.	22	Ker.	x	1972		
Station Total			68				12	14.03
Conemaugh	1	Steam	32	Bit.	x	1970		
W. Wheatfield, PA	2	Steam	33	Bit.	x	1971		
Type Total			65				191	1.91
Type Total	A-D	IC	0.4	#2		1971	96	15.80
Station Total			65.4					
Deepwater	1	Steam	83	N.G.	#6	1958		
Deepwater, NJ	3	Steam	21	#6	x	1950		
	4	Steam	54	#6	x	1950		
	6	Steam	80	Bit/#6	N.G.	1954		
Type Total			238				455	4.08
Type Total	A	G.T.	19	N.G.	Ker.	1969	106	7.10
Station Total			257					

Table II-2-3 (continued)

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Hope Creek Lower Alloways Creek, NJ	3	Nucl/BWR	53	Ur.	x	1987	1755	2.31
Keystone	1	Steam	21	Bit.	x	1967		
Plum Creek, PA	2	Steam	21	Bit.	x	1968		
Type Total			42				175	1.58
Type Total	3-6	I.C./D	0.3	#2		1967	89	8.37
Station Total			42.3					
Mickleton E. Greenwich, NJ	1	G.T.	59	N.G.	Ker.	1974	20	7.16
Middle	1	G.T.	20	Ker.	x	1970		
Cape May, NJ	2	G.T.	20	Ker.	x	1970		
	3	G.T.	37	Ker.	x	1973		
Station Total			77				86	15.16
Missouri Ave	B	G.T.	20	Ker.	x	1969		
Atlantic City, NJ	C	G.T.	20	Ker.	x	1969		
	D	G.T.	20	Ker.	x	1969		
Station Total			60				128	13.74
Peach Bottom	2	Nucl/BWR	79	Ur.	x	1974		
Peach Bottom, PA	3	Nucl/BWR	78	Ur.	x	1974		
Station Total			157				539	8.84
Salem	1	Nucl/PWR	82	Ur.	x	1977		
Lower Alloway, NJ	2	Nucl/PWR	82	Ur.	x	1981		
Type Total			164				937	2.23
Type Total	3	G.T.	3	#2		1977	126	15.90
Station Total			167					
TOTAL INSTALLED CAPACITY			1535.3					

* MAAC, Regional Reliability Council Coordinated Bulk Power Supply Program, April 1, 1988

**AE FERC Form No. 1, 1987, p. 402-403, line 18

Table II-2-4

Jersey Central Power & Light Company
Existing Plants*

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Glen Gardner	A1	G.T.	20	N.G.	#2	1971		
Lebanon, NJ	A2	G.T.	20	N.G.	#2	1971		
	A3	G.T.	20	N.G.	#2	1971		
	A4	G.T.	20	N.G.	#2	1971		
	B5	G.T.	20	N.G.	#2	1971		
	B6	G.T.	20	N.G.	#2	1971		
	B7	G.T.	20	N.G.	#2	1971		
	B8	G.T.	20	N.G.	#2	1971		
Station Total			160				113	9.14
Gilbert	1&2	Steam	45	N.G.	#6	1930		
Holland, NJ	3	Steam	72	N.G.	#6	1949		
Type Total			117				196	6.95
	4	C C	54	N.G.	#2	1974		
	5	C C	54	N.G.	#2	1974		
	6	C C	56	N.G.	#2	1974		
	7	C C	54	N.G.	#2	1974		
	8	C C	114	#2	x	1977		
Type Total			332				332	3.48
	C1	G.T.	25	N.G.	#2	1970		
	C2	G.T.	25	N.G.	#2	1970		
	C3	G.T.	22	N.G.	#2	1970		
	C4	G.T.	25	N.G.	#2	1970		
Type Total			97				131	14.07
Station Total			429					
Keystone	1	Steam	141	Bit.	x	1967		
Plum Creek, PA	2	Steam	142	Bit.	x	1968		
Type Total			283				181	1.58
Type Total	3-6	I.C./D	2	#2	x	1968	104	8.29
Station Total			285					
Oyster Creek	1	Nucl/BWR	620	Ur.	x	1969	1074	4.48
Lacey, NJ								

Table II-2-4 (continued)

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Sayreville	1-3	Steam	84	N.G.	#6	1930		
Sayreville, NJ	4	Steam	108	N.G.	#6	1955		
	5	Steam	112	N.G.	#6	1958		
Type Total			304				198	4.40
	C1	G.T.	53	N.G.	#2	1972		
	C2	G.T.	53	N.G.	#2	1972		
	C3	G.T.	53	N.G.	#2	1972		
	C4	G.T.	53	N.G.	#2	1973		
Type Total			212				130	4.56
Station Total			516					
Three Mile Island Middletown, PA	1	Nucl/PWR	194	Ur.	x	1974	686	2.21
Werner South Amboy, NJ	4	Steam	58	#6	x	1953	350	8.04
	C1	G.T.	53	#2	x	1972		
	C2	G.T.	53	#2	x	1972		
	C3	G.T.	53	#2	x	1972		
	C4	G.T.	53	#2	x	1972		
Type total			212				117	9.06
Station Total			270					
Yards Creek Blairstown, NJ	1-3	P.S.	165	Water	x	1965	86	3.0

TOTAL INSTALLED CAPACITY 2756

* MAAC, Regional Reliability Council Coordinated Bulk Power Supply Program, April 1, 1988

**JCP&L FERC Form No. 1, 1987, p. 402-403, line 18

Table II-2-5

Public Service Electric & Gas Company
Existing Plants*

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Bayonne	1	G.T.	19	Ker.	x	1970		
Bayonne, NJ	2	G.T.	19	Ker.	x	1970		
Station Total			38				113	6.66
Bergen	1	Steam	287	N.G.	#6	1959		
Ridgefield, NJ	2	Steam	283	N.G.	#6	1960		
Type Total			570				234	3.55
	3	G.T.	17	N.G.	x	1967		
	4	G.T.	44	#2	x	1975		
Type Total			61				106	8.84
Station Total			631					
Burlington Burlington, NJ	7	Steam	180	#6	x	1955	260	7.42
	8	G.T.	17	Ker.	x	1967		
	9	G.T.	176	Ker.	x	1972		
	10	G.T.	176	Ker.	x	1972		
	11	G.T.	176	Ker.	x	1972		
Type Total			545				94	9.95
Station Total			725					
Conemaugh	1	Steam	191	Bit.	x	1970		
W. Wheatfield, PA	2	Steam	191	Bit.	x	1971		
Type Total			382				193	1.9
Type Total	A-D	I.C./D	3	#2		1970	88	14.99
Station Total			385					
Edison	1	G.T.	154	N.G.	Ker.	1971		
Edison, NJ	2	G.T.	154	N.G.	Ker.	1971		
	3	G.T.	154	N.G.	Ker.	1971		
Station Total			462				94	4.89

Table II-2-5 (continued)

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Essex	9	G.T.	53	N.G.	Ker.	1971		
Newark, NJ	10	G.T.	155	N.G.	Ker.	1971		
	11	G.T.	176	N.G.	Ker.	1971		
	12	G.T.	176	N.G.	Ker.	1972		
Station Total			560				99	4.67
Hope Creek Lower Alloways Creek, NJ	3	Nucl/BWR	1014	Ur.	x	1986	3527	1.86
Hudson	1	Steam	383	N.G.	#6	1964		
Jersey City, NJ	2	Steam	600	Bit.	N.G.	1968		
Type Total			983				289	2.98
Type Total	3	G.T.	124	Ker.		1967	110	21.51
Station Total			1107					
Kearny	7	Steam	146	#6	x	1953		
Kearny, NJ	8	Steam	146	#6	x	1953		
Type Total			292				235	10.94
	9	G.T.	17	N.G.	x	1967		
	10	G.T.	91	N.G.	Ker.	1970		
	11	G.T.	122	N.G.	Ker.	1969		
	12	G.T.	192	Ker.	x	1973		
Type Total			422				85	10.78
Station Total			714					
Keystone	1	Steam	194	Bit.	x	1967		
Plum Creek, PA	2	Steam	194	Bit.	x	1968		
Type Total			388				174	1.58
Type Total	3-6	I.C./D	2	#2		1968	96	8.29
Station Total			390					

Table II-2-5 (continued)

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Linden	1&4	Steam	234	#6	x	1957		
Linden, NJ	2	Steam	225	#6	x	1957		
Type Total			459				261	5.05
Linden	3	G.T.	17	N.G.	x	1967		
Linden, NJ	5	G.T.	23	N.G.	Ker.	1970		
	6	G.T.	23	N.G.	Ker.	1970		
	7	G.T.	23	N.G.	Ker.	1970		
	8	G.T.	23	N.G.	Ker.	1970		
	9	G.T.	168	Ker.	x	1973		
Type Total			277				105	8.07
Station Total			736					
Mercer	1	Steam	306	Bit.	N.G.	1960		
Hamilton, NJ	2	Steam	306	Bit.	N.G.	1961		
Type Total			612				278	3.24
Type Total	3	G.T.	124	Ker.		1967	100	27.17
Station Total			736					
National Park	1	G.T.	17	Ker.	x	1969	121	37.07
National Park, NJ								
Peach Bottom	2	Nucl/BWR	446	Ur.	x	1974		
Peach Bottom, PA	3	Nucl/BWR	440	Ur.	x	1974		
Station Total			886				533	8.70
Salem	1	Nucl/PWR	471	Ur.	x	1977		
Lower Alloways	2	Nucl/PWR	471	Ur.	x	1981		
Creek, NJ								
Type Total			942				811	1.89
Type Total	3	G.T.	16	#2		1971	158	55.81
Station Total			958					

Table II-2-5 (continued)

Name/Location & Unit #		Plant Type	Summer Cap (MW)	Prim. Fuel	Alt. Fuel	Date	$/KW**	¢/KWH*
Sewaren	1	Steam	104	N.G.	#6	1948		
Sewaren, NJ	2	Steam	111	N.G.	#6	1948		
	3	Steam	107	N.G.	#6	1949		
	4	Steam	124	N.G.	#6	1951		
Type Total			446				325	5.45
Type Total	6	G.T.	62	Ker.		1965	76	75.86
Station Total			508					
Yards Creek Blairstown, NJ	1-3	P.S.	165	Water	x	1965	91	3.1

TOTAL INSTALLED CAPACITY 10032

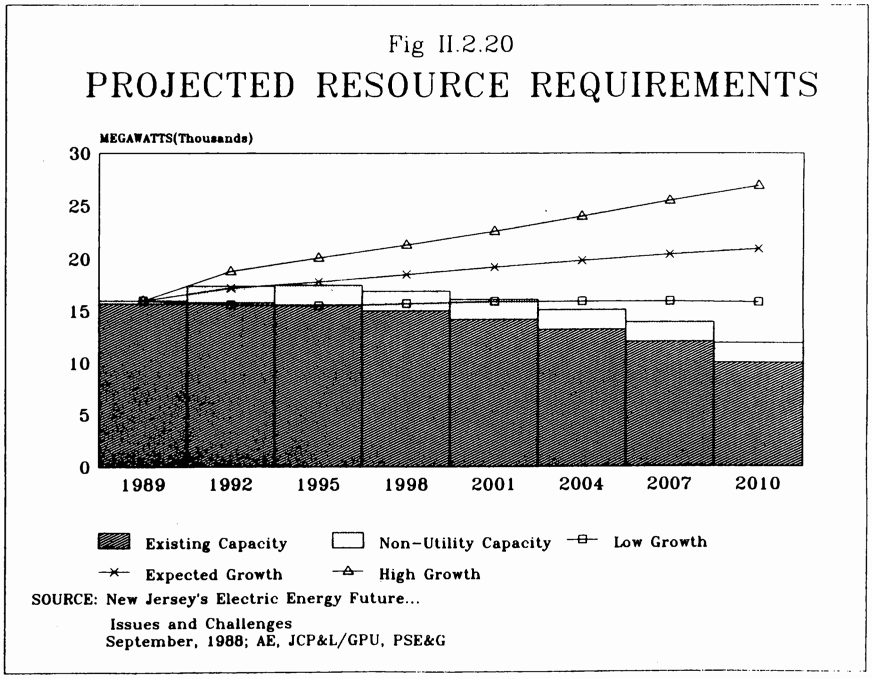
* MAAC, Regional Reliability Council Coordinated Bulk Power Supply Program, April 1, 1988

**PSE&G FERC Form No. 1, 1987, p. 402-403, line 18

Utility Forecast

By the year 2000 New Jersey utilities predict they will need both new generating facilities and expanded transmission facilities to meet the needs of their customers.[23] While the annual growth in both overall energy usage and peak demand has averaged almost 4 percent over the past five years, the utilities believe that aggressive load management and conservation programs with anticipated economic trends will slow this growth to less than 2 percent through the year 2000. Based on such a growth rate, as shown in Figure II-2-20, the New Jersey utilities will require over 2,680 MW of additional generating capacity by the year 2000 and over 9,000 MW by the year 2010.

Figure II-2-20



To illustrate, this aggregated 2,680 MW would be the equivalent of about two and one-half Hope Creeks or more electricity than the approximately 2.5 million residential electric nonheating customers used in all of 1987.

Of course, the utilities need not build large, centralized power plants as they have in the past. Smaller, more localized units closer to the load centers may be another solution. One such option could be a fluidized bed coal unit of about 500 MW, which should come in at 5¢/kwh levelized.[24]

Regardless of economic assumptions, New Jersey utilities expect to need new generating capacity merely to replace existing equipment as units retire and purchase agreements expire. The utilities believe that some 5,800 MW of this capacity should be replaced by the year 2010.[25]

D R A F T

Chapter II-2

Predicting the need for power and/or energy and deciding who should provide the power makes projecting the need for new utility power plants difficult.

Widespread movements toward greater competition in generation are beginning to have effects, as alternative power producers, which include independent power producers, cogenerators, and small power producers (QF's), challenge the utility monopoly with the potential to provide substantial power over the next decade.

The major alternative power producers are cogenerators. The cogeneration industry was created with the passage of the Public Utilities Regulatory Policies Act (PURPA) in 1978. In its Decision and Order in Docket No. 8010-687, the BPU provided the framework for the cogeneration industry to develop in New Jersey in 1981. FERC's four Notices of Proposed Rulemaking issued in 1988, may encourage cogeneration and nonutility generation of electricity. On October 1, 1988, New Jersey electric utilities issued requests for proposal to bidders to supply capacity requirements in response to the adoption of the Cogeneration Stipulation.

For many industries, cogeneration is the means of reducing electricity bills with, in many cases, a short payback. Steam and gas turbines and reciprocating engines with heat recovery, supplemental firing, or combined cycle are the principal types of cogeneration equipment. This equipment meets the latest environmental standards established by DEP. The major fuels used are natural gas, oil, and coal, while alternative fuels include propane, solid waste, hydrogen, and methanol. Manufacturers have come up with packaged units that meet the requirements of a large segment of the market. Capacity and energy are presently being sold to electric utilities.

In December 1988, there are 300 MW of cogeneration operating with in excess of 2,100 MW in various stages of negotiation and/or construction. An additional 480 MW of new capacity are available for bidding under the Stipulation. Cogeneration equipment is exempt from sales tax, while natural gas sold to QFs is exempt from GR&FT. See Chapter II-3.

Although this capacity would be built without direct financial risk to ratepayers, vulnerabilities need be identified and addressed. DCEED's Cogeneration Center acts as the advocate within state government for the fledgling cogeneration industry. To support this effort, DCEED requires that cogenerators report certain financial and operation data.

Power need projections are uncertain. Even if price elasticities are well known, future prices are not, since fuel prices are so volatile. In addition, many analysts believe that cost-effective demand-side opportunities are so great that these should be exploited fully, as quickly as possible.

Chapter II-2

Least Cost Planning

While the electric utility industry has direct control in selecting its own production, transmission, and distribution facilities, it does not completely control the end use. However, with a judicious selection of price signals and marketing techniques, it can influence customer behavior both in the purchase and use of end use equipment. Instead of simply deliverers of electricity, utilities can be marketers of energy services:[26] the heat, light, or power needed to operate the buildings and industries in their service area. The strategic objective would be to deliver energy services at the lowest possible cost to the consumer, commonly referred to as a least cost strategy. With a least cost strategy the utilities would invest in conservation options or end use technologies that conserve electricity on a equal basis with constructing new generation facilities in their resource planning.

Least cost planning is any plan which selects that mixture of demand-side resources (i.e., energy efficiency and load management) and supply-side resources (i.e., small power production and new generating facilities), resulting in reliable service at the lowest reasonable cost. One proxy for "lowest reasonable cost" can be the minimization of the present value of revenue requirements. An integrated utility planning model can analyze the impacts of various mixes of demand- and supply-side options. Exposure to financial risks associated with alternative options is determined using a financial planning model. Since any least cost plan will be subject to uncertainty, decision analysis techniques are required to evaluate the plan's sensitivity to the impacts of uncertain variables over probable ranges to identify the most sensitive variables. Finally, the least cost plan chosen should also include contingencies for revenue requirements, system reliability, and financial integrity should the plan prove undesirable after implementation.

Nationally, 37 states identified a total of 61 approaches to explore and/or promote least cost planning between January 1986 and June 1987.[27] These approaches run the gamut from studies (6) to regulation (23) to legislation (12 states).

Commissions in Illinois, Kentucky, North Carolina, and Washington have initiated rulemaking proceedings. Utilities in Connecticut, Massachusetts, North Dakota, Florida, Nevada, Wisconsin, and Washington have been ordered to prepare least cost resource plans. Commissions in Pennsylvania and Virginia have proposed regulations requiring utilities to submit least cost resource plans. Technical proceedings to examine how to adopt a least cost strategy have been initiated in the District of Columbia, Colorado, Illinois, New York, South Carolina, and Texas. Technical and policy studies have been performed in Arizona, Missouri, New Mexico, Ohio, Vermont, Washington, California, and Maryland.

At a national level very few public utility commissions have adopted comprehensive least cost regulations which insure that utilities invest in the most cost-effective resources to meet new electric demand.[28] In New Jersey, the concept of least cost planning was introduced in the 1985 New Jersey Energy Master Plan:[29]

> The BPU shall require each utility, as a precondition to any rate increase involving a change in base rates, to submit detailed testimony and exhibits regarding a proposed least-cost energy strategy for its consumers. The BPU shall grant no rate increase unless it has first determined that the utility has proposed the least-cost approach to meeting its consumers needs. Specifically, the BPU shall consider and adopt value of service approaches to new power plants, power purchases or other investments traditionally accorded rate base and rate-of-return accounting, if to do so will result in lower rates to consumers at comparable levels of service and system reliability. No rates shall be considered 'just and reasonable' unless they have withstood the above comparison.

While the BPU has not codified least cost concepts, in the PSE&G rate case, Docket No. ER8512-1163, the Board stated:[30]

> ...the Board realizes that [the State's energy policy] objectives cannot be met in the future with any degree of certainty unless the recommendations of the Master Plan are observed. Electric utilities have had ample time to study the Master Plan and organize their procedures to allow them to file a least-cost strategy in future cases. The Board, therefore, HEREBY ORDERS Public Service to submit detailed testimony and exhibits setting forth a least-cost energy strategy as part of their next rate case. The Board will utilize this information in developing a least-cost methodology and setting just and reasonable rates for utility customers. The Board also serves notice on all electric utilities in this State by copy of this Order of its intention to pursue a rulemaking to codify this requirement for all future rate proceedings.

While the benefits of "least cost planning" have been noted in numerous instances, the process has not yet been recognized in legislation or regulation.

Regulatory Issues

Need Determinations

In the late 1970s, a number of proposed and/or partially constructed generating plants had to be cancelled, owing at least in part to lower-than-expected growth rates in electricity consumption.[31] In response to public concerns about ratepayer liabilities for possible unnecessary construction, New Jersey adopted "certificate of need" legislation. The Certificate of Need Act, N.J.S.A. 48:7-18d, requires that any electric utility proposing to build a new generating unit of 100

MW or greater and additions to existing units of 100 MW or 25 percent (whichever is smaller) apply to DCEED for approval. While no utility has yet applied for a Certificate of Need, the criteria are similar to those used in DCEED's coextensive siting authority with other state agencies for energy facilities.

The Coastal Area Facilities Review Act (CAFRA) permit application of JCP&L for the construction of Forked River combustion turbines[40] was expeditiously approved by the DCEED because the utility established that it had significant voltage problems in the southern area. JCP&L agreed to develop a five-year supply plan. If all New Jersey utilities embrace this approach in developing their own least cost plans that meet the goals--to assure uninterrupted energy supplies to all consumers; to promote economic growth and safeguard the environment; to encourage the lowest possible energy bills for all consumers--the regulatory uncertainty can be greatly reduced.

Performance Criteria

Performance Standards

Some of the baseload plants, specifically nuclear plants, have both performed poorly and required significant annual capital costs to keep them operating (Table II-2-6). In New Jersey, therefore, state regulators need to review the ongoing capital additions required at the Oyster Creek, Salem, Hope Creek, TMI, and Peach Bottom units, as substantial capital investment in these plants may not be cost effective. Historically, such reviews for ongoing construction modification costs in New Jersey have not been done.

Table II-2-6

Largest Annual Net Capital Additions - 1982-1986
Ranked by annual cost per KW (1986 dollars)

Plant	Capacity MW	Annual Cost $/KW	Total 1982-86 1000$	Age in 1988
San Onofre-1	436	161	351,146	21
Oyster Creek	650	121	392,970	19
Pilgrim	655	108	353,089	16
Monticello	545	94	257,074	17
Nine Mile Pt.-1	620	93	287,552	19
Beaver Valley-1	835	74	306,945	12
Hatch-1,2	1,700	61	519,500	12
Turkey Pt.-3,4	1,386	57	395,010	15
Ginna	470	57	133,871	19
Robinson-2	700	56	195,013	18
Duane Arnold	538	53	143,303	14
Rancho Seco	918	47	216,872	14
Davis-Besse	906	45	202,993	11

NOTE: Capacity ratings are the design electrical ratings.

With respect to the performance of nuclear plants, the 1985 Energy Master Plan requires:

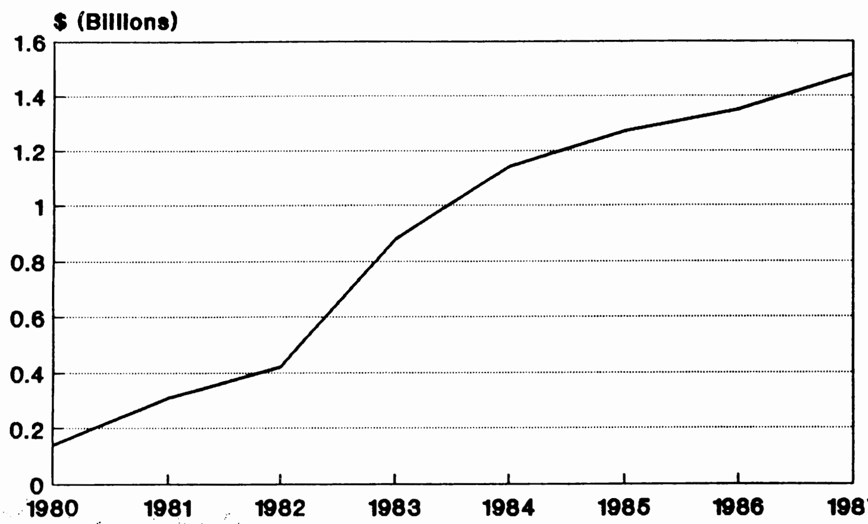
> The BPU shall consider that all base load power plants must achieve the operating efficiencies and reliability levels projected at the time of a regulatory review. Failure to achieve these levels shall subject the utility to restrictions in their authority to pass on excess fuel costs to ratepayers, while exceeding these projected levels shall entitle the utilities to 'bonuses'. The BPU shall promptly establish a regulatory system of penalties and bonuses to implement this policy.[32]

Performance standards are necessary to adequately balance investor and ratepayer interests, owing to the poor performance of nuclear power plants. Without penalties, virtually all replacement power costs are recovered through the Levelized Energy Adjustment Charge (LEAC) and, therefore, passed on to the customers regardless of the cause of the poor performance.

Initially, the high capital costs of nuclear power plants were to be offset by low operating costs, resulting in economical, year-round electricity. However, the nuclear plants actually operated at around 65 percent capacity factor even though they had been estimated to perform at 80 percent capacity factor. Ratepayers therefore bear both the high capital costs in rate base and replacement power costs through LEAC. As shown in Figure II-2-21, the cumulative effect of the substandard nuclear performance has been over $1.4 billion.[33] Conversely, performance standards could reward good performance. If the capacity factor exceeds the target, then some savings could accrue to the company and the remainder to the ratepayers.

Figure II-2-21

NJ Total Cumulative Cost of Substandard Nuclear Performance



The BPU in implementing the Master Plan states:[34]

> Nuclear plants are constructed with the expectation that their high capital costs will be offset by their low operating costs...At the time the decisions were made to construct each of [PSE&G's] five operating nuclear plants..they were projected to perform at approximately 80 percent capacity factors...[PSE&G] reported that the lifetime cumulative capacity factor for Salem I is 51.3 percent, Salem II - 47.7 percent, Peach Bottom 2 - 53.8 percent and Peach Bottom 3 - 60 percent. Further, plant operations have been characterized by wide swings in performance as evidenced by Salem II's 8 percent capacity factor in 1983 and Salem I's 95 percent capacity factor in 1985. Thus, ratepayers have been saddled with the cost burden of the plant's high fixed costs in base rates and expensive replacement power costs incurred as a result of substandard nuclear performance through the LEAC. It is this history of uneven and substandard nuclear performance, its attendant cost burden to ratepayers and [PSE&G's] increasing reliance on nuclear generation that gives rise to the need for nuclear performance standards.

The nuclear performance standard as adopted by the BPU is as follows:

Combined Nuclear Facility Capacity Factor	Result
90-100%	Reward - 25% of replacement power costs
80-90%	Reward - 20% of replacement power costs
60-80%	No disallowance or reward
60-50%	Disallowance - 20% of replacement power costs
50-40%	Disallowance - 25% of replacement power costs
Below 40%	Board Review

This standard is based on a target capacity factor of 70 percent. No reward or penalty is triggered for performance within 10 percent of this target. Outside this band, either a penalty or reward is triggered. Below 40 percent capacity factor, a BPU review is required to determine appropriate action.

The present performance standards raise questions about optimum design:

1. What is the best "setpoint," the divider between performance penalties and rewards? The 1985 Energy Master Plan urged adoption of the (per plant) standards used in planning stages to establish economic viability. Other alternatives would include the capacity factor of plants of the same class nationally.

2. Should there be a "deadband," a range in which performance changes are neither rewarded or penalized? The present system has a broad deadband, which tends to minimize the role performance standards could play.

3. Should standards be based on thresholds or a constant slope? The present system has a peculiar result: within the wide deadband, there is no penalty or reward. At the edge of the deadband, a small incremental availability change leads to a large instantaneous effect (20 percent). Would the incentives work better with penalty and reward proportional to deviation from the setpoint selected?

Load Factor

Load factor, the ratio of average to peak loads, is another measure of performance or efficiency. Meeting peak demands is expensive: peaking equipment is rarely and inefficiently used. New Jersey utilities have annual load factors in the low to mid-fifties range: 54.2 percent for AE,[35] 52.0 percent for JCP&L,[36] 52.4 percent for PSE&G,[37] and 52.5 percent in the aggregate. A comparison of these load factors with those in Table II-2-7 show that New Jersey utilities are below not only the national average but also that of PJM as well.

Table II-2-7
Comparison of Load Factors

Year	National Load Factor	PJM Load Factor	New England Power Pool Load Factor
1986	60.7	59.9	66.7
1985	62.0	58.4	63.0
1984	59.7	59.8	64.9
1983	59.5	59.1	64.0
1982	62.0	57.9	63.1

Source: Edison Electric Institute, Analyst Carl Tobee

Service Reliability

The concept of performance standards for individual power plants is appropriate for regulation in the current rate base environment. If the industry were restructured by divestiture of generation, this kind of standard would be a contract matter between the distribution company and its suppliers. In such a case, the regulator would be indifferent to how electric service was provided but would be concerned that the "obligation to serve" be met. In such a situation, the ideal measure would be the availability and quality of service to the customer at the meter. A proxy might be voltage and availability criteria at the substation.

Restructuring the Industry

Uncertainties abound in today's electricity industry due to fuel prices, growth forecasts, demand side opportunities, and changes in the regulatory environment. The general "deregulatory" climate of the 1980s may affect the vertically-integrated utilities during the 1990s. Two themes have emerged to date: "de-integration," and alternatives to traditional rate-base, rate-of-return regulation.

PURPA and the evolution of QFs and IPPs have shown that electricity generation is not a natural monopoly. For generation, no insurmountable capital barriers prohibit new entrants, many of whom are eager to bid for the right to sell power "to the grid." Utility responses to this situation vary. In New Jersey, the 1988 Cogeneration Stipulation[38] supports the rights of alternative power producers, while allowing utilities to reserve the right to add unspecified amounts of their own capacity. Virginia Electric Power (VEPCO), in contrast, tried to meet its additional capacity needs with alternative power.

The variability of utility responses has led some to propose divesting generation into a competitive industry. Transmission could then function as a regulated common carrier, giving access on behalf of distribution companies to least cost providers. The primary challenges to such divestiture are as follows:

a) In a transition period, is there need for special arrangements for existing power plants that are carried on the rate base at higher value than they can be sold for in a free market? Should special provisions ("excess payments") be provided for wholesale purchases from divested plants of this type, or should the owners be compelled to write down the excess value? During and following the telephone divestiture, there were extensive equipment writeoffs, a possible parallel.

b) Transmission must be sufficient to move electricity from the generators to users as well as to accommodate transactions with neighboring utilities and/or power pools.

c) Maintaining control to meet changing system requirements through dispatch is essential. Present PJM dispatch may be expandable. At minimum, capacity and energy contracts would be separately negotiated, with allowances for operation as "spinning reserve."

d) Reliabililty ensures that sufficient generation capacity exists to cover scheduled and forced outages, reduced capability, and deviations from forecast load. This installed capacity is further affected by the design and performance characteristics of the generating equipment, type of load served, and availability of capacity from other systems.

e) Flexibility includes fuel and technology diversity and ability to meet changed conditions. Regulators and the industry must learn many lessons, including the full cost of "take-or-pay" contracts formerly common in the gas industry. No full analysis of divestiture of generation has yet been published.

Another approach, market-based pricing, has been studied by the Task Force on Market Based Pricing of Electricity. This group considered a transition to an optional system in which retail electricity prices would be regulated instead of profits.[39]

Under the system an exogenous index (*e.g.* consumer or producer price index) would annually mediate electricity price caps (¢/kwh). By regulating price instead of profit (as in rate base systems), utilities would gain efficiency incentives, since they would be assured of capturing the profits. While price caps may adequately protect all ratepayers, difficult problems would have to be overcome to enable a smooth transition from the present system.[40]

Findings

- New Jersey electric prices are significantly higher than the national average.
- GR&FT of 12.5 percent on electric utility revenues--much higher than the national average tax rate of 7 percent--places the New Jersey manufacturing industry at an economic disadvantage with other competitor states.
- The electric utility industry controls selection of its own production, transmission, and distribution facilities.
- Electric utilities can influence customer behavior both in the purchase and use of end use equipment with appropriate price signals and marketing techniques.
- The performance of New Jersey's nuclear plants has been substandard relative to national average.
- Nuclear plants have required significant capital additions on an ongoing basis to meet operating license requirements.
- Load factors of New Jersey utilities have been well below the national average (60 percent).
- New Jersey utilities are relying significantly on power purchases from utilities outside New Jersey.

- Adequacy of transmission capacity and accessibility needs to be determined.

Policy

- The present 12.5 percent GR&FT on electric utility revenues should be gradually reduced to 7 percent by shifting the tax on the value of energy to a tax on a unit of energy for each of the commercial, industrial, and residential sectors on the basis of the present proportional contribution of each sector to the total tax.

- Regulators and electric utilities must develop and adopt mechanisms to implement least cost planning. Utilities shall deliver energy services at the lowest possible cost to consumers by appropriately considering conservation options or end use technologies that conserve electricity on an equal basis with constructing new generation facilities. The least cost plan must assess and include environmental costs. Regulatory incentive may be required.

- Electric utilities should continue to diversify their supply options and not rely on one source of energy for the bulk of their requirements.

- To meet the projected capacity needs of New Jersey consumers, aggressive efficiency improvement and peak load management programs should precede a judicious selection of capacity expansion and life extension to insure the least possible cost to consumers.

- Performance standards for nuclear power plants should be continued and improved.

- Capital additions at existing nuclear facilities should be made only if no other cost-effective alternatives are available.

Implementation

- Least cost planning must be adopted by utilities and regulators as the fundamental strategy for meeting New Jersey's needs for the services provided by electricity. DCEED, BPU and DEP shall develop guidelines for environmental costs within the least cost planning framework.

- As corollary, regulatory mechanisms must be adopted that provide long-range utility incentives for conservation: Utilities must be able to earn as much by investing in saved energy as by building new power plants.

- Although the present high level of gross receipts and franchise taxes may modestly accelerate customer investments in efficiency, it contributes significantly to high electricity costs and resulting economic disadvantages for New Jersey. The Legislature should adopt a schedule to reduce GR&FT to 7 percent, the U.S. average of utility taxes.

- Electric utilities shall identify and submit for review plans to improve load factor by 1 percent per year to reach at least PJM's average value. These plans should not only lower peaks but also reduce total electricity use.

D R A F T

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COGENERATION

Introduction

This chapter analyzes the evolving role of cogeneration in supplying electricity for New Jersey. In an increasingly electrified world, the provision of economic electricity is a priority for users, government planners, and utilities. We show that cogeneration is more energy efficient and less polluting than utility generation on a per kilowatthour basis and thus warrants promotion and investment.

Cogeneration is the simultaneous production of electricity and useful thermal output from one fuel source. The useful thermal output is generally steam or hot water, which we will refer to as heat. Producing both electricity and heat at the same time is more efficient than producing either separately. Neither electric utilities nor industrial process steam users are optimally efficient. Utilities do not recover the waste heat from the exhaust of their boilers or combustion turbines, resulting in an average efficiency of around 30 percent with current systems. Industrial users often need only low-temperature steam, but combustion processes dictate much higher output temperatures to raise steam from boilers. In cogeneration the respective utility and industrial efficiency losses are partially captured, resulting in lower costs for both steam and electricity by using a combined system.

Cogeneration was popular at the beginning of the electricity era because industry recognized its higher efficiency. Cogeneration lost favor, however, as economies of scale made utility plants less expensive to build and operate, and utility-produced electricity cheaper until the late 1960s.

The twin energy crises of the 1970s changed the economics of cogeneration by raising fuel costs relative to capital, but barriers raised by utilities still made it impractical until Congress intervened. The 1978 Public Utility Regulatory Policies Act (PURPA) was part of an omnibus energy bill and included the promotion of cogeneration, primarily by requiring utilities purchase the electrical output.

In New Jersey, which has no native energy sources and high electricity rates, the use of cogeneration has many advantages.

In 1988 New Jersey electric utilities provided more electricity than at any time in the past, and the growth in peak demand and energy use outstripped all forecasts (see Chapter II-2). The high cost of nuclear generation has priced that technology out of the marketplace nationally, since no new nuclear plants have been ordered since 1978 and many of those planned have been cancelled[1]. Coal-fired plants in New Jersey face several obstacles, including stringent air quality standards, need to locate near adequate water supplies, and access to transportation for coal and coal wastes, which combine to make its use difficult. The New Jersey Department of Environmental Protection (DEP) records show that the last coal-burning facility was brought on line in 1981. The last permit was issued for coal in 1982 but the plant was never built.[2] Oil imports are near historic highs and are expected to increase, which make large new use for electrical generation imprudent.[3] Utilities generally use natural gas in intermediate and peaking units with relatively low efficiencies.

Despite PURPA's 10-year history, only about 300 MW of cogeneration are actually on line in New Jersey. AE has 48 MW of supply side cogeneration on line, 12 MW of demand side in place, 687 MW under contract, and 45 MW of future demand side. JCP&L has 136 MW of supply side cogeneration on line, 44 MW of demand-side in place, 813 MW under contract, and 30 MW in negotiations. PSE&G has 31 MW of supply side cogeneration on line, 12 MW of demand side, 160 MW under contract, and 433 MW in negotiations. Rockland has 3.3 MW of demand side cogeneration in place. Cogenerators have filed with FERC proposals ranging in size from 10 KW to 328 MW[4], and under a new bidding procedure the utility companies have made a 1988 commitment to purchase 480 MW from cogenerators.[5]

One of the reasons utilities were reluctant to contract with some cogenerators was a lack of dispatchability. Utilities wanted more control over when the power was delivered, and some cogenerators wanted to provide baseload power only. This issue is largely economic, since electricity is more valuable on-peak and especially during the summer peak. Utilities do not want to take more power than they need. The utilities are also concerned about the interconnection of the various cogenerators to the system. The cogeneration industry believes that the problems can be handled readily.[6]

Cogeneration has an average availability of around 89 percent.[7] Nuclear plants, on a national basis, have a capacity factor of 56.9 percent. Since these plants are base loaded, their capacity factor reflects their availability factor.[8] Thus by comparison cogenerators are far more reliable than the large plants that the utilities have on line. The relatively small size of cogeneration units provides supply diversity, which can help prevent brownouts or blackouts that could occur if several large utility plants are off line simultaneously. The smaller size of cogeneration units also enables adding smaller increments of generation capacity than with conventional power plants, and the time needed to plan and construct them is shorter.[9]

Cogenerators are generally close to load centers, resulting in lower loads on the transmission system and a corresponding lower risk of localized brownouts or blackouts. Connecticut has specifically provided for the implementation of line loss credits based on the avoided cost of transmission and distribution equipment.[10] New Jersey imports from out of state around 35 percent of its electricity and has been on 5 percent voltage reduction during some summer hours because of a lack of transmission capacity.

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The installation of additional electric generating capacity in New Jersey would allow the west-to-east electric transmission system to provide more on-peak electricity and reduce the need for imported electricity and for voltage reductions. This additional capacity would also reduce electricity costs to consumers by obviating new transmission facilities. Since cogeneration is so energy efficient, fuel use and air pollutants are reduced relative to the amount of electricity generated conventionally by the utility and useful heat by an on-site boiler.

Cogeneration has environmental advantages as well. Clean-burning cogeneration units often replace older, more polluting sources of power and limit the need for construction of new central power plants.

Definitions:

Bid cap price - The avoided cost established by a utility, which becomes the highest price at which it will accept bids for capacity.

Bottoming cycle - A cogeneration system using the high pressure steam for process purposes first and then the waste steam for generating electricity.

Combined cycle - A cogeneration system in which a gas turbine generates electricity, the exhaust heat generates steam which is passed through a steam turbine to generate additional electricity, and the waste steam is then used for process purposes.

Dispatchability - The ability of the utility to call upon a particular electric generator to provide power when needed and not to take power at other times.

Force majeure - A contract term that prevents a penalty to one of the parties to a contract due to a calamity beyond that party's control.

Levelization- The amount of advance payment made by a utility to a cogenerator above avoided cost in the early years of a cogeneration contract, which the cogenerator must repay by accepting below avoided cost payments in the latter years.

Qualifying facility (QF) - A cogeneration installation that meets the efficiency and useful thermal output standards of the Federal Energy Regulatory Commission (FERC).

Self-generation - Cogeneration devoted to internal electric and heat needs with no sale of electricity to the utility.

Topping Cycle - A cogeneration system in which electricity is generated first with the waste steam used for process purposes.

Chapter II-3

Present Situation

Legal Status

1978 Public Utilities Regulatory Policies Act

In 1978 Congress passed the Public Utility Regulatory Policies Act (PURPA), which sets forth federal policies for the regulation of utilities that generate and sell electricity. This law, in effect, created the cogeneration and small power industries that we will refer to as cogenerators. After various challenges, the court upheld the regulations put in place by the Federal Energy Regulatory Commission (FERC), and in areas of the country with high electricity rates, cogeneration became an important option for industrial companies.

PURPA Sec. 201 defines qualifying facilities (QF's) to include small power production facilities as well as cogeneration that meets standards established by FERC. Sec. 202 requires utilities to interconnect so long as it is in the public interest, would conserve energy or capital, optimize efficiency in facilities and resources, improve reliability, and meet the review requirements of Section 212 of the Federal Power Act (FPA). Sec. 210 establishes just and reasonable rates for back-up electricity sales to cogenerators by utilities and requires utilities to purchase electricity offered by cogenerators at the "incremental cost of alternative electric energy," later known as "avoided cost." Under PURPA, QF's must be certified by FERC and meet minimum efficiency standards.

Subsequent to the passage of PURPA, FERC issued a rulemaking to implement the law. The result of the rulemaking was new regulations, FERC Section 292.101 *et seq.*, which specified the criteria that cogenerators must meet to enjoy the benefits of PURPA. The most important criteria were efficiency standards and ownership limitations. Minimum efficiencies were established for topping cycles at 42.5 percent and for bottoming cycles at 45 percent. To prevent utilities from dominating the market, the regulations limited utility involvement to 50 percent for a cogenerator to be exempt from public utility regulation.

1981 New Jersey Board of Public Utilities Order

Due to the legal challenges to PURPA at the federal level, the New Jersey Board of Public Utilities (BPU) did not establish its cogeneration policy until October 14, 1981, in its Decision and Order Docket No. 8010-687. The Order contained the ground rules that utilities had to follow when dealing with cogenerators. The most important finding was that the avoided cost rate, *i.e.*, what utilities pay cogenerators, should be the PJM billing rate plus 10 percent for energy and the PJM capacity deficiency rate for capacity. (In the case of JCP&L, the actual cost of a peaking unit was deemed to be more appropriate.) PJM is the interstate power pool of which PSEG, AE, and JCPL are members (see Chapter II-2). The PJM rates were considered to be the "incremental cost" as required by FERC. The 10 percent adder on the energy cost was meant to reflect the "excess value" that cogeneration had over conventional electricity supply as well as to help promote the technology.

1983 New Jersey Board of Public Utilities Modified Order

An Order of Clarification was issued December 7, 1983, due to utility arguments that the avoided cost set in the 1981 Order was only a starting point for negotiation. The Board reiterated that cogenerators were entitled to those rates unless they specifically chose to negotiate price for other favorable contract terms.

1988 Federal Energy Regulatory Commission Notices of Proposed Rulemaking

On March 16, 1988, FERC issued three Notices of Proposed Rulemaking (NOPR's) dealing with the implementation of PURPA for comment by interested parties. The three NOPR'S are:

Administrative Determination of Full Avoided Costs, Sales of Power to Qualifying Facilities, and Interconnection Facilities (ADFAC NOPR): The ADFAC NOPR addresses utility questions about inappropriate methods of determining avoided cost and a lack of consideration of dispatchability or reliability criteria in many states' avoided cost calculations. It contains clarifications that benefit cogenerators, including mandating backup power for the cogenerator and the host served by the facility, and includes any savings from line loss reductions in the avoided cost.

Regulations Governing Bidding Programs (Bidding NOPR): The Bidding NOPR provides the standards for the solicitation and evaluation of bids and state certification of the bids to avoid anti-trust problems. The solicitation of bids must describe the need for capacity and energy, the participation criteria, and the selection criteria. The evaluation must be based on the solicitation criteria, and the state must approve the price and selection.

Regulations Governing Independent Power Producers (IPP NOPR): The IPP NOPR would open up the marketplace to any non-utility generator willing to provide competitively priced electricity and works toward deregulation of the electricity supply or generating function. The crucial aspect of this NOPR is the concept of market power that separates a public utility from an independent power producer (IPP). An IPP has no significant market power when it is outside the buyer's service area and does not control the transmission line. Thus it is exempt from cost of service regulation.

FERC proposed the NOPR's to clarify existing rules as well as to introduce some new concepts to the way the cogeneration industry is regulated. The most important new concept is the introduction of competition to the electricity generation industry.

The NOPR's are controversial. Some state public utility commissions that already have bidding in place felt their systems were not compatible with FERC's view. The three original NOPR's raised so many questions that a fourth was issued on July 29, 1988, called "Regulations Governing the Public Utility Regulatory Policies Act of 1978," to address procedural and technical rules dealing with QF status. The major proposed revisions are to remove the 50 percent ownership limit on utility subsidiaries, to expand self-certification of QF status, and to liberalize the evaluation of efficiency criteria.

New Jersey Board of Public Utilities Cogeneration Stipulation

The 1981 BPU Order specified that it would revisit cogeneration within five years. As a result, in 1987 the Board produced an assessment of the QF activity in New Jersey that called for changes to the 1981 Order. Widespread interest convinced the Board to start a more formal review procedure.

The Board therefore convened a settlement conference on December 18, 1987, in which DCEED participated along with utilities, cogenerators, and other interested parties. The culmination of the process was a Stipulation of Settlement issued on July 1, 1988.

Some of the major provisions are as follows:

1. Bidding to provide capacity and energy to electric utilities commenced on October 1, 1988, and will recur on September 1 each year thereafter;

2. Utilities will advertise solicitations locally and nationally;

3. The utility's incremental need will determine the block size, but existing utility capacity is exempt from consideration;

4. The utility may include IPPs;

5. Conservation investments over 400 KW shall be considered along with energy and capacity sales in the bid process;

6. The utility will determine the bid ceiling price using the differential revenue requirements method. The bid floor is 25 percent of the ceiling;

7. The evaluation will be primarily based on:

    a) Economic/price factors--maximum weight 55 percent

        i. Price
        ii. Dispatchability
        iii. Security

    b) Project status and viability factors--minimum weight 25 percent

i. FERC certification
ii. Scheduling
iii. Engineering
iv. Liquidated damages

c) Non-economic factors--minimum weight 20 percent

i. Promotion of QFs
ii. Fuel type, location, environmental benefits, and fuel efficiency

8. In order to assure financeability, cogenerators will enter into a security agreement with utilities guaranteeing repayment of any advance payments above the avoided cost. Levelization determines the maximum amount of prepayment. The maximum amount of levelization allowed without security is 20 percent of the contract value for oil and natural gas and 35 percent for solid fuel.

9. Performance guarantees will be based on average availability factors for non-nuclear utility units with a cap at 80 percent for solid fuel and 85 percent for all others;

10. "Force majeure" is defined so that no misunderstanding occurs about when performance guarantees apply;

11. Standard offers are allowed for energy-only transactions based on the electric grid price. For small projects of 10 MW or less, the price will be the bid cap price;

12. Resource recovery will receive the bid cap price for the first three years so long as the facility is in the county solid waste plan, has a vendor selected, has QF status, does an interconnection study, and agrees to allow 90 percent of electricity revenues to go to reduce tipping fees;

13. Utilities agree to wheel in-state power to in-state utilities;

14. Utility affiliates cannot bid in their parent's solicitation for three years;

15. The utilities submit detailed backup on how they determined avoided cost and capacity block;

16. A complete schedule for the procurement process is established;

17. The bidder's fee will be $5,000 for those participating in the selective procurement process;

18. A detailed liquidated damages schedule assures that capacity comes on line on when the utility needs it;

19. A regulatory risk provision allows either party to terminate the power purchase contract if a change in governmental policy damages the economics of the contract.

Cogeneration Technology

Technology & Size

There are three basic types of cogeneration prime movers: steam turbines, gas turbines, and reciprocating engines. Each has advantages and disadvantages based on the need for electricity or steam. The steam turbine provides a large amount of steam and a relatively small amount of electricity. The combustion turbine provides a higher electrical output with proportionately less steam. The highest relative electrical output comes from the reciprocating engine. These generalizations reflect the ratio of electricity to heat also known as the net heat rate. Many different combinations of equipment can change these relationships when heat recovery, supplemental firing, or combined cycle systems are included.

The selection of appropriate equipment depends on the size of electric and heat outputs required. Various prime movers are suitable, depending on the electric load and type of business (see Figure II-3-1). Reciprocating engines, which include spark ignition, rotary, and diesel configurations, are available in sizes ranging from household-sized 10 KW units to 25 MW units suitable for many business installations. Gas turbines are available in sizes from 75 KW to large units of 200 MW that could be used in refineries. Steam turbines are primarily suited to large installations from 100 MW to utility-sized units of up to 1000 MW each. Oil, gas, coal or even garbage can fuel these engines.

Temperature, quality of steam, the maintenance schedule, construction time, and environmental impacts (noise, air, water) must all be considered when selecting equipment for a particular application. These considerations can also dictate whether a topping or bottoming cycle is indicated. The amount of steam required will determine whether supplemental firing of the waste heat recovery boilers is needed.

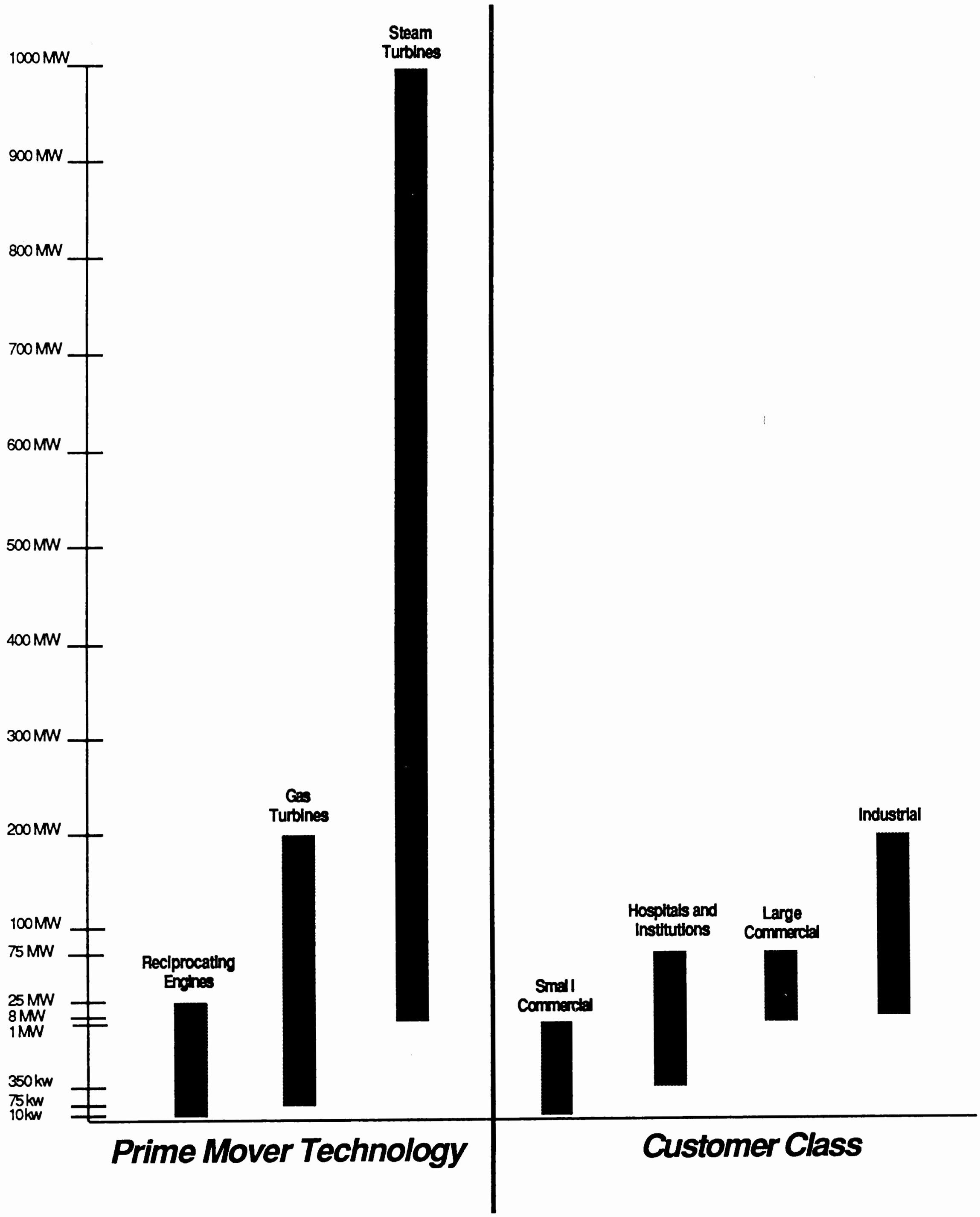
The process steam requirements for a particular facility may even necessitate the installation of backup boilers to keep a plant on line while the cogeneration unit is undergoing maintenance. The characteristics of various systems are shown on Table II-3-1.

Packaged Units

In order to make cogeneration less expensive, manufacturers often assemble the components at the factory. The prime mover and generator are mounted on a skid and delivered to the site, leaving only the fuel and electric hookups to be done at the customer's facility. As manufacturers have become more familiar with the market for cogeneration, the size of skid-mounted units has steadily increased. Today large gas

Figure II-3-1

Cogeneration Technology and Applications



D R A F T

Chapter II-3

Table II-3-1

Table 1

COGENERATION TOPPING CYCLE PERFORMANCE PARAMETERS

Cogeneration Systems	Electrical Capcity of a Single Unit (KW)	Heat Rate[2] (Btu/Kwh)	Electrical Efficiency (%)	Thermal Efficiency (%)	Total Efficiency (%)	Exhaust Temperature °F	Steam #/hr. Generation @ 125 psig
Small reciprocating Gas Engines	1-500	25,000 to 10,000	14-34	52	66-86	600-1200	0-200[1]
Large reciprocating Gas Engines	500-17,000	13,000 to 9,500	26-36	52	78-88	600-1200	200-10,000[1]
Diesel Engines	100-1,000	15,000 to 11,000	23-31	44	67-75	700-1500	100-400[1]
Industrial Gas Turbines	800-10,000	14,000 to 11,000	24-31	50	74-81	800-1000	3,000-30,000
Utility Size Gas Turbines	10,000-75,000	13,000 to 11,000	26-31	50	76-81	700	30,000-300,000
Steam Cycles	5,000-100,000	50,000 to 10,000	12-34	28	35-62	350-1000	10,000-100,000

1 Hot water @ 250°F is available at 10 times the flow of the steam

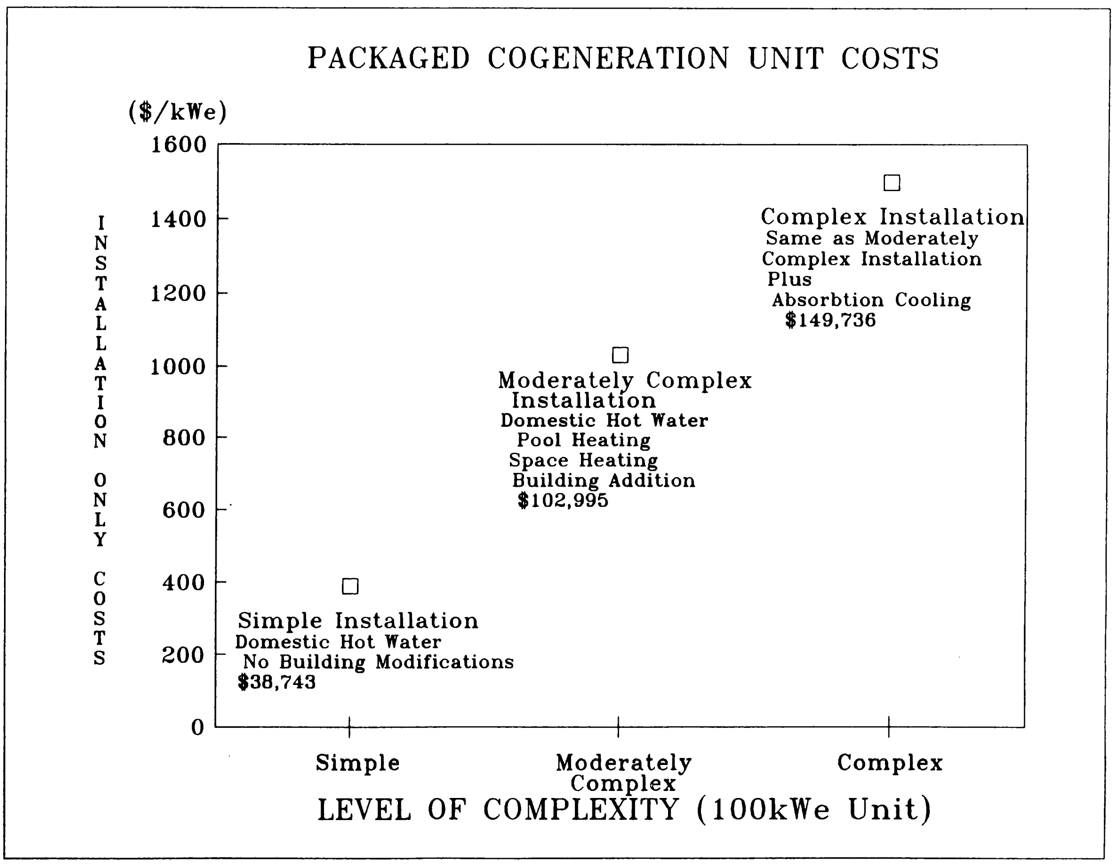
2 Heat rate is the heating value input to the cycle per Kwh of electrical output. The electrical generation efficiency in percent of a prime mover can be determined from its heat rate by the following formula:

$$\text{Electric Efficiency} = \frac{3413}{\text{Heat Rate}} \times 100$$

turbines in the 50 MW range will arrive on site with only a few months installation time required. Many small packaged units are available that can meet the needs of commercial buildings for electricity, heating, and air conditioning requirements.

Since most commercial and industrial sites have substantial electricity and winter heating requirements, a summer use for the heat may be the determining factor in whether a project can be sold. Air conditioning is one of the most important value-added components to fit a cogeneration system to the customer's load profile, but it raises the installed cost when absorption chilling is used for air conditioning purposes.[11] Depending upon the level of complexity, the cost for packaged units can vary for three typical 100 KW set ups as shown on Figure II-3-2.[12] Where the heat load is high enough year around, the cogeneration unit could be sized to meet the electrical needs of the existing air conditioning system with excess electrical sales in the winter. A cogeneration unit could also be sized in conjunction with storage ice-making equipment to level the building's electrical load, thus allowing the unit to operate on a 24-hour basis in the typical office building. Properly evaluating loads and operating conditions determines the number of hours that a cogeneration unit operates and, therefore, the savings over utility-supplied power.

Figure II-3-2



PURPA Machines

So-called PURPA machines, cogeneration units built to the lowest efficiency standard allowed by law, have been criticized by the utility industry as utility units without the protection of regulation. Built by cogenerators primarily to profit from high avoided cost rates, PURPA machines, the cogeneration industry argues, still produce electricity at a lower cost than nuclear plants. For a complete analysis of the problems that have occurred nationally with the implementation of PURPA, see the Federal Energy Regulatory Commission Notice of Proposed Rulemaking Docket No. RM88-6-000.

Efficient Electric Equipment

Cogeneration has encouraged the utilities to be more attentive to assisting their customers identify and make energy efficiency improvements that lower their electric bills. Some of the ways utilities seek to keep customers are by providing technical assistance and by establishing incentive rates. The cogeneration industry recognizes that high efficiency electrical equipment can be more cost effective than cogeneration in certain applications. We believe that even after the energy efficient devices are installed, there is still a place for cogeneration.

Utility Cogeneration Plans

The electric utilities currently have some cogeneration capacity in place and some under contract. In addition, each of the companies has submitted Requests for Proposal (RFPs) as required by the Stipulation.

Atlantic Electric: Since the 1920s Atlantic Electric has had a cogeneration contract with DuPont at its Deepwater location. However, from the time of the 1981 BPU Order through 1985, little cogeneration activity occurred in Atlantic Electric's service territory. Then a number of cogenerators, including several with Atlantic Electric as a partner, began negotiations with the company. After some confusion Atlantic Electric decided to cancel negotiations and go into a bidding procedure. However, since the BPU had not authorized the company to engage in bidding, Atlantic Electric cancelled the bidding and issued a standard offer. AE has 48 MW of supply-side cogeneration on line, 12 MW of demand-side in place, 687 MW under contract, and 45 MW of future demand-side.

The company has submitted no capacity requirement for the initial period covered by the Stipulation, since it maintains that it already has sufficient capacity under contract from the previous standard offer.

Jersey Central Power and Light Company: In 1979 an accident at the Three Mile Island II nuclear generating station closed the plant permanently and the Three Mile Island I plant temporarily, making additional capacity essential. However, JCP&L signed up very little cogeneration at that time. It was not until 1985, when the company issued its first standard offer for 200 MW, that any substantial cogeneration activity took place in New Jersey. Subsequently, another standard offer for 600 MW was issued in 1986. JCP&L has 136 MW of supply-side cogeneration on line, 44 MW of demand-side in place, 813 MW under contract, and 30 in negotiations.

In its request for proposal, JCP&L's initial block size is 180 MW.

Public Service Electric & Gas: The company has had a long-standing contract with Exxon's Linden facility for cogeneration and made no efforts to expand cogeneration under the 1981 Order. In the report by the BPU Division of Electric, "An Assessment of Cogeneration and Small Power Production Policy in New Jersey 1981-1986," the staff expressed its opinion that cogenerators found it difficult to deal with PSE&G. Since PSE&G believed it had sufficient capacity because of the completion of Hope Creek 1, the company had little interest in cogeneration.[13] The company did not issue a standard offer and until early 1988 discouraged negotiations with cogenerators. PSE&G has 31 MW of supply-side cogeneration on line, 12 MW of demand-side, 160 MW under contract, and 433 MW in negotiations.

Despite previous lack of interest in cogeneration PSE&G has an initial block size of 200 MW in its request for proposal.

Rockland: PURPA does not apply to Rockland because of its size, and therefore no substantial cogeneration has been proposed for its service territory. The matter is further complicated because its parent company, Orange and Rockland, is a New York utility not on the PJM grid. There is one demand side cogeneration facility of 3.3 MW in its service territory.

Despite the small size of this company, Rockland has indicated an initial block size of 100 MW in its request for proposal.

Regulatory issues

Taxes

Gross Receipts and Franchise Taxes: In order to equalize the treatment of cogenerators that are QF's under PURPA with that accorded electric utilities, cogenerators are exempt from the payment of gross receipts and franchise taxes (GR&FT) on their purchases of natural gas under N.J.S.A. 54:30A-50. In addition, they are exempt from GR&FT on electricity purchases up to the amount sold or purchased, whichever is smaller.

Sales Tax: Cogenerators are exempt from sales tax under N.J.S.A. 54:32B-8.13.d on the purchase of equipment or supplies specifically dedicated to the cogeneration project. Regulations designated N.J.A.C. 12A:54-1.1 *et seq.* implement this exemption.

Property Taxes: The question of how to tax cogeneration equipment is controversial. The dispute centers on what part of a project is real property subject to tax and what part should be considered personal property that is not taxable. DCEED has examined the issue with the Division of Taxation and believes that the December 1988 regulations allow cogeneration facilities which sell electricity to the host corporation or a utility to be classified as personal property. These regulations appear to require that a subsidiary be established for any company that wishes to self-generate.

Environment

Cogeneration will result in lower net air emmissions at many industrial and commercial sites statewide, since many of these sites have old boilers that are "grandfathered" under DEP regulations. Grandfathering allows old fuel-burning equipment to remain in use without the addition of "state of the art" (SOTA) pollution controls. DEP renews air permits every five years for facilities that pre-date the agency's existence. Businesses thus have an incentive to repair rather than replace grandfathered equipment to avoid meeting SOTA requirements, which can be very expensive.

Since New Jersey purchases about 35 percent of its electricity from out-of-state plants, many of which have no pollution controls and burn high sulfur coal, cogeneration can also help reduce the acid rain problem.

The state of California allows new equipment that replaces higher pollution sources to avoid "prevention of significant deterioration" (PSD) and nonattainment regulations with a "netting" analysis.[14] This analysis allows the new cogeneration installation to receive credit for the reduction in emissions from the boiler on site as well as emissions from utility electricity generation off site. When cogeneration was first becoming popular, the DEP proposed the use of selective catalytic reduction (SCR), an expensive technology for the control of nitrogen oxides (NO_x). In order to allow cogeneration to develop economically, DCEED proposed use of a netting analysis. DEP and DCEED together developed a NO_x control strategy for gas turbine cogenerators that would meet appropriate environmental standards without jeopardizing cogeneration. Thus, DEP's proposal for SCR was changed into an emission limit guideline that was not technology-specific. The applicable control strategy is contained in Table II-3-2.

Because of its efficiency, cogeneration produces lower air emissions than if electricity and heat were produced separately. Therefore, DCEED promoted the netting concept and has supported legislation to implement such a requirement for cogeneration. However, new cogeneration equipment installed by industry can meet all reasonable standards without netting.

Guidelines for internal combustion engines and solid fuel boilers will be based on the turbine standard with appropriate allowances for differences in the type of fuel and combustion process.

Table II-3-2

New Jersey Department of Environmental Protection
April 21, 1987 Cogeneration and Electric Generation
Gas Turbine Nitrogen Oxides Control Strategy

SUMMARY

I. Nitrogen Oxides Emission Limits

A. 1 MMBtu/hr to 100 MMBtu/hr (1)

	Emission Limits (2)
Gas Use	0.2 lb/10^6 Btu
Oil Use	up to 0.4 lb/10^6 Btu (3)

B. 100 MMBtu/hr to 250 MMBtu/hr (1)

	Emission Limits (2)	
	Until 5/1/92	After 5/1/92
Gas Use	0.2	0.1 lb/10^6 Btu (5)
Voluntary Oil Use	up to 0.4 (3)	0.2 lb/10^6 Btu (4)
Oil Use During Gas Curtailment	up to 0.4 (3)	up to 0.4 lb/10^6 Btu (3)

C. Greater than 250 MMBtu/hr (1)

1. Demonstrated NO_x control.

	Emission Limits (2)
Gas Use	0.1 lb/10^6 Btu
Voluntary Oil Use	0.2 lb/10^6 Btu
Oil Use During Gas Curtailment	up to 0.4 lb/10^6 Btu (3)

2. Technology transfer of NO_x control to selected turbine.

	Emission Limits (2)	
	Until 5/1/92	After 5/1/92
Gas Use	0.2	0.1 lb/10^6 Btu (5)
Voluntary Oil Use	up to 0.4 (3)	0.2 lb/10^6 Btu (4)
Oil Use During Gas Curtailment	up to 0.4 (3)	up to 0.4 lb/10^6 Btu (3)

II. Carbon Monoxide Emission Limit

Carbon Monoxide levels must be maintained below 50 ppmv (dry basis) corrected to 15 percent oxygen. For high levels of water or steam injection oxidation catalysts may be required to attain this carbon monoxide emission limit.

Table II-3-2 (con't)

1. Size categories are based on total heat input to the gas turbines on a per facility basis, using lower heating value and ISO conditions on a dry basis (without water injection). MMBtu/hr refers to the heat input rate to the turbines in million British Thermal Units per hour.

2. Emission limits are based on higher heating value and are averaged over 1 hour periods. Compliance is determined based on actual emissions and actual operating conditions during the testing.

3. The nitrogen oxide limit for oil use during gas curtailment should be the lowest guaranteed NO_x limit for that turbine, not to exceed 0.4 lb/MMBtu.

4. The 0.2 lb/MMBtu for voluntary oil use may require SCR or other advanced NO_x control during voluntary use of oil for economic purposes.

5. Demonstrated NO_x control must be retrofit to achieve 0.1 lb/MMBtu when burning gas if technology transfer fails to demonstrate designated limits, unless the Department determines that despite a substantial effort to meet the 0.1 lb/10^6 Btu limit, this is not reasonably achievable based on the results of a demonstration program for technology transfer approved by the Department. In such a case the Department would select a limit between 0.1 and 0.2 based on the results of demonstration programs. The Department intends to limit the option for the demonstration program to applicants with substantial financial commitments prior to July 1, 1986.

6. Duct burners - if supplementary fuel is fired, duct burner nitrogen oxide emissions must comply with the above nitrogen oxide emissions limits for the same category as the associated turbine. The turbine must be tested with and without operation of the duct burners.

Reporting Regulations

As the agency responsible for the promotion and development of a viable cogeneration industry, DCEED has issued reporting regulations for all cogenerators operating in New Jersey (N.J.A.C. 12A:50-1.1 et seq.). The purpose of the regulations is to assist the DCEED in its energy planning responsibilities as well as in monitoring the progress being made by cogeneration in supplying the electrical needs of industry and the electric utilities.

All cogenerators must provide the operating and financial information requested in the regulations, though they may submit pre-existing documents, such as a FERC QF filing. Electric and gas utilities that do business with cogenerators also have reporting requirements.

In addition, the federal government has proposed reporting requirements for cogenerators similar to New Jersey's.

Cogeneration Center

DCEED established the Cogeneration Center within its Division of Energy Planning and Conservation on June 15, 1987. The mission of the Cogeneration Center is to act as a central clearinghouse for cogeneration opportunities; be a full-time advocate for cogeneration in the state; maintain a registry of cogeneration projects in the state to serve as a technology resource for potential cogenerators; and monitor and participate, as appropriate, in regulatory proceedings at other state and federal agencies.

The Center provides information to the industry so that regulatory changes have the full participation of cogenerators, and maintains a comprehensive list of all cogenerators and small power production facilities that have filed and been granted QF status by FERC.

The Center has intervened in BPU hearings to have gas utilities implement special cogeneration tariffs. Each gas utility now has in place interruptible and transportation tariffs that address the needs of the cogeneration industry. The Center worked with DEP to establish reasonable standards for gas turbine emissions and with the BPU at the Stipulation meetings to resolve many problems that were raised by cogenerators. The Center was instrumental in the adoption of the reporting regulations that will assist in determining the need for new electrical generating capacity.

To assist potential cogenerators in evaluating the economics and selecting the correct equipment for a successful cogeneration project, the Center publishes the "Directory of Cogeneration Equipment and Consultants." Many of the companies listed will provide a free initial screening of the suitability of cogeneration for a particular facility.

Technical Issues

Economics of Cogeneration

From the electricity user's standpoint, cogeneration should be considered only when the installation results in cost savings, after examination of basic criteria. The following example compares a cogeneration system with a conventional boiler and purchased electricity in New Jersey, assuming the use of a 1 MW gas turbine with heat recovery that meets the electrical and heat loads of an industrial plant.

The cost of a typical gas turbine cogeneration package in this size range is approximately $1000/KW of installed capacity. The simple cycle efficiency of a gas turbine is 25 percent, and the efficiency of the heat recovery system is 50 percent. The system will operate 90 percent of the time with a heat rate of 13,652 Btu/kwh. In New Jersey typical industrial utility rates are 7¢/kwh for electricity and 44¢/therm for natural gas. Since natural gas is exempt from gross receipts and franchise taxes, the cogenerator's gas price would be 38¢/therm (or less, if an incentive rate is in effect). For a conventional system the boiler efficiency is 80 percent in this size range.[15]

Cogeneration Versus Conventional Boiler and Purchased Electricity

Cogeneration

Electrical Generation

1 MW x 90 percent x 8760 hours = 7,884,000 kwh

Heat Recovery

13,652 Btu/kwh x 50 percent x 7,884,000 kwh = 5.38×10^{10} Btu

Total Natural Gas Energy Input

13,652 Btu/kwh x 7,884,000 kwh = 1.08×10^{11} Btu

Cost of Natural Gas for Cogeneration

1.08×10^{11} Btu x \$.38/therm = \$410,000

Conventional Boiler and Purchased Electricity

Energy Input

$$\frac{5.38 \times 10^{10} \text{ Btu}}{.75} = 6.73 \times 10^{10} \text{ Btu}$$

Cost of Gas for Conventional Boiler

6.73×10^{10} Btu x \$.44/therm = \$296,000

Cost of Electricity Purchased

7.884×10^{6} kwh x \$.07/kwh = \$551,880

Total Cost of Energy Services per Year

\$296,000 + \$551,880 = \$847,880

Comparison

Simple Payback

Cost of a 1 MW gas turbine

1 MW x \$1000/KW = \$1,000,000

Savings on Fuel

\$847,880 - \$410,000 = \$437,880/year

Payback

$$\frac{\$1,000,000}{\$437,880/\text{year}} = 2.28 \text{ years}$$

This example ignores the cost of capital, tax considerations, maintenance, and some other factors, but shows the kinds of benefits that are possible. These factors must also be evaluated since they could affect the payback. However, the payback for most cogeneration projects is short enough to make cogeneration viable for many industrial and commercial electric utility customers.

Self-Generation

In New Jersey, which has relatively high retail electricity rates, self-generation remains an option even if utilities do not need to sign up capacity. Self-generation can be economic in a variety of circumstances. A consultant or in-house staff can take the first step, which is to determine the facility's internal heat and electric load and the types of equipment that are available to meet either or both. The economics of the project should be evaluated and compared to the electricity and fuel costs.

Small cogeneration packages, starting at 37 KW, are already operating in New Jersey at YMCAs, hotels, and other businesses. Large food and pharmaceutical companies have opted to meet their loads with 8 MW to 23 MW units with only excess electrical sales to the local utility. No insoluble problems of providing backup electricity to the self-generators have occurred.

The utilities have reservations about self-generation when they see their baseload customers generate electricity for the majority of their needs while expecting the utility to be the provider of last resort or to furnish peaking service only.

New developments in cogeneration equipment will allow cogenerators to be even more responsive to utility operating conditions and to be able to increase output during peak periods, thus obviating new utility peaking units. Self-generators can help meet peak by load shedding as well as by increasing their output. One cogenerator has even retrofitted an old turbine with steam injection to reduce pollution and provide peaking capacity.

Wheeling Options

For a competitive market to work, the seller of a commodity must have access to the potential buyers. For cogenerators, that access is available only through the utilities in the form of wheeling, which is the movement of electricity from one location to another across utility-owned transmission and distribution lines. Currently, all New Jersey utilities have agreed to limited wheeling within the context of the Stipulation. PSE&G and AE already have tariffs in existence, while Rockland and JCP&L have submitted policies with their bidding programs.

The major areas of contention are retail wheeling and self-wheeling. Retail wheeling is direct competition with the utility, wherein a cogenerator sells electricity directly to an end use customer, using the utility transmission system. Self-wheeling is similar but delivers electricity only to a distant facility owned by the cogenerator.

The economic advantage of self-wheeling is that the cogenerator is using its own excess electricity and offsetting retail rates rather than receiving the lower avoided-cost rate from the utility for the excess. The cogenerators maintain that self-wheeling promotes efficiency by allowing the cogenerator to size the equipment to include the load from sites that may not support stand-alone cogeneration units.

The utilities oppose both concepts because they believe the cogenerator would not be paying its fair share of the transmission or capacity costs of the existing system and thus would transfer costs to other ratepayers.

With retail wheeling the utilities raise the technical problem of control of the current flow over the transmission system to assure reliable delivery of the power to the customer. Utilities also complain about the "cream skimming" effect of serving large customers with a wheeling contract that would result in the remaining customers paying more of the embedded costs of the utility rate base. No state or federal agency now has the legal authority to order a utility to wheel power where wheeling would result in higher costs for the remaining customers.

In wheeling arrangements, the cogenerator compensates the utility for the use of the transmission and distribution facilities. (Of course, the electricity flow described in a wheeling contract does not necessarily correspond to the actual path followed by the cogenerator's electricity.) Electricity will generally go to the nearest load center if needed. For example, the Cogen Tech 165 MW plant in Bayonne sells power to JCP&L, but the power is wheeled over PSE&G transmission facilities. In this case, because of the location, PSE&G also benefits, since the Bayonne facility allows PSE&G to avoid upgrades in the transmission facilities that would otherwise have been needed to serve new development along the Hudson River coastline area. Similarly, the ratepayers will see long-term savings from the reduction of need for interstate transmission lines that will not have to be expanded as well as local upgrades that may be avoided.

Most of the objections to self-wheeling or retail wheeling could be resolved by unbundling the various services provided by the utilities so that they could recover the costs of, or profit from, each service component. Thus the utility would charge customers separately for services such as transmission, generation, backup power, interruptibility, or voltage level. Unbundling has advantages for customers as well, since they can purchase only that level of service they require.

The gas industry has already applied unbundling to many services which were previously part of a package, so that customers can buy gas at the wellhead and transport it for a fee over interstate pipelines. The concept already has limited application in the electric industry since customers can currently get electricity at a lower price by providing their own transformers and taking service at higher voltage levels or by taking interruptible service.

The most important consideration is once again financial. Perhaps split savings arrangements similar to those used for interstate sales of electricity by utilities would allow the utility, the ratepayer, and the cogenerator to profit from wheeling transactions. Companies must make a substantial investment in construction and equipment to engage in self-wheeling, thus demonstrating their commitment to remaining in New Jersey. Self-wheeling simply allows companies to optimize those investments.

Markets

Customers for Cogeneration Equipment

Though the economics and maintenance requirements for household-sized cogeneration are not currently favorable in New Jersey, the equipment is available. Conceivably an electric generation unit with space heating and air conditioning as a package may one day be as common as a refrigerator, if utility electricity prices rise above the costs needed as an incentive for homeowners or as costs go down for equipment and maintenance intervals improve.[16] The present market for cogeneration begins with small scale units starting at 24 KW which can be installed in fast food restaurants, hotels, YMCA's and office buildings where electricity, space heating, and air conditioning loads can all be met by a properly sized unit.

Sale of Power to Utilities

Under the Stipulation large commercial and industrial customers must bid if they wish to sell electricity to the utility, unless they are willing to have a utility purchase excess electricity at PJM rates. Thus bidding or just selling excess becomes a major element of economic evaluation. The utilities establish the cap price under the Stipulation, and the cogenerator must determine if the project would be financeable. Bidders must compete against one another, although utilities are still required by PURPA to buy excess electricity from losing bidders at the PJM billing rate as recognized in the Stipulation.

Fuels

Natural Gas

Natural gas is attractive for cogeneration projects since it is clean-burning and available on a long-term contract basis. The gas turbine equipment is less capital intensive and meets environmental criteria. The state is concerned about reliance on just one fuel for electrical generation purposes. However, since deregulation, natural gas has been in good supply with only interstate pipeline capacity being a barrier to its greater use. The pipelines have applied to FERC to increase capacity substantially to New Jersey so that cogenerators who wish to use gas should be able to do so for the foreseeable future (see Chapter II-1-A).

The gas utilities in New Jersey have put in place incentive rates for cogeneration that support DCEED policies. Firm, interruptible, and transportation rates are available, depending upon the size and type of equipment and facility being served. The variety of tariffs allows the cogenerator to select the most economic choice. Some gas marketers will provide long-term contracts and move gas over interstate pipelines from the wellhead with utility transportation tariffs to deliver to the end user.

The other natural gas ratepayers can also benefit from an increase in gas use by cogenerators. Under traditional ratemaking the cogeneration gas provided by the natural gas utilities will spread fixed costs over larger volumes, thus reducing unit costs of gas. All customers then see lower bills for their gas service.

A critical aspect of natural gas use is the reduction in air pollution that occurs when cogeneration replaces old boilers using oil or coal. Natural gas contains little sulfur dioxide, and nitrogen oxide control strategies are very effective on gas-burning equipment.

Coal gasification technology is being developed that could be implemented in case of a shortage or price spike which makes gas no longer desirable for electric generation. The capital cost of building a gas turbine and later adding coal gasification has been estimated to be comparable to building new coal capacity initially where sufficient space and cooling water are available.[17]

Oil

Since the oil crisis of the 1970s, oil serves as a back-up to industrial interruptible gas for electrical generation for price and environmental reasons. Today many environmental permits limit oil use to periods of gas interruption. In order to burn oil full time, the more severe environmental criteria that apply to gas must be met. In many cases #2 oil is the preferred choice as backup. The price of #2 oil has seldom, if ever, been low enough to warrant switching to it on an economic basis. If we compare the New York Harbor Barge wholesale price of #2 oil to the statewide annual average price for industrial interruptible gas service, we can see the gas price advantage (Table II-3-3).

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Chapter II-3

Coal

The major impediments to the use of coal in New Jersey are environmental (air and water) and transportation. Even with the development of clean coal technology, the water needs of a coal plant can be a severe siting constraint (see Chapter II-1-C).

The other barrier that coal must overcome is the bidding procedure, which may be unwieldy for coal developers to utilize. In fact, Clean Coal Developers, an industry coalition, appealed the final Stipulation since they believe it burdens coal projects unfairly.

The utilities have had new coal capacity in their construction plans as recently as the early 1980s, but financing and siting problems as well as lower than expected load growth caused their removal from more recent plans. Even with higher than expected peak load growth, utilities maintain they do not need new capacity unless it is dispatchable, which is another area where coal plants appear to be at a disadvantage.

Fluidized bed coal units are the only current plants that appear to be capable of meeting environmental standards in New Jersey. Coal gasification remains a future possibility, when natural gas prices or supplies justify its use with gas turbines and combined cycle units. Another coal technology that is being investigated is the use of . pulverized coal in gas turbines. The major drawback is excessive wear on the turbine blades.

Alternative Fuels

Propane

The price of propane has generally confined its use to a peaking supplement to natural gas or a backup to natural gas in turbines. Its use as a primary fuel would occur only due to a shortage of natural gas.

An interruptible gas utility customer can use propane for continuous service on a displacement basis by purchasing a supply of propane and providing it to the utility when an interruption is scheduled to occur. The utility then mixes the propane with air to attain the proper Btu level and injects the mixture into the system, thereby allowing the customer to continue receiving pipeline service. The customer must have a contract with the utility to set up such a program.

Table II-3-3

Average Annual Wholesale Prices
for Fuel Oil ($/Gallon)

Year	#2 Oil NY Harbor Barge
1973	0.1479
1974	0.2693
1975	0.2993
1976	0.3247
1977	0.3689
1978	0.3853
1979	0.5604
1980	0.8111
1981	1.0331
1982	0.9904
1983	0.8646
1984	0.8648
1985	0.8197
1986	0.5170
1987	0.5608

Natural Gas
Annual Average Price ($/Therm)
Sector: Industrial Interruptible

Year	State Average
1973	.053
1974	.073
1975	.127
1976	.163
1977	.200
1978	.261
1979	.293
1980	.344
1981	.456
1982	.459
1983	.484
1984	.498
1985	.471
1986	.326
1987	.319

Source: N. J. Energy Profile, Annualized Data Summary, 1987.

Solid Waste

By 1992, solid waste can fuel the generation of an estimated 370 MW of electricity in New Jersey. Since landfill space in no longer readily available, most of that capacity will eventually be built (see Chapter II-4). This fuel is thus only a small part of the mix of capacity needed to supply New Jersey in the future. Under the Stipulation resource recovery projects receive the bid cap price for three years and then must compete against other sources.

The burning of tires is a special form of waste disposal requiring unique technology to generate electricity. A facility has been built in California, which has stringent environmental standards. The California plant generates 14 MW and burns over 4 million tires per year.[18] The potential is limited, and one 14 MW plant may be the maximum for New Jersey from this option. No permit application for a tire-burning facility has been filed in New Jersey, and no standards specific to this technology currently exist here.

Anerobic digestion of agricultural waste to produce methane is another technology that has potential to generate electricity as well as to solve a disposal problem for farmers. Though the Stipulation addressed household waste, it did not provide any mechanism other than bidding for agricultural wastes. Certainly the inclusion of an agricultural waste facility in the county resource recovery plan should qualify it for the full avoided cost cap price without the requirement that 90 percent of the revenues go to reduce tipping fees, since these facilities do not generate tipping fees from households. A proposal has been made by a farm with 1 million chickens to generate 15 MW.

Hydrogen

Burning hydrogen in cogeneration has the advantage of using a nonpolluting fuel because the product of combustion is water. The cost has always been a deterrent to widespread use. However, chemically produced hydrogen can be an economic fuel source where electric rates are high.[19]

Methanol

The use of methanol as a primary fuel would depend on the price at which it can be brought to market. Capturing more flare gas and converting it to a liquid would be environmentally sound and the most economic way of obtaining methanol. As a clean coal technology that has much promise for the future, it will only be economic if oil or gas are ever in short supply (see Chapter II-1-C). Methanol from coal produces twice as much carbon dioxide, a greenhouse gas, per Btu as methanol from flare gas.

Fuel Diversity

One of the goals of energy planners is to assure a continuous supply of electricity, no matter what fuel supply problems exist. In the past oil, coal, and natural gas have had supply disruptions. Oil embargoes occurred in 1973 and 1979, and there was a gas pipeline capacity problem in 1977. Coal has also had problems in the form of labor strikes, both rail and mine, but since coal is mainly used for electricity generation, its problems have gone almost unnoticed by the general public. The supply of oil and coal can also be affected by barge and tugboat strikes and ice in the rivers. Most of the contracts signed by the utilities with cogenerators are for gas-fired units. Currently the price of oil makes it a suitable substitute for gas so that no capacity would be lost in case of pipeline disruption or unanticipated demand. Within the structure of the Stipulation, the electric utilities have the needed flexibility for fuel diversity.

Since natural gas is in bountiful supply, the fuel diversity problem is a long-term one that can be addressed if and when natural gas price or supply becomes an issue. A 30-year supply at a wellhead price of $3.00 and a 50-year supply at $5.00 should provide enough economic natural gas for forecast need, including cogeneration.[20] In the long run, coal gasification on site or off is feasible and, depending on the price of gas and oil, could substitute in most applications. The fuel diversity question does not appear to be a significant deterrent to the use of gas-fired cogeneration, which uses relatively inexpensive hardware.

Year 2000 Scenarios

Based on the scenarios presented in the Chapter II-2, the extent of new cogeneration capacity required can range from 100 percent to some lesser percentage, depending on capacity requirements, economics and regulation. The cogeneration technology that we have today can meet all of our future needs, provided that the Stipulation works as contemplated.

Without major load management initiatives, various forms of cogeneration can meet the expected load growth. In addition, several thousand megawatts of aging utility powerplants, which are scheduled for retirement, will have to be replaced. New cogeneration can meet this need.

We conclude that the need for additional cogeneration by the year 2000, beyond that already planned, will range from 0 megawatts (see Chapters III-1 and III-2) to 2650 megawatts (see Chapter II-2).

Findings

- Cogeneration can cost effectively meet New Jersey electricity capacity and energy needs.

- Between now and the year 2000, New Jersey can absorb as much as 2650 MW of cogeneration, depending of economic and population growth, and on the end use efficiency changes.

- With new developments in cogeneration equipment, cogenerators will be even more responsive to utility operating conditions and able to increase output during peak periods, thus obviating new utility peaking units.

- Cogeneration can also help reduce the acid rain problem from out-of-state generation that is not as environmentally clean.

- More electric generating capacity in New Jersey would reduce loading on the west-to-east electric transmission system and costs to consumers.

- New gas pipeline capacity would help advance gas turbine and reciprocating cogeneration facilities over other technologies.

- The expansion of gas sales by the natural gas utilities to serve cogeneration will also help the other gas customers save money by spreading fixed costs over larger volumes, thus reducing unit costs of gas.

- The appropriate transportation infrastructure would have to be built in order to successfully expand the use of coal.

- Self-generation by many industrial and commercial electricity users can be installed without bidding under the Stipulation and can be a powerful competitive force on utilities as well as a way to meet the state's capacity requirements.

- Business and industry representatives make strong arguments that self-wheeling will help them to remain in or expand in New Jersey.

- Self-wheeling would further reduce the need for new utility generation, although not for total electricity use, by encouraging additional cost-effective cogeneration by multi-location companies.

Policy

- DCEED shall continue to promote economic cogeneration in New Jersey, since cogeneration is an economical and environmentally attractive means of meeting power needs.

- DCEED shall work to minimize regulatory impediments to rapid deployment of this technology that has so much potential to reduce environmental problems. The cogenerators that use gas-fired combustion turbines have in large part already met or exceeded the 1992 Standards established by DEP, and similar policies for other fuels and technologies must be achieved.

- The environmental advantages of cogeneration require rational policies that allow full development of its potential. New cogeneration technology does not require "netting" so long as reasonable standards are in place. New Jersey can benefit most from a strong environmental program that allows clean, economic cogeneration to come on line.

- To encourage cogeneration and promote reduced emissions, renewal of air emissions permits on a grandfathered basis shall end. Only companies able to prove that cogeneration would not be economic shall be allowed to keep a grandfathered status.

- When the Stipulation is reviewed in five years, the cogenerators shall be allowed to demonstrate that they can displace existing utility capacity and save money for both the utilities and their ratepayers.

- The unbundling concept shall be expanded to allow more competition in the electricity marketplace while maintaining the viability of the electric utilities.

- DCEED shall support the efforts of the interstate pipelines to increase gas supplies to New Jersey.

- Least cost electricity policy must consider all forms of cogeneration as well as transmission access when determining the best policies for the state to pursue.

- If new regulatory policies are adopted due to implementation of the Governor's Task Force on Market Pricing of Electricity, DCEED must guarantee that no provisions in the new system interfere with the continuing development of cogeneration.

- The BPU shall review the Stipulation five years after adoption.

- Fuel diversity must be considered in the energy planning process for cogeneration.

<u>Implementation</u>

- DCEED shall include cogeneration in the least-cost evaluations of electric utilities.

- DCEED and DEP shall cooperate to assure the installation of environmentally sound cogeneration that reduces air emissions and acid rain problems.

- DCEED shall continue to support fuel diversity in cogeneration applications to guard against supply disruptions.

- DCEED and BPU shall ensure regulations are in place that allow optimum use of cogeneration:

  a. Self-wheeling tariffs that permit multi-plant companies to reduce electricity costs shall be implemented.

  b. The whole question of wheeling shall be addressed at an administrative hearing in order to establish an approach that is fair to both the cogenerator and the electric utilities.

  c. Formal rulemaking procedures shall be followed when new cogeneration policies are adopted by the BPU.

  d. DCEED shall monitor the implementation of the Stipulation to insure its long-term success.

- DCEED shall intervene at FERC to assure adequate gas pipeline capacity to the state.

D R A F T

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FOOTNOTES

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2. Telephone conversation with William O'Sullivan, P.E., Assistant Director, Environmental Quality, DEP.

3. G. Alan Petzet, "Higher U.S. demand, prices likely; production expected to keep falling" Oil & Gas Journal, November 14, 1988 p. 76.

4. New Jersey Cogeneration and Small Power Production Facility Filings Septmber, 1988.

5. Requests for Proposals: AE, JCP&L, PSE&G and Rockland.

6. See generally Federal Energy Regulatory Commission Notice of Proposed Rulemaking Docket No. RM88-6-000 Administrative Determination of Full Avoided Costs, Sales of Power to Qualifying Facilities, and Interconnection Facilities.

7. Public Citizen's "Too Costly to Continue" report, November, 1987.

8. Luncheon Address by Joel S. Gilbert, P.E. at the EPRI Seminar "Electric Alternatives to Commercial Cogeneration," October 19, 1988.

9. Roger Sant et al, Creating Abundance (New York: McGraw Hill, 1984), p. 88.

10. State of Connecticut Docket No. 85-04-16 DPUC Investigation into Cogeneration and Small Power Production Decision November 26,1985.

11. J.A. Mullony, Jr. et al., "Packaged Cogeneration Installation Cost Experience," Retrofit Opportunities for Energy Management and Cogeneration, Chapter 64.

12. Ibid.

13. Statement of Rudolph D. Stys, V.P. - System Planning, PSE&G, July 1983 in Docket No. 8010-687, p.5.

14. California Health and Safety Code Section 41605.

15. Scott A. Spiewak, Cogeneration and Small Power Production Manual, 2nd Ed. (Fairmount Press, 1988) p. 290.

16. Gas Research Institute 1987 Annual Report, p. 14.

17. Florida Power & Light Co. Capacity Plan presented at the NARUC Least Cost Utility Planning Seminar, Aspen, Colorado March 1988.

18. Resource Recovery Report, 5313 38th St. N.W., Washington, D.C. 20015

19. Cogeneration Report, Sept 23, 1988, p. 18

20. USDOE President's Energy Security Report 1987

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Chapter II-4

RENEWABLE ENERGY SOURCES

Introduction

Only a small percentage of the energy consumed in New Jersey is from renewable energy sources, about 0.1 percent or 2.3 TBtu per year.[1] This 2.3 TBtu is the equivalent of 430,000 barrels of oil. This chapter examines how much energy New Jersey gets from renewable energy--solar, hydro, wind, and waste--reviews past policies, and suggests directions for the future.

Background

The 1985 Energy Master Plan determined that renewable resources were being underutilized in New Jersey and set as a goal accelerating the commercialization and penetration of renewable energy technologies. The Plan suggested strategies, such as market development and public assurance programs, economic and technical assistance, and mitigation of constraints to the use of renewables.

As a result of the energy crises of the 1970s, interest grew in renewable energy projects for the home, as well as commercial and investor interest in large scale projects. Though often not economic at the time, these projects were carried forward in the expectation of rising energy prices.

As energy prices stabilized and then dropped in inflation-adjusted terms, interest began to flag. In addition to the disappearance of economic incentives, the glamour and status associated with having a residential windmill or solar water heater also faded. However, the commercial side projects that were economic continued to move forward. In some areas, notably that of energy from waste, other factors are driving progress. In this case, incinerators are being built to take the place of landfills, which are no longer available and are nearly impossible to replace. The sale of electricity from these plants offsets part of the cost of incinerating the waste.

Present Sources

Energy Recovery from Solid Waste

Energy can be recovered from municipal solid waste (garbage) by several methods. The method chosen for most existing and proposed New Jersey locations is to burn the waste in specially designed boilers after removal of large, noncombustible materials. Steam produced generates electricity, which is sold to utilities. The potential for cogeneration exists if nearby customers can be found to buy the waste heat from the electric generation process.

Presently, two waste-to-energy facilities operate in New Jersey, one at Fort Dix and the other in Oxford, Warren County. Another three have been approved by regulatory bodies for construction or are already under construction. Three more will be permitted in the near future. The sites, with their expected power output and completion dates, are:

Gloucester (under construction)	14 MW	1990
Essex (under construction)	67 MW	1991
Camden	29 MW	1990
Pennsauken	9 MW	1990
Union	33 MW	1991
Passaic	32 MW	1992

When completed, the eight facilities will generate about 200 MW. The Department of Environmental Protection (DEP) estimates that eventually 10 to 15 plants will operate in New Jersey generating 370 MW.[2] Because many similar plants are operating worldwide, major engineering and operating problems should be minimal.

Since issuance of the 1985 Master Plan, the Office of Recycling and its responsibilities moved from the Department of Energy to the Department of Environmental Protection. However, DCEED continues to review the siting of waste-to-energy plants because it has jurisdiction coextensive with DEP. The following criteria for these plants were set forth in the 1985 Energy Master Plan:[3]

1. The construction and operation of any resource recovery facility should maximize the energy system's output and minimize, to the extent possible, any adverse impacts on the state's physical and social environment.

2. Resource recovery facilities should be located near urban areas and in areas already zoned for industrial use. Depending on the technology selected, resource recovery facilities may require site locations in close proximity to energy consumers.

3. Where feasible, resource recovery facilities should be constructed to encourage industrial development of adjacent properties. Resource recovery facilities offer the potential to provide a lower cost-stable energy supply to industry while improving the municipal tax base.

4. The site of resource recovery facilities should be reasonably close to communities that will provide the necessary quantities of solid waste to efficiently and economically operate the facilities.

5. Resource recovery facilities should be located near a major road or highway system to accommodate heavy truck traffic and minimize any increase of traffic in residential areas.

6. Prior to the design and construction of resource recovery facilities, waste flows should be weighed and analyzed for composition. Impacts of community source separation programs should also be considered, and front-end material recovery systems evaluated. Where municipal source separation programs already exist, planned energy recovery facilities should carefully take into consideration the compatibility of both programs in that municipality.

So far the sponsors of these plants (usually counties or utility authorities) have chosen the sites with care and have met these criteria. Nevertheless, plants usually arouse protest from local residents based on perceived air emission problems. Another environmental issue is disposal of the ash waste.

The driving force behind waste-to-energy plants is not the recovery of energy, but a means of dealing with municipal solid waste. However, the energy produced and sold reduces the cost of operating the plant. The Board of Public Utilities has set the price for the electric power sold by these plants as the "full avoided cost." While this rate is above that being paid to other independent power producers, it is not so high as to significantly subsidize plants. Typical rates are currently around $0.04 per kwh.

Other Energy from Waste

Another way of obtaining energy from waste is to drill into existing landfills and collect the gas generated by decaying organic matter. This gas is a mixture of compounds, but methane predominates. Natural gas, as sold by New Jersey's gas utilities, is almost pure methane. The landfill gas is medium Btu gas, about 500 Btu per cubic foot versus 1,020 for pure methane. Nevertheless, after some cleaning, this medium Btu gas can be used in boilers to produce steam or in combustion turbines to produce electricity.

The first methane project in New Jersey, an experiment to test the practicality of landfill gas, began operation in 1979. A gas utility drilled and operated the wells, installed piping, cleaned the gas, and delivered it to a nearby industrial boiler that was set up to use medium Btu gas. The project is no longer operating because current natural gas prices are too low to justify upgrading that is now needed.

Projects that generate electricity are going forward, however. The rates paid to qualifying independent electric power producers have been sufficient to attract funding from private investors. Presently one site is operating that produces about 26,000 cubic feet of medium Btu gas per hour. The gas generates 2.6 MW of electric power yielding about 11,000 mwh of electric energy a year.[4]

The economic results of these projects have encouraged others to plan projects at New Jersey landfills that will produce about 33 MW in the next five years. Additional energy can, of course, be recovered in landfill gas recovery operations if steam as well as electricity can be used or sold. In such a case, a typical cogeneration arrangement would be practical.

Methane is also produced by the breakdown or anaerobic digestion of sewage sludge. The potential here is for the sewage plant operator to collect the gas and use it for fuel for sludge drying or in a boiler to produce steam and electricity. Sewage plants with anaerobic digesters already use sludge digester gas to supply heat to the digestion process, but much of the gas is merely flared (burned off). This gas can be used in internal combustion engines to generate electricity with waste heat from the engines used for the digesters.[5]

In New Jersey about 350 sewage treatment plants treat some 950 million gallons per day of municipal sewage.[6] Digestion of the sludge from these plants could produce enough gas to generate 238 MW.[7] Using this now mostly wasted resource would displace petroleum, gas, or electric energy currently purchased by the plant operator, while reducing the sludge disposal problem. For plants already using the anaerobic digestion process, the engine-generator system can be added economically without any major obstacles. As the technology gains a track record, most anaerobic digestion plants will likely add electric generators. For those plants not using sludge digestion or using aerobic digestion, the feasibility of converting to anaerobic digestion needs first to be determined.

A similar potential resource is the waste produced by farm animals such as chickens, horses, and cows. Here on a small scale (typically 100 KW - 20 MW) it may be economic for farmers to collect animal feces for on-farm anaerobic digesters. The resulting gas can be used to operate a boiler or internal combustion engine to produce shaft power or electricity.

Solar Energy

About 98,000,000 TBtu of solar energy reach New Jersey each year. If New Jersey could convert only 0.002 percent of this energy to usable form, all of the state's needs could be met by solar energy. Tapping some minute proportion of this potential began only in the late 1970s. Because of New Jersey's sometimes subfreezing and overcast winters, solar domestic water heaters were not installed here until the late 1970s when units that use antifreeze, pumps, and heat exchangers began to be purchased. By 1985, New Jersey had approximately 4,000 active and passive solar systems.[8] Today we estimate that number has grown to 32,000.[9] The 1985 Energy Master Plan recommended 14 actions to promote the use of solar energy in New Jersey. It was an ambitious program, and implementation and results have not been easy to obtain.

Passive solar energy is the use of the sun's energy by a building without the mechanical assistance of pumps, fans, or other devices. A building takes advantage of passive solar by its layout and orientation that optimize the collection of energy in the winter and the rejection of heat and avoidance of its collection in the summer. Mechanical devices may regulate shading and insulation as well as thermal mass to absorb and store heat. We estimate that about 20,000 homes have been designed to use passive solar energy, or only about 6 percent of the homes built in the last 10 years.[10]

Often solar design is hindered by street orientation. The Department of Energy sought to convince municipalities to amend their land use regulations to require proper alignment of streets to accommodate the incorporation of passive solar energy in the design of residential buildings through presentations and mailings. Fourteen municipalities have adopted or proposed appropriate regulations.[11]

The Energy Subcode allows a developer or builder to take credit for solar contribution in complying with the code. This allowance encourages a solar design that may require larger glass areas than the Energy Subcode would ordinarily permit.[12]

Many builders incorporate into new homes passive solar features such as large windows facing south with summer shading from landscape or overhangs, sunspaces, and thermal mass. Often these features also provide desirable aesthetic characteristics. However, few homes built in New Jersey are designed with passive solar as the primary focus. In such a home, passive solar energy can supply 30 to 50 percent of heating needs.[13]

Active solar energy is the use of a system in which pumps, heat exchangers, and other mechanical and/or electromechanical devices transfer the sun's energy from collectors to where it can be utilized. The only commercially available active solar energy systems are domestic water heaters. DCEED has encouraged the installation of active solar domestic water heating by requiring that utilities make Home Energy Savings Program loans available for solar and solar-assisted water heaters, that all new residential construction be eligible for utility solar credit programs, and that utility programs be consistent throughout the state.[14] Approximately 12,000 systems are now in place.[15]

Institutional barriers do not prevent the installation of solar energy systems in New Jersey residences. State law enables property owners to negotiate solar easements to assure continued access to solar energy.[16] The 1985 Master Plan sought to remove regulatory barriers that might be inhibiting the use of solar energy, such as deed restrictions that would prevent the installations of solar collectors.[17] Other proposals, such as training of plumbing inspectors and certification of solar water heater installers, were deemed unnecessary.[18] No significant legal barriers remain to the installation of active solar energy systems.

The problem today is that commercially available active solar domestic water heaters do not produce energy cost-effectively in New Jersey. The most generous subsidy, an eight-year, no-interest loan offered by JCP&L as a part of the Three Mile Island settlement results in no savings over a 20-year operating life at a 6 percent discount rate.[19] If the cost of increased property tax is considered, averaging about $120 per year, installing a solar water heater creates a loss for the homeowner. (See Table II-4-1.) In this analysis we have assumed electric water heating is the alternative and that electricity prices will remain flat. We have also assumed that the solar water heater will not impose any maintenance or part replacement cost on the owner for its 20-year life. The water heaters save the homeowner $150 to $350 per year.

Table II-4-1

Cost of System	Net present value if savings are $150	$350
$4,000	($2,761)	($1,637)
3,000	(1,862)	(738)
2,000	(520)	(604
1,000	600	1,724

We conclude that $1,500 installed cost systems may be cost-effective at today's prices.

In hopes of demonstrating that active solar water heating could be used in office buildings economically, the Department of Energy had intended to require that an evaluation of state-operated facilities for feasibility of active solar water heating be performed before it would disperse energy conservation bond money.[20] However, the theoretical savings over conventional energy sources did not appear sufficient to justify this requirement.[21] One such system was designed and installed on a state office building before conservation bond issue money was available. Due to mechanical problems the system has not yet operated and therefore has not demonstrated what kind of savings and payback might be expected from an operating system of commercial office building size in New Jersey.

This type of water heater is complex and expensive, even when sized to supply only 50 percent of domestic hot water needs. Rebates, grants, tax abatements, and a belief that energy prices would rise continually helped to create a market in New Jersey for these units. Because conventional energy prices have not risen as expected, even the rebates and loans provided by utilities for residential installations do not result in an economic incentive for this use of solar energy.

Photovoltaics, which convert light directly to electricity, is a solar technology that is developing rapidly. Photovoltaic systems consist of collector panels, mounting hardware, and wiring. If conventional AC appliances are to be powered, an inverter converts the DC output of the collectors. In some systems, storage, such as batteries, may be needed if power is required when light is insufficient. To interconnect with the electric utility, additional electrical control equipment may be needed.

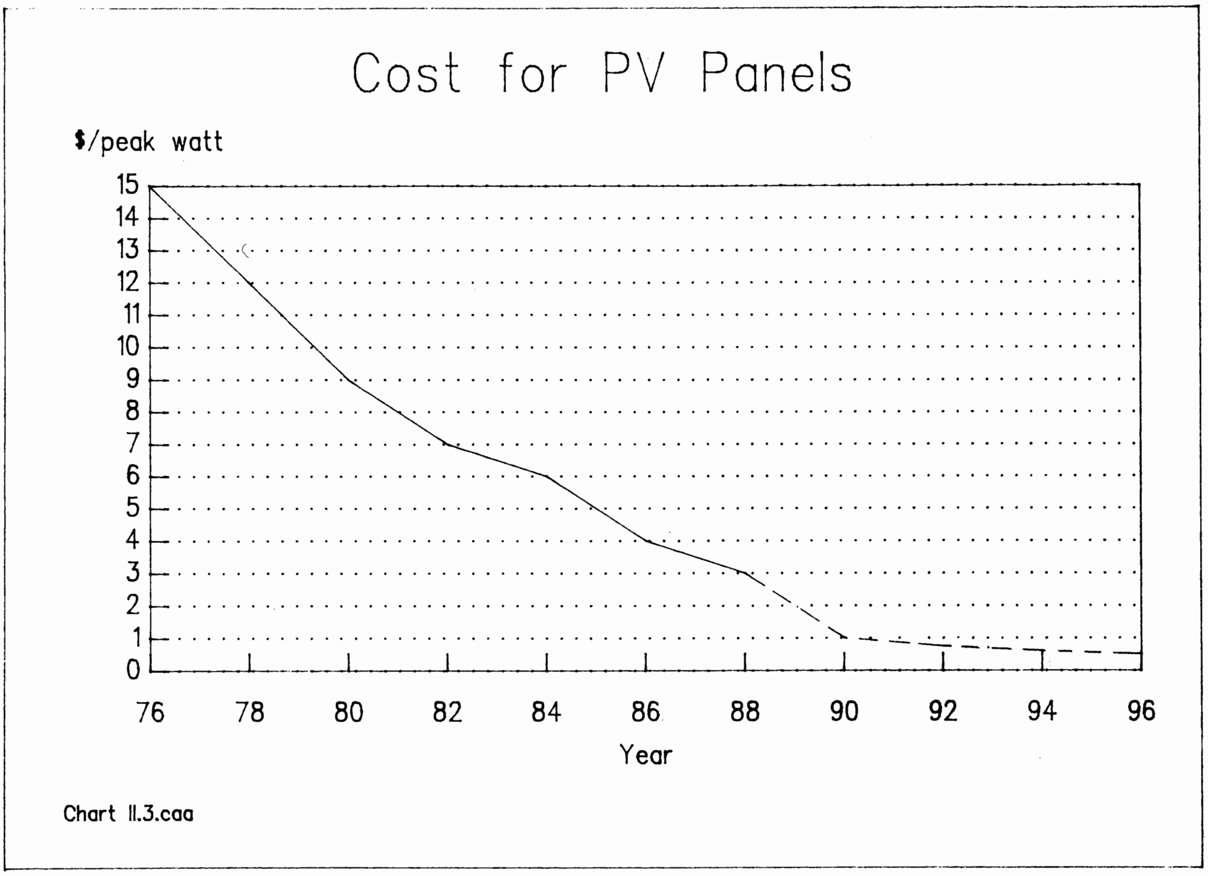
Some photovoltaic systems track the sun as it moves in the sky; some use lenses to concentrate sunlight on the solar cell; and still others are simply flat plates mounted at the optimum angle for best total energy production. Some panels even use a combination approach.

One particular advantage of the conversion of sunlight to electricity is that it produces power during summer afternoons when the utility is most likely to be overburdened. Currently, complete photovoltaic systems cost $5,000 to $10,000/KW, far too expensive for general uses.[22]

In Arizona a 24-home subdivision has been constructed with a photovoltaic system with a peak rating of 192 KW. The full system cost about $9,500/KW. This system uses the utility for "storage," selling excess electricity during the day and purchasing electricity at night.[23] The nominal cost for the electricity from the system is about $0.38 to $0.40/kwh if the system lasts, and is financed for, 30 years at 6 percent.[24] At this price this type of system will not become widespread. However, Arco Solar was recently able to improve the efficiency of its thin film copper indium diselenide photovoltaic materials. Once in commercial production, the price of panels will be about $900/KW.[25] If the Arizona subdivision could have used these panels, the complete system price would have been $5,000/KW, which would have brought the price to about $0.20/per kwh over the life of the project.[26]

Arco has been working toward achieving a $350/KW panel. As prices drop, the cost of the balance of the system becomes the controlling factor. The balance of the system consists of equipment to convert the output of the panels to standard AC voltages, wiring, interconnection, and installation costs. Balance of system costs were about $4000/KW for the 192 KW system. Balance of system costs for a single residential installation have been estimated at around $2000/KW.[27]

Fig. II-4-1



These costs are not likely to experience the same cost reduction factors as the panels. However, some reductions may come from improved technology for the solid state inverter, the component that converts DC power to AC. Table II-4-2 shows the impact that technological progress has had on the cost of photovoltaic panels. When Arco or another company produces a panel with a price of $350/KW, photovoltaics become cost competitive with conventional means of electricity production for many applications. That market would be huge, since every building has a roof and most are not shaded during most of the daylight hours. Already, at today's cost, $1.5 billion worth of consumer products that use photovoltaics is being marketed each year. If the cost becomes competitive with conventional electricity, sales of consumer products would rise to about $5 billion a year, which photovoltaic industry experts say could happen by 1995.[28]

To put photovoltaic power into perspective, it is interesting to compare it with some other power systems and see how close photovoltaic power production is to having a place in New Jersey's power mix.

Table II-4-2

	Capital Cost/kwh ($)	Operating Cost/kwh ($)	Aggregate kwh cost ($)
Chronar Proposal 50 MW PV	2,500	0.05	0.13
Hope Creek 1100 MW Nuclear	3,600	0.11	0.13
JCP&L 100 MW Combustion Turbine	400	0.13	0.21
Stand Alone PV with Storage .006 MW	9,000	0.0	0.42

All costs estimated

Hydroelectricity

Hydroelectricity, the production of electric power using moving water, is one of the oldest means of generation. This technology is fully developed subject only to refinements, though refinements will probably not provide breakthroughs in the capital cost to develop sites.

Due to its geography, New Jersey has only a small potential for hydroelectric power, about 26 MW located at 23 separate sites, enough to supply about 0.3 percent of its electric energy needs.[29] However, 26 MW operating 24 hours a day would be worth about $24 million per year at today's retail electricity rates. Currently 14 MW are installed, which can generate about 63,000 mwh per year.[30] Most of the remaining potential has little likelihood of development unless electricity prices double in real (noninflation) terms.

Another type of hydroelectricity is tidal power. With its relatively small difference between low and high tides, New Jersey is not expected to get any energy from this resource.

Wind Energy

Because wind speeds in New Jersey average less than 16 mph along the coast and less than 10 mph inland, the potential for obtaining energy from the wind in New Jersey is even smaller than that from hydro.[31] In addition, the problems are similar but more severe. New Jersey has few sites with steady winds. Individual sites can be expected to produce from 1 KW to about 40 KW depending on wind speed and the model of wind turbine used. At these levels most of the electricity generated can be used on site, making the power worth about 11 cents/kwh to the owner of the wind generator. Still, with the capital cost of equipment, there is little incentive to install these systems at today's electricity prices.

Currently, fewer than 35 wind generating systems operate in New Jersey, and none are under development.[32] An indication of the current interest in wind generation systems is that the DCEED has received a total of only 13 inquiries in 1987 and the first half of 1988, compared to 45 inquiries in 1984.[33]

How Much Energy?

Table II-4-3 shows how much each of the major renewable energy sources supplies New Jersey at the present time. In 1993 we expect that renewables will be contributing 20 TBtu, or about 1 percent, increasing to 28 TBtu by the year 2000. This expected contribution is based on existing policies and reasonable assumptions of cost-effectiveness.

Projections for the potential that might be achieved if cost were not an important consideration also appear in the table. These projections assume that all new housing will install active solar-assisted water heaters, which is unlikely unless required by law. Under current and likely energy prices, most of these units would not be economic unless costs are reduced by 50 to 75 percent. With electricity as the alternate fuel, the economic justification is, at best, marginal. With gas as the alternate fuel, no economic basis justifies such legislation. Other assumptions are that 60 percent of all new housing will have significant passive solar features, that photovoltaic systems will be available at $2000/KW, and that all of the hydroelectric sites and landfill and waste water treatment gas will be developed and put into operation.

Table II-4-3

New Jersey's Renewable Energy Sources

	Solar									
	Active DWH	Passive Design	Photovoltaics	Wind	Hydro	Land Fill Gas	Wastewater Treatment Gas	Municipal Waste	Total	%
Current year	0.181	0.711	0.000	0.005	0.648	0.117	0.097	0.538	2.298	0.11%
Probable by 1993	0.201	1.346	0.029	0.005	0.648	0.671	0.097	17.103	20.101	1.01%
Probable by 2000	0.230	2.235	0.439	0.005	1.004	0.747	6.259	17.103	28.023	1.40%
Potential by 1993	2.889	2.890	0.086	0.005	1.004	9.343	6.162	17.103	39.483	1.97%
Potential by 2000	6.631	5.941	2.079	0.005	1.149	9.343	17.042	17.103	59.294	2.96%

In TBTU equivelant (total consumption of NJ about 2000 TBTU):
Electricity credited at 10,000 BTU/kwh produced

Source: DCEED Analysis

Issues

Because all sources of energy compete against one another in the marketplace, the development of renewable energy resources cannot be encouraged if investment in other sources or conservation can produce a better return. Consistent with a commitment to least cost planning for all energy supplies, only the renewable energy projects that provide a better return than competing energy sources should be promoted. However, some special conditions may be relevant.

First, costs and benefits that may be external, i.e., not reflected in prices, must be considered. These include environmental and other societal benefits. Second, some regulations and restrictions may distort or circumvent market incentives and discourage the use of cost-effective alternative energy sources.

Currently, for example, utilities are paying 4¢/kwh to 5.5¢/kwh for power from independent power producers.[34] The special issues surrounding the prices utilities pay for this electricity (see Chapter II-3) may apply here as well. The retail electric rates and the rates paid to independents, whether cogenerators or other independent electric power producers such as renewable energy project operators, determine how much generation will be brought on-line. The electricity used on-site by an independent power producers is never worth more than the retail rate.

New Jersey cannot expect renewable energy to be a major source of energy. Even under the most optimistic circumstances, we could expect no more than 3 percent of New Jersey's energy to come from renewables.

Findings

- At current prices, active solar water heating is not a cost-effective way to utilize the sun's energy.

- Building design is an ideal way to use the sun's energy when combined with other energy efficient building techniques.
- Nearly all regulatory barriers to the use of renewable energy sources have been eliminated.
- Photovoltaic production of electricity holds a great promise for the future due to declining costs in the technology.

Policies

- Since the potential of wind as an energy source is so small and the cost high, the state should not provide economic aid to developers of wind energy sites. The DCEED shall, however, continue to assist them in obtaining permits and overcoming any other regulatory roadblocks.
- The DCEED shall assist hydroelectric developers, if necessary, in obtaining any permits required.
- Although even total recovery of methane from waste would not amount to a large portion of the energy used by the state, DCEED shall assist utilities, sewage plant operators, or other developers in overcoming regulatory obstacles.
- The Passaic Valley Sewerage Commission treats 200 mgd using aerobic digestion, which does not produce methane. A study should determine if it is economically feasible to convert this plant to the anaerobic digestion process.
- Development of more cost-effective photovoltaics is an area where market incentives are strong; there is no need for intervention by state government.
- The state shall continue to make all reasonable efforts, short of compulsory measures, to encourage the use of passive solar energy.
- Government shall fund projects that could demonstrate cost-effectiveness at today's energy prices.

Implementation

- New Jersey shall continue to help break down any nonmarket barriers to use of renewables and to render whatever assistance it can on a case-by-case basis to individuals and institutions who wish to utilize solar, wind, or any other renewable resources. This assistance shall include interceding with state and municipal agencies to assure that, where appropriate, trade-offs are made. (See Chapter II-3).

- In the area of passive solar energy, the state shall encourage appropriate design to use natural heating and cooling to improve the efficiency of its housing stock (see Chapters IV-1 and IV-2). Both passive and active solar energy are part and parcel of an efficient building stock.

- Whenever it can assist any developer of cost-effective use of a renewable energy source, DCEED shall devote appropriate resources to provide that assistance.

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FOOTNOTES

1. Table II-4-3.

2. N.J. Department of Environmental Protection (DEP), Status of Solid Waste Management & Resource Recovery, 3/88.

3. 1985 New Jersey Energy Master Plan, pp. 188-189.

4. N.J. Department of Commerce, Energy and Economic Development (DCEED) "Qualifying Facilities Report...," 5/88 Draft.

5. Conversations with DEP and New York/New Jersey Waste Water Treatment Operators.

6. Ibid.

7. Estimate based on all municipal sewage sludge, being process by anaerobic digestion.

8. 1985 New Jersey Energy Master Plan, p. 85.

9. Estimate based on building permits; 22% south orientation, 5% optimum south glazing, 1% special glazing and summer shading.

10. DCEED staff estimate.

11. DCEED program manager's records.

12. Energy Subcode of the Uniform Construction Code.

13. "Passive Solar," brochure by Passive Solar Council, Alexandria, Virginia.

14. 1985 New Jersey Energy Master Plan, p. 86.

15. Total of those reported by each New Jersey electric utility.

16. N.J.S.A. 46:3-25.

17. 1985 New Jersey Energy Master Plan, p. 88.

18 1985 New Jersey Energy Master Plan, pp. 88-89

19. Based on no-interest 8-year $4000 loan and savings range provided by JCP&L.

20. 1985 New Jersey Energy Master Plan, p. 89.

21. Statement by DCEED program manager.

22. Range from various publications including Solar Age, and Research News.

23. Solar Age, January, 1986, pp. 40-43.

24. Calculated using present value of costs divided by lifetime energy produced.

25. Research News, August 19, 1988, p. 910.

26. Calculated using present value of costs divided by lifetime energy produced.

27. Atlantic Electric, "Customer Photovoltaic Feasibility Study," October 13, 1986, p. 13.

28. Wall Street Journal, July 12, 1988.

29. DCEED, "Development Status of Dam Sites," January 22, 1988.

30. Calculated based on 50% capacity factor.

31. Public Service Electric & Gas, R&D Quarterly, Spring 1983.

32. Utility conservation plans filed in 1987.

33. DCEED, Monthly reports of Office of Community, Education and Information Services.

34. Electric utility reports, 1988.

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CHAPTER II-5

ENERGY FACILITY SITING

Introduction

Authority for general energy facility siting is contained in The Department of Energy Act, N.J.S.A. 52:27F-1 *et seq*. P. L. 1987, c. 365 amended the DOE Act. The implementation of the Energy Master Plan, including facility siting, was left exclusively to the Division of Energy Planning and Conservation of the Department of Commerce, Energy and Economic Development (DCEED) as originally provided for in the DOE Act. Regulations to implement the Energy Facility Review Board established by the Act are contained in N.J.A.C. 14A:8-1 *et seq*. Specific authority over electric utilities is contained in P.L. 1983, c. 115., the Certificate of Need Act and attendant regulations, N.J.A.C. 14A:14-1.1 *et seq*. Review procedures for energy facilities in the coastal zone are recognized in a Memorandum of Understanding between the Division of Energy and the Department of Environmental Protection. (DEP)

Department of Energy Act

The Department of Energy Act (N.J.S.A. 52:27F-15F-(c) *et seq*.) provides the Department of Energy (now the Division of Energy Planning and Conservation, or DEPC) with "jurisdiction coextensive with that of any other State instrumentality, with respect to the siting of any energy facility in any part of New Jersey." Any state agency with permitting authority over the location or construction of any energy facility must solicit the opinion of DEPC before exercising powers. DEPC must submit its findings on the application in the form of a report to the permitting agency. If the two agencies disagree over whether the application should be approved, an Energy Facility Review Board will render a binding decision. The Energy Facility Review Board will be composed of representatives from the DEPC, the permitting agency, and a designee of the Governor. To date, the Review Board has not been convened, although regulations governing its conduct are in effect (N.J.A.C. 14A:8-1 *et seq*.).

The Act defines "energy facility" as "any plant or operation which produces, converts, distributes or stores energy or converts one form of energy to another." It further defines "energy" as "all power derived from...any natural or man-made agent, including but not limited to, petroleum products, gases,...". The Act charges the DEPC with two specific siting-related responsibilities: the determination of future energy supply and demand, and the evaluation of alternative energy sources. These are contained in the mandate to "collect and analyze data relating to present and future demand and resources for all forms of energy." Authorization to evaluate alternative means of meeting future energy demand is contained in the Act's direction to "formulate proposals designed to encourage the lowest possible cost of energy and fuels consumed...consistent with the conservation and efficient use of energy"; and to "conduct and supervise research projects and programs for the purpose of increasing the efficiency of energy use and developing new sources of energy."

DEPC has explicit authority under the Act to address questions of facility location as defined by its "coextensive jurisdiction" with respect to the siting of energy facilities. In addition, the Act confers implicit authority on DEPC to develop long-range policies regarding the preferred location of energy facilities by specifically empowering DEPC to "insure the wise and efficient production, distribution, use and conservation of energy," and to "conduct the long-term planning and management needed to eliminate or alleviate the potential adverse effects...of practices of production, distribution and consumption detrimental to the quality of life or the environment."

The state views its facility siting planning mandate as a pro-active process to encourage long-term coordinated approaches to facility siting. For example, resource recovery facility site selections offer synergistic opportunities with other energy-consuming facilities as well as with the proposed island component of Project ICONN, which is designed to host up to 1,000 MW of electricity from independent power producers.

Determination of Need and Facility Siting Policies

Certificate of Need Act

In the past, electric utilities had to cancel a number of proposed and/or partially constructed generating plants. One of the reasons was a lower-than-expected growth rate in electricity consumption. In order to avoid this problem in the future, the Legislature passed the Certificate of Need Act. The Act applies to:

- new electric generating units of 100 MW or greater; and
- additions of 100 MW or 25 percent (whichever is smaller) to existing units.

Regulations to implement the Act are contained in N.J.A.C. 14A:14-1.1 *et seq*.

Implementation

The Division of Energy's facility siting and fuel policies incorporate the benefits of both the reactive and initiative roles and mirror the evaluation required by the Certificate of Need Act. The Master Plan siting policies apply to utility- and nonutility-sponsored projects and serve as a guide to the siting of proposed facilities in New Jersey. In addition, DEPC has developed a process for review of specific energy proposals so that questions of need, technology, fuel type, and location can be evaluated thoroughly on a case-by-case basis.

DEPC thus will determine need for future major energy facilities according to three basic standards:

1) Will existing sources of supply be adequate to meet future levels of demand, including careful consideration of the potential effects of on-going conservation programs?

2) Do any better technological alternatives to the proposed facility exist?

3) Do any better locational alternatives to the proposed facility exist?

First, DEPC will determine whether additional energy facility capacity is required; that is, whether forecast levels of demand will exceed forecast levels of supply. DEPC will consider the extent to which conservation and alternative energy sources, including government-sponsored and private efforts, will reduce future demand levels. The extent to which a facility is needed as part of a larger network, such as a regional power pool, will be part of this analysis.

The second finding in a need determination is whether the proposed facility uses the best technical means of providing the required capacity determined by the first finding. Identification of optimal technology for meeting future energy demand will consider energy system reliability and efficiency, the ultimate cost of the energy supply, and the facility's beneficial or adverse impacts on the state's economy and on its natural and social environments.

The third finding is whether the proposed site is the best location for the proposed facility. Identification of optimal facility location will consider the facility's impact on energy consumption, the ultimate cost of the energy supplied by the facility, overall energy system reliability and stability, the state and regional economies, the natural and socio-economic impacts, safety, and community attitude.

DEPC will propose these standards in an administrative rulemaking pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq.

Coastal Management Program

If the proposed facility is to be located within the coastal zone, a Memorandum of Understanding signed in 1978 and readopted with amendments in 1989 details the specific and additional procedures to be followed. The policies toward particular facilities within the coastal zone are contained in Section 7:7E-7.4 (Energy Use Policies) of the New Jersey Coastal Management Program (August 1980).

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Policies

The following are siting policies for various types of energy facilities listed in alphabetical order.

Coal Transshipment Facilities

Policy: Coal transshipment terminals are acceptable in urban port locations consistent with the New Jersey Coastal Management Program.

Facilities that maximize coal transshipment for export and domestic consumption will be encouraged over a proliferation of small, single-function facilities.

Terminals that involve mode shifts or over-the-water transfers of coal (rail to barge and barge to collier) will be discouraged.

Facilities that minimize noise, fugitive dust, and water quality impacts on communities will be encouraged.

Rationale: Construction of a coal terminal in New Jersey could occur if interest in the coal export market is stimulated.

In assessing the need for coal terminals, DEPC and DEP will consider whether the facilities serve a combined export/domestic function and whether these facilities are in the national or regional interest as defined by the New Jersey Coastal Management Program.

Cogeneration Facilities

Policy: The state encourages all commercial and industrial electricity consumers with suitable heat requirements to investigate the applicability of cogeneration.

Siting Criteria: All cogeneration facilities will be evaluated using the criteria established herein for electric generating facilities. Cogeneration facilities that use refuse as a fuel will be evaluated using the criteria established herein for resource recovery facilities.

Rationale: Although cogeneration facilities will be encouraged (see Chapter II-3, Cogeneration), they must meet criteria similar to all other facilities.

Electric Generating Facilities

Policy: New or expanded electric generating facilities (for base load, cycling, or peaking purposes) and related facilities must meet the following three basic need standards established by the Plan:

1. Existing sources of supply will not be adequate to meet future levels of demand, including careful consideration of the potential effects of conservation.

2. No better technological alternative exists to meet future levels of demand.

3. No better locational alternative exists to the proposed site. Regarding locational alternatives, these criteria also apply:

   a. The construction and operation of the proposed facility shall comply with the Coastal Resource and Development Policies of the New Jersey Coastal Management Plan when such facilities are proposed within the state's coastal zone, as defined in the Federal Coastal Zone Management Plan.

   b. DEPC and DEP shall determine if the site selected is reasonable and that no other site can be clearly demonstrated to be superior in terms of operating and delivery efficiencies without compromising environmental and safety standards.

   c. Nuclear powerplants shall be sited in low density population areas consistent with the criteria specified in the Nuclear Regulatory Commission Regulations, 10 CFR 100, and with other related federal regulations. Due to the nature of nuclear generation, it must be clearly demonstrated that:

      i. cooling waters are adequate to the needs of the facility;

      ii. the area proposed is generally remote, rural and of a low population density that will be maintained in that manner. Techniques such as buffer zones, land use controls, and transfer of development rights should be used to the maximum extent practicable to minimize population densities in the immediate area surrounding a nuclear plant; and

      iii. the disposal of spent fuel produced by the facility will be safe, conform to standards established by the U.S. Nuclear Regulatory Commission, and effectively minimize danger to life and the environment. The siting shall consider both on-site storage and eventual disposal at a federally-designated disposal site (once such a facility is established).

   d. Coal-fired powerplants shall be sited in such a manner as to:

      i. meet federal and state air quality regulations on type of coal burned, the technology selected for combustion, and the type of pollutant elimination systems used on smokestacks;

ii. minimize the adverse impacts of coal transportation to the plant site, such as railroads without grade crossings, and possible conflicts between barge traffic and existing commercial or recreational traffic. Conflicts with residential areas should be minimized where possible and movement of trains timed so that conflicts with vehicular traffic are ameliorated.

iii. address the concerns associated with the storage of coal, including runoff, dust, and noise problems. Water quality can be safequarded by considering on-site soil conditions, using liners, and installing retention basins for runoff. Sites that are groundwater recharge areas will be discouraged because of the long-term adverse effects on water quality;

iv. consider the availability of cooling waters on a long-term basis so that low flows do not cause the facility to reduce capacity for long periods of time; and

v. address the manner in which ash/sludge from combustion is stored and disposed. Ash/sludge storage and disposal should be planned through on-site and off-site engineering systems that will not allow surface water or ground water to be polluted by run-off or leachates.

e. Natural gas-fired powerplants shall include:

i. existing plants that could be economically converted to natural gas use; and

ii. conversions to allow maximum flexibility with regard to air quality standards.

Rationale: The siting of an electric generating facility within the state can have far-reaching impacts, both positive and negative. In addition, the projected increase in electricity demand growth rates for the region makes the siting of a plant a particularly crucial issue. The state believes that proper planning for a site from its inception would alleviate many of the delays normally associated with the construction of a plant and the attendant costs that would have to be incurred by the electric company and, ultimately, the consumer.

The state recognizes that new powerplants can be more efficient than the ones they are replacing and in most cases can improve air quality levels more effectively than by retrofitting older plants with add-on technologies. Furthermore, natural gas is a desirable fuel for electricity production because of its clean burning nature.

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Electrical Transmission Lines

Policy:

1. New electrical transmission lines are to be located in or adjacent to existing road, railroad, pipeline, electrical transmission, or other rights-of-way (ROWs) to the maximum extent practicable.

2. If new ROWs are required, they must be developed in such a manner that joint utilization with their facilities can be accomplished if needed in the future.

3. New ROWs shall be prohibited in environmentally sensitive areas unless the utility company can clearly demonstrate that energy efficiency and costs will be severely burdened by meeting this criterion. If sited in environmentally sensitive areas, all steps must be taken to minimize impacts and provide opportunity for mitigation compensation.

4. Re-utilization and upgrading of existing transmission lines must be considered and addressed where practicable before new ROWs are considered.

Rationale: Proper ROW planning can minimize acquisition, construction, and operating costs to the utility company. Minimizing costs to the utility, however, may not minimize the social costs of constructing and operating a transmission line.

The development of new ROWs uses up large amounts of land, including agricultural and potential residential areas. In a state that is the most urbanized in the nation, retaining land areas for alternative uses should be of paramount importance. Therefore, joint utilization of ROWs is a guiding factor in decision-making.

Natural Gas

Increased use of natural gas will usually require additional pipeline construction and will sometimes require other facilities. The type of facility to be constructed is dependent upon the state of the resource (liquid or gaseous), its source, and its end use.

Liquefied Natural Gas (LNG) Import Facilities

Policy: LNG marine terminals and associated facilities that receive, store, and vaporize natural gas are discouraged in the state's coastal zone unless:

1. a clear and precise justification for such facilities exists in the national interest;

2. the proposed facility is located and constructed so it will not unduly endanger human life and property or otherwise impair the public health, safety, and welfare, as required by N.J.S.A. 13:19-10(f); and

3. such facilities comply with DEP's Coastal Resource and Development Policies.

Any applications to construct LNG importation facilities must be evaluated on a case-by-case basis and be treated as a regional issue.

Rationale: Transporting natural gas economically from nations outside North America requires the gas to be liquefied. This option necessitates specialized liquefaction facilities, specially-equipped ships, and an onshore LNG receiving terminal usually located on coastlines or interstate waterways. In view of the controversy over the potential risk to the public's health, safety, and welfare posed by the tankering, transfer, and storage, LNG imports are discouraged.

Pursuant to the amendments to the Natural Gas Pipeline Safety Act of 1968 under P.L. 96-129 (November 30, 1979), and more specifically Title I, Subtitle B, Section 6(a)92), the U.S. Department of Transportation established regulations for the siting, design, construction, initial inspection, and initial testing of any new LNG facility. The comprehensive standards developed by the USDOT's Materials Transportation Bureau appeared in the February 11, 1980 Federal Register (Volume 45, #29) and became effective as of March 15, 1980. Other federal agencies (e.g., the U.S. Coast Guard, the Economic Regulatory Administration, and the Federal Energy Regulatory Commission) have additional responsibilities in the siting and operation of LNG import facilities.

There are four completed LNG import terminals in the United States. Together, they could receive about 900 Bcf of LNG annually. However, the large terminals at Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana no longer operate. Only the smallest LNG terminal, the Distrigas facility at Everett, Massachusetts, still operates and can receive 42 Bcf of LNG annually. Since late 1985 that facility has had no long-term commitments for LNG supplies.[1]

While potential LNG supplies are significant, no resurgence of LNG is expected in the near future since its cost is not likely to be competitive with other fuels in natural gas markets. The presence of these under-utilized facilities alleviates any need for import terminals within New Jersey.

LNG Peak-Shaving facilities

Policy: Since no underground natural gas storage facilities are presently operational in New Jersey, LNG peak-shaving facilities continue to be an option for meeting the state's winter peaking gas supply needs.

New LNG facilities that liquefy, store, and vaporize LNG to serve demand during peak periods shall be located in generally remote, rural, and low population density areas where land use controls and/or buffer zones are likely to be maintained.

Rationale: With an increased emphasis on the utilization of natural gas, there is a need to increase gas storage facilities to meet winter heating season needs. Such facilities would supplement natural gas supplies currently limited by long-haul pipeline capacity during high demand periods.

Since New Jersey produces no natural gas, it is critical to develop adequate storage capacity by increasing underground storage in nearby states and by utilizing LNG peak-shaving.

Natural Gas Pipelines - Onshore and Offshore

Policy: In order to expand the natural gas delivery system, the interstate pipeline system capacity needs to be increased. Using existing ROWs where possible will minimize the need to acquire new land and the environmental impact of pipeline construction. Additionally, utilization of these ROWs by more than one pipeline should be encouraged to the maximum extent practicable.

Rationale: New Jersey currently has no indigenous natural gas supply and thus receives the major percentage of its natural gas from the United States' gas producing regions (primarily the Gulf Coast states) via a vast network of pipelines. By late 1990 or early 1991 small volumes of Canadian gas should become available to New Jersey via the Iroquois pipeline. By means of this national network, gas flows from one pipeline to another in response to changes in supply locations, demand patterns, short-term system outages, and emergencies.

In order to obtain adequate supplies of natural gas as well as to meet the increasing residential demand for gas service, new pipelines will be constructed as part of FERC's 1988 settlement agreement that provides additional supplies to the Northeast. The concept of joint utilization of existing ROWs by new or looping pipelines is one mechanism that can substantially decrease construction impacts. Pipelines, as linear facilities, require continuous strips of land that traverse a wide range of ecological and cultural systems. Joint utilization of ROWs will reduce disturbance to these systems.

Natural Gas Pipelines - Offshore

Policy: New Jersey encourages oil and gas exploration efforts off its coast, provided that experimental and developmental activities are conducted in an environmentally sensitive manner. The use of natural gas pipelines to transport gas resources to existing onshore interstate gas transmission systems is acceptable, subject to the following conditions:

1. For safety and the conservation of resources, the number of pipeline corridors, including trunk pipelines for natural gas,

shall be limited to the maximum extent feasible. Approval should follow appropriate study and analysis by the DEP and DEPC, as well as interested federal, state, and local agencies and affected industries.

2. Pipeline corridors for transporting Outer Continental Shelf (OCS) natural gas onshore are conditionally acceptable provided they locate in or run parallel and adjacent to existing road, railroad, pipeline, electrical transmission, or other ROWs to the maximum extent practicable.

3. Pipeline corridors for natural gas are discouraged in the Central Pinelands area of the Mullica River, Cedar Creek watersheds, and portions of the Rancocas Creek and Toms River watersheds,[2] and discouraged in other undeveloped parts of the Pinelands, unless the developer can demonstrate that construction and operation of the proposed pipeline will meet the adopted nondegradation standards for water quality and cause no long-term adverse environmental impacts.

4. Proposals to construct a natural gas pipeline that originates from the OCS to a connection with an interstate natural gas transmission line and/or a gas distribution system connected, or in close proximity, to a separation and dehydration facility gas processing plant, shall be evaluated by DEP and DEPC in terms of the impacts of the entire pipeline corridor through New Jersey. This evaluation will include all the following contemplated or potential ancillary facilities: separation and dehydration facilities, odorization facilities, gas processing plant(s), compressor station(s), metering and regulating station(s), and block valve assemblies.

5. Pipeline corridors through the state coastal waters shall at a minimum avoid offshore munitions, chemical and waste disposal areas, heavily used bay and ocean channels, geological faults, wetlands, and significant fish and shellfish habitats.

6. Pipelines shall be trenched to a depth sufficient to withstand exposure by scouring, shipgroundings (anchors), fishing and clamming, and other potential obstacles on the seafloor. Trenching operations will be conducted in accordance with 49 CFR 191 and 192.

7. To preserve the recreational and tourism character of the coastal areas, major new ancillary facilities (such as gas processing plants and compressor stations) shall be prohibited from locations in the Bay and the Ocean Shore segment. Construction of separation and dehydration facilities, metering and regulating stations, and block valves are conditionally acceptable in the Bay and Ocean Shore segment, provided they are protected by adequate visual, sound, and vegetative buffer areas. Offshore platforms for compressors or other facilities as part of the transportation system should be located out of sight of the shoreline.

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Rationale: At present, it is far more likely that commercial quantities of natural gas, as opposed to oil, will be developed. This statement is supported by the five confirmed strikes of natural gas in the Mid-Atlantic as well as the analysis of the geologic data for the region.

New Jersey recognizes that pipelines, rather than liquefaction, are the more environmentally acceptable and economically feasible transportation mode for OCS natural gas. All natural gas produced in the United States OCS to date has been transported to shore by pipeline.

The impacts of a pipeline are most evident during the construction phase. These impacts, however, will be short-term and should not have any serious long-term effects, provided proper construction technologies, mitigating measures, scheduling practices, and restoration efforts are utilized. Pipelines are generally routed to avoid unnecessary disturbance to historic, archeological, scenic and/or environmentally sensitive areas. At the same time, particular attention should focus on the potential impacts of any necessary ancillary facilities that are part of the pipeline system.

Initial decisions concerning the siting and accommodation of a natural gas pipeline and any necessary ancillary facilities should be made by New Jersey in a cautious and prudent manner in light of the long-term cumulative impacts of the overall gas transportation system. Final approval of pipeline corridors, specific alignments, and locations of ancillary facilities will necessarily involve trade-offs between environmental, socio-economic, technical, and institutional considerations.

The state of New Jersey, along with the numerous public and private interests at the local, state, and national levels involved in pipeline siting, is participating in the intergovernmental offshore oil and gas transportation planning process being coordinated by the U.S. Department of the Interior's Minerals Management Service (MMS). MMS, in recent years, has reinforced the concept of a common carrier pipeline by including a stipulation in all lease sales that "reserves the right (to MMS) to require any pipeline between a structure on the OCS and an onshore facility to be placed in certain designated corridors through the submerged lands of the OCS." The Federal Energy Regulatory Commission, which has the overriding responsibility for siting natural gas pipelines onshore, has also endorsed the joint utilization of ROWs in its guidelines that were published as 18 CFR 2.60.

Gas Separation and Dehydration Facilities for Offshore Pipelines

Policy: Separation and dehydration facilities are discouraged in the Bay and Ocean Shore segment of the state as defined in the state's approved Coastal Zone Management Plan. Any separation/dehydration facility must meet all air and water quality standards as well as be protected by adequate visual, sound, and vegetative buffers. Any request to construct such a facility will be jointly evaluated by DEPC and DEP with the facility reviewed as a part of the proposed overall gas transportation project.

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Rationale: Based upon information to date, it is anticipated that any commercial quantities of natural gas found in the OCS will be mostly methane and water, along with relatively small amounts of liquid hydrocarbons. Most of the water can be removed from the natural gas stream on the production platform. The liquid hydrocarbons or condensate will be returned to the gas stream downstream of gas measurement equipment on the platform and will be transported to shore with the gas in a single pipeline. The natural gas liquids and small amounts of water that reach landfall by the pipeline must be separated from the gas stream before it connects with an existing interstate natural gas transmission line.

Separation/dehydration facilities essentially remove water, natural gas liquids, and other impurities from the gas stream. The natural gas liquids are temporarily stored in fixed-roof storage tanks with vapor recovery systems until transported off-site by rail, tank truck, or pipeline to a fractionation facility. Water will be disposed of by either deep well injection or by trucking it to an approved off-site disposal location.

There is no standard size or design for a separation/dehydration facility. Each facility is designed specifically for the gas stream to be handled, and its lifetime is dependent primarily on the availability and duration of the natural gas supply.

The natural gas company usually prefers to locate a separation/dehydration facility within several miles of the pipeline's landfall to allow for the most efficient and economical transportation of the natural gas. Generalized siting criteria require up to 50 acres of fairly level land, with 20-30 acres intensively utilized and the remaining acreage serving as a buffer zone around the plant. Easy access to either highway and/or railroad facilities is also desirable.

Compressor Stations

Policy: In general, construction of new compressor facilities and/or the modification of existing facilities will be looked upon favorably because they would facilitate the increased utilization of natural gas in the state.

Specifically, the modification of existing compressor stations (i.e., addition of new turbines, replacement of inefficient turbines, replacement of turbines with high pollutant discharge levels, or retrofitting existing turbines) is encouraged as long as all applicable air and water quality standards are met. Adequate visual and vegetative buffers and compliance with the noise standards established in N.J.A.C. 7:29-1.1 et seq. are also required.

The design and construction of new compressor stations must meet the standards specified by USDOT's Materials Transportation Bureau in 49 CFR 192, sections 163 to 171 inclusive. Additionally, companies wishing to construct new compressor stations must obtain the appropriate federal and state PSD or offset permits. If possible, compressor stations should be co-located with other facilities composing the gas transportation system.

Should commercial quantities of OCS natural gas be discovered, compressor stations, if needed, are encouraged to be located out of sight of the shoreline on platforms in offshore waters.

Rationale: Compressors are an integral part of the natural gas system. They are required at intervals along a pipeline to maintain the desired rate of flow within the system. For long distance pipelines the need to install compressors at various intervals is based on friction within the pipeline and the terrain over which the pipeline passes.

In order for interstate natural gas pipeline companies and distribution companies to increase their ability to deliver natural gas, they must enlarge their system capacity. Generally, they can increase throughput by constructing new looping pipeline segments that parallel existing pipelines, by increasing operating pressures, or by a combination of both of these strategies. New pipeline construction requires new compressor stations. When existing pipelines are to be operated at higher pressure to increase throughput, new compressors must be added to the system or existing compressors retrofitted to increase pressure.

Gas Processing Plants

Policy: Gas processing plants, including partial processing plants, located between the offshore pipeline, landfall, and the interstate natural gas transmission lines, shall be excluded from sites within the Bay and Ocean Shore segment and the Central Pinelands critical area, to the maximum extent practicable and shall be located the maximum feasible distance from the shoreline. The siting of gas processing plants will be reviewed in terms of the total pipeline routing system and will be subject to review by DEPC and DEP.

Rationale: Discovery of commercially recoverable quantities of natural gas off New Jersey's shore and its transportion to a landfall in New Jersey by pipelines may necessitate construction of gas processing plants.

These facilities, however, do not require locations on the shoreline. If the amount of liquids separated from the gas stream are minimal, the liquids can be trucked or transported by rail to existing processing facilities. A gas processing plant may influence the location and/or expansion of chemical plants since gas and its by-products often provide the feedstock for the petrochemical industry.

To promote the most efficient use of land, gas processing plants could be located close to existing interstate natural gas transmission pipelines. Alternatively, where natural gas is associated with oil in oil pipelines, gas processing plants should be located close to refineries to which the oil pipeline will be routed. Thus, gas processing plants that are economically and technically feasible and do not exceed new source and performance standards for air and water quality are conditionally acceptable in the Delaware River and northern waterfront areas.

Gas Pipeline "Pigging" (Scraping) Facilities

Policy: To ensure economic and efficient operations, pigs or scrapers are introduced from launching traps into the pipeline and retrieved at a receiving trap without loss of fluid or gas. The pig or scraper is run through the pipeline to clean out accumulations of wax, scale, gas liquids, or any other foreign materials from the inside walls of the pipe, thus ensuring more efficient operation. The decision to site a pigging facility will be based upon the evaluation of the proposal to construct a natural gas pipeline and a review of the entire gas pipeline system.

Rationale: Gas pigging facilities or scraper traps are installed parallel to and at the beginning and end of a pipeline or, if the total length is too long, at certain set intervals. The size of these facilities, which are not land use intensive, depend on the size of the pipeline and the quantity of liquids in the gas stream.

In an OCS natural gas pipeline, the pig could be introduced at the offshore platform and removed at an onshore location at the separation/dehydration facility or nearer to the landfall site according to the overall configuration of the planned transmission system.

Valves

Policy: Block valves will be located at intervals along pipelines according to appropriate sections of 49 CFR 192. Essentially, such valves will be sited according to the amount of development and type of land use in areas traversed by the pipeline.

Rationale: Valves are located at intervals along pipelines as well as where main lines join branch lines, loops, other main lines, and at the entrances and exits of pump, compressor, and meter stations. These valves must be placed in readily accessible locations to facilitate their operation in an emergency. Their spacing is determined by the pipeline's operating pressure, the size of the pipeline, and local physical conditions that translate into population density and land uses in the areas traversed by the pipeline.

Oil Pipelines

Policy: Crude oil pipelines to bring hydrocarbons from offshore areas adjacent to New Jersey's coast to existing refineries, oil distribution systems, and other new oil pipelines are acceptable, subject to the following conditions:

1. For purposes of safety and conservation of resources, the number of pipeline corridors, including trunk pipelines for oil, shall be limited. These corridors shall be designated following

appropriate study and analysis by the DEPC, DEP, DOT, relevant federal, state and local agencies, and affected industries.

2. Pipeline corridors for landing oil are prohibited in the Central Pinelands area of the Mullica River, Cedar Creek watersheds and portions of the Rancocas and Toms River watersheds. Such pipeline corridors are also discouraged in other undeveloped parts of the Pine Barrens.

3. Pipeline corridors for transporting OCS oil onshore are encouraged and are conditionally acceptable provided they locate in or run parallel and adjacent to existing road, railroad, pipeline, electrical transmission or other ROWs to the maximum extent practicable.

4. Proposals to construct onshore oil pipelines, originating from the OCS, as well as all contemplated or potential ancillary facilities (i.e., oil storage terminals, surge tanks, pumping stations, etc.) that compose the oil transportation system, shall be evaluated by DEP and DEPC in terms of the cumulative impacts of the overall transportation system that is proposed.

5. Pipeline corridors through the state coastal waters shall, at a minimum, avoid offshore munitions, chemical and waste disposal areas, heavily used waterways, geological faults, wetlands, and significant fish or shellfish habitats.

6. Pipelines shall be trenched to a depth sufficient to withstand exposure by scouring, shipgroundings (anchors), fishing and clamming, and other potential obstacles on the seafloor. Trenching operations will be conducted in accordance with 49 CFR 195.

Rationale: New Jersey recognizes that transportation of oil by pipeline, rather than by other modes of surface transportation such as tankers and barges, is the preferred and more environmentally sound method of transporting OCS oil to shore.

The construction impacts of an oil pipeline are similar to those of a gas pipeline. However, the operational impacts of an oil pipeline are of greater concern. Oil transportation will involve either a pipeline to shore or offshore storage and shipment by tankers and barges to a petroleum refinery. The amount of reserves, the geographic proximity and configuration of individual fields, and distance from shore are the major factors that will determine whether offshore storage and tankers or a pipeline will be used to transport offshore oil.

The state of New Jersey, along with numerous public and private interests at the local, state, and national levels involved in OCS activities, is participating in the intergovernmental offshore oil and gas transportation process which is being coordinated by the U.S. Department of the Interior's Minerals Management Service. The state will work closely with this group to ensure the prudent and safe transportation of oil to its ultimate destination.

CHAPTER II-5

Oil Refineries

Policy: New oil refineries are acceptable in New Jersey, except in that part of the state known as the Bay and Ocean Shore area.

Any proposed refinery would be encouraged to locate in an established industrial area accessible to its potential labor force. Although new refineries are not likely, they will be allowed provided an environmental impact statement determines that the facility will have no unacceptable impacts and will comply with all applicable federal and state air and water quality standards.

The expansion in capacity of existing oil refineries, all of which are located outside of the Bay and Ocean Shore area, is acceptable providing that such an expansion does not violate applicable air and water quality standards.

Rationale: The demand for refined petroleum products is currently rising moderately. In 1987, United States refineries operated at about 83 percent of capacity.[3] New Jersey's refineries generally operate at utilization rates close to the national rate. New refineries using advanced technology to control air and water pollution and other hazards could be compatible with existing development in the Delaware River area or northern waterfront.

In the next two decades, modifications and/or expansion of on-line refineries can be expected. Contributing factors to such modifications and/or expansions are:

1) the relative demand for the mix of refined products is changing, making light products such as diesel and jet fuel more desirable; and

2) the crude being imported into the United States is gradually becoming heavier and has a higher sulfur content. Since about 90 percent of the crude oil delivered to New Jersey in 1986 was imported, existing refineries will continue modifying their downstream processing capability.

Resource Recovery Facilities

Policy: The use of landfills as the exclusive means of disposing of municipal solid waste is no longer acceptable in New Jersey. Landfills are an anachronistic misuse of land, material, and energy resources and have been polluting our groundwater. In addition, existing landfill space is limited and siting of new landfills is difficult from environmental, social, political, and economic points of view.

The development of a balanced solid waste management program that includes waste minimization at the source, re-use, convertion of organic waste into compost, intensive recycling, and energy recovery, as well as environmentally sound landfill practices is a major goal of the

New Jersey Solid Waste Management Act (P.L. 1975, c. 326), the State Recycling Plan (Recycling in the 1980's, Sept. 1980; Progress Report and Program Recommendations, Oct. 1984), the "State Recycling Act" (A-2283), and the State Energy Master Plan.

It is a state goal to source separate and recycle 25 percent of the municipal solid waste stream, to develop energy recovery facilities (incinerators) to process much of the remaining waste stream, and to permit the operation of only environmentally sound landfills to accept residue and nonrecyclable materials.

Japan currently recycles about 50 percent of its waste stream and a pilot program in East Hampton, Long Island, has been recycling at the 90 percent level. Therefore, more intensive recycling is achievable in New Jersey and would reduce the total weight and volume of waste requiring incineration.[4] New Jersey's mandated recycling applies only to residential waste, which is about one-third of the total waste stream.

In recognition of such problems, the Coalition of Northeastern Governors established a task force in 1988 to identify actions which can effectively reduce the total volume of disposable packaging material.[5]

Siting Criteria:

1. The construction and operation of any resource recovery facility should maximize the energy system's output and minimize any adverse impacts on the state's physical and social environment.

2. Resource recovery facilities should be located near urban areas and in areas already zoned for industrial use. Depending on the technology selected, resource recovery facilities may require site locations in close proximity to energy consumers.

3. Where feasible, resource recovery facilities should be constructed to encourage industrial development of adjacent properties. Resource recovery facilities offer the potential to provide a lower cost, stable energy supply to industry while improving the municipal tax base.

4. The site of resource recovery facilities should be reasonably close to communities that will provide the necessary quantities of solid waste to efficiently and economically operate the facilities.

5. Resource recovery facilities should be located near a major road or highway system to accommodate heavy truck traffic and minimize any increase of traffic in residential areas.

6. Prior to the design and construction of resource recovery facilities, waste flows should be weighed and analyzed for composition. Front-end material recovery systems should be evaluated. Since county waste separation programs are now functioning, planned energy recovery facilities should be based upon compatibility with such programs.

Rationale: Faced with the high costs of getting rid of garbage, (about half is trucked to out-of-state landfills), New Jersey has been planning to convert wastes into energy instead of burying trash in the ground or dumping sludge in the ocean. The proposed energy recovery facilities or incinerators would burn waste volumes reduced by intensive re-use and recycling programs, thereby producing electricity or steam for nearby users. Each county must develop its own waste management program. Warren County's incinerator went into operation in September 1988. Sussex cancelled its incinerator plans and has implemented composting and intensive recyling.

Energy recovery facilities will significantly reduce solid waste requiring landfill and reduce the cost to municipalities of hauling refuse by reducing distances traveled, truck turnaround time, and vehicle maintenance. In addition, resource recovery facilities will also provide construction and operating employment opportunities.

Overall, the development of waste recovery programs is part of a balanced solid waste management program for the state.

Storage Facilities for Crude Oil, Petroleum Products, and Other Hazardous Liquid Substances

Policy: The storage of crude oil, liquefied gases, and other potentially hazardous liquid substances (as defined in N.J.A.C. 7:1E.1) under the Spill Compensation and Control Act (N.J.S.A. 58:10-23.11) is prohibited on barrier islands and discouraged elsewhere in the Delaware and Raritan Bay and Atlantic Ocean Shore region.

The siting of new storage facilities in the urban port regions is conditionally acceptable provided the following criteria are met:

1. there is a clearly demonstrated need for such facilities that would encompass strategic and demonstrated industrial factors;

2. other siting alternatives outside the coastal zone are clearly unfeasible or counter-productive to energy efficiency;

3. the construction and operation of storage facilities utilizes the best and safest technologies to minimize spills and pollutants discharged into the atmosphere; and

4. the facilities meet all applicable air and water resource policies and regulations and are compatible with or adequately buffered from surrounding uses.

Proposals for storage facilities outside the coastal zone will be reviewed on a case-by-case basis and must meet need criteria as well as prudent siting standards that address adjacent land uses.

Rationale: Historically, the urban coastal zone has been the site of a great percentage of the storage facilities linked to the waterborne transportation of petroleum products. However, the associated storage facilities, which traditionally have been sited on the urban waterfront, are not necessarily coastal dependent. Facilities that are coastal dependent have been precluded from coastal locations due to the siting of crude oil, liquefied gas, and other potentially hazardous liquid substance storage facilities. Thus, DEPC will critically review submissions for new facilities both from coastal dependent viewpoint and need criteria.

Tanker Terminals

Policy: New or expanded conventional tanker facilities are acceptable provided they meet the following conditions:

1. urban port locations are used for dockside transfer of fuels where required channel depths exist to accommodate coastal tankers;

2. joint utilization or multi-company use of dockside unloading facilities will be explored as part of a strategy to minimize unnecessary urban waterfront development that would preempt alternative coastal dependent uses; and

3. a positive need determination has been made by DEPC.

DEPC encourages the establishment of deep draft, in-harbor oil terminals where feasible, especially when they are developed in concert with coal transshipment facilities and/or container ship terminals that would require deep draft channels for access to dockside.

Offshore tanker terminals and deepwater ports will be reviewed on a case-by-case basis. The siting of such terminals shall be in compliance with New Jersey's Coastal Zone Management Plan.

Rationale: Tanker terminals presently operate and exist in the established urban port locations because of the existence of natural harbors and dredged channels capable of accommodating tankers. Tanker and barge shipments continue to furnish significant amounts of the crude oil and petroleum products transferred to New Jersey, including imports. Waterways should continue to be used in this manner because of land use considerations and conflicts that would occur if tanker terminals were to be located in other areas of the state where adequate harbors and channels do not naturally exist.

Deepwater ports have been developed in other parts of the world as an alternative to transitional transshipment modes that include the use of small tankers or lightering of medium size tankers in harbor areas. Deepwater ports that include offshore monobuoy systems are capital intensive and require high rates of utilization and throughput to justify their initial cost. The DOE Alternative Crude Oil Transportation Study determined that the economies of constructing a monobuoy system to serve New Jersey's refineries do not exist.

Deep draft, in-harbor oil terminals, however, are encouraged according to the analysis contained in the study. The study also concluded that oil spills can be reduced by minimizing the number of small tankers that must enter the Delaware Bay and the New York Harbor area and therefore the number of transfers that will occur. For those vessels that require lightering before progressing to the tanker terminals, spills and hydrocarbon emissions can also be eliminated. Thus, in-harbor, deep draft terminals will be a more environmentally acceptable alternative as well as a method to reduce transportation costs that could be passed on to the consumer.

Another study by the DOE in the early 1980s entitled "Deepwater Port Alternatives for New Jersey" concluded an in-harbor deepwater oil terminal for New York Harbor appears feasible.

D R A F T

CHAPTER II-5

FOOTNOTES

1. New York State Natural Gas Supply Assessment, August 1987, p. 14.

2. This 760 square mile region is a "critical area" for sewerage purposes and nondegradation surface and ground water quality standards--see N.J.A.C. 7:9-4.6(i),(j) and N.J.A.C.

3. National Petroleum News, August 1988, pp. 51-52.

4. "Biologist Says Industry must Halt Pollution at its Source, " Newark Star Ledger, 11/15/87, p. 19.
   "New Plants will Turn Garbage into Energy, "Newark Star Ledger, 11/20/88, p. 49.

5. "Northeast Governors Attack one Sector (packaging) of Waste Crisis," Newark Star Ledger, 8/26/88, p. 23.

Part III

Energy Use

Chapter III-1

THE RESIDENTIAL SECTOR

Introduction

This chapter examines residential energy consumption by end use and the potential impact of energy efficiency on this consumption. End use is examined at two levels: by fuel and by appliance, both electric and natural gas.

The focus of the energy efficiency analysis is at the appliance level. It considers the potential for increased energy efficiency by the year 2000, through improved appliance efficiency and building shell, or home insulation and weatherization, improvements. The chapter analyzes present usage, and looks ahead to potential "year 2000" usage as impacted by energy efficiency.

End-Use Patterns - The Present Situation

Fuels - New Jersey Residential Fuel Mix

In 1986, the greatest portion of energy sales to residential customers was from natural gas at 162.4 TBtu or 49 percent, followed by petroleum, 106.3 TBtu or 32 percent; electricity, 61.6 TBtu or 18.6 percent; and coal, 0.9 TBtu or .2 percent. When electric losses are considered, electric consumption, as opposed to sales, accounted for 43 percent (204.4 TBtu) of total energy consumption. (see Table III-1-1 and Figure III-1-1)

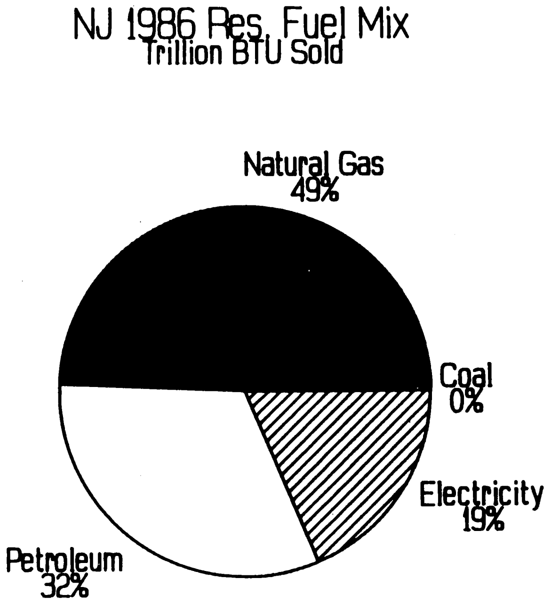
Table III-1-1
New Jersey Energy Consumption (TBtu)
Residential Sector

Year	Coal	Nat. Gas	Petroleum	Electricity Sales	Electricity Losses*	Total
1960	6.3	77.7	158.8	17.3	43.1	303.2
1961	5.8	91.3	163.1	19.2	46.7	326.1
1962	4.9	99.7	168.0	19.9	47.9	340.4
1963	4.7	107.5	176.8	21.4	51.3	361.7
1964	4.2	112.0	175.2	23.3	55.4	370.1
1965	3.8	119.6	177.3	25.3	60.4	386.4
1966	3.1	127.8	177.8	28.1	67.3	404.1
1967	2.7	140.5	184.4	30.6	73.0	431.2
1968	2.5	142.2	190.6	33.9	80.9	450.1
1969	2.3	150.9	195.0	37.4	89.2	474.8
1970	2.1	143.9	199.3	41.4	100.3	487.0
1971	2.0	146.9	198.0	43.9	106.0	496.8
1972	1.5	153.8	213.5	46.3	111.4	526.5
1973	1.6	140.3	214.9	50.6	121.2	528.6
1974	1.3	139.4	188.0	48.8	119.0	496.5
1975	1.0	133.4	184.6	49.5	119.3	487.8
1976	1.0	152.5	191.1	51.2	123.8	519.6
1977	1.0	138.7	183.4	52.5	126.8	502.4
1978	0.9	141.1	173.3	53.5	131.0	499.8
1979	0.7	129.3	129.5	53.9	130.1	443.5
1980	0.8	140.9	144.0	55.7	135.5	476.9
1981	1.4	150.8	139.5	54.7	130.3	476.7
1982	1.4	153.4	117.4	53.8	129.1	455.1
1983	1.2	150.9	98.8	57.6	137.7	446.2
1984	0.5	154.9	101.9	58.3	135.8	451.4
1985	1.4	154.3	111.0	58.3	137.8	462.8
1986	0.9	162.4	106.3	61.6	142.8	474.0

Source: State Energy Data Report, Consumption Estimates 1960--1986, EIA, April 1988

* "Losses" consist of losses incurred in the generation, transmission, and distribution of electricity, industry plant use, and net interstate sales. They primarily reflect the fact that electric facilities are approximately 30 percent efficient. Losses are computed by multiplying sales by an annual national average ratio of losses to sales. This ratio is approximately 2.4.

Figure III-1-1



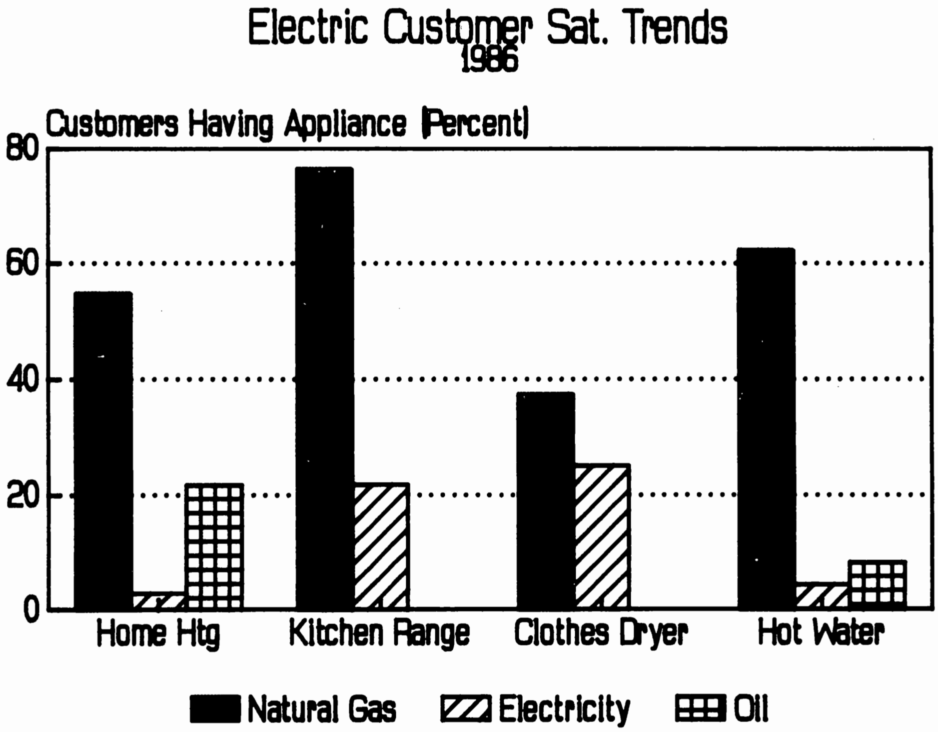
Source:State Energy Data Report,EIA 1987

Appliance Saturation Trends

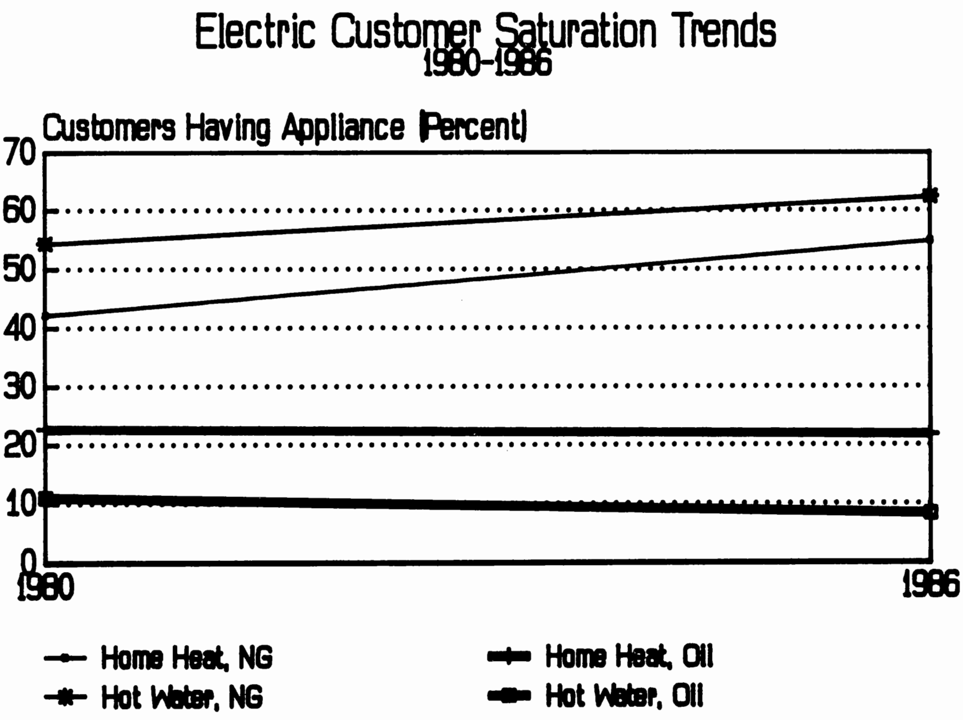
Figure III-1-2 and Tables III-1-2 and III-1-3 depict pertinent results of a recent customer appliance saturation survey by Public Service Electric and Gas Company (PSE&G). The survey was conducted by randomly selecting approximately 1 percent of total customers in each group to receive appliance use questionnaires. The response rate was approximately 60 percent. The percentages shown represent total customer use, based on the survey results.[1]

The figure and tables indicate that natural gas is the predominant fuel used for home heating, kitchen ranges, water heating, and clothes dryers. Between 1980 and 1986, the percentage of customers using natural gas for these applications has increased, while those using oil has decreased. Additionally, nearly 80 percent of electric customers have some type of air conditioning.

Figure III-1-2



Source: See Appendix A



Source: See Appendix A

Table III-1-2

Electric Customer Saturation Trends

Appliance	Customers having Appliance (Percent) 1980	1986
Principal Home Heating System		
Electricity	2.1	2.9
Natural Gas	42.1	54.8
Oil	22.6	21.7
Not Stated	11.3	1.7
Kitchen Range		
Electricity	19.8	21.8
Natural Gas	78.6	76.4
Not Stated	1.3	1.6
Water Heater		
Electricity	4.9	4.4
Natural Gas	54.3	62.3
Oil	10.9	8.2
Not Stated	6.9	4.3
Clothes Dryer		
Electricity	22.1	25.1
Natural Gas	33.4	37.4
Air Conditioner		
One Bedroom Unit	29.1	28.0
Central	16.7	22.2
None	23.2	21.8

Source: See Appendix A

Table III-1-3

Natural Gas Customer Saturation Trends

Appliance	Customers having Appliance (Percent) 1980	1986
Principal Home Heating System		
Natural Gas	53.5	67.8
Electricity	.1	.3
Oil	18.3	17.4
Not Stated	11.3	.9
Kitchen Range		
Natural Gas	84.5	82.6
Electricity	13.7	15.7
Not Stated	1.4	1.5
Hot Water Heater		
Natural Gas	66.5	74.8
Electricity	1.6	1.3
Oil	7.2	5.1
Not Stated	7.0	3.9
Clothes Dryer		
Natural Gas	40.0	45.1
Electricity	19.9	23.0

Source: See Appendix B

Chapter III-1

Role of the Building Shell

Per-appliance consumption is a function of several factors. These include the technology of the appliance, the structure of the building shell or envelope of the home in which the appliance is used, as well as the habits of the individuals using the appliance. In this chapter, figures are adopted for New Jersey per-appliance consumption from Public Service Gas and Electric Company's residential forecast and from a study by the New England Energy Policy Council. The purpose of the analysis is to determine how New Jersey residential consumption would be affected by changes in appliance technology and in the building shell. It is assumed, for simplicity, that habits or lifestyles remain constant.

Although appliance consumption is a function of several factors, the combined effects on energy efficiency of altering these factors is not precisely understood. In fact, a home which retains more heat may have some negative effects on appliance efficiency. For the purposes of this analysis, a multiplicative effect is assumed between improvements in appliance efficiency and the building shell. That is, given the consumption of the appliance, the consumption of the appliance in an improved building shell can be determined by multiplying by the percent savings attributable to the shell (see Analysis).

Improvements to the building shell considered here are weatherization and superinsulation. Weatherization is exclusively applicable to existing structures and involves "seal-up" techniques that keep the structure from losing heat. Superinsulation is exclusively applicable to new construction. Superinsulated structures are defined as structures that are 1) airtight with controlled ventilation; and 2) characterized by a high 'R' or heat resistivity value.[2]

Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89 now in press, sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of four microcuries per liter. These and other codes set minimum but not maximum ventilation standards. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Housing shell improvements primarily affect home heating and, to some extent, cooling. Historically, low-income homes have been disproportionately poorly weatherized.[3] Accordingly, they have been the target of a number of subsidy programs to help low-income residents pay for weatherization improvements. A discussion of housing shell in New Jersey means first, therefore, discussing New Jersey's weatherization programs--their objectives, problems, and accomplishments (see Chapters IV-1 and IV-2). Similarly, superinsulation of new construction is largely a function of building codes (see Chapter IV-1-B).

Analysis

Year 2000 Use Scenario: Electric Appliances

Tables III-1-4 and III-1-5, and Figures III-1-3 and III-1-4 depict present and potential electric appliance end use in New Jersey.

Zero Customer Growth Scenario: Table III-1-4 assumes no customer growth between 1987 and 2000. This assumption isolates the effects of the energy efficiency improvements considered. Table III-1-4 first presents the "status quo" picture, breaking total New Jersey residential electric sales into sales by nine major appliances and appliance groups for present day (1987) consumption. Secondly, the table presents the same breakdown, assuming all presently used appliances are replaced with efficient, commercially available appliances by the year 2000. For heating and cooling appliances, it is also assumed that retrofit weatherization improvements are made, with a savings rate of 25 percent. (See Table III-1-5, notes A, B, and C).

Referring to Table III-1-4, New Jersey residential electric consumption could be reduced through use of more efficient, presently available electric appliances, from 19,044 gwh to 12,300 gwh, a savings of 6,744 gwh or 35 percent. Assuming that this savings is spread over an entire 8,760-hour year, a load savings of approximately .77 GW or 770 MW results. This is the equivalent of two or three average coal plants, or roughly half of a modern nuclear facility.

Figure III-1-3 presents a graphic comparison of savings on a percentage and total gigawatt-hour basis respectively, utilizing data from Table III-1-4. Four major appliance groups are shown: refrigerators plus freezers; lighting; heat pumps; and cooling. Cooling combines room and central air conditioners. While no significant change on a percentage basis is seen for heating and cooling (Figure III-1-3), change occurs on a gigawatt-hour basis (Figure III-1-4). The greatest savings are from the refrigerator/freezer group and from lighting. For refrigerators plus freezers, a combined savings for New Jersey of 2,638 gwh, or a reduction of from 30 percent to 25 percent of total consumption is estimated. For lighting, the savings are estimated at 1,086 gwh, or a reduction of from 9 percent to 6 percent of total use.

Ten Percent Customer Growth Scenario: Table III-1-5 and Figure III-1-3 present the same basic analysis as Table III-1-4, with two distinctions. First, Table III-1-5 assumes 10 percent customer growth between 1987 and 2000. This growth is accounted for by multiplying total New Jersey sales, after appliance efficiency reductions, by 10 percent.

Second, for heating and cooling appliances, it is assumed that all efficiency improvements occur in new, superinsulated[4] houses, with a superinsulation savings rate of 43 percent. In contrast, in Table III-1-4, it was assumed that all heating and cooling efficiency improvements occured along with retrofit weatherization measures, with a savings rate of 25 percent. For both tables, a multiplicative relationship is assumed between savings from housing shell improvements and resultant savings in appliance energy consumption. Thus, for example, efficient heat pump consumption is multiplied by 57 percent to calculate heat pump savings in a superinsulated house.

These assumptions, while oversimplified, are intended to address certain concepts: (1) Housing shell improvements have some positive impact on appliance consumption. (2) "No customer growth" means only retrofit improvements to the building shell. "Customer growth" is accompanied by new, superinsulated construction.

Referring to Table III-1-5, New Jersey residential electric consumption could be reduced, assuming a 10 percent increase in numbers of customers between 1987 and 2000, through use of more efficient, presently available electric appliances, from 19,044 gwh to 13,135 gwh, a savings of 31 percent.

Year 2000 Use Scenario: Gas Appliances

Table III-1-6 and Figures III-1-5 and III-1-6 depict present and potential natural gas consumption by appliance in New Jersey. They compare current (1987) gas consumption by appliance to that where more efficient appliances are utilized. For space heating, the effects of insulation improvements are also considered. Four major appliance or groups are shown: dryers, ranges, water heaters, and space heating. Based on the calculations shown, consumption of gas residential customers could be reduced approximately 20 percent by the year 2000.

Figures III-1-5 and III-1-6 present a graphic comparison of savings on a percentage and total therm basis respectively. The biggest savings on a percentage and therm basis is from space heating, where a savings of 460 million therms statewide, or a reduction from 67 percent to 56 percent of total consumption, is estimated.

Table III-1-4
New Jersey Residential Electric Conservation Through Appliance Efficiency and Insulation Improvements
Zero Customer Growth Scenario

Appliance	1987 Percent of Sales(1)	1987 NJ Sales (gwh)(2)	Appliance Consumption (kwh/yr)(1)	Appliance Consumption (kwh/yr)(3)	Appliance type or Conservation Measure (3)	Percent Savings with Efficient Appliance	NJ Savings with Efficient Appliance (gwh)	NJ Total Sales Efficient Appliance (gwh)
Refrigerator	25.45%	4847	1355	744	Whirlpool ET17HK1M	45.09%	2185	2661
Water Heating	3.44%	655	4300	2150	Tank wrap & bottom board insulation, anti-convection valves, pipe insulation, low-flow fixtures, front-loading clothes washer (Gibson WS 27M6-P), water-efficient dishwasher (Sears #22F15565N)	50.00%	328	328
Heat Pumps	0.28%	53	1315	707 A	Efficiency plus retrofit factor, see note A	46.00%	25	29
Lighting	9.50%	1809			Compact fluorescents for incandescents (Phillips/Norelco SL-18), high-pressure sodium for porch & yard security lighting	60.00%	1086	724
Range	3.86%	735	1000	814	Cooking improvements: increased insulation, improved door seals, reduced contact resistance(surface), more reflective pans beneath elements	18.60%	137	598
Clothes Washer	1.39%	265	105	98*		6.67%	18	247
Clothes Dryer	4.21%	802	940	799	Moisture sensor model, Sears #26F66811N	15.00%	120	681
T.V. (Color)	8.14%	1550	285	150	Best available models	47.37%	734	816
Freezer	4.50%	857	1125	530	Weighted average, Woods OC50 (chest) and Frigidaire UFE16DL (upright)	52.89%	453	404

Table III-1-4 (con't)

Appliance	1987 Percent of Sales(1)	1987 NJ Sales (gwh)(2)	Appliance Consumption (kwh/yr)(1)	Appliance Consumption (kwh/yr)(3)	Appliance type or Conservation Measure (3)	Percent Savings with Efficient Appliance	NJ Savings with Efficient Appliance (gwh)	NJ Total Sales Efficient Appliance (gwh)
Room A/C	8.17%	1556	400	171 B	Upgrade to EER of 11.0 plus retrofit factor, see note B	57.25%	891	665
Central A/C	7.36%	1402	1930	1103 C	Upgrade to SEER of 12.0 plus retrofit factor, see note C	42.85%	601	801
Refrigerator	25.45%	4847	1355	744	Whirlpool ET17HK1M	45.09%	2185	2661
Dehumidifier	0.90%	171	310	286*		7.74%	13	158
Dishwashers	2.45%	467	320	214		33.00%	154	313
Other	20.35%	3875	*	*		*	*	3875
Total		19044						12300
Total Percent Reduction								35.41%

Sources:
(1) PSE&G Electric Appliance Residential Forecast, 1987-2017
(2) Based on 1987 New Jersey total residential sales of 19044 gwh, NJEDS
(3) New England, Power to Spare, New England Energy Policy Council, July 1987, unless otherwise indicated

* PSE&G Forecast, Year 2000 data

A: (943*)(.75)=707; where 943 is PSE&G year 2000 efficiency, and a 25 percent retrofit savings is assumed
B: (304)(9/12)(.75)=171; where 304 is NEEPC best commercially available efficiency for 10 EER unit, upgraded to 12 EER, plus 25 percent retrofit savings
C: (1930-460)(.75)=1103; where 1930 is PSE&G current average unit consumption, 460 is savings from upgrade to 12 SEER (conversation with A.J. Polomski, DCEED), and a 25 percent retrofit savings is assumed

Figure III-1-3

NJ Res. Electric End-Use
Present and Potential

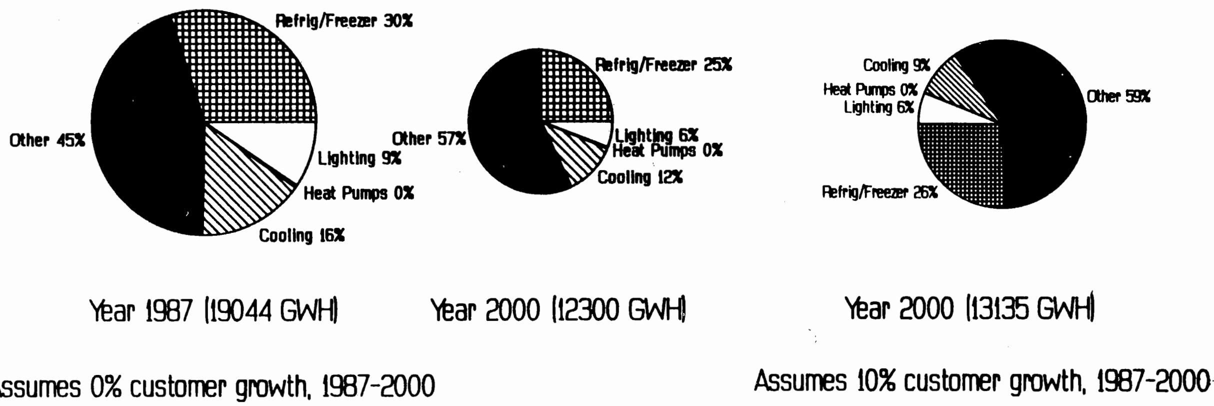


Figure III-1-4

NJ Electric End-Use (GWH)
Assumes 0% customer growth, 1987-2000

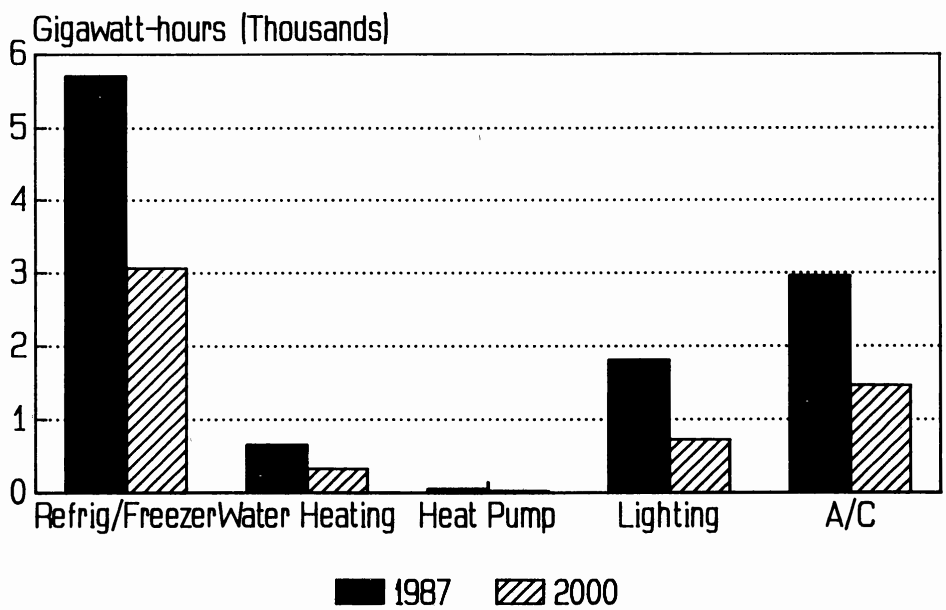


Table III-1-5
New Jersey Residential Electric Conservation Through Appliance Efficiency and Insulation Improvements
Ten Percent Customer Growth Between 1987 and 2000

Appliance	1987 Percent of Sales(1)	1987 NJ Sales (gwh)(2)	Appliance Consumption (kwh/yr)(1)	Appliance Consumption (kwh/yr)(3)	Appliance type or Conservation Measure (3)	Percent Savings with Efficient Appliance	NJ Savings with Efficient Appliance(gwh)	NJ Total Sales Efficient Appliance(gwh)	NJ Total Sales Efficient App. 10% Growth
Refrigerator	25.45%	4847	1355	744	See Table 8	45.09%	2185	2661	2927
Water Heating	3.44%	655	4300	2150	See Table 8	50.00%	328	328	360
Heat Pumps	0.28%	53	1315	538 A	See note A	59.09%	32	24	22
Lighting	9.50%	1809			See Table 8	60.00%	1086	724	796
Range	3.86%	735	1000	814	See Table 8	18.60%	137	598	658
Clothes Washer	1.39%	265	105	98*		6.67%	18	247	272
Clothes Dryer	4.21%	802	940	799	See Table 8	15.00%	120	681	750
T.V. (Color)	8.14%	1550	285	150	See Table 8	47.37%	734	816	897
Freezer	4.50%	857	1125	530	See Table 8	52.89%	453	404	444
Room A/C	8.17%	1556	400	130 B	See note B	67.50%	1050	506	556
Central A/C	7.36%	1402	1930	838 C	See note C	56.58%	793	609	669
Dehumidifier	0.90%	171	310	286*		7.74%	13	158	174
Dishwashers	2.45%	467	320	214		33.00%	154	313	344
Other	20.35%	3875	*	*		*	*	3875	4263
Total		19044							13135
Total Percent Reduction									31.03%

Sources:
- (1) PSE&G Electric Appliance Residential Forecast, 1987-2017
- (2) Based on 1987 New Jersey total residential sales of 19044 gwh, NJEDS
- (3) New England, Power to Spare, New England Energy Policy Council, July 1987, unless otherwise indicated

A: (943*)(.57)=538; where 943 is PSE&G year 2000 efficiency, and a 57 percent new construction insulation savings is assumed
B: (304)(9/12)(.57)=130; where 304 is NEEPC best commercially available efficiency for 10 EER unit, upgraded to 12 EER, plus 57 percent insulation savings
C: (1930-460)(.57)=838; where 1930 is PSE&G current average unit consumption, 460 is savings from upgrade to 12 SEER (conversation with A.J. Polcmski, DCEED), and a 57 percent insulation savings is assumed

* PSE&G Forecast, Year 2000 data

D R A F T

Chapter III-1

Table III-1-6
New Jersey Residential Natural Gas Conservation Through Appliance and Insulation Improvements

Appliance	N.J. NG Res 1987 % of Total Use	1987 State Use (MThms)	1987 (Avg. Appliance) Consumption (Therms)	2000 (New Appliance) Consumption (Therms)	N.J. State Savings with Year 2000 Appliance	N.J. State Savings with Year 2000 Appliance(MThms)	N.J. State Total Sales Efficient Appliance (MThms)
Dryers	2.33%	40	47	43	8.30%	3	37
Ranges	6.86%	119	76	54	28.95%	34	84
Water Heaters	23.65%	409	286	292	-2.24%	-9	419
Space Heating	66.77%	1156	976	588 A	40.00%	460	696
Other	0.39%	7	*		*	*	7
Total	100.00%	1731					1243
Total Percent Reduction							28.00%

A: ((784.8)(.75), where 784.8 is PSE&G year 2000 efficiency,
and a 25 percent retrofit savings is assumed.

Source: PSE&G Residential Gas Appliance Model Forecast: 1987-2017

Figure III-1-5

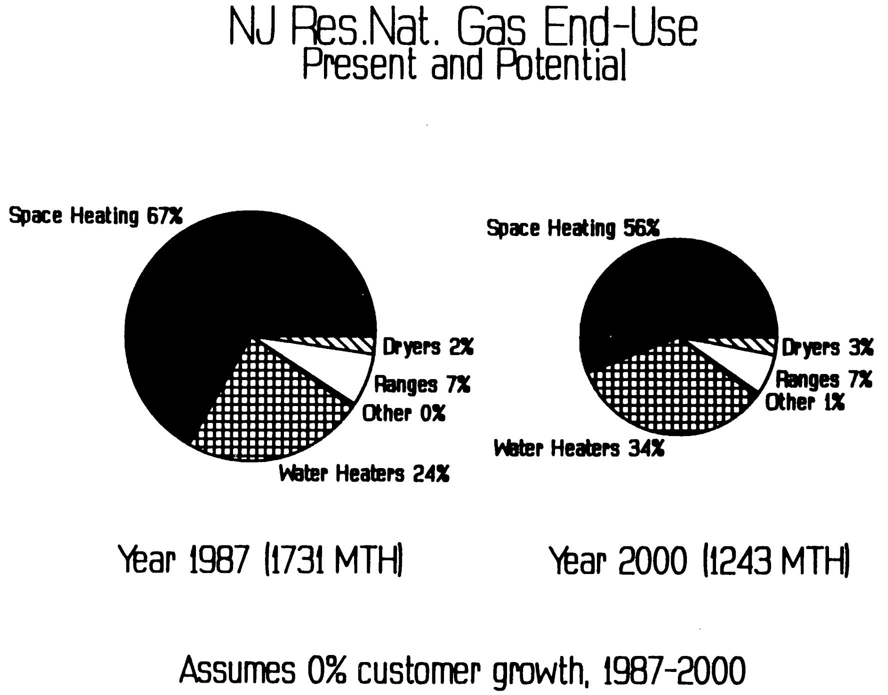
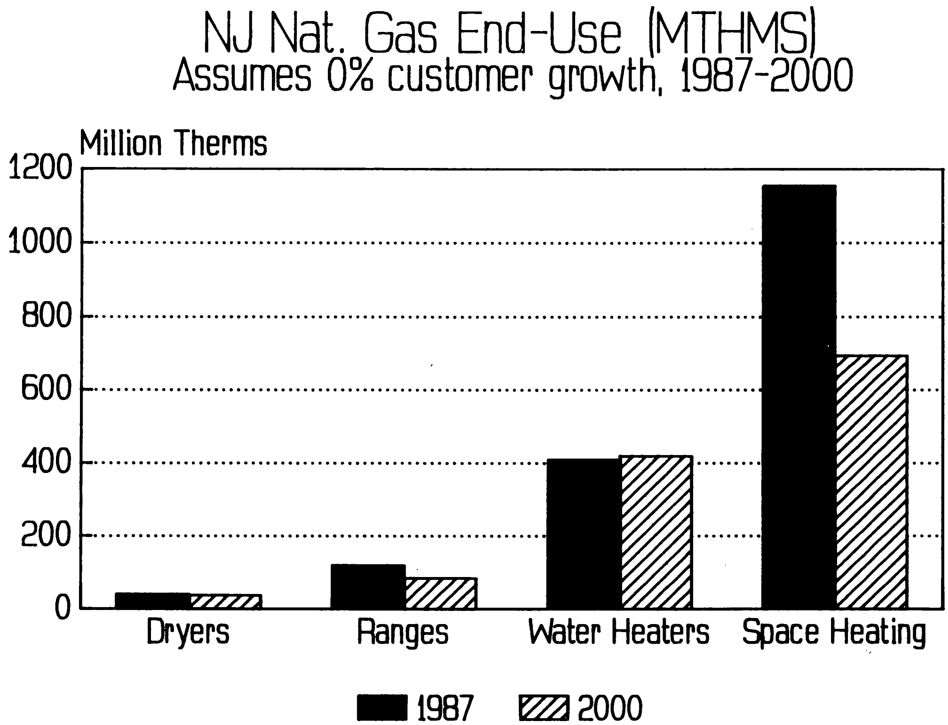


Figure III-1-6



Year 2000 Use Scenario: Building Envelope

Electric Appliances, Zero Customer Growth: Table III-1-4 and Figure III-1-3 presents the electric appliance zero customer growth scenario. In this scenario, a retrofit factor of 25 percent was applied to savings from heat pumps, room air conditioning, and central air conditioning. For heat pumps, annual consumption was assumed to be reduced 25 percent from 943 kwh per unit to 707 kwh per unit, due to the impact of weatherization. Similarly, room air conditioning consumption was reduced from 228 kwh per year to 171 kwh per year, and central air conditioning consumption was reduced from 1,470 to 1,103 kwh per year. This scenario resulted in an estimated total state savings of approximately 500 gwh attributable to weatherization retrofits.

Electric Appliances, 10 Percent Customer Growth: Table III-1-5 and Figure III-1-3 presents the electric appliance 10 percent customer growth scenario. In this scenario, a superinsulation factor of 43 percent was applied to savings from heat pumps, room air conditioners, and central air conditioners. For heat pumps, annual consumption was assumed to be reduced 43 percent from 943 kwh per year to 538 kwh per year per unit, due to the impact of superinsulation. Similarly, room air conditioning consumption was reduced from 228 kwh per unit annually to 130 kwh, and central air conditioning was reduced from 1,470 to 838 kwh per year. This scenario resulted in an estimated savings of 857 gwh.

Natural Gas Appliances, Zero Customer Growth: Table III-1-6 and Figures III-1-5 and III-1-6 present the natural gas appliance scenario. For this scenario, a 25 percent weatherization factor was applied to annual unit space heating consumption. This scenario resulted in a reduction from 784 to 588 therms per year, or a total savings of approximately 233 million therms attributable to weatherization.

Policy Implications

The preceding analysis indicates that, from a technical standpoint, three techniques would be effective in reducing energy consumption from appliances in the residential sector. These are: (1) increased utilization of appliances with greater efficiencies; (2) weatherization of existing housing structures; and (3) increased insulation of new housing structures. The next step is to determine how or if these technical findings should be translated into policy and how to implement this policy.

Appliance Efficiency Standards

Federal appliance efficiency standards presently exist in the National Appliance Energy Conservation Act of 1987 (NAECA). The relevant codification for consumer appliances is U.S.C.A. 42, 6291-6309, Subchapter III - Improving Energy Efficiency, Part A - Energy Conservation Program for Consumer Products Other Than Automobiles.

Covered products include: (6292):

1) refrigerators and refrigerator-freezers
2) freezers
3) dishwashers
4) clothes dryers
5) water heaters
6) room air conditioners
7) home heating equipment, not including furnaces
8) television sets
9) kitchen ranges and ovens
10) clothes washers
11) humidifiers and dehumidifiers
12) central air conditioners
13) furnaces

Section 6295, Energy Conservation Standards, states:

"The purposes of this section are to:

1) provide Federal energy conservation standards applicable to covered products; and

2) authorize the Secretary to prescribe amended or new energy conservation standards for each type (or class) of covered product."

Specific standards are then set out for each type of covered product, with dates by which the standards must be achieved. The specific standards for each product are generally followed by language indicating that the Secretary must publish rules by a particular cut-off date, to determine whether the standards should be amended.

In general, the federal standards preempt state standards. Section 6297 states: "Effective March 17, 1987, and ending on the effective date of an energy conservation standard established under section 6295 of this title for any covered product, no state regulation, or revision thereof, concerning the energy efficiency or energy use of the covered product shall be effective [with certain exceptions]."

The state may, however, apply for a waiver of federal preemption under Section 6297(d). Under 6297(d)(1)(B), the test to be applied in such cases to determine whether a waiver should be granted is that the state regulation is needed to meet "unusual and compelling state or local energy interests."

Appliance Efficiency

For the most part, the federal government has taken over appliance efficiency standard improvements. The calculations presented previously indicate that energy savings can be achieved in New Jersey by utilizing more efficient appliances. The extent to which savings will be realized through the federal standards is difficult to determine at this time, since the NAECA allows for further rulemaking, which could change the standards as presently set out. Analysis is needed to determine, from a legal standpoint, if it is feasible to override the federal standards with New Jersey's own state standards, or from a technical standpoint, if it is desirable to do so.

Once the impact of NAECA is known, if the state decides that additional appliance efficiency measures are needed, several approaches warrant consideration.

The state could continue to promote appliance efficiency standards or particular appliance efficiency measures through various approaches. These may include mandated utility rebates/incentives to customers for the purchase of more efficient appliances; modification of rate schedules and/or terms and conditions to ban inefficient technologies such as electric resistive heating except in superinsulated structures where the heating load is so low that the choice of heating source is immaterial; modification of rate schedules to require higher efficiency levels as a condition for service. A careful analysis would be needed to determine the extent to which these approaches may be preempted or limited by NAECA, or existing laws, if at all.

Weatherization

There are presently two New Jersey State weatherization programs: the Department of Community Affairs' (DCA) Low-Income Energy Conservation Program, and the New Jersey electric utilities' weatherization programs, mandated by DCEED Conservation Regulations. Both target low-income households for weatherization measures as a means to conserve energy.

For an in-depth discussion of the status of these programs and their effectiveness, see Chapter IV, Energy Efficient Buildings.

Insulation of New Construction

New Jersey requirements for insulation in new construction are governed by the Building Officials and Code Administrators (BOCA) code. Chapter IV-1-B (Building Codes) presents a comparison of energy costs associated with a home built to the 1987 BOCA standards and one built to a more stringent standard. The standard utilized is the 1988 Model Energy Code of the Council of American Building Officials. This analysis demonstrates that an estimated $100 per house could be saved on the average 2,000 square foot home, by use of the Model Energy Code rather than the BOCA Code. However, it is likely that the 1988 version of the BOCA Code will contain revisions that will make it comparable to the 1988 Model Energy Standard. An analysis is necessary to examine the dollar savings associated with installing more efficient appliances in homes built to a Model Energy Code standard.

In addition, utility programs, such as the Super Good Cents program, provide incentives to builders to build with insulation above the BOCA Code standard. For further discussion and analysis of these programs, see Chapter IV-2-B (HERS).

Findings

- Electricity accounted for approximately 19 percent of residential fuel consumption, or 43 percent when power plant losses are considered, in 1986.
- Petroleum accounted for 32 percent of residential fuel use in 1986, without considering power plant losses. Its use as a residential fuel has been decreasing in the 1980s. The number of barrels consumed dropped from approximately 25,000 in 1980 to 18,000 in 1986, a decrease of approximately 25 percent.
- Natural gas accounted for nearly half (49 percent) of New Jersey residential fuel consumption in 1986, without considering power plant losses. Its use as a residential fuel has been increasing in the 1980s. The number of cubic feet consumed increased from 136 billion in 1980 to 158 billion in 1986, an increase of 16 percent.
- Natural gas is the predominant fuel for residential heating applications (e.g., home heating, water heating, cooking).
- The electric appliances that accounted for the greatest percentage of electric consumption were refrigerators plus freezers (approximately 30 percent) and air conditioners (approximately 6 percent).
- There is potential for increased energy savings in the residential sector in New Jersey, by replacing presently used appliances with more efficient, commercially available appliances. Potential savings of electricity are estimated at between 30-35 percent annually for the state. Potential savings of natural gas are estimated at approximately 20 percent annually for the state.
- Improvements to the building shell, which primarily reduce heat loss, will generate additional savings. Housing shell improvements can be stimulated by increasing New Jersey state building code requirements, beyond those required by BOCA to maximum cost effective level. (See Chapter IV-1-B).
- Improvement in building shell performance and the use of higher efficiency appliances can be stimulated by mandated utility incentive/penalty programs and modification of rate schedules and/or terms and conditions of service to ban inefficient technologies.

Policy

- The state shall set as its goal, for environmental and economic reasons, achieving residential energy efficiency by the year 2000 represented by the level of the best commercially available technology in 1988.

- New Jersey shall promote use of more efficient appliances in homes and apartments to avoid economic penalties and environmental effects of increased energy consumption.

- New Jersey shall promote weatherization of existing structures and superinsulation of new structures, accompanied by proper ventilation techniques to control potential dangers of increased indoor air pollution.

Implementation

- Utility bounty and rebate programs shall be revised and upgraded to ensure replacement of old, inefficient appliances with more efficient new ones. Utilities must be able to earn income from these investments.

- Federal appliance efficiency regulations shall be tracked to determine if development and marketing of improved technologies are being satisfactorily stimulated.

- Consumer education at many levels is required. For example, life cycle cost labels for light bulbs (like unit prices for groceries) would allow consumers to compare total costs of screw-in fluorescents versus incandescent bulbs.

- DCA and BPU shall evaluate measures to achieve greater building shell efficiency in new construction. These measures can include future changes of building code and utility incentive programs or tariff design.

FOOTNOTES

1. Public Service Electric and Gas (PSE&G) Appliance Survey, 1986, pp. 2-4.

2. Walls range from R-25 to R-40, ceilings range from R-35 to R-65, and windows are at least R-2. See, J.D. Ned Nisson, Gautam Dutt, The Superinsulated Home Book, (New York, NY: John Wiley and Sons, 1985). For New Jersey, the minimum values for the walls and ceilings of a superinsulated house are estimated at R-25 and R-40 to R-50 respectively. (Conversations with J.D. Ned Nisson, Editor, Energy Design Update, October, 1988).

3. See, e.g., W.U. Chandler, H.S. Geller, and M.R. Ledbetter, Energy Efficiency: A New Agenda, (Washington, D.C.: American Council for an Energy Efficient Economy, 1988), p. 48.

4. See note 2 and accompanying text.

APPENDIX A
Public Service Electric & Gas
1986 Residential Survey

Trends in Appliance Saturation
Electric Residential Customers

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Heating System				
Principal fuel Purchased for Heating Home				
Gas	42.1	54.8	617,300	859,700
Electricity	2.1	2.9	30,800	45,500
Oil	22.6	21.7	331,300	340,400
Not Stated	11.3	1.7	165,700	26,700
Heat Furnished by Landlord	21.9	18.9	321,100	296,500
Automatic Thermostat	20.8	28.8	305,000	451,800
Portable Electric Room Heaters				
One	9.4	14.5	137,800	227,500
Two	1.4	3.0	41,000	94,100
Three or More	.4	.7	17,700	32,900
Total	13.4*	22.6*	196,500	354,500
Wood Burning Stove	2.3	3.1	33,700	48,600
Fireplace	18.8	18.9	275,600	296,500
Kerosene Heater	N.A.	7.8	N.A.	122,400

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Comfort Cooling Equipment				
Central Refrigerated Air Conditioning System				
Electric	16.7	22.2	244,900	348,300
Cooling Furnished by Landlord	.2	.2	3,000	3,100
Room or Window Air Conditioners				
Living Room				
One	35.0	33.3	513,200	522,400
Two or More	.5	1.1	14,600	34,500
Total	36.0*	35.5*	527,800	556,900
Bedrooms				
One	29.1	28.0	426,700	439,300
Two	10.2	9.1	299,200	285,500
Three	2.7	3.6	118,800	169,400
Four or More	.7	.8	41,200	50,200
Total	60.4*	60.2*	885,900	944,400
Any Other Location				
One	16.8	15.2	246,300	238,500
Two	1.9	2.1	55,800	65,900
Three or More	.4	.4	17,700	18,800
Total	21.8	20.6*	319,800	323,200
Total Room Air Conditioning	118.2*	116.3*	1,733,500	1,824,500
No Air Conditioners	23.2	21.8	346,500	342,000
Dehumidifier	16.5	16.3	242,000	255,700
Power Attic Ventilating Fan	19.7	24.0	288,900	376,500
Room Ceiling Fan	N.A	25.2	N.A	395,300

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Water Heaters				
Gas	54.3	62.3	796,200	977,300
Electric	4.9	4.4	71,900	69,000
Oil	10.9	8.2	159,900	128,600
Hot Water Furnished by Landlord	2.9	20.7	335,800	324,700
None	.1	.1	1,500	1,600
Not Stated	6.9	4.3	103,000	67,500
Food Preparation & Preservation Equipment				
Kitchen Range				
Gas	78.6	76.4	1,152,500	1,198,500
Electric	19.8	21.8	290,300	342,000
None	.3	.2	4,500	3,100
Not Stated	1.3	1.6	19,400	25,100
Refrigerators:				
Single Outside Door				
One	41.4	40.6	607,000	636,900
Two or More	7.8	9.3	228,800	291,800
Total	57.0*	59.2*	835,800	928,700
Appliances				
Refrigerator-Freezer (Two Outside Doors)				
One	55.7	54.8	816,700	859,700
Two or More	7.1	9.1	208,200	285,500
Total	69.9*	73.0*	1,024,900	1,145,200
Separate Food Freezer	20.6	22.4	302,000	351,400
Microwave Oven	5.6	38.1	89,100	597,700

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Laundry & Dishwashing Equipment				
Clothes Washing				
Washing Machines	74.1	76.5	1,086,500	1,200,100
Use Commercial Laundry	13.8	13.2	202,300	207,100
Use Laundry Room in Apartment	10.1	8.7	148,100	136,500
Clothes Drying				
Gas Dryers	33.4	37.4	489,700	586,700
Electric Dryers	22.1	25.1	324,000	393,800
Use Commercial Laundry	11.8	13.4	173,000	210,200
Use Laundry Room in Apartment	9.6	8.3	140,800	130,200
Dishwashers	36.8	43.1	539,600	676,100
Other Home Appliances				
Black and White TV Sets				
One	42.9	32.2	629,000	505,100
Two	11.1	7.0	325,600	219,600
Three or More	2.2	1.3	96,900	61,200
Total	71.7*	50.1*	1,051,500	785,900
Color Television Sets				
One	59.7	45.3	875,400	710,600
Two	19.4	36.3	569,000	1,138,900
Three or More	3.2	13.3	140,700	625,900
Total	108.1*	157.8*	1,585,100	2,475,400
TV Video Tape Recorder	4.7	45.7	68,900	716,900
Home Computer Game	N.A	12.1	N.A.	189,800
Personal Computer	N.A	11.7	N.A	183,500
Swimming Pool Pump	7.1	7.0	104,100	109,800
Jacuzzi or Hot Tub	N.A.	1.1	N.A.	17,300
Electric Blanket				
One	11.9	13.2	174,500	207,100
Two	2.3	3.2	67,400	100,400
Three or More	.8	1.3	35,100	61,200
Total	18.9*	23.5*	277,000	368,700

*Number of Appliances per 100 residences

APPENDIX B

Public Service Electric & Gas 1986 Residential Survey

Trends in Appliance Saturation Gas Residential Customers

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
<u>Appliances</u>				
<u>Heating System</u>				
Principal fuel Purchased for Heating Home:				
Gas	53.5	67.8	625,300	838,600
Electricity	.1	.3	1,200	3,700
Oil	18.3	17.4	213,400	215,200
Not Stated	11.3	.9	132,100	11,100
Heat Furnished by Landlord	16.8	13.6	196,400	168,200
Automatic Thermostat	21.9	31.5	256,000	389,600
Portable Electric Room Heaters				
One	9.8	14.8	114,500	183,100
Two	1.6	3.2	37,400	79,200
Three or More	.4	.7	14,100	26,000
Total	14.2*	23.3*	166,000	288,300
Wood Burning Stove	2.5	3.5	29,200	43,300
Fireplace	22.3	23.5	260,700	290,700
Kerosene Heater	N.A.	8.3	N.A.	102,700

	Customers Having Appliances (Percent)		Estimated Number of Appliances	
	1980	1986	1980	1986
Appliances				
Comfort Cooling Equipment				
Central Refrigerated Air Conditioning System				
Electric	18.0	24.1	210,400	298,100
Cooling Furnished by Landlord	.1	.1	1,200	1,200
Room or Window Air Conditioners				
Living Room				
One	30.7	29.2	358,800	361,200
Two or More	.5	1.1	11,600	27,200
Total	31.7*	31.4*	370,400	388,400
Bedrooms				
One	27.6	26.4	322,600	326,500
Two	10.2	9.0	238,400	222,600
Three	2.7	3.9	94,800	144,700
Four or More	.7	.8	32,800	39,600
Total	58.9*	59.3*	688,600	733,400
Any Other Location				
One	16.5	15.4	192,900	190,500
Two	1.8	2.1	42,000	51,900
Three or More	.5	.4	17,400	14,800
Total	21.6*	20.8*	252,300	257,200
Total Room Air Conditioning	112.2*	111.5*	1,311,300	1,379,000
Dehumidifier	19.6	20.2	229,100	249,800
Power Attic Ventilating Fan	22.5	27.9	263,000	345,100
Room Ceiling Fan	N.A.	26.1	N.A.	322,800

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Water Heaters				
Gas	66.5	74.8	777,300	925,200
Electric	1.6	1.3	18,700	16,100
Oil	7.2	5.1	84,200	63,100
Hot Water Furnished by Landlord	17.6	14.8	205,700	183,100
None	.1	.1	1,200	1,200
Not Stated	7.0	3.9	81,800	48,200
Food Preparation & Preservation Equipment				
Kitchen Range				
Gas	84.5	82.6	987,600	1,021,700
Electric	13.7	15.7	160,100	194,200
None	.4	.2	4,700	2,500
Not Stated	1.4	1.5	16,400	18,600
Refrigerators:				
Single Outside Door				
One	39.1	37.7	457,000	466,300
Two or More	8.3	10.1	194,000	249,800
Total	55.7*	57.9*	651,000	716,000
Refrigerator/Freezer				
Two Outside Doors				
One	56.3	56.2	658,000	695,100
Two or More	8.5	10.7	198,600	264,700
Total	73.3*	77.6*	856,600	959,800
Separate Food Freezer	22.0	24.4	257,100	301,800
Microwave Oven	6.2	40.2	72,500	497,200

	Customers Having Appliances (Percent) 1980	1986	Estimated Number of Appliances 1980	1986
Appliances				
Laundry & Dishwashing Equipment				
Clothes Washing				
Washing Machines	79.7	82.4	931,500	1,019,200
Use Commercial Laundry	13.1	12.0	153,100	148,400
Use Laundry Room in Apartment	5.5	4.3	64,300	53,200
Clothes Drying				
Gas Dryers	40.0	45.1	467,500	557,800
Electric Dryers	19.9	23.0	232,600	284,500
Use Commercial Laundry	11.2	12.4	130,900	153,400
Use Laundry Room in Apartment	5.1	4.2	59,600	51,900
Dishwashers	39.8	47.1	465,200	582,600
Other Home Appliances				
Black and White TV Sets				
One	43.1	32.3	503,800	399,500
Two	11.7	7.4	273,600	183,100
Three or More	2.4	1.6	56,200	59,400
Total	73.7*	51.9*	833,600	642,000
Color Television Sets				
One	58.2	42.0	680,200	519,400
Two	21.0	37.5	490,800	927,700
Three or More	3.6	15.7	84,200	582,600
Total	111.0*	164.1*	1,255,200	2,029,700
TV Video Tape Recorder	4.5	47.6	52,600	588,700
Home Computer Game	N.A.	13.8	N.A.	170,700
Personal Computer	N.A.	13.6	N.A.	168,200
Swimming Pool Pump	8.0	8.4	93,500	103,900
Jacuzzi or Hot Tub	N.A.	1.7	N.A.	21,000
Electric Blanket				
One	12.5	14.3	146,100	176,900
Two	2.7	3.7	63,200	91,500
Three or More	1.0	1.8	35,100	66,800
Total	20.9	27.1*	244,400	335,200

*Number of Appliances per 100 residences

Chapter III-1

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Chapter III-2

THE NONRESIDENTIAL SECTORS

Introduction

This chapter considers end-use energy consumption and the potential impact of energy efficiency on this consumption in the commercial and industrial sectors.

The present energy use in these sectors is presented by examining the end uses of fuel and appliances. The chapter then analyzes potential changes in end-use consumption by the year 2000 and compares forecasts based on utility and nonutility data sources. It discusses barriers to implementing energy efficiency changes, incentives to overcome them, and, finally, recommendations for these changes to occur.

Present Situation - Energy Use

Commercial Fuel Mix

In 1986, the greatest percentage of energy sales to commercial customers was from natural gas sales at 88 TBtu or 38 percent, followed by electricity, 75.6 TBtu or 32.7 percent and petroleum at 67 TBtu or 29 percent. Coal was a distant fourth at .6 TBtu or .26 percent. Electricity accounted for 251 TBtu or 62 percent if losses are considered (See Tables III-2-1 and III-2-2 and Figure III-2-1).

Commercial End Use - Appliances, Systems and Business Types

Public Service Electric and Gas (PSE&G), the state's largest electric utility, prepares periodic reports on energy use of its commercial customers based on customer surveys. Because PSE&G sales account for approximately 60 percent of total New Jersey electric sales, the consumption patterns of PSE&G commercial customers may be considered somewhat representative of the state as a whole.

Based on the most recent report, in the PSE&G service territory in 1986, the largest single use of electricity (38.9 percent) was for lighting, followed by air conditioning (22.4 percent). The combined lighting and cooling load therefore represents about 61 percent of primary energy use. The next major use of energy in PSE&G's commercial sector was for business machines and computers (7.4 percent), followed by space heating (5.0 percent) (Table III-2-3).

Table III-2-1

New Jersey Energy Consumption
Commercial Sector

Year	Coal (thousand short tons)	Nat Gas (billion cubic feet)	Petroleum (thousand barrels)	Electricity (million kwh) Sales	Losses*
1960	197	10	16,661	4,390	10,920
1961	182	12	19,085	4,920	11,991
1962	154	14	20,310	5,325	12,802
1963	151	16	19,766	5,756	13,765
1964	126	21	19,081	6,353	15,131
1965	120	20	18,194	6,945	16,583
1966	93	23	20,672	7,605	18,248
1967	83	29	23,323	8,163	19,501
1968	74	33	23,059	8,972	21,407
1969	71	35	23,121	9,826	23,473
1970	61	56	23,595	10,835	26,256
1971	58	60	22,042	11,736	28,374
1972	45	63	22,472	12,810	30,834
1973	57	62	22,828	13,927	33,342
1974	44	58	19,782	13,609	33,183
1975	32	53	17,807	13,888	33,500
1976	30	90	20,918	14,687	35,378
1977	28	54	19,516	15,192	36,684
1978	23	48	18,291	15,885	38,864
1979	18	52	19,025	16,171	39,026
1980	22	60	20,590	16,881	41,049
1981	41	75	14,597	17,257	41,129
1982	38	79	12,221	17,720	42,534
1983	34	80	10,785	18,644	44,597
1984	15	84	10,777	19,748	45,968
1985	46	83	8,674	20,966	49,592
1986	25	86	11,501	22,160	51,410

Source: State Energy Data Report, Consumption Estimates 1960--1986, EIA, April 1988

* "Losses" consist of losses incurred in the generation, transmission, and distribution of electricity, industry plant use, and net interstate sales. They primarily reflect the fact that electric facilities are approximately 30 percent efficient. Losses are computed by multiplying sales by an annual national average ratio of losses to sales. This ratio is approximately 2.4.

Table III-2-2

New Jersey Energy Consumption (TBtu)
Commercial Sector

Year	Coal	Nat Gas	Petroleum	Electricity Sales	Electricity Losses*	Total
1960	4.9	10.7	99.9	15.0	37.3	167.8
1961	4.5	12.7	115.0	16.8	40.9	189.9
1962	3.8	14.2	122.5	18.2	43.7	202.4
1963	3.7	16.5	118.8	19.6	47.0	205.6
1964	3.0	22.4	114.5	21.7	51.6	213.2
1965	2.9	21.1	108.9	23.7	56.6	213.2
1966	2.2	23.5	124.4	25.9	62.3	238.3
1967	2.0	29.8	140.8	27.9	66.5	267.0
1968	1.7	33.8	139.0	30.6	73.0	278.1
1969	1.6	35.8	139.2	33.5	80.1	290.2
1970	1.4	57.4	142.0	37.0	89.6	327.4
1971	1.4	61.8	132.1	40.0	96.8	332.1
1972	1.0	64.5	134.6	43.7	105.2	349.0
1973	1.3	63.5	136.7	47.5	113.8	362.8
1974	1.0	59.7	118.3	46.4	113.2	338.6
1975	0.7	55.0	106.0	47.4	114.3	323.4
1976	0.7	93.6	125.3	50.1	120.7	390.4
1977	0.7	55.7	116.7	51.8	125.2	350.1
1978	0.6	49.7	109.1	54.2	132.6	346.2
1979	0.4	54.2	114.7	55.2	133.2	357.7
1980	0.5	62.5	124.5	57.6	140.1	385.2
1981	1.0	77.1	87.4	58.9	140.3	364.7
1982	0.9	81.2	72.8	60.5	145.1	360.5
1983	0.8	81.9	63.2	63.6	152.2	361.7
1984	0.4	85.6	63.2	67.4	156.8	373.4
1985	1.1	85.3	50.8	71.5	169.2	377.9
1986	0.6	88.0	67.0	75.6	175.4	406.6

Source: State Energy Data Report, Consumption Estimates 1960--1986, EIA, April 1988

* "Losses" consist of losses incurred in the generation, transmission, and distribution of electricity, industry plant use, and net interstate sales. They primarily reflect the fact that electric facilities are approximately 30 percent efficient. Losses are computed by multiplying sales by an annual national average ratio of losses to sales. This ratio is approximately 2.4.

Figure III-2-1

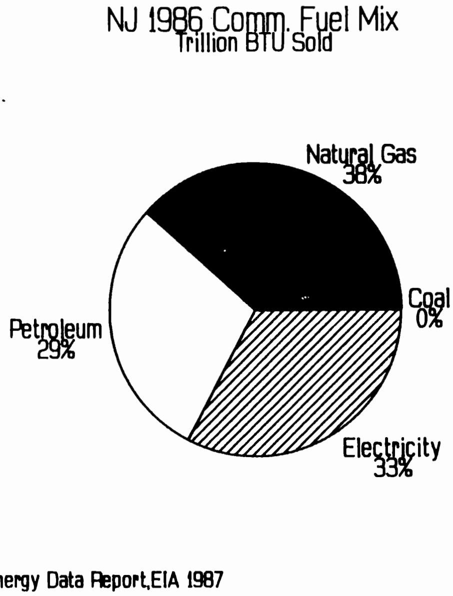


Table III-2-3

Public Service Electric & Gas 1984 & 1986 Customer Energy Use Survey
Commercial Market

Energy Use Characteristics
Electric End Uses

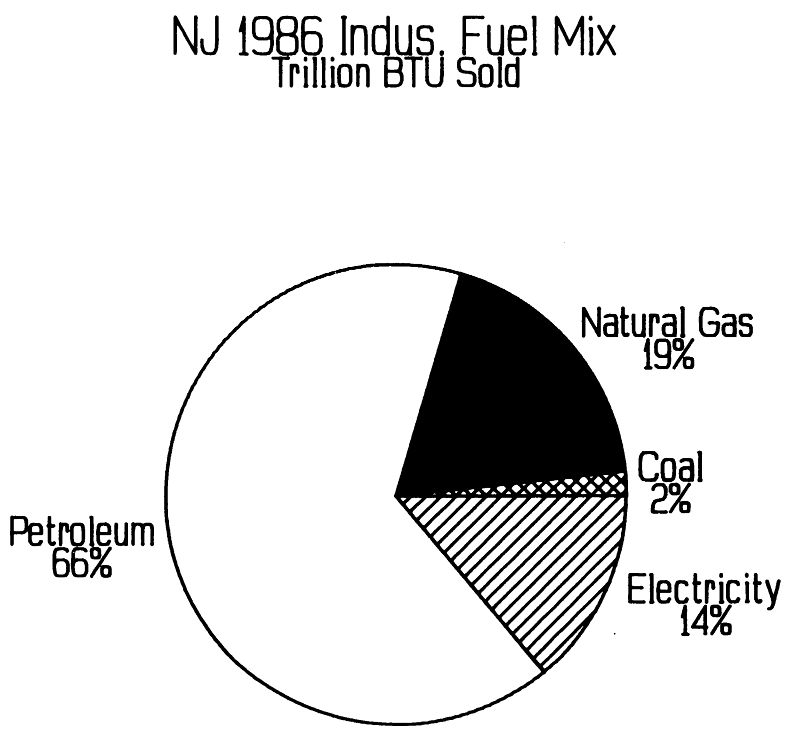
Sector	1984	1986
Cooking/Foodstuffs	1.7%	1.7%
Refrigeration	7.3%	8.7%
Motor Drive	5.1%	9.9%
Comfort/Space Heating	8.7%	5.0%
Air Conditioning	14.5%	22.4%
Other/Miscellaneous	9.9%	5.6%
Bus. Machines/Computers	9.0%	7.4%
Lighting	39.9%	38.4%
Total	100.0%	100.0%

Industrial Fuel Mix

In 1986, direct sales of petroleum accounted for 65 percent (250.8 TBtu) of total sales, followed by natural gas, 18.7 percent (71.5 TBtu) and electricity, 13.9 percent (53.2 TBtu). Coal accounted for 1.7 percent (6.6 TBtu). Electricity accounted for 177 TBtu or 35 percent if losses are considered (see Table III-2-4).

Industrial natural gas consumption in New Jersey decreased 15 percent between 1982 and 1986. In the same time period, petroleum sales decreased 17 percent (Table III-2-4). Coal consumption in the industrial sector (excluding electric generation) peaked in the early 1960s, declining from that point on. The sharpest decrease occurred between 1970 and 1971 (81.7 percent). The downward trend appeared to bottom out, however, and reverse somewhat after 1981. Between 1982 and 1986, an 83 percent increase in industrial nonelectric coal consumption occurred. Nonetheless, 1986 usage was down 89.2 percent from 1960 (Table III-2-4).

Figure III-2-2



Source:State Energy Data Report,EIA 1987

Table III-2-4

New Jersey Energy Consumption (TBtu)
Industrial Sector

Year	Coal	Nat Gas	Petroleum	Electricity Sales	Electricity Losses*	Total
1960	61.2	28.7	288.6	27.4	68.1	474.0
1961	58.0	31.0	306.6	29.1	71.0	495.7
1962	60.4	37.5	326.6	31.8	76.5	532.8
1963	52.3	42.3	316.2	33.8	80.9	525.5
1964	48.8	45.4	344.1	36.2	86.2	560.7
1965	49.0	54.6	347.7	39.3	93.8	584.4
1966	43.3	61.2	338.6	42.9	103.0	589.0
1967	39.0	65.7	370.0	44.2	105.7	624.6
1968	37.2	73.5	403.7	46.7	111.5	672.6
1969	24.7	79.9	409.7	50.7	121.1	686.1
1970	18.6	81.9	414.7	51.9	125.8	692.9
1971	3.4	84.6	385.8	52.5	127.0	653.3
1972	1.4	84.8	401.6	54.5	131.2	673.5
1973	2.3	80.0	426.9	57.1	136.7	703.0
1974	3.7	67.1	391.4	55.4	135.0	652.6
1975	1.6	54.0	356.9	49.7	119.9	582.1
1976	0.9	75.5	368.6	52.2	125.9	623.1
1977	2.3	53.1	384.3	53.3	128.7	621.7
1978	1.4	44.7	388.1	55.8	136.6	626.6
1979	0.4	53.9	476.0	56.6	136.5	723.4
1980	0.8	64.9	400.3	55.8	135.6	657.4
1981	0.5	91.8	347.1	55.7	132.6	627.7
1982	3.6	84.1	302.5	52.0	124.8	567.0
1983	6.8	83.6	247.9	52.5	125.5	516.3
1984	7.7	86.6	260.4	53.6	124.8	533.1
1985	8.8	83.0	221.5	53.4	126.2	492.9
1986	6.6	71.5	250.8	53.2	123.4	505.5

Source: State Energy Data Report, Consumption Estimates 1960--1986, EIA, April 1988

* "Losses" consist of losses incurred in the generation, transmission, and distribution of electricity, industry plant use, and net interstate sales. They primarily reflect the fact that electric facilities are approximately 30 percent efficient. Losses are computed by multiplying sales by an annual national average ratio of losses to sales. This ratio is approximately 2.4.

Chapter III-2

Industrial End-Use

In PSE&G's territory in 1984, the chemical and metal industries were the largest energy consumers (20.7 and 23.7 percent of total energy consumption respectively, Table III-2-5). In 1986, process boiler fuel accounted for the greatest share of natural gas and petroleum consumption (Table III-2-6). In the United States as a whole in 1980, electric motor drive accounted for the overwhelming share of industrial electric consumption (Table III-2-7).

Table III-2-5

Public Service Electric & Gas
1984 Customer Energy Use Survey
Industrial Market

Sample Mix by Business Classification
(Weighted)

Sector	Percent
Food and Kindred Products	12.9
Textile Mill Products	0.1
Apparel, other Textile Products	3.4
Lumber and Wood Products	--
Furniture and Fixture	0.2
Paper and Allied Products	3.8
Printing and Publishing	4.1
Chemicals and Allied Products	20.7
Petroleum and Coal Products	4.1
Rubber, Misc. Plastic Products	1.3
Leather, Leather Products	--
Stone, Clay & Glass Products	--
Primary Metals Industries	5.0
Fabricated Metals Products	18.0
Machinery, Except Electrical	12.7
Electrical, Electronic Equip.	5.2
Transportation Equip.	0.4
Instruments, related Products	0.1
Misc. Manufacturing Industries	4.3

Table III-2-6

Public Service Electric & Gas 1986 Customer Energy Use Survey, Industrial End Use

Electric Use	
Process (Production)	40%
Other Functions (A/C lighting, pumping, etc.)	60%
Fuel Oil Use	
Process Boiler Fuel	60%
Space Heat	18%
Other	22%
Natural Gas Use	
Process Boiler Fuel	60%
Space Heat	18%
Other	22%
Fuel Switching Capability (Firm rate LVG and/or GSG customers)	39%
Conservation	
No further energy efficiency measures planned	75%
No further conservation measures planned in next two years	25%

Table III-2-7

Manufacturing Electricity Consumption by End-Use
and 2-Digit SIC, United States, 1980
(Percentage Shares)

	Percent Share of Manufacturing Electricity Consumption by End-Use					
Sector	Dryers	Furnaces	Lights	Motors	Other	Space Heat
Food	7	5	5	70	7	6
Tobacco	12	0	2	73	9	4
Textiles	5	2	2	81	6	3
Apparel	4	3	2	73	13	5
Lumber	8	3	7	74	5	3
Furniture	6	5	2	74	10	4
Paper	7	4	2	81	3	4
Printing	8	2	2	73	10	5
Chemicals	8	10	2	63	11	6
Petroleum	4	2	2	83	3	6
Rubber	3	4	2	87	1	3
Leather	7	3	2	73	9	6
Stone, Clay & Glass	0	2	2	92	1	3
Primary Metals	2	10	1	77	7	3
Fabricated Metals	4	5	2	85	2	2
Machinery	4	5	2	81	5	2
Electrical Equip.	3	2	2	36	4	6
Transportation Equip.	4	2	15	76	1	2
Instruments	5	4	2	70	17	6
Misc. Manufacturing	5	4	2	70	17	6

Source: Energy Use Patterns and Indicators
Vol 2, EPRI, April 1987

Chapter III-2

Analysis

Year 2000 Scenarios

In examining the energy efficiency potential for commercial and industrial electric usage by the year 2000, it is assumed that in the year 2000 present appliance usage will be replaced by the most efficient appliances commercially now available. It is also assumed that no change will occur in economic productivity in New Jersey's commercial or industrial sectors between 1987 and 2000, and that numbers of commercial or industrial customers will not change.

Commercial Sector

Table III-2-8 and Figures III-2-3 and III-2-4 depict potential energy conservation through improved efficiency of electric appliances in the commercial sector. The figures are based on appliances commercially available at the present time.

Four major commercial appliance groups are examined: cooling, lighting, heating, and ventilation. The calculations indicate a potential reduction in electric commercial consumption of 42 percent or approximately 9,760 gwh. The appliance group with the largest savings on both a percentage and gigawatt-hour basis is lighting, with a potential reduction of 70 percent of current sales, or 6,978 gwh. Ventilation potential savings amount to 60 percent of present ventilation use, or 1,391 gwh, followed by cooling at 50 percent of present cooling use, or 1,391 gwh. No savings are indicated for space heating.

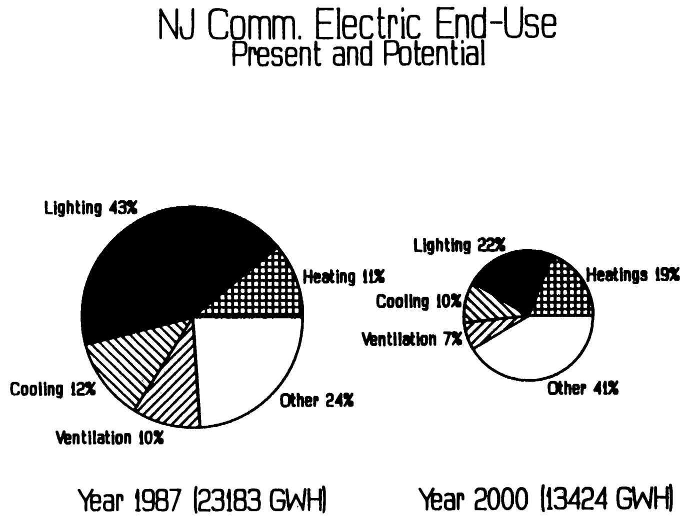
Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89 now in press, sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of four microcuries per liter. These and other codes set minimum but not maximum ventilation standards. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Table III-2-8
New Jersey Commercial Electric Conservation
Through Appliance Efficiency Improvements

Appliance	Percent of Sales (1)	New Jersey Sales (gwh)(2)	Appliance type or Conservation Measure (3)	N.J. Percent Saving with Efficient Appliance	N.J. Savings with Efficient Appliance (gwh)	Total Sales Efficient Appliance (gwh)
Cooling	12.00	2782	load reduction from light savings; efficiency measures; economizers, high-efficiency chillers (Trane Centravac), chiller downsizing, chiller capacity modulation, filter chiller water, clean condenser coils	50.00	1391	1391
Lighting	43.00	9969	Davis (1987) high-efficiency bulbs (Phillips-34 Econ-o-Watt Lite White Lamps), electronic dimmable ballasts (XO Industries), specular imaging reflectors (Maximum Technology Bright Idea), day-light dimming	70.00	6978	2990
Heating	11.00	2550	shell improvements, O&M improvements, advanced glazing, heating recovery, heat pumps	0.00	0	2550
Ventilation	10.00	2318	load reduction from light savings; high-torque fan belts (Uniroyal High Torque Drive), duct/fan cleaning, high efficiency motor, variable air volume (VAV) conversion, cut duct friction, tape duct leaks, scheduled controller, occupancy sensors	60.00	1391	927
Other	24.00	5564				5564
Total		23183				13424
Total Percent Reduction						42%

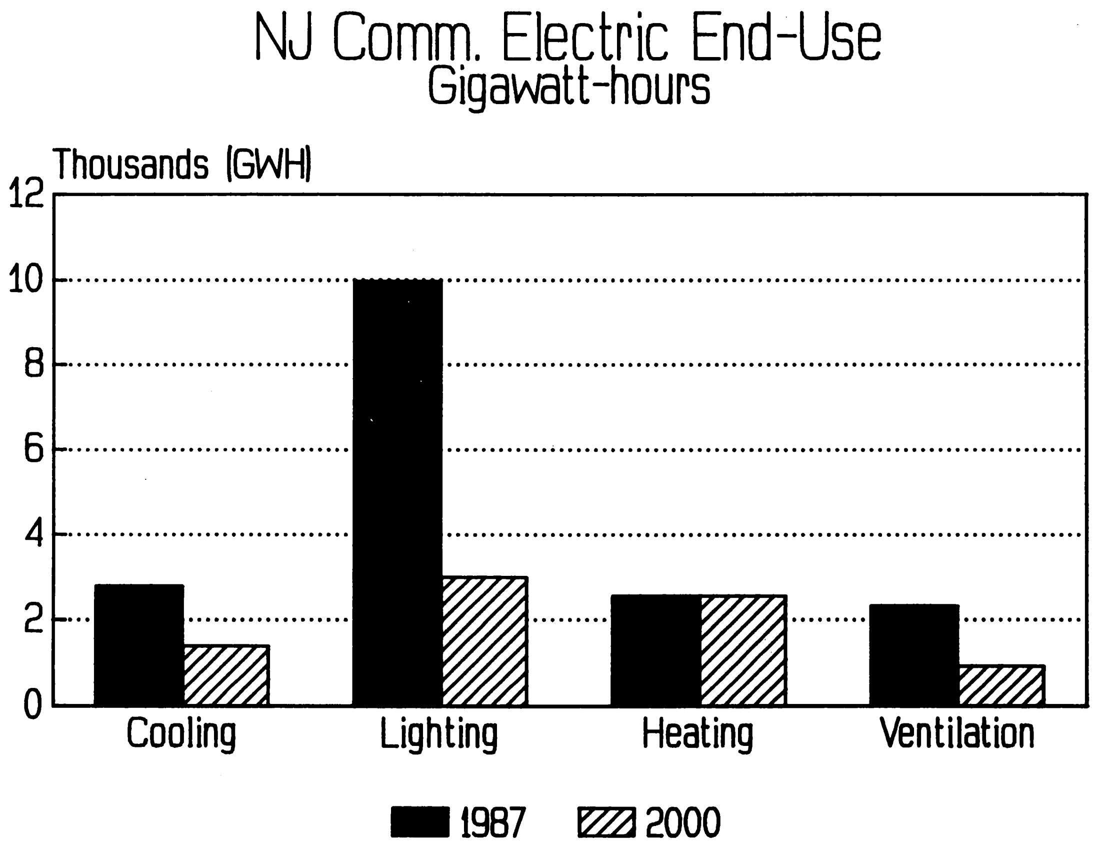
Sources: (1) New England, 1985, Power to Spare, New England Energy Policy Council, July 1987, Table D-3
(2) Based on 1987 New Jersey total commercial sales of 23184 gwh, NJEDS
(3) New England, Power to Spare, New England Energy Policy Council, July 1987, Table C-1

Figure III-2-3



Assumes 0% customer growth, 1987-2000

Figure III-2-4



Assumes 0% customer growth, 1987-2000

Industrial Sector

Table III-2-9 and Figures III-2-5 and III-2-6 depict potential energy conservation through improved efficiency of electric appliances used in the industrial sector. The assumptions are based on the use of appliances commercially available at the present time.

Four major industrial appliance groups are examined: motor drive, process heating, lighting, and space heating. The calculations indicate a potential reduction in industrial electric consumption in New Jersey of 18.7 percent or 2,915 gwh. The appliance group with the largest savings on a percentage basis is lighting, indicating a savings of 32 percent of current usage or 669 gwh. The appliance with the largest savings on the gigawatt-hour basis is motor drives, with a savings of 18.3 percent of current use or 2,054 gwh. Notably, motor drive is estimated in Table III-2-11 to account for approximately 72 percent of electric industrial sales. Savings in process heating electric usage are estimated at 10 percent or approximately 133 gwh.

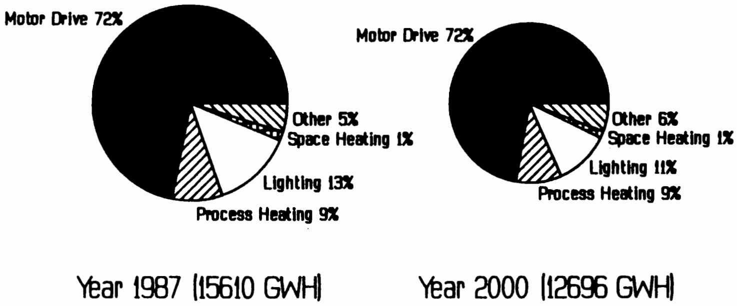
Table III-2-9
New Jersey Industrial Electric Conservation
Through Appliance Efficiency Improvements

Appliance	Percent of Sales (1)	New Jersey Sales (gwh)(2)	Appliance type or Conservation Measure (3)	N.J. Percent Saving with Efficient Appliance	N.J. Savings with Efficient Appliance (gwh)	Total Sales Efficient Appliance (gwh)
Motor Drive	71.90	11224	average savings from high efficiency motors and adjustable speed drives	18.30	2054	9170
Process Heating	8.50	1327	insulation, control systems	10.00	133	1194
Lighting	13.40	2091	high pressure sodium for mercury fluorescent upgrade	32.00	669	1422
Space Heating	1.50	234	weatherization, heat recovery	25.00	59	176
Other	4.70	734				734
Total		15610				12696
Total Percent Reduction						18%

Sources: (1) New England, 1985, Power to Spare, New England Energy Policy Council, July 1987, Table D-4
(2) Based on 1987 New Jersey total industrial sales of 15111 gwh, NJEDS
(3) New England, Power to Spare, New England Energy Policy Council, July 1987, Table C-1

Figure III-2-5

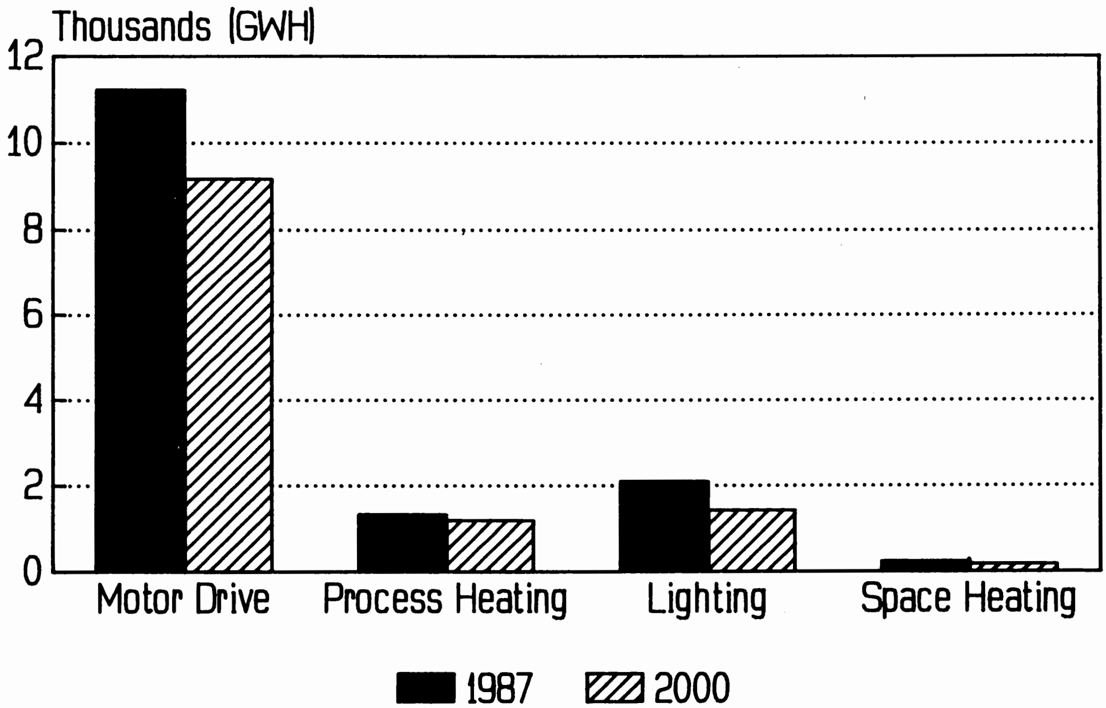
NJ Ind. Electric End-Use
Present and Potential



Assumes 0% customer growth, 1987-2000

Figure III-2-6

NJ Ind. Electric End-Use
Gigawatt-hours



Assumes 0% customer growth, 1987-2000

DRAFT

Chapter III-2

Barriers to Change

Certain studies indicate that conservation efforts throughout the country have leveled off over the last several years. A recent publication by the American Council for an Energy-Efficient Economy noted: "The country...is losing momentum in energy efficiency. The United States reduced energy use per dollar output by an average of 2.7 percent per year between 1976-86. But the energy intensity of the U.S. economy dropped minimally in 1987, and an overall slowdown in efficiency improvements can be discerned in major end uses."[1] The authors state that the two main reasons for the "slowdown" are the fall in energy prices and the federal government's reduced commitment to energy conservation in the 1980s.

One indicator of national energy efficiency is the consumption per dollar of gross national product. As Table III-2-10 shows, this ratio leveled off between 1984 and 1988, after falling 20.6 percent between 1973 and 1983. Similarly, passenger car efficiency has leveled in the 1980s. Table III-2-11 shows passenger car efficiency measured as fuel consumed per car. This index dropped 23.3 percent between 1973 and 1980, compared to 11.2 percent between 1980 and 1985, and no drop at all between 1985 and 1986.

Specifically, then, what measures should be taken in New Jersey to improve the state's energy efficiency?

Table III-2-10

Energy Consumption
per Dollar of Gross National Product
(seasonably adjusted at annual rates)

Year	Energy Consumption per Dollar of GNP
1973	27.1
1974	26.6
1975	26.2
1976	26.3
1977	25.8
1978	25.1
1979	24.7
1980	23.8
1981	22.8
1982	22.4
1983	21.5
1984	21.2
1985	20.5

Source: EIA/Monthly Energy Review March 1988

Table III-2-11

Passenger Car Efficiency

Year	Average Fuel Consumer per Car Gallons	Index
1967	715	100.0
1968	731	102.2
1969	746	104.3
1970	760	106.3
1971	770	107.7
1972	785	109.8
1973	771	107.8
1974	716	100.1
1975	716	100.1
1976	723	101.1
1977	716	100.1
1978	701	98.0
1979	653	91.3
1980	591	82.7
1981	576	80.6
1982	566	79.2
1983	553	77.3
1984	536	75.0
1985	525	73.4
1986	525	73.4

Source: EIA/Monthly Energy Review March 1988

Policy Implications

Commercial

In the commercial sector, heaviest end use is in lighting and cooling. These end uses are, in fact, related as more efficient lighting sources also generally produce less heat, thus reducing air conditioning requirements.

Lighting

Technology for substantially more efficient lighting exists but has been slow to penetrate the consumer market, largely due to increased capital costs. High-efficiency lighting sources include high frequency electronic ballasts, high-efficiency magnetic ballasts, and high efficiency fluorescent lamps. Additionally, the compact, screw-in fluorescent bulb represents a high-efficiency replacement for the standard incandescent.

Table III-2-12 depicts a cost comparison of a compact fluorescent and an incandescent bulb. For the comparison shown, the table indicates that the compact fluorescent represents a fifteen dollar savings over the incandescent bulb.

The American Council for an Energy-Efficient Economy (ACEEE) study proposes minimum efficiency standards for common lamps, similar to the 1987 efficiency standards recently set for appliances. Efficiency standards, the authors note, already exist for ballasts in at least four states: California, Massachusetts, New York, and Florida, while Congress recently passed a national ballast efficiency standard bill.[5] The federal ballast regulation "prohibits the manufacture of standard magnetic ballasts and, conversely, requires the use of energy-efficient magnetic ballasts or electronic ballasts. The standard goes into effect on January 1, 1990. The regulation also contains labeling requirements to indicate compliance."[6] The ballast efficiency regulations could result in a cumulative savings of 27,600 gwh by the year 2000.[7]

New Jersey presently has Lighting Efficiency Standards under the Uniform Construction Code, 5:23-30.18, Energy Subcode. Under 5:23-3.18(a)(1), New Jersey adopts as its standard the "IES Recommended Procedure for Light Power Limit Determination" (LEM-1). LEM-1 sets watt/sq. ft. limitations for specific applications. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has recently proposed a new standard "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings," April 1988. This proposed standard sets lower watt/sq. ft. limits for many applications.

Table III-2-12

Compact Fluorescent and Incandescent Bulb Comparison

	18 Watt Compact Fluorescent Bulb (Phillips SL-18)	75 Watt Incandescent Bulb
Cost	$20.00	$0.50
Life	7500 hours	750 hours
Lifetime Energy Cost	$10.00	$4.00
Energy Cost for 7500 Hours of Light	$10.00	$40.00
Hardware Cost for 7500 Hours of Light	$20.00	$5.00
Total Cost for 7500 Hours of Light	$30.00	$45.00

Note: This comparison underestimates potential savings to the extent that the operations and maintenance (O&M) expenses saved by avoiding nine bulb changes is not accounted for. In commercial facilities, such labor expenses may be significant.

Source: Arthur H. Rosenfeld and David Hafemeister, "Energy-Efficient Buildings," Scientific American, April 1988, p. 83.

Present Status of New Jersey Utility Lighting Efficiency Programs

All three major electric utilities in New Jersey (AE, PSE&G and JCP&L), as well as Rockland Electric have certain lighting efficiency incentive programs currently in place.

Atlantic Electric: Through its Save-a-Watt commercial/industrial energy-efficient lighting program, AE offers incentives in the form of rebates for lighting efficiency improvements. For example, for replacement with high efficiency light sources with a 2,000 to 10,000 hour life, the customer is eligible for a 5¢/watt saved rebate. For sources with a greater than 10,000 hour life, 10¢/watt saved rebates are available.

Jersey Central Power & Light: JCP&L has an energy-efficient lighting system program for commercial and industrial customers. This program includes rebates of 10¢/watt saved through installation of energy-efficient light sources, as well as rebates for occupancy sensors.

Public Service Electric & Gas: PSE&G offers rebates to commercial customers for installation of conservation measures recommended by a CACS audit, which may include lighting efficiency measures (see Chapter IV-2-A for a description of the CACS Program).

Rockland Electric: Rockland Electric provides cash incentive rebates to commercial and industrial electric customers for installation of high-efficiency lighting measures, specifically, $.50 per lamp for replacement of standard fluorescent lamps with high-efficiency fluorescent lamps; $2.50 for replacement of standard fluorescent ballasts with magnetic ballasts; and $5.00 for replacement of standard ballasts with high-efficiency electronic ballasts.

Cooling

Table III-2-13 depicts commercial electric sales on a kwh/square foot basis for the New York/New Jersey region. Sales are broken down by appliances and business or building types. Table III-2-14 presents the same data for the United States as a whole. This table indicates that the average commercial cooling usage for both small and large offices in the New York/New Jersey area is about 7 kwh/square foot, which is equivalent to about 23,884 Btu/square foot. It is also about 2.8 percent lower than the national average for small offices, and 3.6 percent lower than the national average for large offices. Nonetheless, there is room for improvement in this area. New energy-efficient offices consume between 10 and 15 kwh/square foot in total electric usage.[8] Therefore, 7 kwh/square foot may represent too high a percentage.

Perhaps more important than total consumption in commercial cooling is peak demand. All New Jersey electric utilities reach their peak demand in the summer months. This peak has been rising steadily over the last several years (Figure III-2-7) due to increased air conditioning usage. In the PSE&G service territory, air conditioning electric consumption, as a percent of total commercial electric consumption, rose from 14.5 percent in 1984 to 22.4 percent in 1986, a relative increase of 54 percent (Table III-2-3).

Table III-2-13

Commercial Electric End-Use
by Building Type, 1983 (kwh per square foot)
DOE Region II (New York/New Jersey)

Sector	Heating	Cooling	Lights	Refrig.	Water Cooking	Ventil.	Water Heat
Small Office	13.5111	6.9754	4.8359	0.0000	0.0000	1.4068	0.4690
Large Office	13.5111	6.9754	4.8359	0.0000	0.0000	1.4068	0.4689
Restaurants	40.0645	10.0821	9.0270	0.9672	0.2930	4.1324	16.0610
Retail	10.5217	4.2204	4.7479	0.2931	0.0293	1.1430	0.2931
Grocery	19.1383	0.8792	9.7890	16.2661	0.1465	2.1102	0.3224
Warehouse	3.9566	0.7620	1.7878	1.0551	0.0000	0.2344	0.0293
Schools	9.1442	1.8757	3.1946	0.0586	0.0000	0.4982	1.0258
Colleges	16.2954	5.1876	5.7151	0.0879	0.0000	1.1430	1.8464
Health	15.8558	4.1032	6.0375	0.1758	0.2051	1.2016	2.5791
Hotel	9.7597	7.2098	3.0188	0.1465	0.0879	2.1688	2.0809
Misc.	3.5170	1.1137	3.9859	0.0000	0.0000	0.5275	0.1172

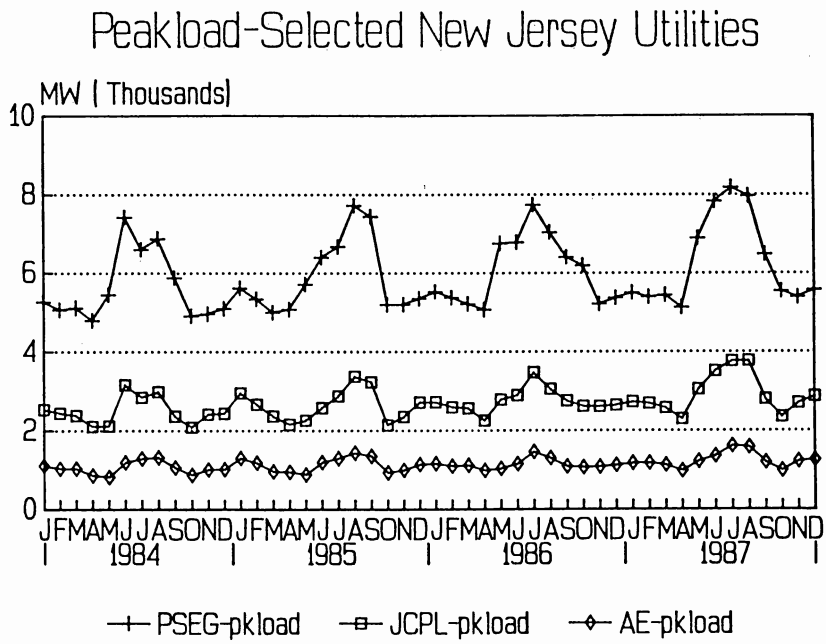
Source: Energy Use Patterns and Indicators
Vol. 2, EPRI, April 1987

Table III-2-14

Commercial Electric End-Use
by Building Type, 1983 (kwh per square foot)
United States

Sector	Heating	Cooling	Lights	Refrig.	Water Cooking	Ventil.	Water Heat
Small Office	13.2477	7.1740	5.3041	0.0075	0.0000	1.4364	0.4643
Large Office	13.2931	7.2364	5.3753	0.0150	0.0000	1.4491	0.4658
Restaurants	42.5610	11.1204	9.3503	0.9347	0.2818	4.0179	15.2373
Retail	10.7599	5.6662	5.6750	0.2853	0.0233	1.2342	0.2942
Grocery	18.6503	1.7228	12.5320	17.6929	0.1638	2.6360	0.3660
Warehouse	3.6314	0.9986	2.3434	1.1906	0.0000	0.2850	0.0493
Schools	8.7230	2.1563	3.1561	0.0543	0.0000	0.5234	0.9926
Colleges	16.3926	4.8443	5.4985	0.0752	0.0000	1.0275	1.6292
Health	16.5028	8.3242	7.5944	0.2495	0.2472	1.6671	3.1516
Hotel	9.1692	7.1910	3.2986	0.1315	0.0698	1.9087	1.8385
Misc.	3.8514	2.0435	4.6882	0.0205	0.0000	0.6155	0.1227

Figure III-2-7



Thermal storage: One method for shifting cooling peak demand to nonpeak hours is thermal storage. Thermal storage employs electric refrigeration at night to chill water or make ice that cools air during the daytime peaks. Approximately 40 to 50 percent of electrical demand could be moved to off-peak hours through the use of thermal storage.[9]

Gas air conditioning: Gas air conditioning can reduce the peak load of electric utilities in New Jersey, while benefiting the gas utilities. New Jersey's gas utilities are winter peakers, experiencing their heaviest gas demand in the winter heating months. Gas air conditioning can flatten the gas utilities' load profile by filling the "summer valley" with a previously nonexistent usage, i.e., cooling. At the same time, it can "shave" the cooling-related peak load of the summer peaking electric utilities. A flatter load curve is economically beneficial for both gas and electric utilities.

Industrial

The industrial sector has made substantial improvements in energy efficiency since 1973. The ACEEE study found that, on a national level, "Industry has made the largest gains, cutting energy requirements per unit of output by 30 percent between 1973 and 1984."[10] However, opportunities still remain for increased energy efficiency in the industrial sector.

1. Electric Motors: A report by the U.S. Office of Technology Assessment (OTA) noted: "The use of electricity by industry in

> 1980 was 2.8 Quads...Of that, roughly 80 percent was for mechanical drive, which essentially means electric motors. Accordingly, there is a large energy-savings opportunity associated with increasing the efficiency of electric motors. Standard electric motors range in efficiency from between 80 to 90 percent. By increasing the iron and copper content of the core and windings, respectively, energy efficiencies can be improved to beyond 95 percent.

"This incremental increase in efficiency may not appear significant at first sight. However, electric motors are almost unique among capital investments in that their capital costs are only a small fraction of their operating costs, even with the added iron and copper content of the higher efficiency motors. For example, an electric motor could use in excess of 10 times its capital cost in energy each year, and <u>the difference between a 90- and 95-percent efficiency could mean an annual energy saving of between 50 and 60 percent of a motor's capital costs.</u> However, the electric motor is a very reliable item of equipment. In normal atmospheric applications it can have a life expectancy in excess of 20 years. Because of this, the replacement of a low-efficient electric motor with its high-efficient counterpart often comes under discretionary spending. Although the replacement of a functioning motor could be economically justified, it would certainly not be mandatory. On the other hand, when an electric motor has reached the end of its useful life, it is common to replace it by a newer, more efficient type." (Emphasis added)[11]

2. <u>Industrial Processes</u>: Major energy using industries in New Jersey are the chemical and metal industries. For the chemical industry, OTA found that areas for improving energy use included energy recovery, such as cogeneration, waste heat recovery, and methods for improving chemical separation processes.[12]

3. <u>Increased Use of Natural Gas, Decreased Use of Petroleum:</u> The state has encouraged use of natural gas in the industrial sector for several reasons. First, natural gas comes from mostly domestic sources. Second, industrial sector use serves a critical function in the state's natural gas market since it provides an outlet for excess supplies during the nonheating season.

<u>Findings</u>

- In New Jersey's commercial sector, the fuel mix in 1986 consisted primarily of relatively equal shares of natural gas (38 percent), electricity (33 percent), and petroleum (29 percent).

- In the industrial sector, fuel consumption was dominated in 1986 by petroleum, constituting 66 percent of consumption. Natural gas and electricity had relatively equal shares at 19 percent and 14 percent of consumption respectively.

- Electric peak demand has been rising steadily in New Jersey over the last several years. Between 1984 and 1987, the peak load of the state's largest electric utility, Public Service Gas and Electric Company (PSE&G), rose from 7,422 to 8,173 MW, an increase of approximately 10 percent.

- In the commercial sector, the primary uses for electricity are for cooling and lighting. The primary uses for natural gas and petroleum are for space and hot water heating.

- In the industrial sector, the primary use of electricity is to power electric motors. The primary use for natural gas and petroleum is for process boiler fuel.

Policy

- The state shall promote use of more efficient cooling and lighting technologies to reduce electric consumption in the commercial sector.

- The state shall promote use of thermal storage and natural gas air conditioning to reduce peak demand in the commercial sector.

- The state shall promote use of more efficient motor drive technologies to reduce electric consumption in the industrial sector.

Implementation

- Utility rebate programs shall be revised and upgraded to ensure replacement of old, inefficient lighting and cooling appliances with the most efficient commercially available technology.

- BPU shall require the utilities to adopt a combination of tariff and incentive programs that assure the most cost-effective lighting that meets the user's needs.

- Incentives shall be provided to encourage use of off-peak cooling technologies as well as more efficient motor drives.

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FOOTNOTES

1. William V. Chandler, Howard S. Geller, Marc R. Ledbetter, Energy Efficiency: A New Agenda, (Washington, D.C.: American Council for an Energy-Efficient Economy, 1988), p. 14.

2. Arthur H. Rosenfeld and David Hafemeister, "Energy-Efficient Buildings," Scientific American, April 1988, p. 78.

3. Philip H. Abelson, "Need for Long-Range Energy Policies," Science, Vol. 240, No. 4856, May 1988, p. 1121.

4. Rosenfeld and Hafemeister, p. 83.

5. Chandler et al., p. 52.

6. Howard S. Gelber and Peter M. Miller, 1988 Lighting Ballast Efficiency Standards: Analysis of Electricity and Economic Savings, (Washington, D.C.: American Council for an Energy-Efficient Economy, August 1988), p. 3.

7. Ibid., p.7.

8. Rosenfeld and Hafemeister, p. 81.

9. Ibid.

10. Chandler et al. p. 13.

11. Industrial Energy Use, OTA-E-198, (Washington D.C.: U.S. Congress, Office of Technology Assessment, June 1983), p. 50.

12. Ibid., pp. 126-127.

Chapter III-2

Chapter III-3

ENERGY USE IN TRANSPORTATION

Introduction

Transportation accounts for over a third of energy use in New Jersey, and petroleum supplies 99 percent of that energy. Most people are dependent on automobiles, trucks, and/or buses for getting to work, shopping, moving goods, and other daily needs. This dependence helps make the state's highways the busiest in nation and among the most congested. The congestion caused by increased reliance on single-passenger, petroleum-fueled vehicles results in wasted energy, hinders economic growth, and produces adverse environmental effects, such as harmful levels of carbon monoxide and ozone.

In the short-term, before 1992, the most effective measures for improving energy productivity and for reducing fuel use and air pollution in transport will be ridesharing, vanpooling, and improved bus transit options. Also effective will be measures easing congestion through traffic signal management, express buses, and high occupancy vehicle (HOV) lanes. In the mid-term, by 2000, in addition to these above measures, the state can reduce fuel use and air pollution through encouraging purchase of vehicles incorporating today's best available technological advances in fuel efficiency. Over the long-term, coordinated land use can reduce dependence on single occupancy vehicles by enabling more people to work, shop, and fulfill daily needs near their homes or within reach of mass transit.

New Jersey, at the heart of the Boston-to-Washington megalopolis, is the most densely populated state in the country. A period of sustained economic prosperity coupled with spreading development has overloaded the transport system, particularly the highways.[1] New Jersey is 8th in the country in autos per capita (0.62/capita), and its highways are the busiest in the nation, as Table III-3-1 shows.

Table III-3-1

Comparison of Highway Use in the United States

State	Vehicles Per Road Mile Per Day
New Jersey	4,320
Maryland	3,314
California	3,267
New York	2,254
Pennsylvania	1,787
Texas	1,391
Wyoming	387

Source: "An Analysis of the Economic Impact of Increased Highway Funding in New Jersey," paper prepared by The Road Information Program, Washington, D.C., 1987, p. 3.

Over the past 20 years population shifts to suburbs and rural areas, followed by the movement of employers out of the older urban centers, have changed transportation patterns. In northern New Jersey the separation between home and workplace has increased, trips to work have become longer, and total travel time has increased. The added travel is by automobile; public transit ridership has barely increased.[2]

The same economic forces that have influenced energy prices across the nation have affected New Jersey and caused falling prices for transport fuels and a resumption of growth in their use, after a period of decreased consumption and significantly increased efficiency. (See Chapter II-1-B, Petroleum, for a fuller history of oil prices.)

Transportation in New Jersey Today

Aggregate Energy Use

In the past five years transport has accounted for a third of New Jersey's energy use.[3] Table III-3-2 and Figure III-3-1 show that petroleum fuels provided over 99 percent, 121 million barrels (664.6 TBtu), of transportation energy in 1986. Natural gas and electricity provided the remaining 1 percent, used in rail and transit systems. Figure III-3-2 shows the components of transport petroleum. Motor gasoline, the largest component over the last 16 years, accounted for 65.8 percent of petroleum use in 1986. In 1987, motor fuel sales rose 4 percent over 1986.[4]

Table III-3-2
Transportation Energy Consumption Estimates
(TBtu)

			Petroleum Products											Electric System	
Year	Coal	Nat. Gas[1]	Avia. Gas.	Dist. Fuel	Jet Fuel	LPG[2]	Lube Prdts.	Motor Gas.	Resid Fuel	Total	Elect. Sales[3]	Sub-total[4]	Energy Losses[5]	Total[4]
1960	1.0	0.6	5.6	27.7	11.6	*	4.2	251.0	36.2	336.3	*	337.9	*	338.0
1970	*	1.0	0.8	49.8	37.7	0.2	3.5	342.6	57.1	491.7	*	492.7	*	492.7
1975	*	0.4	0.4	51.9	32.4	0.3	3.7	403.2	26.7	518.6	*	519.1	*	519.1
1980	0.0	0.5	0.4	59.7	45.4	0.2	4.3	379.8	75.8	565.5	0.1	566.1	0.2	566.3
1983	0.0	1.0	0.8	66.9	#62.7	0.7	4.0	403.5	77.8	#616.3	0.1	#617.4	0.2	#617.6
1984	0.0	2.4	0.7	71.5	#83.7	0.6	4.2	401.9	73.3	#636.0	0.2	#638.6	0.4	#639.0
1985	0.0	2.3	0.9	78.5	#98.7	0.6	3.9	390.1	64.5	#637.2	0.3	#639.8	0.7	#640.5
1986	0.0	2.9	0.8	85.5	#90.6	0.5	3.8	418.0	61.2	#660.5	0.3	#663.7	0.7	#664.3

1. Includes supplemental gaseous fuels.
2. Liquefied petroleum gases (LPG) series estimates since 1979 may be affected by the changing data sources and estimation procedures.
3. Includes electricity generated for distribution from wood, waste, geothermal, wind, photovoltaic, and solar thermal energy.
4. Due to the lack of consistent historical data, statistics exclude wood, waste, geothermal, wind, photovoltaic and solar thermal energy (except for small amounts used by electric utilities to generate electricity for distribution).
5. Incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses.

* Btu value less than 0.05.
\# Value estimated by New Jersey Division of Energy. EIA reported the following figures:
(TBtu)

	Jet fuel	Petroleum total	Sub-total	Total
1983	209.8	763.4	764.5	764.7
1984	239.9	792.2	794.8	795.2
1985	248.6	787.1	789.7 790.4	
1986	221.8	791.7	794.9 795.5	

Note: Totals may not equal sum of components due to independent rounding.

Source: State Energy Data Report, 1960-1986, Energy Information Administration, April 1988.

Figure III-3-1

ENERGY USE IN TRANSPORT 1986

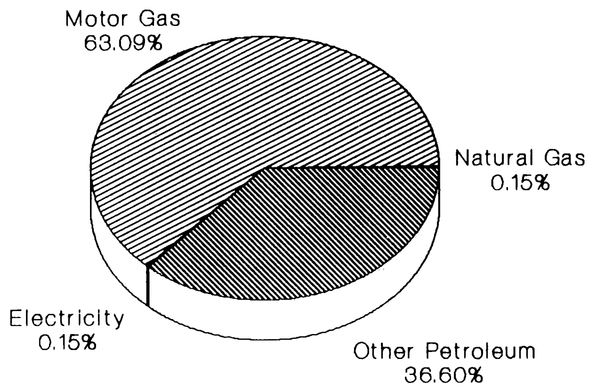
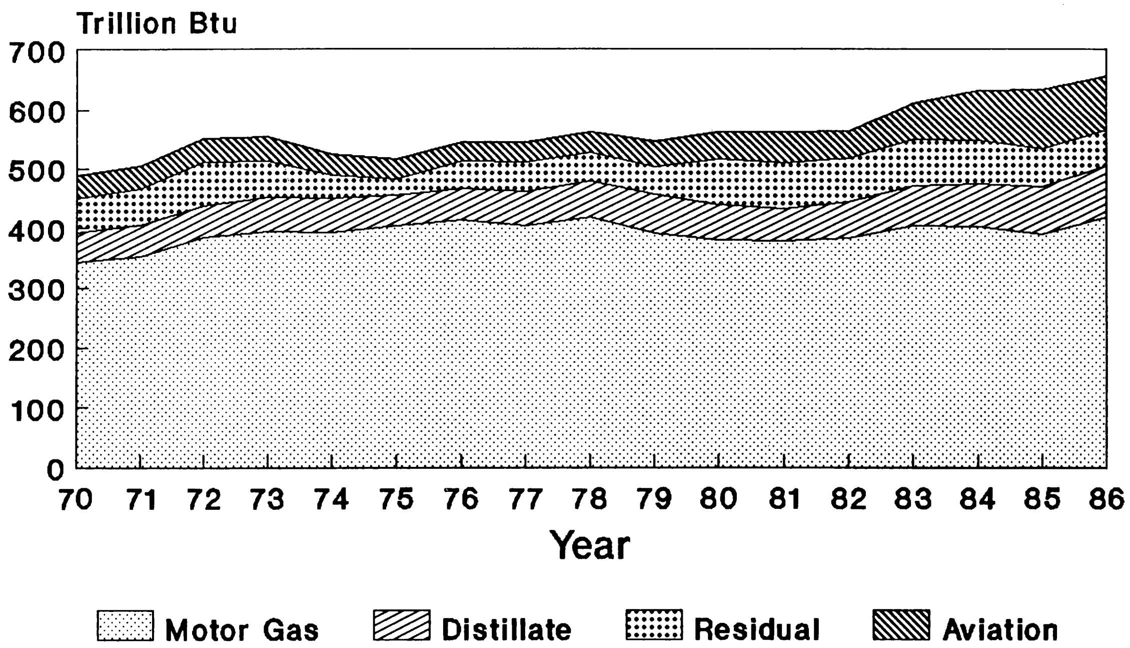


Figure III-3-2

N.J. Transport Petroleum Consumption 1986 Estimates



Source:State Energy Data Rpt., EIA, 1986

Table III-3-3 compares New Jersey's use to other states. It was 25th in total per capita transportation energy use (88.4 million Btu/capita) and 39th in per capita use of motor fuels (516.3 gallons per capita).

Table III-3-3

Per Capita Transportation Energy Use - 1986

State	All Transportation TBtu/capita	Motor Fuel gals/capita
U.S. highest	282.8	874.4
U.S. average	92.2	566.2
lowest	49.9	301.9
New Jersey	88.4	516.3
Maryland	72.5	522.5
Pennsylvania	66.0	449.8
New York	49.9	370.2
N.J. rank among states & D.C. (highest to lowest)	25th	39th

Sources: Bureau of the Census, Current Population Reports, 1987, Table 26, p. 22.
EIA, State Energy Data Report, 1960-86, Table 1, p. 5.
Federal Highway Administration, Highway Statistics, 1986, Table MF-21, p.5.

Energy Costs

Table III-3-4 shows expenditures for transport energy from 1970 to 1985. Expenditures for transport energy increased by 88.1 percent in real terms, while personal income increased by only 54.8 percent in real terms over the same time period.[5] Over 99 percent of this spending was for petroleum products.

The leveling off and decline in petroleum fuel prices since 1980 is in part responsible for the rise in the fuel demand (see Figure III-3-3). When corrected for inflation, the price of crude oil is now lower than at any time since before the 1973 Arab oil embargo (see Figure III-3-4). The resultant fall in prices has meant that gasoline now accounts for the smallest proportion of consumer income since 1963.[6] Consumers purchased gasoline at a rate of 7.3 million barrels a day in 1988 (through September) - a level not seen since before the oil shortages of the 1970s.[7]

Table III-3-4

New Jersey Transportation
Energy Expenditure Estimates
1970, 1975 and 1980-1985
(million dollars)

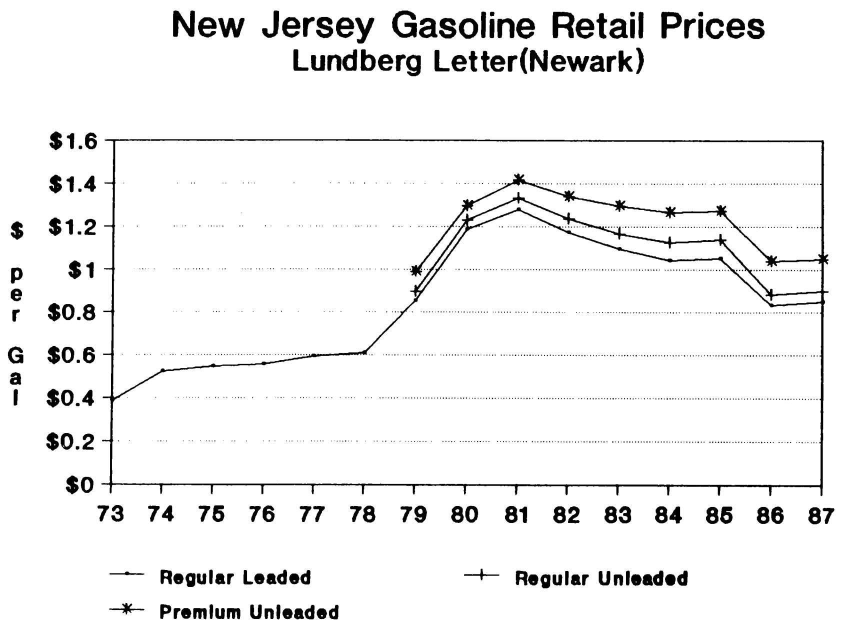
Energy Source	1970	1975	1980	1981	1982	1983	1984	1985
Total	1,173.8	2,241.9	4,865.6	5,825.1	6,115.9	5,984.2	5,947.9	5,862.
Primary Energy	1,173.7	2,241.8	4,864.0	5,822.4	6,113.5	5,982.2	5,944.0	5,858.
Coal	*	*	*	*	*	*	*	*
Petro. Prodts.	1,173.7	2,241.8	4,864.0	5,822.4	6,113.5	5,982.2	5,944.0	5,858.
Aviation Gas.	2.6	2.5	5.7	6.1	11.8	13.0	11.4	15.
Distillates	78.4	166.5	438.0	478.0	502.7	511.9	550.9	573.
Jet Fuel	27.1	65.1	284.7	740.8	1,341.5	1,350.6	1,478.3	1,427.
LPG & Ethane	0.3	1.1	0.8	2.9	3.9	5.4	4.5	4.
Lubricants	17.7	27.5	62.1	74.6	65.2	67.2	74.4	69.
Mtr. Gasoline	1,024.3	1,930.8	3,774.2	4,153.9	3,854.2	3,690.7	3,483.6	3,499.
Residual Fuel	23.3	48.3	298.7	366.1	334.3	343.4	340.8	269.
Electricity	0.1	0.2	1.5	2.7	2.4	1.9	3.9	4.

*Expenditure less than 0.05 rounded to zero

Note: Totals may not equal sum of components due to independent rounding.

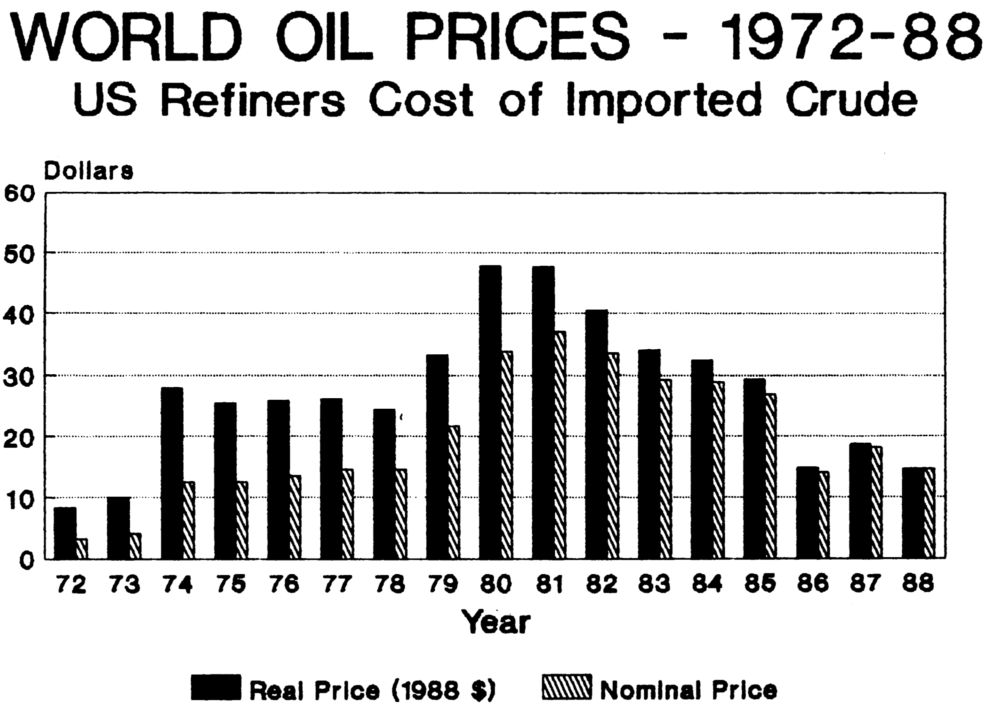
Source: State Energy Price and Expenditure Report 1985, Energy Information Adminstration, October, 1987

Figure III-3-3



Source: New Jersey AEP, 1987 Edition

Figure III-3-4



Source: EIA

Road Transport Use

Total vehicle miles traveled in New Jersey was 57,072 million in 1987.[8] At one passenger per car this amounts to fifty times the mass transit passenger miles provided by the major mass transit systems shown in Table III-3-5. The New Jersey Turnpike, a prime route crossing the region, accounted for 4.08 billion vehicle miles in 1987 and the Garden State Parkway for 4.93 billion miles. The Atlantic City Expressway, serving the growing casino industry of Atlantic City, had over 685 million vehicle miles traveled in 1987.[9]

Mass Transit Energy Use and Cost

Mass transit services in New Jersey include heavy rail, light rail, local bus, intercity bus, and ferry. Table III-3-5 compares the state's major mass transit systems as to ridership, energy use, energy costs, and public subsidies.

Table III-3-5

Mass Transit Ridership and Energy Use in New Jersey - 1987

Transit System	Passenger Miles	Energy Used	Energy as Percent of Operating Budget	Subsidy as Percent of Operating Budget
N.J. Transit*				40
bus	1,326,253,786	19,232,832 gals.	3.9	
rail	905,700,000		9.4	
electric		kwh		
diesel		10,200,000 gals.		
PATH	306,030,139	77,617,400 kwh	4.9	0
PATCO	94,096,538	38,602,788 kwh	15.7	0

* Figures for N.J. Transit are for fiscal year ending June 30, 1987.

Sources: N.J. Transit, <u>Annual Report, 1987</u>, and interviews.
PATCO and PATH interviews.

N.J. Transit is the statewide public transit corporation. It operates the commuter (heavy) rail service, the Newark City Subway--the state's only light rail system--and bus service throughout the state. N.J. Transit also provides operating subsidies and support for capital improvements to several private bus companies.

The Port Authority of New York and New Jersey owns and operates the Port Authority Transit-Hudson Corporation (PATH) system, connecting Hoboken, Jersey City, and Newark to New York City. The Port Authority Transit Corporation of Pennsylvania and New Jersey (PATCO), a subsidiary of the Delaware River Port Authority, operates the Lindenwold High Speed Transit Line, connecting Camden and environs to Philadelphia. PATCO estimates that 99 percent of its riders travel within New Jersey or across Delaware into Philadelphia. The Southeastern Pennsylvania Transportation Authority (SEPTA) carries about 1,000 New Jersey residents a day to Philadelphia and surrounding communities from terminals in Trenton and West Trenton. New Jersey riders make up only about 1 percent of SEPTA's ridership.

Ferry Services

Three private companies operate eight ferry routes between northern New Jersey and New York. Combined ridership has averaged approximately 5,000 per day and is generally increasing as the operators test new routes and re-evaluate existing ones. In southern New Jersey, a private ferry service runs from the Philadelphia Naval Ship Yard to Red Bank across the Delaware River. The Delaware River and Bay Authority owns and operates the Cape May-Lewes ferry service, which carries 2,700 passengers and 860 vehicles per day between Cape May and Lewes, Delaware.

The Port Authority plans to start operating ferry service from Hoboken to Battery Park City in spring 1989 to relieve overcrowding on PATH trains. It projects the service to grow and carry over 20,000 riders a day by the year 2000.[10] None of the present ferry operators in the state receive public subsidies.[11]

Passenger Air Transport

Commercial air travel has increased rapidly in New Jersey during the 1980s, as it has across the country. Passengers using Newark Airport have increased from 9.22 million in 1980 to 23.47 million in 1987, a rise of 255 percent.[12] However, during the same period jet fuel use has risen by only 100 percent.

In response to higher fuel prices, the airline industry made substantial gains in using energy more efficiently. Like other industries subject to competitive pressures, the airlines have made substantial capital investments to decrease energy consumption per unit output. With the purchase of new aircraft, fuel costs as a proportion of total airline costs have dropped from about 60 percent in 1982 to 20 percent in 1988.[13]

Subsidies to Transport Modes

The state and federal governments subsidize the cost paid by the end user for each type of transport. Table III-3-6 shows the total direct cost (excluding social costs, such as air and noise pollution) of travel per passenger mile for different transport modes.

Table III-3-6

Comparison of Direct Costs for Transport Modes
(in cents per passenger mile)

Travel Mode	User Cost	Public Subsidy	Direct Cost
Auto	20.10	-0.01	20.09
Vanpool	4.17	-0.01	4.16
Train	18.53	13.42	31.95
Bus	12.94	9.37	22.31

Sources:
Auto costs: American Automobile Association, 1988
Auto occupancy: 1983-84 Nationwide Personal Transportation Study, U.S. DOT, 1985, p. 15
Vanpool costs: DOT, 1984, updated by Rideworks of Greater New Haven, 1986. Van Pool of N.J. gives cost at 5 cents/pass. mile
Vanpool occupancy: Association for Commuter Transportation, 1988
Auto, van subsidy: Highway Statistics, 1986, U.S. DOT. See Note below
Bus, and rail costs, subsidies and occupancy: N.J. Transit, 1987

Note on calculation of subsidies for autos and vanpools:
Subsidy = Total disbursements for highways less Total receipts
= $1,619,253,000 - 1,629,732,000
= (10,479,000)

Subsidy/passenger mile = Subsidy/Total vehicle miles x passengers/vehicle
= $(10,479,000)/55,350,000,000 x 1.6
= $(10,479,000)/88,560,000,000 passenger miles
= $(0.0001)/passenger mile

Fares and other operating revenues from the mass transit services of N.J. Transit have covered from 55 to 58 percent of its operating expenses from 1985-87. In 1986 and 1987, N.J. Transit received from the state and federal governments, respectively, $201 million and $216 million to cover operating expenses.[14] Nationally the average amount of operating costs recovered from fares was less, averaging about 49.3 percent from 1980-82.[15] PATCO and the Port Authority receive no funds from federal, state, or local governments for operating their transit systems. Each organization makes up the difference between operating costs and operating revenues (fares) from bridge and tunnel tolls, port fees, and other sources of income.

Subsidies can also take the form of lower tax receipts. For example, businesses may deduct the cost of providing free or reduced rate parking to their employees in calculating their tax liability. The value of the parking subsidy received by their employees is also not taxable. A study by the U.S. Senate-House Committee on Taxation estimated that taxing employer-provided parking could raise $1.5 billion a year in additional federal taxes.[16]

An example of the unequal treatment of employer-provided subsidies for automobile and mass transit travel is that employers may provide parking tax free to their employees but face a $15 per month per employee tax-free limit in support of mass transit. Any subsidy in excess of $15 a month would require that the employee pay taxes on the entire amount.[17]

Frequency of Use of Transport Modes

In New Jersey the auto is the principal means of transport: 92 percent of person trips are made by auto.[18] The scattered nature of living and commuting patterns has prevented large-scale shifts to more efficient travel modes.[19]

The last detailed research on New Jerseyans' travel to work, in 1980, showed a decisive majority using private automobiles. Table III-3-7 compares the 1980 study with a more recent U.S. Department of Transportation (USDOT) national survey corroborating the earlier results. The USDOT survey reported a somewhat greater use of automobiles and lower utilization of public transport modes. One interesting difference is the increase, from 1 to 3.5 percent, in people working at home.

Table III-3-7

Principal Mode of Transport to Work

Mode of Transport to Work	Percent of N.J. Workers (1980)*		Percent of U.S.A. Workers (1984)**	
Private Vehicle		82.7		85.5
drive alone	64.4			
carpool	18.3			
Public Transportation		9.2		5.2
bus	6.1		3.2	
subway	0.8		1.0	
railroad	2.2		0.9	
taxi	0.2		0.1	
Miscellaneous		6.7		5.8
bicycle	0.3		0.5	
motorcycle	0.2		0.5	
walk	5.7		4.1	
other	0.5		0.6	
Work at home		1.3		3.5
Total		100.0		100.0

Totals may not add due to rounding.

Sources: * U.S. Census Bureau, 1980 Census, Table 65, Chapter C, General Social & Economic Characteristics in New Jersey, as presented in New Jersey Energy Master Plan 1985
**U.S. Department of Transportation, Nationwide Personal Transportation Study, Nov. 1985, Table 52, p. 88-90.

Analysis of Policy Options

Existing Programs

Table III-3-8 lists the major existing programs designed to increase transport system efficiency. The Department of Transportation (DOT); Department of Commerce, Energy and Economic Development (DCEED); the Port Authority of N.Y. & N.J.; and N.J. Transit implement the programs. In addition, DOT is making efforts to address the needs of bicyclists and pedestrians to encourage alternatives to motor vehicle trips.

Table III-3-8

Existing Programs and Energy Savings - 1987

Responsible entity	Program	Cost/yr. (000's)	Est. energy savings/yr. (mill gal.)	Est.cost/ gallon saved
DOT, DCEED	Ridesharing/vanpooling*	1,100	147.7	$0.007
DOT,PA,NJHA	High occupancy vehicle	N.A.	N.A.	N.A.
	(HOV) lanes		1.4	N.A.
Local Govt.	Traffic Management	N.A.		
	Associations (TMA)		2.0	N.A.
Local Govt.	Traffic reduction	N.A.		
	ordinances			
DOT, DCEED	Traffic signal management	190	0.5	$0.38
DCEED	School bus fleet program	60	2.0	$0.03
DOT	Road maintenance	**486,000	528.4	$0.92

*Since April 1988, DOT has assumed responsibility for all ridesharing/vanpooling activities.
**disbursements by state and local governments for 1986.

Sources: Division of Energy Planning and Conservation, School Bus Fleet Energy Assessment Program, Final Report, January 1988. Federal Highway Administration, Highway Statistics,1987, Table HF-2, p. 41. The Road Information Program, "An Analysis of the Economic Impact of Increased Highway Funding in New Jersey," Washington, D.C., 1987, p. 10.

Vanpooling/Ridesharing: The ridesharing/vanpooling activities of the state were, until April 1988, carried on jointly by the Department of

Commerce, Energy and Economic Development with the Department of Transportation, which now handles them alone. The Tax Reform Act of 1986 dealt such activities a severe blow by disallowing ridesharing/vanpooling business expenditures as a deduction on federal income taxes. The tax code change caused many companies to abandon ridesharing efforts completely or to turn them over to private concerns.[20] Some private concerns charged more or used less convenient pick-up points, removing incentives for company employees to participate.

The DOT ridesharing program recruits riders through a toll-free telephone number advertised on highways, in newspapers, and on public television. It then attempts to match origins and destinations of those who call. DOT is developing a sophisticated computer program to match riders more effectively. The company-centered approach to ridesharing has been left to traffic management associations (TMA) to implement.[21]

<u>High occupancy vehicle lanes</u>: Dedicated (express) lanes for high occupancy vehicles (HOV) or buses have had an up and down history in New Jersey. The state installed HOVs for cars on its portion of the Garden State Parkway in 1979 but removed them in 1982 for a variety of reasons. Since 1984, dedicated lanes for buses and HOVs exist on the eastbound approaches to the Holland and Lincoln tunnels and the westbound approaches to the Lincoln Tunnel, and since 1986, on the eastbound approaches to the George Washington Bridge. As of October 1987, about 700 carpools, down from 775 when the lanes opened, used the lanes on the GW Bridge each morning.[22] The Port Authority "rideshare tix" program allows a reduction of 83 percent on all trans-Hudson tolls for cars or vans carrying three or more people. The Authority sells approximately 1300 of these ticket books every month, compared to over 90,000 regular commuter ticket books, which give only a 33 percent discount.[23] The program saves, based on the number of commuter books sold, over 1.3 million gallons of fuel a year.

<u>Traffic management associations</u>: TMAs are nonprofit regional groups, funded by state and county governments as well as by corporations and developers, whose purpose is to furnish comprehensive transportation services to commuters. They provide employers and developers with technical capabilities in transport planning and act as a forum for government-private sector consultation and collaboration in considering local transport issues. There were four TMAs in New Jersey as of March 1989--the Greater Princeton TMA, Morris County Rides, Inc. (MC RIDES), Meadowlands Transportation Brokerage Corp. (MEADOWLINKS), and Keep Middlesex Moving (KMM). Their emergence--MEADOWLINKS and the Princeton TMA were both founded in 1984--was a response to worsening traffic and an indication of the strong role that the private sector intends to play in ameliorating it. Subsequently, the state has adopted a program to encourage the creation of TMAs in other areas.

To combat congestion, TMAs have endorsed broad programs, including variable work hours, added parking arrangements for mass transit users, operation of shuttle buses to transit stations and malls, promotion of mass transit, monitoring of local traffic conditions, and ridesharing. Successful implementation of demand management programs will result in the more efficient use of the present transportation network and saving large amounts of fuel. Morris County authorities estimated an energy saving of over 2 million gallons of gasoline a year, if the local ridesharing organizations were successful in reducing vehicle trips by 10 percent.[24]

Traffic reduction ordinances: Severe traffic congestion spurred North Brunswick Township (Middlesex County) to adopt a traffic management ordinance in October 1987. The ordinance requires businesses to conduct an annual traffic survey and to submit a traffic reduction plan. The plan requirements vary according to the size of the business or residential development, encompassing such measures as reducing peak period trips of the workforce, providing vanpool parking areas, establishing flextime work hours, running a shuttle bus service to mass transit, and sponsoring in-house or third-party rideshare programs. The ordinance affects existing businesses with 50 or more employees, proposed new residential developments of 20 or more units, and proposed new nonresidential developments with gross building space of 15,000 square feet or more. Exemptions are allowed for hotels, food and other retail establishments, shopping centers, and others as a need is shown.

While recognizing that traffic reduction is a regional problem and that North Brunswick can have little effect on total traffic volume, township leaders are attempting to reduce projected peak-hour employee trips by 40 percent for established businesses and by 30 percent for new ones.[25] The Urban Mass Transit Administration has provided funds for implementation. The funds will help North Brunswick to publicize the ordinance widely around the state. MC RIDES and KMM have plans to get similar ordinances adopted in their respective service areas.

Traffic signal management: Using oil overcharge funds, DCEED is implementing a program to improve traffic flow by synchronizing traffic signals. The program upgrades traffic monitoring equipment at 140 intersections on nonstate roads meeting certain traffic flow conditions. Local governments propose the sites and pay for the labor required to do the installation. DCEED has calculated the energy savings at over one-half million gallons of gasoline per year and estimated payback at less than a year. DOT has a similar program, although its objective is primarily to improve traffic flow.

School bus fleet energy assessment program: DCEED, in collaboration with the Bureau of Pupil Transportation, Department of Education, has initiated a voluntary program to improve the efficiency of school bus fleets. The activity involves bus maintenance, driver training, recordkeeping, and fuel storage and disbursement. This program, which could be extended to municipal vehicle fleets or police departments, has projected an annual energy savings of about 2 million gallons costing $1.6 million (at 1987 prices) in the twelve school districts (out of 632 districts statewide) that participated in the demonstration program.[26]

Road maintenance: Highway maintenance has certain economic and energy benefits. Maintenance is necessary to gain maximum use from the present road system. A study of the state's roads by an industry advocacy group has estimated that the added annual motor fuel cost of driving on rough, uneven road surfaces is about $502 million.[27] Well-maintained roads allow drivers to travel at more even speeds, thus improving miles per gallon.

Measuring Program Effectiveness

Accurately measuring the effect of transport programs on energy use is difficult. Since most programs target traffic congestion, DOT typically measures the change in traffic congestion at signals and calculates the small amounts saved individually by thousands of drivers.

Energy intensity: One study, summarized in Table III-3-9, calculated energy intensity, in Btus per passenger mile, for different travel modes. In 1983, for local travel, the study found cars used 25 percent more energy per person than buses or trains. For intercity travel, commercial air carriers used 22 percent more energy than cars, 52 percent more than rail and 317 percent more than buses. Energy intensities depend on passenger load as well as efficiencies of the carrier.

Over the period 1975 to 1983, energy intensity of autos has improved by about 18 percent as a result of strengthened auto fuel economy standards.[28] Energy intensity of bus and rail transit, which are among the most efficient forms of travel, worsened slightly due to a combination of factors: a loss of riders to autos, the addition of higher performance vehicles, and the provision of more climate control and safety features. General aviation is now the least energy efficient means of travel, but its high cost acts to limit its use.

Table III-3-9

Historical Energy Intensities of Passenger Modes - 1970-83
Btu/Passenger Mile Traveled

Year	Auto	Bus		Air		Rail	
		Intercity	Local	Certified Carriers	General Aviation	AMTRAK Intercity	** Local
1970	4,270	1,050	2,470	10,350	10,420	n.a.*	2,450
1975	4,740	980	2,810	7,880	10,680	3,680	2,960
1980	4,410	1,170	2,810	5,840	11,520	3,180	3,000
1981	4,300	1,150	3,030	5,740	11,160	2,980	2,940
1982	4,110	1,150	3,230	5,160	13,050	3,200	3,070
1983	4,000	1,170	3 170	4,890	13,860	2,960	3,210
Annual Average Percentage Change							
1970-83	-1.3	0.8	1.9	-5.5	2.6	-2.4*	2.6

* Data previous to 1973 not available; annual average covers 1973-83.
** Large system to system variations exist within this category.

Source: Craig M. Hanchey and Mary C. Holcomb, Transportation Energy Data Book: Edition 8, Oak Ridge National Laboratory, November 1985, Table 1.19, p.1-30.

Avoided costs: Cost evaluation of alternative measures to provide mobility will result in cost-effective transportation policies. Widening existing roads or building new ones is less cost-effective than other solutions, as vehicles rapidly fill the added lanes and roads. Controlling traffic patterns and enhancing use of existing roadways can avoid the high direct and indirect cost of road building. Direct costs will reach as high as $14 million per lane mile for the New Jersey Turnpike widening.[29] Indirect costs include loss of land from tax rolls and for more productive use, added noise, and air pollution.

Table III-3-10 gives some recent capital costs for alternate means of increasing transport system capacity. It shows how many persons would benefit and the cost per person for each alternative.

Table III-3-10

Comparison of Capital Costs of Increasing Transport System Capacity

Type of Project	Example	Cost millions	Persons Benefiting #/day	Persons Benefiting $/person
Vehicle occupancy	Vanpool subsidy	3.0	3,600	833
		5.5	6,600	833
Vehicle occupancy	Vanpool grants	6.0	3,600	1,667
		11.0	6,600	1,667
Road construction	Turnpike widening	$14.0	6,600	2,121
Rail rehabilitation	Monmouth/Ocean	$130.0	3,500	37,143

Sources: Vanpool costs: DOT, 1984, updated by Rideworks of Greater New Haven, 1986. Van Pool of N.J. gives cost at 5 cents/pass. mile
Vanpool occupancy: Assoc. for Commuter Transportation, 1988.
Rail rehabilitation: N.J. Transit, Meeting New Jersey's Growth Challenge (Newark, N.J.: N.J. Transit, June 1987) and personal communication.
Road construction: New Jersey Turnpike Authority (NJTA), 1987 Annual Report (New Brunswick, NJ: NJTA, 1988); New Jersey Highway Authority (NJHA), personal communication

An avoided cost analysis would measure the cost of increasing vehicle occupancy or of spreading out the peak use against the cost of changing intersections, adding lanes, or building new roads. Programs to reduce or spread peak use, such as flexible work schedules, vanpooling, and parking charges or restrictions, can reduce peak use at little or no public cost. On most highways peak congestion occurs during the two and one-half hours of the morning commute and three hours during the evening rush home.

Table III-3-10 shows that vanpool subsidies are the most cost-effective investment for reducing commuter highway use and, thus, peak period congestion. Vanpool subsidies cost less per person benefiting than new rail lines or roadways or road lanes. In addition, it is relatively easy and quick to start vanpooling. Even vanpool grants would cost about the same as rail rehabilitation. Assuming that the state provided vans free to companies administering vanpool programs and that occupancy rate was 80 percent (12 passengers in a 15-passenger van), the capital cost of benefiting 3,600 riders a day would be $6 million and the capital costs of benefiting 6,600 riders a day would be $11 million. If the riders paid half of the depreciation costs, the capital costs would be cut in half.

The Monmouth/Ocean rail rehabilitation project, still in the planning stages, is an example of a rail project requiring large capital expenditures. It is slated to cost approximately $130 million for replacing and re-laying the tracks, new rolling stock, signals, and other infrastructure to permit reopening of the line from Matawan to Lakewood via Freehold and Farmingdale.[30]

The estimate for this project is $130 million in capital costs for 29.2 miles of new line expected to serve 3,500 riders a day. Installation of this line would relieve Garden State Parkway congestion (if it did not at the same time promote development in those counties). Based on standard traffic flow calculations, an additional Garden State Parkway lane could carry 3,500 commuters.[31] However, at costs of $10 million/lane mile for 29 miles, the added lane would cost $290 million, more than double the capital costs of the rail line. A full evaluation would consider, in addition, any public subsidy to rail operating costs, such as tax-free bond financing. The lower cost of rail arises partly from the availability of underutilized rights-of-way. One rail track can serve ten times more office space than one highway lane, if workers and workplaces are conveniently located in relation to the line.[32]

Existing Policies Affecting Energy Use in Transportation

Stable energy prices in the near future may encourage driving, aggravate traffic congestion, and increase air pollution. With 60 percent of New Jersey's urban roads operating near or above peak capacity, the ability to efficiently move people and goods remains crucial to sustaining the state's economic prosperity.[33]

The state's influence on energy use in transport includes:

(1) its authority to site and construct roads and allow access to them;

(2) its funding and promotion of other transportation modes, such as buses, trains, vanpooling, and ridesharing;

(3) its responsibilities to ensure clean air by controlling motor vehicle emissions;

(4) its powers to tax gasoline and other transport fuels;

(5) its powers to regulate development, such as in the Pine Barrens, the Meadowlands, Atlantic City, and the coastal zone; and

(6) its capability to alter people's actions through educational and informational programs.

Policies in Road Building: For many years, the state's primary means of maintaining mobility was through road building and maintenance. In recent years even the addition of lanes and roads has not eliminated congestion. Therefore, the state is turning to comprehensive planning of alternative transport modes and efforts to reduce low-occupancy auto traffic. A current indication of this change is a package of bills, known as "NJ Transplan," being considered by the state legislature. The three bills are the State Highway Access Management Act (already signed into law), the Transportation Development District Act, and the Municipal County Planning Partnership Act[34]. The state's creation and support of N.J. Transit is another example of the revised approach to transport policy.

Policies Encouraging Shifts to Other Transport Modes: Subsidies for New Jersey transit bus and rail, providing 40 percent of operating costs, encourage mode shifting by lowering mass transit fares.

Policies reducing motor vehicle emissions: Motor vehicles using petroleum fuels emit significant quantities of carbon monoxide, hydrocarbons, nitrogen oxides, fine particles, and lead, each of which can adversely affect human health and the environment. The expanding vehicle population and increasing number of miles driven[35] have caused serious air pollution. In addition to pollution harming people, animals, forests, and water, growing evidence shows that motor vehicle emissions contribute to upper atmospheric changes that could modify global climate. (For further detail, see Chapter IV-4.)

The federal Clean Air Act and amendments to it set air quality standards. Regulations have limited motor vehicle emissions since the 1968 model year.[36] Like other states implementing the Clean Air Act, New Jersey's first steps to reduce air pollution from mobile sources (cars and trucks) included setting emissions standards, requiring periodic inspections, and limiting motor idling.[37] A number of possible state actions can enhance the emission control/inspection program, e.g., adding under-the-hood inspection to check for tampering with emission control equipment, broadening emission control standards to off-road vehicles, and adopting the stringent California standards for new car certification.

Policies on taxation of gas and other fuel: The state levies a tax on the sale of gasoline and other petroleum products, and the amount of that tax affects the price and, therefore, the demand for the products. New Jersey's motor fuel tax rate is tied at fourth lowest of all the states. In general U.S. motor fuel tax rates are much lower than those of other industrialized nations. (See Table III-3-11.)

Table III-3-11

Gasoline Taxes for Selected
Industrialized Countries & States
1987

Country	Current US dollars/gallon
Australia	$0.65
Denmark	2.93
France	2.32
West Germany	1.34
Italy	2.78
Japan	1.47
United Kingdom	1.53
U.S. federal tax	0.09
Highest U.S. state tax	0.209
New Jersey	0.105
New York	0.1475
Delaware	0.16
Pennsylvania	0.174
Maryland	0.185
Average U.S. state tax	0.1572
N.J. rank among 50 states & D.C. (#)	47 tie

Sources: International Energy Agency, <u>Energy Prices and Taxes, Second Quarter 1987</u> (Paris: Organization for Economic Co-operation and Development, 1987). Highway Users Federation, Washington, D.C., October 1, 1988.

Raising taxes on motor fuels to the level common in Europe would not only cause people to drive less and send a strong signal to car purchasers to select fuel efficient models but would also bring revenues for needed transport projects.

However, a motor fuel tax increase of five or ten cents may not significantly affect driving habits because the additional cost is relatively small and because people choose to drive for reasons other than cost.

The surrounding states all have higher motor fuel taxes. At present 30 percent of New Jersey's motor fuel taxes are paid by out-of-state residents who use the state's roads.[38] A motor fuel tax increase would thus be paid only in part by New Jerseyans.

The state levies a Gross Receipts and Franchise (GR&FT) of approximately 14 percent on the revenues of electric and gas companies. The application of the GR&FT on electricity purchased by the railroads and mass transit operators of the state, such as N.J. Transit, PATH and PATCO, raises the costs of their operations. Removing the GR&FT on energy supplied to mass transit operators would be a welcome relief to their tight budgets.

Policies regulating development: State and local governments affect the use of energy in transportation through land use powers and their role in regulating the construction of homes, offices, and manufacturing facilities. In recent decades, these powers have taken on new significance, as population growth and social trends have caused the movement of people, and later industry and commerce, out of older cities to suburbs and rural areas. This movement has reinforced a trend toward automobile use by spreading workers and workplaces so that existing mass transit, focused on the major cities--Newark, New York, Philadelphia--is not available for many trips. Suburb to suburb travel is minimally served by conventional mass transit systems.

The state's powers over land use are being re-examined by the State Planning Commission in the State Development and Redevelopment Plan. This plan espouses strengthening the state's tools over land use, resulting in improved viability of mass transit and the reduced need to drive. By encouraging or requiring greater mixed land use, higher development densities, and closer proximity and interconnections among developments (housing, retail, office, and industrial), the plan addresses energy use for transport to work and at other times.[39]

Strategies to Improve Energy Efficiency in Transport

Over the next decade improving the efficiency of particular transport modes appears to be the most effective strategy in reducing transport fuel use. Table III-3-9 indicates the potential available in each transport mode.

A study of commuting patterns in the New York metropolitan region, indicated that little energy savings would be attained from mode shifting. The study showed that people favor certain modes of transit for reasons other than economy and that encouraging shifts, except for commuter shifts from cars to vanpools, would be ineffective.[40] However this finding does not imply an abandonment or even de-emphasis on mass transit modes. For reasons of air quality and traffic congestion alone, mass transit would remain a vital part of the state's transport system. From energy efficiency standpoint, increases in the efficiency of mass transit modes are best achieved by increasing ridership on the present system. A more recent problem stems from the fact that although many New Jersey commuters use mass transit to Manhattan,[41] most new employment in recent years is in Middlesex, Morris, Mercer and Somerset counties in areas removed from mass transit.[42]

Policies aimed at increasing fuel efficiency (mpg) can also rely on either market forces such as price changes or on direct government intervention. The state can affect the market by raising gas taxes. Direct state action can vary from instituting HOV lanes to limiting the importation of oil.

Federal fuel efficiency standards: Auto fuel efficiency has improved markedly from 1972 to 1986. A strong force for efficiency was the Corporate Auto Fuel Economy (CAFE) standards set by the National Highway Traffic Safety Administration (NHTSA). NHTSA lowered the standard from its original levels for the 1989 model year to 26.5 mpg for cars and 20.5 for light trucks. For 1990 model year cars, NHTSA is again considering a petition from GM and Ford for a lower standard than 27.5 mpg to which it would revert if NHTSA does not act. NHTSA has already decided that the standard for 1990 trucks will fall to 20.0.[43]

The fuel efficiency improvements so far achieved have been cost effective, that is, the costs of making the improvements have been less than the cost of the fuel saved as a result of the improvements. For an individual new car buyer, cost-effective improvements have meant that the increase in the original price of the car due to changes made to increase fuel efficiency has been more than offset by savings gained from fuel saved, i.e., not purchased, over the life of the vehicle. Such a calculation based on total costs over vehicle life is called life cycle costing.

Technology is already available to auto manufacturers to increase average new car fuel efficiency over 50 percent.[44] The improved efficiency will require only minor changes in vehicle size.[45] The continuously variable transmission alone could increase fuel economy by 12 percent over CAFE.[46] Additional improvements, such as multi-point fuel injection and variable valve timing, could improve fuel efficiency about 100 percent in future years. An American Council for an Energy-Efficient Economy analysis finds the improvements cost-effective today.[47] An Oak Ridge National Laboratory analysis, citing U.S. Department of Energy figures, calculates that fuel price increases of $1.50 to $2.00 per gallon, would justify, based on life cycle costing, fuel efficiency increases to 35-40 mpg.[48]

Gas guzzler tax/gas sipper rebate: A method for New Jersey to promote energy efficient cars and light trucks is to alter its sales tax on auto purchases to take account of their efficiency. A program to promote fuel efficient cars would rely on a variable sales tax instead of the constant 6 percent tax now in force. Such a program, called a gas guzzler tax/gas sipper rebate would be revenue neutral: It would raise the same amount of taxes as the present system, but would reward or penalize people who buy autos in proportion to the fuel efficiency or inefficiency as compared to the CAFE standard presently in effect. One study projects a saving of 1.6-2.4 million gallons of gasoline a year for New Jersey.[49]

To reinforce the effect of such a program, annual auto registration fees could be weighted according to a similar formula favoring fuel efficient cars. However, the impact of a gas guzzler tax on registration fees would fall on lower income people to a much greater extent than the program based on new car sales. Also, as registration fees are small, the force of the signal would be relatively minor.

Gas Sipper Rebate/Gas Guzzler Tax Examples

EXAMPLE 1 Base case

Sales tax = tax rate x car price x (CAFE mpg standard/car's rated mpg) x A

"A" - factor to maintain total sales tax receipts at level equivalent to a constant 6 percent tax. By changing A annually one could compensate for changes in auto fleet average mpg.

assumptions: when CAFE standard = 26.5 mpg. A = 0.95

No. 1: Car X costs $6,000 and is rated at 38.0 mpg.

Sales tax = 0.06 x $6,000 x (26.5/38) x .95

= $238.50 (versus $360 with no gas sipper rebate)

No. 2: Car Y costs $18,000 and is rated at 20.4 mpg.

Sales tax = 0.06 x $18,000 x (26.5/20.4) x .95

= $1,332.79 (versus $1,080 with no gas guzzler tax.)

EXAMPLE 2 Modification giving buyers of very fuel efficient cars a rebate from the state instead of paying any sales tax.

Car X is rated at 50 mpg. Tax rebate = $300 (buyer receives from state)

Car Y is rated at 15 mpg. Sales tax = $1,500.

Impact of Transport Modes on Air Quality

Another important consequence of energy used in the transport system is the environmental effect. New Jersey is a nonattainment state for ozone and carbon monoxide according to the National Ambient Air Quality Standards contained in the Federal Clean Air Act.[50] The spring-summer of 1988 was especially poor as far as ozone pollution is concerned: ozone exceeded federally mandated levels 212 times (as measured at 14 sites) from April 1 through August 31, 1988, a very high count due partly to the hot, dry weather summer. There were 45 exceedances in 1986 and 119 in 1987.[51]

In addition to fines, loss of federal monies, or other sanctions the federal government might eventually impose for nonattainment, New Jerseyans suffer from the detrimental health effects of exposure to high levels of these pollutants--impaired breathing and lung diseases. Recent studies indicate that exposure to ozone concentrations at or in excess of the federal standards leaves little or no margin before the potential onset of adverse health effects.[52] Gasoline-fueled vehicles are a principal source of ozone and carbon monoxide emissions.

Ferries are an example of a transport mode that could ameliorate air pollution. According to a study by the Port Authority, when its ferry service carries the 11,000 passengers a day projected in 1991/92, significant reductions in air pollutants would occur if ferry transport replaces the auto as the means to travel to Manhattan (see Table III-3-12).

Table III-3-12

Annual Emissions of Selected Pollutants
Amount Emitted/Year (in tons)

Pollutant	Ferry	Auto*
carbon monoxide	6.6	228.3
hydrocarbons	10.5	30.0
nitrogen oxides	8.9	41.0

* based on emissions of 4,504 cars traveling 40 round-trip miles, carrying 1.2 passengers per trip.

Source: Port Authority of New York & New Jersey, 1988.

<u>Alternative fuels</u>: Powering autos with alternative fuels could reduce harmful air emissions. Widespread use of nonpetroleum fuels would also lessen dependence on imported oil. Alternative fuels include compressed natural gas (CNG) and liquefied natural gas (LNG) that derive from natural gas; methanol from coal, natural gas, lignite, or biomass; ethanol from renewable sources and hydrogen from water. Electricity can also power vehicles. Table III-3-13 contains a summary of the characteristics of the major alternative fuels as compared to gasoline.

During the next decade, methanol and CNG have the potential to compete with gasoline and diesel on the basis of price, availability, performance, and conformance with present internal combustion engine requirements. Ethanol, derived from sugars, comes from the same raw materials as foodstuffs. Methanol's advantage is the variety of feedstocks from which it can be produced--natural gas, coal, lignite, and biomass--and their abundance in the United States. Methanol offers the possibility of displacing petroleum-based imports with a domestically-derived alternative[53].

The widespread use of methanol as a substitute for gasoline as an automobile fuel may be an effective strategy for reducing emissions of carbon monoxide, oxides of nitrogen, and reactive hydrocarbons. These reductions could lead toward a more expeditious attainment of the ambient air quality standard for ground level ozone.[54]. The total environmental impact of the large-scale use of methanol will depend on the feedstock used. Each of the different sources--natural gas, coal or biomass--has a different effect on the atmosphere, particularly in regard to the amount of carbon dioxide released into it. The coal-derived methanol cycle, for example, yields unusually large amounts of carbon dioxide per unit of useful work. A model of large-scale substitution of methanol for gasoline demonstrated the positive benefits of methanol use with only a minor increase in atmospheric formaldehyde levels in some scenarios.[55]

A key problem with introducing methanol- and CNG-powered vehicles on a large scale is the need to develop simultaneously a market for vehicles and a network of fueling stations to service them. Both methanol and CNG can be used in dual-fuel vehicles.[56]

During the introductory period for alternative fuel vehicles when refueling stations are few, it will be necessary to equip vehicles to run on gasoline and the alternative fuel. Because the engines of such vehicles will have to be able to operate on either fuel, they will not be running optimally. Data on fuel efficiency, emissions, and other measurements should therefore not be considered as representative of the alternative fuel being used.

Table III-3-13
Summary of Alternative Fuel and Vehicle Characteristics in Comparison with Gasoline[a]

	Ethanol	Methanol	CNG	Electricity
Near-term technology	Proven	Proven	Proven; Satisfactory for some uses	Close to commercial
Unit Price vs. \$0.53-0.78/gal.[ab]	\$1.25-1.45	\$0.35-0.45	\$3.62-7.46 /1000 scf	0.015-0.133 /kWh
\$/million Btu vs. \$4.2-6.2	\$14.9-17.2	\$5.5-7.0	\$2.1-8.3	\$1.7-37.9
Fuel Volume (vs. Gasoline)	1.5X	2X	5X	2X-3X[bc] (lower range)
<u>Energy Content</u>				
vs. 18,500 Btu/lb. for gasoline	11,500	8,600	21,300	N.A.
vs. 125,000 Btu/gal. for gasoline	75,700	56,600	22,800	N.A.
Refueling Procedure	No different	No different	somewhat lengthier	Recharging takes hours
Fuel Storage Tank Cost	Nominal	Nominal	\$850-1,000	Depends on battery type
Current State of Technology	Standard in Brazil	Pre-production	Commercial	Used in niche markets
Performance Characteristics	Small power gain	8% power gain	10% power loss	Trade-off for range
Exhaust Emissions	Same or better	Same or better	NOx same or higher	No mobile source
HC, CO, NOx, & HC reactivity	lower NOx and HC reactivity	lower NOx and HC reactivity potentially lower CO	lower for non-methane HC; lower CO	emissions at power plants

[a] Values are representative of engines with dual-fuel capability and not for one optimized to take advantage of the inherent quantities of each fuel.
[b] Methanol spot market prices vary, the estimate here is based on the estimated long-run cost of production.
[c] Volume of typical battery pack for a lower range (approx. 100 mi) electric vehicle.

Source: U.S. Dept. of Energy, "Assessment of Costs & Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector: Progress Report 1," DOE/PE-0080, January 1988, Tables 2 & A-1, taken from Greene <u>et al</u>.

Projections

Motor fuel use was about three-quarters of total transport energy use in 1986 and consequently presents the most likely category for finding energy savings. Table III-3-14 outlines a scenario based on best currently available technology as a baseline for measuring movement toward efficiency in motor fuel uses. The scenario shows that if the best currently available technology for motor vehicles were to be adopted and phased in over the next decade, the amount of energy that could be saved in New Jersey by petroleum-fueled motor vehicles per year is almost 2 billion gallons, more than half of present use of motor fuels.

Alternatively, if the state does not promote energy-saving technologies and policies, present trends indicate that New Jerseyans will be consuming about 2 percent more motor fuels in the year 2000 than they are now.[57] The projected increase in motor fuels would occur in spite of an increase in average fuel economy for cars that will come about as old cars are replaced by new ones that have met higher CAFE standards.

Table III-3-14

Potential Energy Savings of Motor Fuels
Based on Today's Best Available Technology

Transport Mode	1987 Vehicle Miles million	1987 Gallons Used million	1987 Avg. MPG	Today's Best Avail. Technology MPG	% Imprv.	Gallons Used million	Gallons Saved million
Autos	45,672	2,378.8	19.2	50	160	913.4	1,465.4
Motorcycles	116	2.3	50	50	-	-	-
Light trucks	7,256	562.5	12.9	35	171	207.3	355.2
Heavy trucks	3,727	642.6	5.8	8.0	38	465.8	176.8
Buses	302	51.2	5.9	10.0	69	30.2	22.9
Total	57,072	3,637.4	-	-	-	1,616.7	2,020.2

Totals may not add due to previous rounding.

Sources: Vehicle miles: N.J. Department of Transportation
Average fuel economy figures (mpg) are national averages derived from Federal Highway Administration, Highway Statistics 1987 (Washington, D.C,: Dept. of Transportation), Table VM-1.

Mode shifting, particularly shifting commuters from single passenger autos to ridesharing, vanpooling, or mass transit, would be the most immediately effective means for reducing congestion and reducing fuel use. What is not clear is the extent to which state policy can force those shifts without raising the price of gasoline. A major force for mode shifting would come from changes in land uses so that more workers find common paths between home and work.

DRAFT

Chapter III-3

Findings:

- Motor fuel accounts for three-quarters of the state's transport energy use.
- As a result of economic growth, population density, and its position in the densely populated Boston-Washington corridor, New Jersey has the most crowded roads in the country.
- Mass transit can play an important role in meeting mobility needs.
- Increased traffic congestion on New Jersey's roads is wasting greater amounts of energy.
- New Jersey has not attained federal air quality standards, and auto emissions are a major contributor to the state's air pollution.
- As the price of motor fuels has leveled off and fallen, the amount of motor fuels used has increased and reached new highs.
- Higher vehicle occupancy is the most cost-effective and most quickly implemented means of reducing peak period congestion and reducing fuel use per person.
- Avoided cost calculations can compare investments in road improvements with those (such as vanpool subsidies) that would alternate congestion without new construction. Alternatives may be less expensive in many situations.
- Vanpooling and ridesharing will reduce congestion. Support measures, such as parking restrictions; express lanes for high occupancy vehicles (HOVs); lower bridge, tunnel and turnpike tolls for HOVs; and special assessments on developers of projects generating large amounts of low-occupancy traffic, will increase vanpooling and ridesharing.
- Substantial improvement in motor vehicle fuel efficiency is possible.
- Fleet energy assessment programs can save large amounts of energy. Both state and municipal fleets could benefit.
- Alternative fuels could reduce dependence on oil imports as well as improve air quality.
- Traffic signal management programs can reduce energy use and reduce congestion.
- Mass transit modes, rail and bus, are more efficient and cause less polluting than cars.

Chapter III-3

Policy

- State agencies shall test transportation network improvements against the costs tha would be avoided by implementing alternative solutions, such as vanpool subsidies.
- The state shall budget funds to encourage the use of alternatives to the single-occupant vehicle, such as vanpooling, ridesharing, and bicycling to the greatest extent feasible.
- The state shall discourage driving during peak hours, when congestion is worst and car emissions contribute most to air pollution.
- The state shall continue, expand, or adopt programs to save energy in the operation of its own fleet, and other publicly-owned fleets.
- The state shall provide stable support to mass transit and provide sufficient funds for trial bus lines from areas of low employment to areas in need of workers.
- The state shall encourage vehicle efficiency.
- The state shall encourage ferry operators.
- The state shall encourage efforts to reduce traffic congestion, such as traffic reduction ordinances and transportation management associations.

Implementation

Administrative Actions

In order to implement the policies outlined, the state should take the following administrative actions:

Promote the use of alternatives to single-occupant vehicles, including vanpooling, ridesharing, and mass transit, through:

- developing a means of fully and accurately evaluating cost advantages of vanpooling/ridesharing versus road widening or building.
- strengthening existing information and matching programs in the commercial sector.
- subsidizing vanpooling up to the maximum cost-effective level as measured by an avoided cost evaluation.

- providing incentives to companies to supply vans for employees.
- providing vans to groups of riders where vanpooling would be a cost-effective alternative to road widening or building.
- finding which measures are effective for TMA and testing those measures in other areas.
- developing, with New Jersey Transit, experimental routes where buses might provide even more cost-effective transport and encourage employment.

Discourage peak hour road use through:

- testing, on toll roads and river crossings, variable rates designed to encourage off-peak hour driving and discourage peak hour driving.
- encouraging private sector participation in competitively providing bus transportation.
- providing new and expanded park-and-ride facilities.
- promoting flex-time, a four-day work week, and similar travel-reducing measures.

Adopt or expand improved fleet operation and evaluate purchases based on life cycle costing through:

- instituting programs based on the school bus energy assessment program in all school districts, and investigate the potential for similar savings by applying the program to New Jersey's transit bus operators.
- purchase vehicles based on life cycle cost including fuel, rather than purchase price.

Legislative Initiatives

In order to implement the policies outlined, the state should encourage the following legislative initiatives:

Promote the use of alternatives to single-occupant vehicles, including vanpooling, ridesharing, and mass transit, through:

- restoring state corporate tax incentive for vanpooling removed by 1986 federal tax reform

- removing state sales tax for all United States-manufactured vans purchased by any vanpool sponsor.
- providing state vanpool funding based on avoided costs associated with building new roads or expanding existing roads.
- encouraging third-party (leasing) vanpool organizations to provide service.
- providing specific criteria for TMA accountability in reducing congestion, promoting ridesharing, reducing energy use, and reducing costs of programs.

Provide stable funding for mass transit through:

- exempting mass transit operators from paying the Gross Receipts and Franchise Tax on energy purchased for their operations.

Encourage vehicle efficiency through:

- adopting a gas sipper rebate/gas guzzler tax in place of a standard sales tax on new car purchases.
- raising the gas tax to make it at the same level as surrounding states.
- increasing gas taxes to reinforce the incentive to conserve petroleum fuels when gasoline prices rise as the result of shortages.
- investigating which alternative fuels would be best suited to a situation and initiating a pilot program utilizing the state fleet that involves private fleet operators, when possible.

FOOTNOTES

Unless otherwise stated, all figures in this chapter are for 1986 and are based on Energy Information Administration, State Energy Data Report, 1960-86 (Washington, D.C.: U.S. Department of Energy, 1987) hereinafter referred to as EIA, State Energy Data Report.

1. Boris S. Pushkarev and Barbara L. Lawrence, "Development Trends and Transportation Implications for Northern New Jersey," New Jersey Bell Journal, fall 1986, p. 4.

2. Pushkarev and Lawrence, p. 3-4.

3. There is good reason to believe that the EIA statistics overstate the total amount of energy used in the transport sector in New Jersey. For example, because of the lower gasoline tax in the state, gasoline prices in New Jersey are lower than most surrounding areas, and therefore many residents of neighboring states make a point of filling up their automobiles with gasoline whenever in New Jersey.

   The statistics on interstate traffic on the New Jersey Turnpike may also exaggerate New Jersey's energy consumption statistics. Present data indicate that 11 percent (source: N.J. Turnpike Authority, 1988) of total traffic on the Turnpike enters at one end and exits at the other without any destinations in the state. While conclusive evidence of nonresidents' purchase of motor fuel is not available, the amount of gasoline and diesel fuel purchased in the state for their vehicles would constitute an overstatement of energy consumed in New Jersey.

   Another statistical artifact can be discerned in the figures for jet fuel, resulting in a significant overstatement of energy consumed in the transport sector. The data do not reflect a change in the pattern for purchasing jet fuel that occurred after the jump in fuel prices in late 1979, which was the result of the Iranian revolution. Beginning at that time the airlines took over from the oil companies the movement of jet fuel from the Buckeye Pipeline terminal in Linden to the area airports. Consequently all purchases for the airlines operations in the region's airports (New Jersey and New York) were reported as occurring in Linden. Previously the purchases were reported by the oil companies at the airports, which were also the points of consumption. A comparison of the figures for jet fuel consumption in New Jersey and New York for the period 1980-83 offers striking confirmation:

Year	New York	New Jersey
	thousands of barrels	
1980	35,916	8,088
1981	25,381	17,518
1982	4,815	33,809
1983	3,790	37,077

(EIA, State Energy Data Report, Table 202, New Jersey Transportation Energy Consumption Estimates, and Table 214, New York Transportation Energy Consumption Estimates.)

The U.S. Department of Energy's Energy Information Administration has acknowledged the error in the reporting of jet fuel use between New Jersey and New York. In light of the size of the error introduced by the change in reporting of jet fuel sales, the N.J. Division of Energy Planning and Conservation has estimated jet fuel consumption for New Jersey from 1980-1986 based on the relative number of passengers served by the three major airports in the New York-Northern New Jersey region, i.e., Newark, LaGuardia, and Kennedy. The revised estimated figures are reported in Table III-3-2. A note to the table indicates the figures originally reported by the Department of Energy.

4. New Jersey Department of Commerce, Energy and Economic Development, New Jersey Energy Database System.

5. New Jersey Department of Labor, New Jersey State Data Center.

6. New York Times, October 9, 1988, section 3, p. 5.

7. New York Times, November 29, 1988, p. D6.

8. Federal Highway Administration, Highway Statistics 1987 (Washington, D.C.: U.S. Department of Transportation, 1988), Table VM-2, p. 178.

9. New Jersey Turnpike Authority, 1987 Annual Report (New Brunswick, N.J.: N.J. Turnpike Authority, 1988); New Jersey Highway Authority personal communication.

10. Newark Star Ledger, August 26, 1988, p. 1 and 29, and Port Authority of New York and New Jersey, personal communication.

11. The largest ferry operators in New Jersey are Direct Line Commuter Service and Arcorp Properties. Direct Line runs ferry service from several points in New Jersey (Bayonne, Keyport, and Highlands) to lower Manhattan (Pier 11) as well as service from Bayonne and Jersey City to Sandy Hook and Highlands to meet demand during warmer months. Arcorp has two routes from Weehawken to Manhattan. In October 1988, Arcorp ferries carried about 4,000 passengers a day.

12. Port Authority of New York and New Jersey, personal communication.

13. Journal of Commerce, March 1, 1982, p. 1, and New York Times, October 27, 1988, p. A .

14. N.J. Transit, Annual Report 1986 and 1987 (Newark, N.J.: N.J. Transit, 1987 and 1988).

15. Daniel K. Boyle, Nathan S. Erlbaum and Betty J. Yelich, Transit Viability in the 1980's, Transportation Analysis Report, No. 45 (Albany, N.Y.: New York State Department of Transportation, January 1985), Table No. 1, p. 17.

16. Washington Post, November 11, 1987. If the estimated $1.5 million in lost federal tax receipts is taken into account in calculating the subsidy to New Jersey drivers, the figure in Table III-3-6 for the auto subsidy would change from -0.01 to +0.07, still not a significant figure in relation to total costs.

17. New York Times, July 3, 1988. See also Jesse A. Simon and Joel Woodhull, "Parking Subsidization and Travel Mode Choice," Southern California Rapid Transit District, August 1987.

18. Dwight Dively and John R. Lago, "Transportation Planning and Land-Use Decision Making," in New Jersey Issues: Papers from the Council on New Jersey Affairs (Princeton, N.J.: Princeton University, 1988), p. 232.

19. See Chapter IV-3, Energy Efficient Land Development.

20. The Asbury Park Advisor Journal and personal communications.

21. Urban Mobility Corp., "New Jersey Ridesharing Study: Summary Final Report," unpublished study, Feb. 1988.

22. John C. Powers, "George Washington Bridge Bus-Carpool Lane One Year Operational Report," N.J. Department of Transportation, unpublished study, June 1988.

23. Port Authority of New York & New Jersey, personal communication.

24. Letter of September 10, 1986 from Alex DeCroce, Freeholder Director of Morris County to Governor Thomas H. Kean.

25. Malcolm D. Rivkin, "Can Transportation Management Reduce Traffic in the Suburbs? Ask the Nuclear Regulatory Commission," Urban Land, November 1988.

26. Division of Energy Planning and Conservation, School Bus Fleet Energy Assessment, Final Report (Newark: Department of Commerce, Energy and Economic Development, January 1988).

27. The Road Information Program, "An Analysis of the Economic Impact of Increased Highway Funding in New Jersey," unpublished study, Washington, D.C., December 1987, p. 10.

28. The increase in auto intensity reported in Table III-3-4 does not appear to be as great as the increase in auto fuel efficiency indicated by gains in average miles per gallon (mpg) reported by others. For example, the International Energy Agency (IEA) indicated that U.S. new car gasoline consumption decreased by 46 percent from 1973-83. (IEA, Energy Conservation in IEA Countries, Paris 1987, Table 4, p. 54.) Ignoring the slight difference in period covered by the two figures because CAFE standards did not come into effect until after 1975, the difference between these two measures can be explained by two facts: (1) the IEA is using new car figures, while the energy intensity figures are averages including new and old cars; and (2) the energy intensity figures include occupancy per vehicle, which was reported to have fallen by 15 percent from 1970 to 1983.

29. New Jersey Turnpike Authority, personal communication.

30. N.J. Transit, Meeting New Jersey's Growth Challenge (Newark, N.J.: N.J. Transit, June 1987) and personal communication.

31. Based on 1800 cars/lane/hour (single passenger cars). New Jersey Highway Authority, personal communication.

32. Pushkarev and Lawrence, p. 9.

33. New Jersey Office of State Planning, Infrastructure Needs Assessment, Vol. II: Transportation, Technical Reference Document 88-29 (Trenton: N.J. Office of State Planning, January 1988).

34. See the New Jersey 1989 Transportation Plan (Trenton: Department of Transportation, in preparation) for details on Transplan.

35. Average annual miles traveled per passenger vehicle have increased from 9,560 in 1985, to 9,608 in 1986 and 9,883 in 1987, reaching levels not seen since the first oil crisis of 1973. Federal Highway Administration, Highway Statistics, Summary to 1985, 1986, and 1987 (Washington, D.C.: 1986, 1987, 1988), Table VM-201A, Table VM-1, and Table VM-1, respectively.

36. Michael P. Walsh, "Critical Analysis of the Federal Motor Vehicle Control Program," Northeast States for Coordinated Air Use Management, July 1988, p. 1.

37. N.J.A.C. 7:27-14 & 15.

38. Thomas H. Kean, "Governor's Annual Message to the New Jersey State Legislature," Trenton, January 12, 1988, p. 89.

39. See also Chapter IV-3, Energy Efficient Land Development.

40. Regional Plan Association and Resources for the Future, Regional Energy Consumption (New York, N.Y.: Regional Plan Association, 1974), p. 16.

41. Regional Plan Association and Resources for the Future, p. 16.

42. Pushkarev and Lawrence, p. 3-6.

43. Federal Highway Administration, Highway Statistics: Summary to 1985 and Highway Statistics 1986 (Washington, D.C.: Department of Transportation, 1987); The New York Times, March 12, 1989, Section 4, p. 6.

44. W.U.Chandler, H.S.Geller, and M.R.Ledbetter, Energy Efficiency: A New Agenda (Washington, D.C.: American Council for an Energy-Efficient Economy, 1988), p. 28.

45. David L. Greene, Daniel Sperling and Barry McNutt, "Transportation Energy to the Year 2000," Oak Ridge National Laboratory, Oak Ridge, Tennessee, August 1988, p. 14-18.

46. Energy and Environmental Analysis, "Analysis of the Capabilities of Domestic Auto Manufacturers to Improve CAFE," Arlington, Virginia, 1986, and Chandler et al, Table 2, p. 29.

47. Chandler et al, p. 29-30.

48. Greene et al, p. 16.

49. Chandler et al, p. 35.

50. Federal Register, June 6, 1988, p. 20722-34.

51. N.J. Department of Environmental Protection, personal communication.

52. T.J. Kulle, L.R. Sauder, J.R. Hebel and M.D. Catham, "Ozone Relationships in Healthy Nonsmokers," American Review of Respiratory Disorders, No. 132, p. 36-41.

53. California Energy Commission, Fuels Report (Sacramento: California Energy Commission, December 1987), p. 30-31.

54. Acurex Corp., "California's Methanol Program Evaluation Report," Vol. II, Technical Analysis, cited in California Energy Commission, Fuels Report.

55. Joel N. Harris, Armistead G. Russell, and Jane B. Milford, "Air Quality Implications of Methanol Fuel Utilization," SAE Technical Paper Series No. 881198, August 1988.

56. Greene et al, p. 20-21, and Brooklyn Union Gas, personal communication.

57. The projection of motor fuels consumption for year 2000 is based on submode ANL-86L in Marianne Millar Mintz, Margaret Singh, Anant Vyas, and Larry Johnson, "Transportation Energy Outlook Under Conditions of Persistently Low Petroleum Prices," Transportation Research Record 1155 (Washington, D.C.: Transportation Research Board, 1987), p. 60-68. Submode ANL-86L, which is based on economic forecasts by Data Resources, Inc., was chosen because it best fits present trends.

Part IV

Analysis

ENERGY EFFICIENT BUILDINGS

Introduction

The state of New Jersey and its seven gas and electric utilities operate conservation programs designed to reduce energy consumption in state, institutional, commercial, and residential building stock. The DCEED Division of Energy Planning and Conservation administers most state government programs. Each utility administers a separate set of programs for its own customers.

Federal and state regulations and spending restrictions imposed at funding sources determine the shape and direction each program takes. State-run programs derive their operating funds from multiple sources. The State Energy Conservation Bond (SECB) issues finance improvements to state-owned and long-term lease buildings. Other state programs that aid schools, hospitals, commercial, industrial businesses, farms and residential sector clients draw funds from U.S. Department of Energy (USDOE) allocations and from New Jersey's share of oil overcharge funds.

In the late 1970s and early 1980s, the USDOE and the federal courts found that some U.S. oil companies violated price controls in effect from 1973 through 1981 under the authority of the Emergency Petroleum Allocation Act of 1973. The price violations resulted in billions of dollars of overcharges, and the USDOE obtained restitution for the overpricing.

The USDOE settled many cases through administrative means, obtained settlements, and placed the monies in escrow for eventual distribution both directly to individual consumers who could prove injury and indirectly to all other consumers by awarding funds to states for conservation programs. In virtually all cases, the USDOE and courts determined settlement/judgment amounts based on an offending company's total sales at inflated prices during the 1973 through 1981 period. They further directed distribution of oil overcharge monies to the states in proportion to each state's petroleum product purchases in the same period. Additionally, the USDOE and courts, case by case, placed stringent spending constraints on the restitutionary monies.[1]

Oil overcharge monies flow from the USDOE to the states. Each state must submit spending proposals to the USDOE and to the federal courts (where applicable) to ensure that the state plan complies with USDOE or court strictures. The plans must describe proposed programs and costs and explain how the programs restitute injured energy consumers.

In New Jersey, once the USDOE and federal courts issue spending plan approvals, the state legislature must draft and pass an appropriation bill to release the funds for use in approved programs. The following table illustrates the oil overcharge funding sources and program destinations enabling August 1987 through August 1990 spending as defined in Senate Bill #2666.

Table IV-1-1

10-Jan-89 S2666 ALLOCATION BY FUNDING SOURCE

DEPT	PROGRAM	EXXON	STRIPPER WELL	DIAMOND SHAMROCK	TOTAL
		SOURCE OF FUNDS MILLIONS OF DOLLARS			
DCA	LOW INCOME WEATHERIZATION	8.5			8.5
DCEED	INSTITUTIONAL CONSERVATION PROGRAM	19.8	0.2		20.0
	BUSINESS ENERGY IMPROVEMENT PROGRAM		6.8	0.2	7.0
	NJ HOUSING AND MORTGAGE FINANCE AGENCY	4.0	11.0		15.0
	RESOURCE RECOVERY PROGRAM		9.8	0.2	10.0
	PROGRAM ADMINISTRATION			1.5	1.5
DHS	HOME ENERGY ASSISTANCE PROGRAM	30.0			30.0
	BOARDING HOMES & HOMELESS SHELTERS	5.0			5.0
TOTALS		67.3	27.8	1.9	97.0

DCA = DEPARTMENT OF COMMUNITY AFFAIRS
DCEED = DEPARTMENT OF COMMERCE, ENERGY & ECONOMIC DEVELOPMENT
DHS = DEPARTMENT OF HUMAN SERVICES

Source: DCEED Division of Energy Planning and Conservation

Utility programs, in contrast, operate with funds collected through base rate allowances controlled by the state Board of Public Utilities (BPU). Utilities conduct conservation programs pursuant to residential and commercial conservation regulations formulated by the state Department of Energy (DOE) in 1982 and 1984 and revised as needed by the DCEED. Sharing regulatory power, the BPU and the DCEED review and approve biannual utility conservation program plans and all proposed expenditures.

All programs, state- and utility-sponsored, that provide monies for energy improvements require an audit or feasibility study prior to project funding to ensure responsible and cost-effective spending.

Table IV-1-2 summarizes current state and utility conservation programs examined in this chapter.

This chapter and Chapter IV-2 review state and utility conservation initiatives to improve building stock energy efficiency, attempts to assess program efficacy, and suggests future directions and funding sources for continued conservation efforts.

Table IV-1-2

Target Sector	Program Sponsor State	Utility
State Buildings	State Energy Conservation Bond (SECB) Program District Heating & Cooling Cogeneration Initiatives	
Institutional	Institutional Conservation Program (ICP)	
Commercial/ Industrial*	Business Energy Improvement Program (BEIP) offering - loan interest subsidies - 0%/low-interest loans - grants *Eligibles also include nonprofit organizations, municipalities, and farms.	Commercial and Apartment Conservation Service (CACS)
Residential		
Low Income	Weatherization Assistance Program (WAP)	Direct Investment
All	Home Energy Rating System (HERS)	Home Energy Savings Program (HESP) 0%/low-interest loans
All Sectors	New Jersey Uniform Construction Code Energy Subcode	

State Initiatives

State Buildings

The state of New Jersey owns or leases approximately 43 million square feet of heated building space. Cost-effective retrofits of this stock can save energy and show the potential for savings in private sector buildings.

The energy crisis of the 1970s first compelled state government to thoroughly evaluate physical structures, usage patterns, and fuel requirements of a heterogeneous state building stock. The DCEED energy division now employs three approaches to control energy use in state building stock: SECB, the expanded use of cogeneration where it can save money, and state building tie-ins to cost-effective district heating and cooling systems. These initiatives seek to achieve a net reduction in energy consumption by reducing the fossil fuel and electricity used to provide heating, cooling, power, and light to state facilities.

D R A F T

Chapter IV-1-A

State buildings comprise offices, psychiatric and veterans' hospitals, centers for the developmentally disabled, correctional facilities, educational institutions, transportation maintenance yards and garages, environmental outposts, state police buildings, state parks facilities, and historic sites.

According to the most recent available figures, the state spent more than $80 million during fiscal year (FY) 1988 to supply fuel and power to state facilities operated by 20 cabinet-level departments. Round-the-clock operations, such as hospitals, correctional facilities, higher education dormitories, and state police facilities, account for the largest portion--approximately 85 percent--of the state's energy use. The balance of facilities (office, day care, parks, and maintenance buildings) operate on a more limited schedule and consume the balance of the state's energy budget.

The diversity in age and size of state buildings is extreme. Many were built in the 19th century and several date back to the 18th century. Most were designed and constructed before energy consumption and conservation became ranking concerns.

Structures range in size from storage or maintenance sheds of a few square feet to buildings half a million square feet in area or larger, such as Trenton's Labor and Industry Building, the University of Medicine and Dentistry of New Jersey in Newark, and Greystone Park Psychiatric Hospital in Morris County.

Heating and ventilating systems are also diverse. Over 60 percent of the total space is heated by central steam systems serving two or more buildings. Less than 50 percent of the space is air-conditioned, but each year an increasing percentage of existing space requires installation of air conditioning due to expanded or altered use.

Residential facilities that house the sick, disabled, and incarcerated use a substantial portion of their total thermal load to provide sufficient hot water for bathing, laundry, and food preparation for growing populations. Energy systems that support these operations also vary greatly in size and efficiency among individual facilities.

To identify areas of energy loss and opportunities for energy efficient improvements in state building stock requires evaluating each facility's boilers; water heaters; heating, ventilating, and air conditioning (HVAC) systems; and electrical and lighting systems.

Present Mode of Operations

State Energy Conservation Bond Program (SECB)

During the oil crisis of the 1970s, state officials witnessed the severe budgetary impact of increasing fuel oil, electricity, and natural gas prices. In December 1974, the Governor's office issued Executive Order No. 13, requiring that each state department submit electric and fuel use data on a monthly basis to the (then) State Energy Office. Still in force today, Executive Order No. 13 also calls for each department to appoint an energy conservation coordinator to be responsible for all reporting and to act as the department's primary liaison with DCEED on energy issues. The 1977 Department of Energy (DOE) Act required state departments and agencies to submit annual energy utilization reports and conservation plans to DOE. Each plan was to detail energy reduction efforts through maintenance and operation improvements and equipment repairs and retrofits.

The legislature placed the State Energy Conservation Bond Act of 1980 on the ballot on November 4, 1980. Passed by voter referendum, the $50 million bond issue provided $3 million for energy audits and $47 million for energy conserving renovations in state buildings.

To participate in the bond program, state departments and agencies first request an energy audit and then apply for a grant to finance energy conserving renovations identified in the audit. DCEED reviews and ranks project applications and awards funds for those renovations with the quickest payback that save the greatest amount of energy.

To date, DCEED has spent or dedicated $27 million of the $50 million bond issue to implement eligible energy conservation projects with a payback of 10 years or less. Approximately $7 million of SECB monies funded Cycle I audits and projects during fiscal years 1981 and 1982. A $20 million legislative appropriation funded the program's Cycle II in FYs 1983 through 1988. In the autumn of 1988, the Legislature and Governor approved the final $23 million appropriation for the SECB program Cycle III in FY 1989 and beyond. By year-end 1988, the DCEED had approved pending project applications for $17 million of the final $23 million in program funds.

Figure IV-1-1 shows the focus of SECB program spending through three cycles by energy conservation measure type. Note the progressive increase of funds used to purchase and install energy management systems (EMS). These state-of-the-art computerized systems control and coordinate all facets of a facility's energy production and distribution including temperature and lighting control. EMS maximize savings generated by other equipment retrofits to achieve the greatest possible system efficiency.

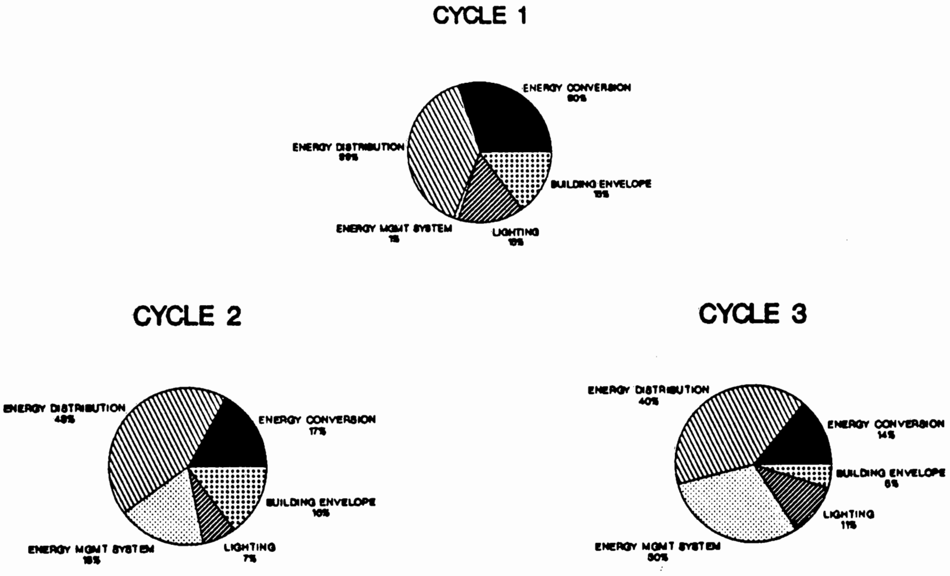
Cogeneration in State Buildings

In its 1986 report, the Governor's Cogeneration Cabinet Committee reviewed state buildings and identified 10 facilities where the state could use cogeneration systems to reduce energy costs. The committee's report recommended that the state commission feasibility studies at these sites, where annual energy costs total approximately $28 million.

Cost-efficient cogeneration systems could enable state facilities to obtain thermal energy and electricity at an overall cost up to 30 percent less than that of conventional power and heat sources.[2] The state is pursuing cogeneration projects through private investment to avoid high

Figure IV-1-1

PROJECTS BY TYPE
ENERGY BOND PROGRAM



Energy distribution -	duct/pipe insulation, modification or replacement, HVAC system improvement or replacement, and the installation of meters.
Energy conversion -	improvements to combustion systems such as boiler, furnace, or water heater retrofits, chiller improvement/replacement, and the installation of energy recovery equipment.
Building envelope -	double glazing or window replacement, reduction of glass area, and the installation of roof or wall insulation and storm doors.
Lighting -	retrofits on electrical systems, bulbs/tubes and fixtures, motors and manual or automatic on/off controls.
Energy management systems -	components of computerized system.

initial capital outlay and to speed project completion and realization of savings.

The state Cogeneration Evaluation Committee has selected vendors to design, construct, and operate cogeneration systems for the Vineland and Hunterdon developmental centers and Montclair and Glassboro state colleges. Work continues to advance the six other projects identified as potentially economically feasible.

A vendor may size a system to meet facility load or may oversize the system to produce excess electricity intended for sale to a utility to increase project revenues. Federal and state regulations outlined in Chapter II-3 affect the rate negotiation process for systems sized to produce excess electricity. Therefore, a vendor must factor complex sizing options, cost, and rate projections to determine whether to proceed with each project. The execution of planned and future cogeneration projects in state buildings hinges on private sector assessments of the risks and potential profits associated with specific projects.

<u>District Heating And Cooling for State Buildings</u>

The state may also reduce energy cost by encouraging state building tie-ins to privately sponsored district heating and cooling (DHC) systems. An older and established technology enjoying renewed interest, a DHC system employs a large central boiler or cogenerator and channels heat to system participants via underground steam and hot water pipes. DHC systems that incorporate absorption chillers at the plant (in a four-pipe system) or at the end-user (in a two-pipe system) may also help to cool buildings and reduce air conditioning bills.

Efficient systems produce energy at lower cost, enable facilities to discontinue use of inefficient boilers, and improve air quality by eliminating the use of older, unregulated boilers. DHC system operators must observe stringent pollution standards at the central boiler site. Participants save on both energy and plant maintenance costs. DHC systems can help revive and attract business to the state's older cities because urban areas have sufficient density to support district projects.

Almost a decade ago, the state entered into a 20-year contract with the Trenton District Energy Company (TDEC) to participate in a two-pipe district heating system through which Trenton's Capitol Complex obtains all of its thermal energy. Operational since 1983, this system employs two diesel-driven generators to cogenerate electricity for sale to PSE&G and distributes thermal energy via nine miles of piping to 15 state buildings and to eight other public and commercial structures connected to the heating loop. The 160 MMBtu/hour boiler capacity more than satisfies the 150 MMBtu/hour system peak demand. The system produces hot water at an estimated cost of $1.80 per MMBtu.

In additional to Trenton's Capitol Complex, Trenton State Prison, Edison College, the Old Barracks and War Memorial, TDEC's customers include three public housing developments, Mercer County Courthouse and Detention Center, one school, and two commercial buildings.

Through cogeneration, TDEC consumes approximately 30 percent less fuel than that required by conventional generators and boilers to produce each usable Btu. TDEC estimates that the state realizes savings of approximately 20 percent via system participation in terms of reduced fuel, operating, and energy system maintenance costs. TDEC estimates that the DHC system saves 5 million gallons of fuel per year.[3]

TDEC projects even greater savings for system users once an additional two-pipe cooling loop begins to supply chilled water for air conditioning in 1989, enabling customers to reduce electric consumption. TDEC has leased a state site on which it constructed a 2.8 million gallon cool storage tank and leased three Justice Complex absorption chillers with a total chiller capacity of 6,600 tons/hour to partially satisfy a system peak demand of 9,000 tons/hour.[4]

Outside of Trenton, DCEED has funded DHC feasibility studies for Camden and Jersey City. Atlantic City is also currently reviewing its potential as a viable DHC candidate. The state may discover opportunities for state facilities to participate and reduce costs should DHC system plans come to fruition in these cities.

Based on Camden feasibility study results, the city's public works department spearheaded an effort to attract public and private buildings to the DHC system and obtained authorization to develop the underground piping system and to proceed with the next phase of engineering analysis.

The Camden system's initial service loop includes Rutgers University's Camden Campus, Riverfront State Prison and HMFA low-income housing and should be installed and activated within the next few years. Due to planned expansion of the prison and the subsequent increase of heating loads, the state's commitment is essential to the system's success.

Analysis

Tables IV-1-3 and IV-1-4 and Figures IV-1-2 and IV-1-3 summarize state building energy consumption in FYs 1973, 1979, 1984 and 1988. These particular years illustrate consumption prior to any formal state building program (1979), consumption in a year when the state completed a substantial number of SECB projects (1984), and the most current available consumption figures (1988).

Table IV-1-3 and Figure IV-1-2 depict consumption in Btu per square foot, while Table IV-1-4 and Figure IV-1-3 depict consumption in total Btu consumed for New Jersey state buildings. The Btu per square foot data are examined to negate the effect of increased building area on increased consumption. For example, referring to Figure IV-1-2, total electric consumption rose 16.9 percent between 1979 and 1988. However, on a Btu per square foot basis (Figure IV-1-3), there was a slight decrease (0.8 percent) in electric consumption between 1979 and 1988.

The data indicate greater reductions in thermal than in electric consumption. Between 1979 and 1988, thermal consumption decreased approximately 7.54 percent on a total Btu basis, and 21.5 percent measured in Btu per square foot. The combined electric and thermal Btu per square foot consumption of New Jersey state buildings decreased 13.0 percent between 1979 and 1988.

Table IV-1-5 depicts annual energy bills for New Jersey state departments in 1979, 1984, and 1988. The sharp rise between 1979 and 1984 (approximately $43,300 million or 85 percent) most likely reflects the sharp rise in electric and natural gas prices in this period, particularly following the 1979 oil embargo.[5]

The six-year lag in SECB appropriations between FY 83's Cycle II and FY 89's Cycle III approval delayed the implementation of many technically approved projects that could have further affected consumption and expenditures through the present. SECB projects require an average of two years to progress from application, through design, approval and contract stages, to construction.

To improve the state's ability to track energy use and costs and to identify opportunities to curb consumption in this sector, the DCEED maintains a comprehensive State Buildings Data Base. The usefulness of this data base and the success of associated monitoring efforts depend on prompt and accurate monthly reporting by all state facilities.

However, many factors hinder uniform reporting of data, such as lack of staff coordination, shifts in assignments, and insufficient metering. The absence of timely and accurate data limits the meaningful evaluation of the effects of SECB projects on actual consumption. Reporting problems also hamper attempts to define future SECB projects and confirm use and savings calculations.

State budgeting procedures themselves may act as a disincentive for saving energy and may warrant change. Since unused funds revert to the state treasury at the end of each fiscal year, departments that successfully reduce consumption and consistently show a balance of unused (i.e., "saved") funds could risk a future budget cutback equal to energy costs saved.

DCEED anticipates the exhaustion of SECB funds before all cost-effective improvements to state building stock are accomplished. To achieve real efficiency in this stock, the state will require additional monies to continue to finance identified ECMs.

As an alternative to legislative action to raise additional SECB funds, the state could consider shared savings arrangements as a future source of project funding. Through shared savings agreements, a private vendor may absorb all capital, maintenance, and operational costs of an energy system. The vendor obtains payment for equipment and services rendered by taking a percentage of the energy savings generated. State facilities could thus reduce energy costs without any capital outlay once SECB funds are depleted.

Table IV-1-3

New Jersey State Buildings Energy Consumption
Million Btu

	Electric MMBtu				Thermal MMBtu			
	1973	1979	1984	1988	1973	1979	1984	1988
Corrections	354,162	350,394	503,440	848,349	1,078,085	1,017,471	1,175,998	1,266,235
Defense	*	*	*	*	*	*	*	*
Education	28,652	31,064	29,000	20,659	90,573	83,977	87,000	15,340
Energy (Pub Broad)	6,264	12,855	13,920	68,729	1,990	1,958	2,000	**
Environmental Protection	*	*	*	*	*	*	*	*
Higher Education								
NJIT	133,026	108,063	111,360	164,394	144,725	94,788	8,849	99,920
Rutgers	1,275,099	1,444,859	1,799,496	979,487	1,723,260	1,486,743	1,259,020	1,386,809
UMDNJ	573,555	1,036,719	881,600	890,248	357,691	1,101,621	1,084,687	799,950
State Colleges	879,632	1,224,134	990,640	1,376,524	1,188,894	1,279,556	1,016,994	1,236,257
Human Services	923,882	941,822	1,094,332	1,123,518	2,940,399	2,805,577	2,441,154	2,034,151
L&P Safety	162,864	163,394	156,600	178,359	36,436	32,588	30,649	30,912
Transportation	*	*	*	*	*	*	*	*
Treasury (Cap Serv)	412,380	359,577	627,838	982,868	174,163	130,169	176,013	561,079
Totals	4,749,516	6,672,881	6,208,226	6,633,135	7,756,216	8,034,448	7,282,364	7,430,653

* Complete data not available or unapplicable for study period
** Switched to electric heat

Table IV-1-4

New Jersey State Buildings Energy Consumption
Million Btu/Square Foot

	Electric MMBtu				Thermal MMBtu			
	1973	1979	1984	1988	1973	1979	1984	1988
Corrections	0.2181	0.2158	0.2432	0.2377	0.6638	0.6265	0.5681	0.3547
Defense	*	*	*	*	*	*	*	*
Education	0.0441	0.0478	0.0387	0.0361	0.1393	0.1292	0.1160	0.0268
Energy (Pub Broad)	0.1566	0.2143	0.2175	1.0739	0.0498	0.0326	0.0313	**
Environmental Protection	*	*	*	*	*	*	*	*
Higher Education								
NJIT	0.1601	0.1291	0.1295	0.1370	0.1742	0.1132	0.0103	0.0833
Rutgers	0.1462	0.1401	0.1643	0.0732	0.1975	0.1442	0.1150	0.1037
UMDNJ	0.3294	0.3316	0.2890	0.2359	0.2055	0.3524	0.3556	0.2119
State Colleges	0.1670	0.1612	0.1303	0.1404	0.2258	0.1685	0.1338	0.1261
Human Services	0.0986	0.0993	0.1154	0.1358	0.3138	0.2958	0.2574	0.2458
L&P Safety	0.1810	0.1815	0.1740	0.2903	0.0405	0.0362	0.0341	0.0503
Transportation	*	*	*	*	*	*	*	*
Treasury (Cap Serv)	0.2749	0.2355	0.2462	0.7436	0.1161	0.0852	0.0690	0.4245
Totals	0.1550	0.1571	0.1622	0.1558	0.2524	0.2225	0.1902	0.1746

* Complete data not available or unapplicable for study period
** Switched to electric heat

Fig. IV-1-2: NJ State Building Energy Consumption, Million Btu Per Year

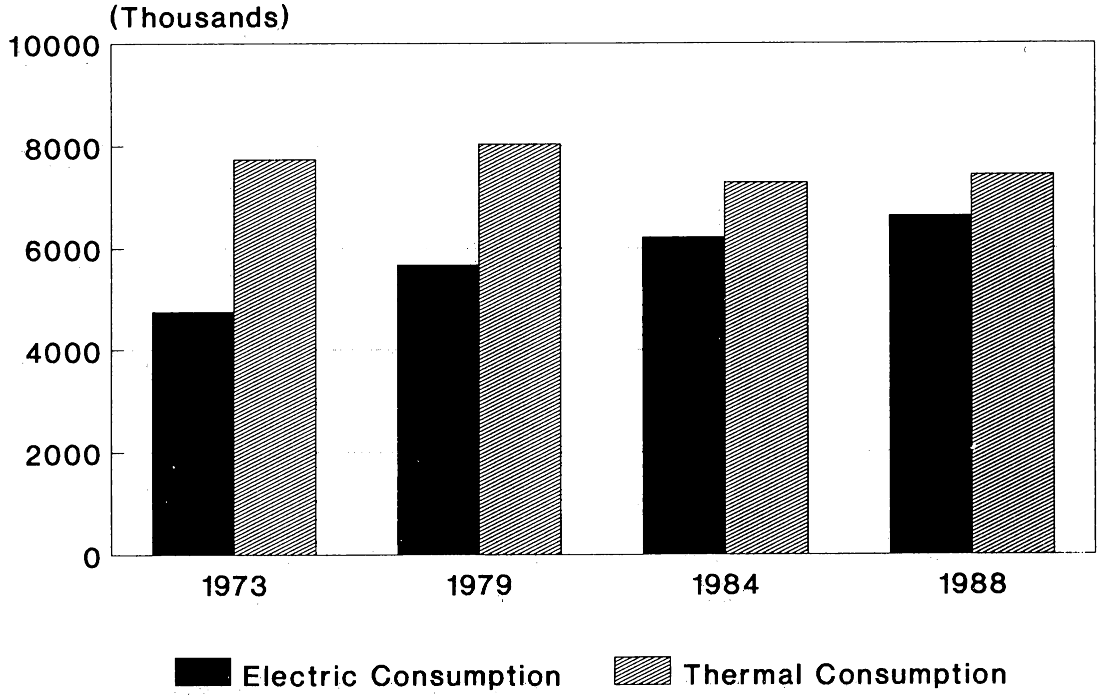


Fig. IV-1-3: NJ State Building Energy Consumption, Million Btu/Sq. Ft./Year

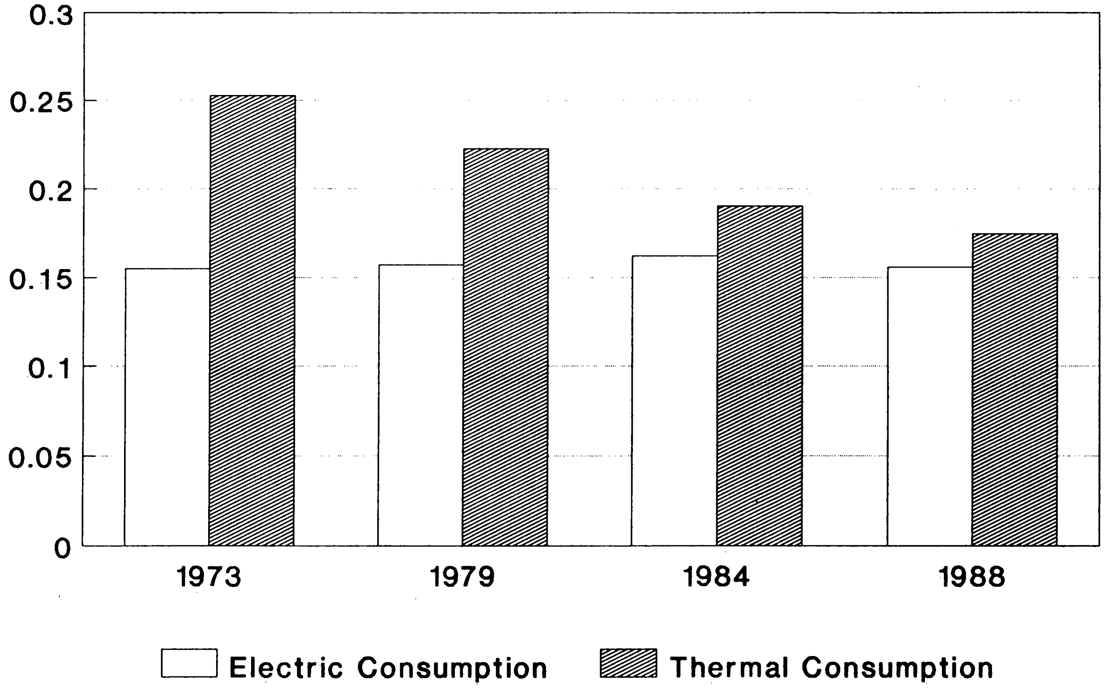


Table IV-1-5

Annual Energy Bill by Department
N.J. State Buildings
(Million Dollars)

	1979	1984	1988
Law	$ 934	$ 1489	$ 1571
Treasury	1830	3996	8670
Defense	969	1472	1487
Public Bdcsting	314	354	437
DEP	979	1761	1849
Education	736	821	601
Higher Ed	24487	44963	40451
Transportation	4492	7577	7729
Human Services	11520	21374	15559
Corrections	4873	10623	7529
Total	$51134	$94431	$85883

*Energy costs for the Departments of Banking, Agriculture, Community Affairs, Commerce, Labor, Veterans' Affairs, Health, the Public Advocate, Personnel, and Insurance, all located in the Capitol Complex, are represented in the Treasury figure.

Source: DCEED Division of Energy Planning and Conservation

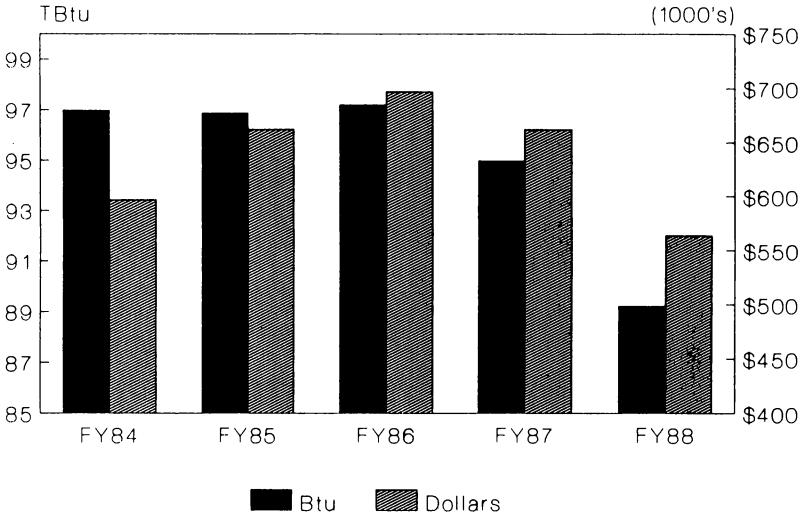
<u>SECB Program Case Study - Jersey City State College</u>: In 1984, DCEED approved SECB funding for a Jersey City State College project that included the installation of an energy management system (EMS), chiller upgrades, heating, ventilating, and air conditioning (HVAC) modifications, and lighting retrofits. The improvements were designed to control consumption in five of 10 campus buildings that represent 63 percent, or 335,000 square feet, of the college's total 485,600 square feet of space. In total, the state spent $372,394 on improvements estimated to yield $96,000 in annual energy savings annually by reducing yearly energy consumption by 14,653 MMBtu.

Figures IV-1-4 and IV-1-5 chart Jersey City State College's electric and thermal Btu consumption and expenditures from fiscal year (FY) 1984 through 1988. SECB projects were completed and became operational during FY 1987.

Between FY 1984 and FY 1986, prior to SECB project installations, electric consumption averaged 97,000 MMBtu and thermal consumption averaged more than 97,500 MMBtu at the college. By FY 1988, the first year that fully reflects savings achieved by SECB improvements, both electric and thermal consumption dropped to the 89,000 MMBtu level illustrated in Figure IV-1-6. These actual savings of almost 16,000 MMBtu exceed the initial savings estimate for the project and represent an overall reduction in consumption of almost 10 percent at the college.

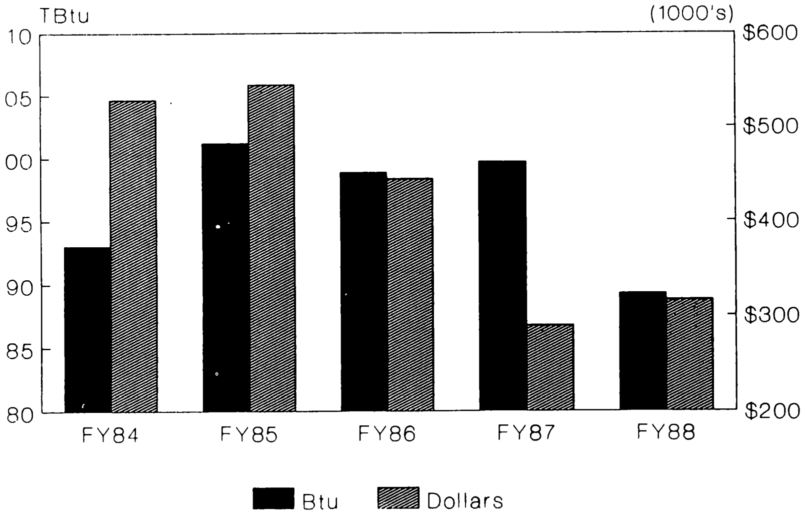
Further, the college's electric bill dropped 15 percent in FY 1988 to $563,600 from an average $651,600 per year in the FY 1984-1986 period. Thermal costs declined 38 percent to $316,300 in FY 1988 from an average $505,800 in the pre-retrofit period.

Fig. IV-1-4: Jersey City State College Electric Consumption



Source: DCEED State Buildings Data Base

Fig. IV-1-5: Jersey City State College Thermal Consumption

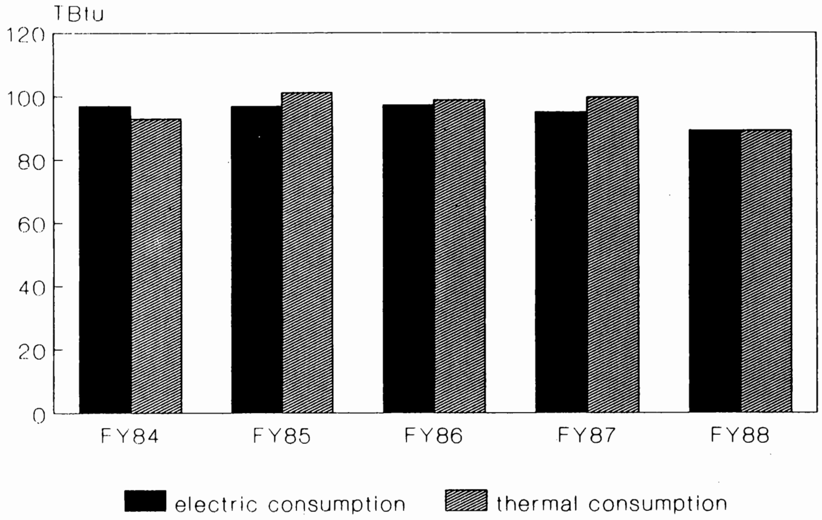


Source: DCEED State Buildings Data Base

The energy management system represented 85 percent of total project costs at Jersey City State. Project specifications estimated that the EMS alone would generate 88 percent of total project savings. Energy management systems maximize overall energy system efficiency and have proven to be a vital component of state SECB project designs.

In absolute terms, the college has reduced consumption from 581 MBtu/sq.ft. to 532 MBtu/sq.ft. via SECB program improvements. In terms of expenditures, for an initial capital outlay of $1.11/sq.ft., Jersey City State College saves $.83/sq.ft. each year in avoided energy costs relative to pre-retrofit costs.

Fig. IV-1-6: JERSEY CITY STATE COLLEGE
Total Consumption



Source: DCEED State Buildings Data Base

Findings

- The state can achieve significant energy and dollar savings through energy retrofits to state building stock and through the use of energy management systems.
- The failure or inability of some state facilities to accurately report fuel consumption and expenditures to DCEED's data base hinders state efforts to reduce consumption and lessens the state's ability to reap maximum savings from SECB-funded retrofits.
- Current state budgeting procedures may act as a disincentive for individual departments to pursue conservation goals.
- Some state facilities can reduce energy costs through the use of cogeneration.
- The state can avoid large capital outlays to reap cogeneration savings by employing third-party vendors to construct and operate cogeneration systems.

- The state realized savings of approximately 20 percent through the Trenton Capitol Complex district heating tie-in and may identify similar opportunities in other cities where DHC is under study.
- With the majority of all SECB funds dedicated to projects, new sources of funding must be identified for the program to continue.

Policy

- Each department must report consumption and cost figures to the DCEED's state buildings data base in a timely and accurate manner to enable meaningful evaluation of SECB consumption and identification of future cost-effective projects.
- All SECB projects shall include sufficient metering in their design to ensure the integrity of energy data collected and to enhance the state's ability to review retrofits for cost-effectiveness.
- Individual departments shall be rewarded for effective energy conservation efforts by being able to capture a share of the savings they generate and divert a portion of saved dollars to support the programs they run.
- The state shall pursue cogeneration opportunities at facilities identified in the Governor's Cogeneration Cabinet Committee report.
- As private firms plan and construct district heating and cooling systems throughout New Jersey, the state shall consider DHC participation where state buildings' location and thermal load indicate energy rate relief through a DHC tie-in.
- The state shall formulate new SECB legislation to fund projects once current monies are exhausted and shall explore using shared savings agreements to finance future energy improvements to state buildings stock.

Implementation

- Department heads shall assign a single energy coordinator who will provide the central coordination crucial to the success of monitoring efforts and see that each facility under the department's jurisdiction complies with data reporting rules.
- The Governor's office can most effectively provide the leadership necessary to reestablish energy conservation as an ongoing priority for all branches of state government by voicing renewed support for Executive Order No. 13 and by stressing the importance of a central energy coordinator's role within each department.

- The state shall either amend SECB regulations or earmark a separate pool of funds to pay for the installation of meters wherever appropriate in state buildings to ensure that the departments will have the tools necessary to evaluate energy systems and conservation dollars spent.

- The treasury department's Office of Management and Budget shall determine whether the state can devise a mechanism to return a portion of dollar savings to departments that successfully reduce their energy consumption, thereby creating a real incentive for conservation. Officials might pattern a procedure after the administrative fund component of state third-party cogeneration agreements, which allows a 10 percent set-aside of project savings.

- State facilities should proceed with the bidding process to attract third-party vendors to install cogeneration systems.

- The state shall cooperate in providing vendors with data pertinent to cost and sizing calculations.

- DCEED shall facilitate efforts to explore district heating and cooling opportunities.

- As departmental reporting procedures improve, DCEED shall provide the Legislature with an analysis of past performance and developing trends in state energy use to evaluate the extension of the SECB program.

- The DCEED shall act as the lead agency for identifying shared savings opportunities and shall continue to cultivate private contacts and lend technical support where studies indicate the feasibility of shared savings for state facilities. Departments and agencies shall draw on DCEED's shared savings experience in the commercial and institutional sectors to develop cost- and energy-efficient public-private partnerships.

Institutional Conservation Program (ICP)

To support the educational and medical services they supply to the general public, nonprofit schools, colleges, and hospitals consume large amounts of electricity and fossil fuels. Energy improvements in the institutional sector can yield proportionally large Btu savings and offer an excellent return on dollars invested in cost-effective energy conservation measures.

The nonprofit institutional sector requires special aid to implement energy improvements. These institutions traditionally suffer from budgetary constraints that often preclude capital expenditures for large-scale energy improvements. The Institutional Conservation Program (ICP) grants provide this sector with sufficient incentive and means to install retrofits that will, in effect, pay for themselves through energy savings and avoided energy costs.

Chapter IV-1-A

Increasing the energy efficiency of New Jersey's institutional building stock benefits the state and its citizens in a number of ways. A reduction in the energy required to power institutional operations can alleviate the need for utilities to import energy or build additional generating plants. Reduced energy consumption translates directly into reduced energy costs. Institutions may use savings to maintain or expand services or to stabilize user fees. ICP-funded improvements installed to optimize energy efficiency also afford institutions a hedge against future energy price inflation.

Legislative Authority

Under the authority of the National Energy Act of 1978, the USDOE developed the Institutional Conservation Program to provide 50/50 matching grants for technical assistance and energy conservation measures to help public and private nonprofit schools, colleges, and hospitals reduce energy consumption and operating costs through energy retrofits on institutional sector building stock.

The USDOE published the ICP regulations[6] in 1979 giving states the responsibility for and funds to conduct preliminary energy audits on schools, hospitals, and buildings owned by local government units, and on public care institutions. Further, each state was to use audit results to formulate a state plan that would specify methods through which the state would deliver technical assistance and promote the installation of energy conservation measures in schools and hospitals.

The New Jersey Department of Energy (DOE), predecessor of today's DCEED Division of Energy Planning and Conservation, was designated to administer the ICP in New Jersey. During 1979 and 1980, DOE commissioned audits on 90 percent of the state's existing eligible institutional buildings and designed funding mechanisms to deliver grants in accordance with the stringent federal guidelines. Presently, DCEED's Division of Energy Planning and Conservation administers the ICP in New Jersey.

In part, the ICP derives its funding from USDOE-allotted monies. New Jersey received a total of $15.6 million from the USDOE over the first four annual program cycles from 1979 through 1982. However, in program cycles five through eight, the USDOE reduced its annual allotment to the state to approximately $1.1 million per year. During these four cycles, the state received oil overcharge funds to provide a grand total of $9.8 million in grants from 1983 through 1986.

In 1986, the USDOE notified the state that New Jersey would receive approximately $75 million in Exxon oil overcharge monies. Of this total, the state earmarked approximately $20 million for the ICP to be distributed over the course of three funding cycles beginning in 1987. The current bulk of annual ICP funds emerge from New Jersey's share of Exxon oil overcharge monies.

Chapter IV-1-A

The Target Building Stock

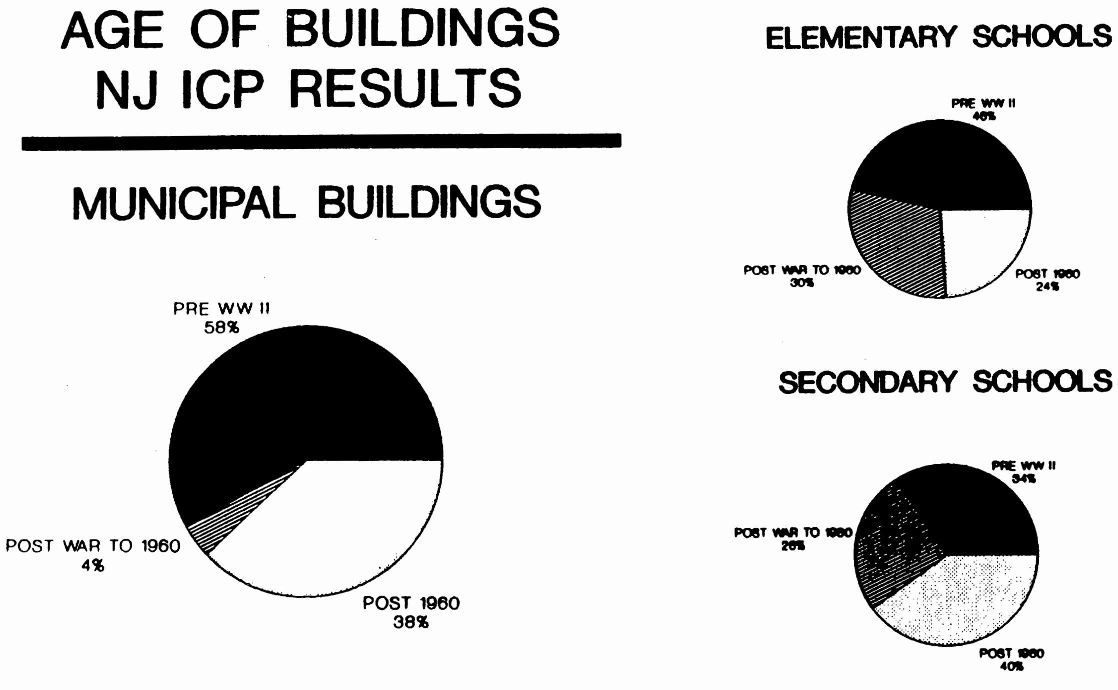
The annual ICP State Plan, submitted to the USDOE by the DCEED, indicates that approximately 3,200 primary and secondary schools, 65 colleges, 114 hospitals, and 300 residential public health care facilities are eligible to participate. Buildings range in size from schools of 30,000 to 40,000 square feet to hospitals averaging 150,000 square feet and college complexes in excess of 175,000 square feet.

Preliminary audits (on file with DCEED) conducted from 1979 through 1981 on approximately 80 percent of the state's K-12 schools, 94 percent of its colleges, and 98 percent of all nonprofit hospitals estimated average usage levels for primary and secondary schools to be 156,000 Btu/sq.ft./year. The audits revealed an average college usage rate of 470,000 Btu/sq.ft./year, and a hospital consumption rate of 569,000 Btu/sq.ft./year.

Figure IV-1-7 characterizes the stuctural age of municipal and school building stock based on preliminary audit information. Hospital and college stock, having undergone more radical changes in terms of modifications, additions, and new construction, resists such characterization.

Buildings constructed during each period possess design features common to the period that affect the stock's energy efficiency. For example, pre-World War II buildings, often noted for their composition of high-grade building materials, typically lack insulation and require upgrades to inefficient heating systems.

Figure IV-1-7



Source: DCEED Institutional Conservation Program State Plan

Post-1960 structures built prior to the energy crisis fare the worst in terms of efficiency. Popular architectural design elements, such as high percentages of glass, single-story layout, and thin walls, contribute to inefficiencies compounded by poor insulation and low-efficiency boilers installed when fuel was perceived to be cheap and expendable. Though exceptions exist, these design elements frequently prevailed and continue to affect energy consumption levels today.

Figure IV-1-7 shows that 96 percent of municipal stock either predates World War II or was constructed after 1960. Ineligible for ICP retrofit monies according to the federal regulations, municipalities may obtain retrofit loan assistance through the DCEED's commercial/industrial programs.

More than one-third of secondary schools and 46 percent of elementary schools were built before World War II. Almost one-quarter of elementary schools and 40 percent of secondary school structures were built post-1960. This client group relies heavily on ICP funding to identify and carry out conservation strategies.

ICP Operations

The DCEED administers ICP grants in annual cycles. To qualify, a building must have been in existence on or before April 20, 1977, and must be owned and primarily occupied by the institution requesting funds.

The ICP operates in three phases. First, the building owner must carry out an acceptable preliminary energy audit. Second, the institution may apply for a matching grant to fund a required technical assistance (TA) report. This detailed engineering study evaluates buildings and equipment for energy-saving opportunities. It recommends both low-cost and no-cost maintenance and operating procedures that an institution can implement immediately to begin saving energy as well as cost-effective energy conservation measures (ECMs) that require a greater purchase and installation investment. The TA analysis must be performed by a DCEED pre-qualified professional architect or engineer who is licensed by the state. Finally, an institution may apply for a matching grant to fund identified ECMs with paybacks of two to ten years.

All applications submitted within an annual funding cycle compete for the funds available within that particular cycle. DCEED scores and ranks projects according to the following weighted criteria: The combined simple payback of all ECMs requested for a building accounts for 70 percent of the score. The presence or absence of renewable resource technology contributes to 15 percent of the score. Consideration given the type and quantity of fuel to be saved equals 13 percent of the score, and climate considerations contribute 2 percent to the total.

Typical ICP-funded ECMs include improvements to a building's heating, cooling, and distribution system, lighting upgrade projects, installation of insulation and storm windows, the addition of energy management systems to optimize operations and savings, and the installation of cogeneration systems.

DCEED grants ICP funds on a 50/50 matching basis. However, if an institution cannot meet the matching fund requirement and is located in a "hardship district" as defined in the New Jersey State Plan, DCEED may grant up to 90 percent of the estimated approved project costs. Federal guidelines require state ICP administrators to set aside 10 percent of each cycle's funds to service hardship applications.

Analysis

Since the program's inception in 1979, New Jersey schools, hospitals, and colleges have received over $45 million in ICP grants. DCEED records indicate that overall payback on total grants awarded to date through 10 program cycles averages 3.5 years and suggest aggregate energy savings of more than $12 million each year statewide.

DCEED and USDOE staff monitors grantees to ensure that installed ECMs conform to specifications, but no system for post-implementation analysis of actual measured savings exists.

Table IV-1-6 summarizes the Institutional Conservation Program grant activity from 1979 through 1988.

Table IV-1-6

Institutional Conservation Program Grants, 1979-1988

Cycle #	Number of Grants Awarded	Dollars Awarded
Cycle I	155	4.7 million
Cycle II	158	4.0 million
Cycle III	208	5.4 million
Cycle IV	72	1.5 million
Cycle V	93	4.1 million
Cycle VI	66	1.8 million
Cycle VII	69	2.3 million
Cycle VIII	38	1.6 million
Cycle IX	80	15.2 million
Cycle X	70	4.9 million

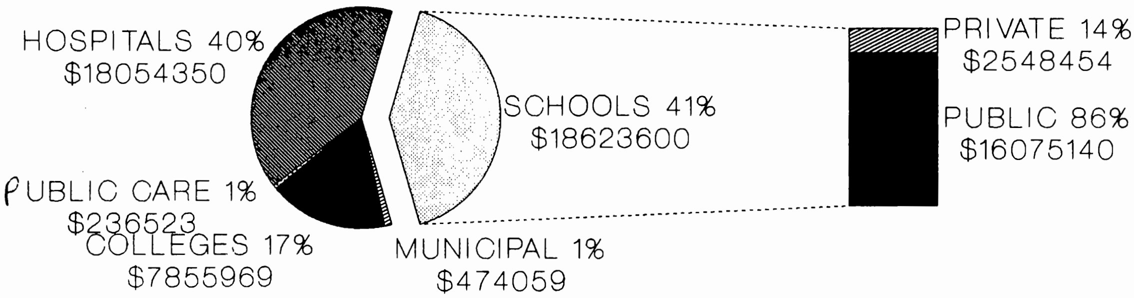
Source: DCEED Division of Energy Planning and Conservation

Figure IV-1-8 demonstrates an equitable distribution of ICP funds by client group in New Jersey over the life of the program. Federal regulations require that no single group (<u>i.e.</u>, schools or hospitals) receive more than 70 percent of the funds available within any given cycle. Although public care and municipal facilities are not eligible for grants, they are represented according to funds spent on preliminary audits at the program's inception.

The annual ICP State Plan estimates that together all ICP-eligible schools and hospitals consume approximately 50 TBtu per year. Through review and analysis of actual grant recipients, the State Plan also suggests that participating schools can achieve a 15 percent reduction in energy costs by implementing low-cost and no-cost maintenance and operating procedures outlined in TA reports and can cut energy costs by an additional 16 percent through installation of eligible ECMs. For

Figure IV-1-8

ICP GRANTS BY SECTOR
ALL CYCLES



Source: DCEED Division of Energy Planning and Conservation

hospitals, the State Plan estimates a potential 16 percent reduction in costs through operating and maintenance procedure improvements and an average additional 13 percent reduction in costs through funded ECMs.

Extending these sample findings to the whole body of ICP-eligibles, DCEED projects a total energy savings potential yet to be captured of almost 29 percent or 6 TBtu/year in hospitals and over 10 TBtu/year or 31 percent in schools throughout the state.

To achieve these savings, the institutional sector will continue to require substantial aid to mobilize the capital necessary to effect energy improvements.

The USDOE and federal courts have now adjudicated virtually all oil overcharge cases and have distributed most of the resultant monies. Even if the USDOE continues the ICP after oil overcharge funds are exhausted, New Jersey's ICP will possess insufficient monies to fund many cost-effective projects capable of generating savings year after year. Such lost opportunities to capture savings and increase efficiency contribute to unnecessarily high loads and demands on utility energy supplies.

Findings

- The ICP uses federal and oil overcharge dollars to enable nonprofit schools and hospitals to implement cost-effective improvements that can pay for themselves in energy savings and help stabilize institutional operating costs.

- From 1979 through 1988, the state's ICP has awarded New Jersey schools, hospitals, and colleges more than $45 million in grants to fund projects with an average 3.5 year payback yielding aggregate energy savings of more than $12 million each year statewide.

- Few other programs offer as ideal an opportunity to reap large quantity energy and cost savings as the ICP. The high energy consumption in schools and hospitals maximizes savings possible through the installation of ICP-funded measures.

- Potential savings are still available through upgrades to the balance of New Jersey's institutional sector building stock.

Policy

- To harness projected savings of approximately 16 TBtu/year in schools and hospitals, the state shall strengthen and continue the ICP.

Implementation

- The state shall develop a future ICP funding mechanism to succeed ICP oil overcharge funding. The legislature should consider drafting legislation allowing for a special bond issue similar to the SECB bill.

Commercial/Industrial Programs

Spending constraints attached to USDOE and oil overcharge monies steered conservation program development and delivery. The residential, institutional, and state buildings sectors received attention first based on need, volume of consumption, degree of savings opportunity, and appropriate spending considerations.

D R A F T

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Initial state efforts to assist business were limited to DOE's sponsorship of technical workshops and the dissemination of energy literature. The state later expanded programs to serve the commercial/industrial sector as additional oil overcharge funds were channelled to New Jersey.

Responding to the need for technical energy conservation guidance and assistance in the commercial sector, DOE introduced the Commercial and Light Industrial Energy Technical Service (CLIENTS) in 1982. Through CLIENTS, DOE staff conducted energy audits on small businesses, light industries, nonprofit facilities, and multi-family dwellings of five or more units. The DOE deemed 65,000 of the existing 165,000 businesses in the state to be eligible for the free CLIENTS audit.

In the first program year, 642 firms obtained free audits. Analysis of first-year program costs and audit results revealed that each administrative dollar spent by the DOE yielded an opportunity for participants to save $12. While the CLIENTS program provided the commercial/industrial sector with technical assistance to determine cost-effective energy investments, it offered no financial assistance to help small businesses implement improvements identified by the audit.

In 1983, the DOE proposed to use $2 million in oil overcharge monies for a loan interest subsidy program to provide CLIENTS audit recipients with financial incentives to implement retrofits. The result was the Business Energy Improvement Loan Subsidy Program, N.J.A.C. 14A:6-2, and in May 1984 the DOE began subsidizing half the interest, up to a 6 percent DOE share, on approved energy conservation project loans obtained by CLIENTS program eligibles.

The June 1984 adoption of the Commercial and Apartment Conservation Service (CACS) regulations, N.J.A.C. 14A:22-1 et seq., shifted audit responsibilities for small-scale commercial energy users from DOE to the utilities. Through the CACS, owners/tenants of commercial buildings and multi-family dwellings using 4,500 MMBtu/year or less could obtain an energy audit from their utility for $25, $50, or $75 depending on square footage or number of dwelling units. In addition, nonprofit organizations, municipalities, and housing authorities could obtain free audits.

The CACS regulations identified a range of operating and maintenance procedures and energy conservation measures to be addressed in a final audit report that also described available financing programs. The regulations directed utilities to expend sufficient promotional effort to achieve an annual 2 percent completion rate based on their total eligible customer base. (For detail, see the CACS program description in Chapter IV-2-A.)

DOE conducted 200 CLIENTS audits in 1984 prior to the CACS becoming operational and continued to promote the loan interest subsidy program. DOE staff also set up CACS auditor testing procedures and validated utility algorithms for CACS analyses to enable the utilities to begin to deliver CACS audits in December 1984.

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Present Mode of Operation

Commercial and Light Industrial Energy Technical Service (CLIENTS)

With the advent of the utility-sponsored CACS, DOE reformatted the CLIENTS to furnish large-scale commercial energy users (ineligible for the CACS) with a means to obtain audits. DOE staff enlisted energy equipment/materials suppliers to perform audits for large commercial users. Motivated by the potential to increase product sales where audits suggested improvements, private energy equipment firms agreed to deliver unbiased no-cost audits to DOE-referred clients.

The DCEED maintains a list of CLIENTS auditor firms and recommends the audit to non-CACS-eligible businesses and organizations.

Business Energy Improvement Program (BEIP)

In 1986, the Legislature named DCEED's Division of Energy Planning and Conservation, successor agency to DOE, to act as the state's lead agency in the distribution of $28 million in Stripper Well oil overcharge monies. The DCEED formulated a three-year spending plan for these funds that reaches out to client groups not previously served by oil overcharge-funded programs. The Legislature appropriated funds in August 1987 and adopted the new Business Energy Improvement Program regulations, N.J.A.C. 14A:6 et seq., in March 1988.

The DCEED dedicated $17 million to improve commercial building stock efficiency and promote energy efficient industrial/agricultural process technologies through BEIP grants, loan interest subsidies, and no-interest and low-interest energy loans.

The Stripper Well spending plan earmarks $2 million for family-owned farm, demonstration, and Urban Enterprise Zone (UEZ) energy project grants; $250,000 for loan interest subsidies and $4.75 million for no-interest loans for commercial, nonprofit, and municipal energy retrofits; and $10 million for loan interest subsidies or revolving loans to local government units to finance the purchase of add-on equipment that can enhance the amount of energy productively harnessed and used from municipal solid waste resource recovery facilities. Table IV-1-7 projects program spending in FYs 1988, 1989 and 1990.

Family-owned Farm Matching Grants

In 1988, principals of family-owned farms that produced in excess of $2,500 worth of agricultural products annually applied for grants to increase efficiency through retrofits, machinery replacement, or the construction of alternative energy production facilities.

DCEED was able to grant up to $100,000 per project on the basis of a maximum 80 percent DCEED match share. The required farm match was calculated on a sliding scale based on the farm operation's income relative to the statewide median farm income. Project payback could not exceed 10 years. Grants were awarded on a first-come-first-served competitive basis with consideration given to payback.

Program oversubscription exhausted grant funds in 1988 and moved the Legislature to consider funding additional program cycles in the future.

Table IV-1-7

DCEED Division of Energy/Operations
Oil Overcharge Funds-Million of Dollars
Contract Activity Various Fiscal Years

Program	Type of Funding	1988	1989	1990
BEIP	Loan Subsidies	0.04	1.96	2.00
	Zero Interest Loans	0.00	6.00	5.00
	Grants	1.00	1.00	0.00
Totals		1.04	8.96	7.00

Source: DCEED Division of Energy Planning and Conservation

Urban Enterprise Zone (UEZ) Incremental Grants

In 1988, the DCEED offered grants to qualified UEZ businesses to cover the incremental cost of installing energy-related materials/equipment that exceed New Jersey Uniform Construction Energy Subcode requirements. To be eligible for funding, the UEZ applicants had to incorporate materials with a maximum 10-year payback into major renovations or new construction within state-designated zones.

The DCEED developed an alternative UEZ lighting grant program for 1989 to use the $285,000 balance of the $500,000 originally earmarked for UEZ grants. Depending on the client's utility, the new program will either supplement existing utility commercial lighting rebate programs or will provide clients with a new high efficiency lighting grant opportunity.

Demonstration Program Grants

The DCEED set aside $350,000 in 1988 to fund independent projects that demonstrate new energy technologies and show promise for wide application in the commercial sector. An independent committee scored applications based on the projects' technical merits, transferability within the commercial sector, and the quality of project management.

Loan Interest Subsidy Program

In 1988, DCEED allocated $250,000 to the loan interest subsidy program to subsidize half the interest (up to a 6 percent DCEED share) on loans obtained by small and UEZ businesses, nonprofits, municipalities, family-owned farms, condominium and cooperative apartment owners, and 5+-unit multi-family homeowners to finance energy improvements and alternative energy production projects with a maximum 10-year payback.

Zero Percent-Interest Revolving Loans

The BEIP no-interest revolving loan program aims to distribute $4.75 million through FY 1990 to family-owned farms, individually-owned and closely-held companies, private nonprofit organizations, and municipalities for energy projects. In this program, the DCEED seeks to assist very small businesses and institutions that find it difficult to raise capital by traditional methods.

The DCEED lends up to a maximum of $200,000 for energy conservation renovations or alternative energy production facility projects with a payback and loan term not to exceed 10 years.

Loan recipients repay the loan to DCEED out of annual energy cost savings or avoided energy costs and must settle any outstanding debt at the end of the loan term with a balloon payment. As an effective incentive, borrowers retain up to half of the annual savings as the balance of savings reduces the principal over the ten-year loan term. Once established, the revolving loan program replenishes itself through the collection and redistribution of principal, creating a self-sustaining funding mechanism.

Resource Recovery Interest Subsidies and Low-Interest Loans

The DCEED has allocated $10 million for loan interest subsidies and low-cost revolving loans to local government units to fund energy efficient resource recovery alternative technologies. Municipal solid waste resource recovery facility operators may purchase "add-on" equipment that will increase the facilities' ability to capture, sell, and put energy to efficient use. Savings or revenues generated by the projects help defray operating costs. Acceptable energy applications, such as district heating and cooling and ash vitrification equipment, capture waste heat and maximize a facility's overall efficiency. All projects must possess a maximum payback of 20 years.

Local government units or their contract designees may apply for a low-interest loan of up to $3 million per project or DCEED may subsidize 50 percent of the loan interest on projects up to $2 million in cost. Lump sum subsidy recipients must secure the loan from a licensed lending institution or from the Department of Environmental Protection, Division of Solid Waste Management's Solid Waste Disposal Facility Fund.

Alternative Financing/Shared Savings Program

In addition to direct audit and financial assistance programs, DCEED provides information on alternative financing methods to commercial and institutional clients. Assuming a liaison role to cultivate partnerships, the DCEED energy division facilitates meetings between commercial energy users and energy service companies (ESCOs) and publishes a comprehensive guide to formulating alternative finance agreements.

The DOE first explored the shared savings concept in 1982 to attempt to service state building and institutional clients unable to obtain SECB and ICP grants, and promulgated shared savings regulations, N.J.A.C. 14A:12-1 et seq., in 1982. These regulations remain in effect to govern municipal, county, state, and school district agreements. However, commercial participants may utilize the information contained in the regulations to shape favorable commercial sector contracts.

Shared and guaranteed savings agreements take many shapes. In general, however, a firm or organization "performance contracts" with an ESCO that supplies energy-saving equipment to reduce energy consumption and costs. The energy user pays the ESCO by sharing the energy savings generated by the ESCO-installed equipment. Thus, the user can begin saving energy and money immediately without making any capital investments.

In a guaranteed savings agreement, an ESCO usually leases energy-saving equipment to a user and guarantees that the equipment will generate savings in excess of installation and lease costs. If actual savings fall short of the minimum dollar savings specified in the contract, the ESCO absorbs the loss. Should savings exceed those projected, the user may retain all additional savings. The lease or lease with purchase option available through guaranteed savings enables the user to spread capital equipment costs over the life of the contract.

Analysis

The USDOE estimates that New Jersey's commercial/industrial sector consumes in excess of 900 TBtu of energy each year and accounts for almost 45 percent of the state's total energy consumption.[7] In developing programs to reduce consumption in this sector, the DCEED has tried to balance the degree of financial assistance it offers with the target group's ability to raise capital on its own or from other sources.

Historically, DOE and DCEED have stressed the importance of first documenting energy consumption and potential savings, and only then extending financial assistance for improvements. The required energy audit or feasibility study provides the state with a tool to assess its dollar investments and provides profit-oriented clients with detailed payback information. Many companies may find sufficient profit incentives in audit results to implement ECMs without financial aid. However, some clients in this sector simply cannot raise capital on their own and require substantial assistance. Still others need only a slight incentive to sway their investment decision.

The following evaluation measures program response to various degrees of assistance and suggests the savings enabled by the BEIP component programs to date.

Responding to the March 1988 family-owned farm grant program announcement, 594 farmers requested matching grants for $11 million worth of projects by the May application deadline. The DCEED quickly exhausted the $1.15 million in grant money to fund $1.6 million worth of projects.

The DCEED estimates that the $1.6 million in improvements will yield more than $466,000 in annual energy savings. These figures reflect an average simple payback of 3.46 years on total monies or a 2.43-year payback on DCEED-supplied dollars. State farmers project they will save 28.9 billion Btu each year with the improvements. Grantees focused on rapid-payback diesel pump irrigation, plate cooler, and absorption chiller technologies.

The DCEED received national recognition from the National Association of State Energy Officials (NASEO) for the farm grant program with a first place prize for energy impact in 1988. The NASEO reviews energy programs nationwide to identify cost-effective programs that may be used as models for other states.

The 11:1 ratio of matching farm grant funds requested to those available in the program's first cycle indicates the strong desire of state family-farmers to increase system and energy efficiency. The sheer volume of applications and Btu-savings potential demonstrate a real need and viable opportunity to achieve substantial energy savings within this target group.

If funds became available to service the outstanding $10 million in farm grant applications, DCEED's analysis of applications on file indicates that the state could capture an additional 185 billion Btu/year in energy savings.

In 1988, the DCEED awarded $215,105 in UEZ incremental grants. Successful grantees used the funds to install energy management systems, thermal windows and doors, insulation, and high efficiency HVAC and lighting systems. Project payback on dollars awarded averaged approximately three years. Based on approved application savings calculations, the funded projects will yield savings of more than $72,000/year, equivalent to almost 5 billion saved Btu annually.

DCEED's $350,000 in 1988 grant awards for demonstration projects will showcase the use of a variety of technologies and applications. Funded projects are a solar energy system, improved industrial process technology and modified process unit design, and a resource recovery technology.

The DCEED has awarded businesses almost $224,000 in loan interest subsidies throughout the life of this program to offset the cost of installing more than $2.5 million worth of energy improvements with paybacks of less than 10 years. The overall payback of interest subsidy projects historically averages less than five years. Payback on DCEED-supplied funds averages less than one year. The subsidized projects enable businesses to save approximately 112.5 billion Btu/year, yielding annual dollar savings of more than $743,000.

As of December 1988, DCEED tentatively approved almost $2.5 million worth of revolving loan applications with the potential to save almost $430,000 in energy costs annually. Family-owned farms that turned to the revolving loan fund for aid once first-cycle grant funds were exhausted estimate potential savings of $355,000 per year through implementation of $1.7 million in ECMs. Nonfarm applicants received tentative approval on $591,000 in loans to enable annual savings of approximately $74,000. These figures show an average simple payback of almost 4.8 years for farm projects and 7.9 years for all others. Viewed as a whole, the average payback for all projects under this phase of the BEIP is 5.3 years.

Two counties submitted preliminary resource recovery funding requests to DCEED in 1988. Many other local government units statewide have developed proposals to build facilities in compliance with state solid waste legislation, but must resolve design and siting controversies before proceeding with plans.

The refinement and use of alternative financing agreements may become increasingly important in the future as program funding sources dwindle or disappear. The DCEED keeps pace with industry changes and legislation that could affect the feasibility of agreements and continues to act as an information clearinghouse, lending technical support and advice to interested energy users.

Findings

- State conservation initiatives in the commercial/industrial sector address both the need to establish energy improvement costs and benefits through the audit tool and the subsequent need to provide varying levels of financial assistance to implement energy improvements.

- The DCEED received $11 million in eligible funding requests during the first cycle of the family-owned farm matching grant program in 1988 and satisfied $1.15 million worth of requests, exhausting available funds. This 11:1 ratio demonstrates family-farmers' desire to increase efficiency and a potential for significant future savings in this target group.

- Of all programs initiated in 1988 under the new BEIP regulations, grant and no-interest loan programs offer the greatest degree of assistance, attract the largest number of participants, and result in the most immediate implementation of cost-effective energy improvements.

- The DCEED estimates that the $1.365 million in grants distributed to family farms and UEZ businesses in 1988 will yield annual energy savings of more than $500,000, demonstrating a 2.7 year payback on DCEED oil overcharge monies.

- The DCEED estimates annual savings of $430,000 via the implementation of $2.5 million in no-interest loan projects tentatively approved by year-end 1988. Project paybacks average 5.3 years, but more importantly, DCEED can fully recover its investment and redistribute the monies to fund more projects in perpetuity.

- As the state depletes its share of oil overcharge funds, the commercial/industrial sector may need to turn to alternative financing agreements with private energy service companies to reduce consumption and capture savings.

<u>Policy</u>

- The state shall seek to further reduce energy consumption in its commercial/industrial sector that accounts for more than 40 percent of the state's annual energy use.

- The state shall continue to make energy audit delivery to the commercial/industrial sector a priority and a prerequisite for financial aid.

- The state shall increase financial incentives for commercial/industrial clients to become more energy efficient.

- The state shall continue to improve its expertise in the development and evaluation of favorable alternative financing packages.

Implementation

- The DCEED shall work with utilities to increase audit delivery to the commercial/industrial sector. The state and utilities shall also ensure that audit reports provide comprehensive listings of both state- and utility-sponsored financial assistance programs.

- The DCEED shall track and analyze response to the various BEIP programs introduced in 1988 to identify the most effective means of achieving retrofits in the commercial/industrial sector.

- The state shall develop legislation to enlarge the pool of revolving loan monies and to expand this program's eligible client base.

- The DCEED shall continue to monitor all economic and legislative factors that affect the viability of alternative financing agreements and shall continue to provide agreement guidelines to potential users.

Weatherization Assistance Program

Without government or utility aid, low-income residents lack the means to weatherize their homes. Low-income families possess the least disposable income or capital to invest in energy conservation improvements. By expediting the weatherization of low-income dwellings, individual households and the state as a whole may more quickly reap the benefits of reduced consumption in this sector.

In accordance with initial USDOE and later federal court spending directives for oil overcharge monies, the state implemented the Weatherization Assistance Program (WAP) for low-income eligibles in 1977. The federal government distributes program funds to the states based on population, past weatherization program performance, and various economic and climate-related factors. Each state must submit annual spending plans and file reports of program accomplishments.

The Governor designated the Department of Community Affairs (DCA) as WAP administrator in New Jersey prior to the existence of a Department of Energy, and DCA continues to administer this program today through its Division of Community Resources, Office of Low-Income Energy Conservation.

Present Mode of Operation

To deliver weatherization assistance, DCA grants funds to community action agencies, native American tribal organizations, community-based organizations, and units of local government who manage localized weatherization programs that identify needy, eligible households and install weatherization materials to reduce energy consumption in the low-income residential sector. Low-income state residents with household incomes of 150 percent of federal poverty guidelines or less may contact DCA to obtain WAP services through a local weatherization program.

All 21 counties within the state receive WAP funds for at least one weatherization project to guarantee equitable distribution of funds throughout the state. In selecting projects, the DCA gives preference to community action agencies and nonprofit organizations that have previously demonstrated an ability to deliver quality work and meet program performance goals.

The DCA utilizes New Jersey's Residential Conservation Service (HESP) audit procedures to evaluate one- to four-family structures and the Commercial and Apartment Conservation Service (CACS) audit to assess larger multi-family dwelling for energy efficiency. These standardized survey tools provide customized energy reports and rank improvements in order of cost-effectiveness, thereby improving DCA's ability to prioritize project spending.

Through the WAP, eligible low-income homes may obtain insulation, weatherstripping and caulking, replacement prime windows and doors, replacement storm windows and doors, window shades and heating systems depending upon audit results. The DCA may invest up to a maximum of $2,000 worth of materials and services per eligible home.

A WAP Policy Advisory Council helps program administrators develop policies and seek ways to improve program delivery and efficacy. The council strives to solicit input from all concerned parties and includes representatives from local government, the Community Action Program Executive Director's Association, trades and utilities, as well as from native American, senior citizen, and handicapped advocacy groups. The DCA also invited the DCEED to join the council in 1988.

Analysis

Continued federal program support for the WAP relies heavily on demonstrated program results. The DCA monitors subgrantees and projects to ensure productivity and cost-effective application of funds. The DCA also attempts to maintain continuity of program delivery and screens subgrantees to ascertain their experience and ability to deliver WAP services.

Through the WAP, DCA weatherized more that 60,000 low-income dwellings between January 1978 and December 1988. DCA estimates that it will reach an additional 11,500 homes in 1989. At this rate it would take 32 years to reach the remaining 365,000 dwelling units in the state that are estimated to be eligible.[8]

However, DCA cannot count on weatherizing 11,500 units a year after 1989 because Exxon oil overcharge monies, which fund 70 percent of these efforts, will be almost entirely expended. Following is a breakdown of DCA's funding and production for all programs in 1989:

Source	Dollars	Planned Production
DOE	$ 4,434,657	2,308 units
DHS	2,202,060	1,228 units
Exxon	12,800,000	8,000 units
Total	$19,436,717	11,536 units

In 1986, by adopting the USDOE-approved HESP and CACS audit standards used for utility low-income programs, the DCA moved towards program standardization and the goal of ensuring that low-income families will receive equal benefit regardless of whether they seek aid through WAP or through utility-sponsored low-income programs.

The DCA's WAP targets the same state residents that utility low-income seal-up and direct grant programs target. The DCA and most utilities identify weatherization clients through local Community Action Programs (CAPs). Whereas DCA contracts with CAP agencies to deliver services, utilities may deliver services through their own subcontractors or through CAP contractors.

Given this scenario, much of the responsibility for coordinating weatherization services falls on the local CAP agencies. These nonprofit agencies may lack sufficient staff or record-keeping ability to fully track and monitor all weatherization efforts.

The state and utilities should explore ways to coordinate the WAP and utility-sponsored low-income weatherization programs to streamline the delivery of services and avoid duplicative efforts within the eligible population. State and utility low-income program managers have increased communication at the highest level of administration and identified ways to enhance subgrantee and subcontractor communication and tracking abilities.

Findings

- DCA uses oil overcharge funds to deliver up to $2,000 per household of weatherization materials and services to the state's low-income residents.
- To date, DCA has weatherized more than 60,000 homes and has estimated that an additional 365,000 homes are still program-eligible.
- DCA estimates that continuing at its current annual rate of completion, it will require more than 30 years to weatherize remaining eligible households.

Policy

- The state shall continue its efforts to weatherize low-income building stock throughout the state and shall coordinate more closely with utility programs that aid the same low-income population to streamline program delivery and ensure effective spending.

Implementation

- The state shall identify new funding sources to continue low-income weatherization efforts in the future.
- The state and utilities shall conduct a comprehensive review of their separate low-income programs to identify ways to maximize dollars spent in this sector.

FOOTNOTES

1. National Association of State Energy Officials, Exxon State Programs: Innovative Uses of Oil Overcharge Funds by State Energy Officials, 1987.

2. P.G. Bos and S.A. Davis, Economic Screening Guidebook for Cogeneration in Buildings, (Wellesley, MA: ARS Group, Inc. for the Gas Research Institute, 1985), p. 1.

3. Trenton District Energy Company, Cogenerated District Heating: Trenton, New Jersey - A Study of Energy Development in and Urban Environment, (Trenton, NJ, 1985).

4. Trenton District Energy Company, information compiled by Don Leibowitz, President.

5. DCEED, Division of Energy Planning and Conservation, "New Jersey Energy Profile - 1987 Edition," and "New Jersey Monthly Energy Profile - September 1988," New Jersey, 1988.

6. Code of Federal Regulations, Title 10, Chapter II, Parts 450 and 455 (10CFR Parts 450 and 455).

7. Energy Information Administration, State Energy Data Report, 1986.

8. Based on conversations with Greg Adkins, Supervisor, Department of Community Affairs (DCA) Low-Income Weatherization Program, November 1988.

DRAFT

Chapter IV-1-A

STATE INITIATIVES

BUILDING CODES

Introduction

New buildings in New Jersey must comply with or exceed requirements of the Uniform Construction Code (UCC), which sets standards in its subcodes for plumbing, electrical, energy, and other systems. These codes are designed to assure that buildings are safe, protect the health and welfare of occupants, and perform adequately for their intended uses. Although all new and renovated buildings must comply with the UCC, DCEED has concentrated its efforts on residential buildings because of the almost unique role of buildings in our society:

1. The house is by far the largest investment made by most consumers.

2. Neither consumers nor lenders can adequately assess the quality of a completed building; codes assure both parties that minimum quality concerns are met to protect their investments.

3. In general, houses are used for scores of years and become part of the state's economic infrastructure, giving the state an interest in adequate construction and performance.

This chapter reviews the current energy subcode used in New Jersey and documents the cost-effective improvements in energy efficiency that would be expected from tightening this code. In this context, we define cost-effective to mean that any incremental capital costs must be offset by the dollar value of energy savings within 10 years (simple payback) at 1988 energy prices.

The Department of Community Affairs (DCA) is responsible for building codes and for training the building inspectors who enforce them. The DCA uses the BOCA National Building and Energy Conservation Codes as amended, adopted as part of the New Jersey Administrative Code (N.J.A.C. 5:23), as the standard code for the state; municipalities are not permitted to promulgate alternative standards.

To construct a building in New Jersey, a builder must first obtain a building permit, which is granted only if the proposed structure meets or exceeds the requirements set forth in the UCC. The DCA has designated the nationally recognized model codes and standards of various professional organizations as the UCC subcodes. The energy subcode currently in force comprises the National Energy Conservation Code/1987, of the Building Officials and Code Administrators International, Inc., (BOCA) and the LEM-1-1982 of the Illuminating Engineering Society.

D R A F T

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New Jersey's first energy subcode came in 1977, when DCA incorporated into the Uniform Construction Code the BOCA Basic Energy Conservation Code - 1977. Subsequently, under the Department of Energy Act, the authority to adopt the energy subcode was transferred to the Department of Energy (DOE), while the authority to enforce its provisions was retained by DCA.

Over the years, DOE strove to promote energy efficiency in new construction and major renovations by continuing to use the BOCA Basic Energy Conservation Code while adopting amendments periodically to raise the minimum requirements and to reflect cost-effective efficiency improvements.

On January 18, 1982, DOE upgraded the energy subcode by adopting the 1981 edition of the BOCA Basic Energy Conservation Code and amending it (N.J.A.C. 14A:3-4.1 *et seq.*) to be consistent with ASHRAE Standard 90A-1980. The procedures contained in the Illuminating Engineering Society's (IES) publication LEM-1-1982 were also adopted as part of the UCC Energy Subcode.

On August 10, 1984, the subcode was further amended to incorporate the higher post-January 1, 1984 equipment performance requirements specified in ASHRAE Standard 90A-1980.

The BOCA Basic Energy Conservation Code is based upon an American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard that sets limits for the combined thermal transmittance (U_O) value of each of the components of the structure or, as an option, the overall structure. It also specifies standards for equipment performance, and lighting.

The U-value is a quantitative measurement of the rate at which energy migrates through a building material such as wood or fiberglass; each material has an associated U-value. The standard unit of U is Btu/ft^2/hour/degree. The term R-value is more familiar to nonengineers because it is used to rate insulation. The R-value is the thermal resistance of a material. It is the reciprocal of the U-value. When used with a subscript "o", *i.e.*, U_O, the term indicates the rate of energy loss through a building component such as a wall or ceiling, which is made up of various materials, each with its own U-value.

Some of the BOCA Basic Energy Conservation Code requirements are prescriptive, others are performance. Prescriptive requirements tell a builder precisely what to do or what materials to use. Performance requirements allow the builder to use any materials or methods as long as the final product can perform according to the requirement. An important feature of the BOCA Basic Energy Conservation Code is that it affords an opportunity to deviate from the specific design criteria of Articles 3 through 6 if it can be demonstrated that the alternative building systems and equipment design will result in annual energy consumption equal to or less than that resulting from compliance with the specific criteria. In order for proposed alternative designs to be approved, they must be accompanied by documentation in accordance with the exemptions specified in Sections 10 and 11 of ASHRAE Standard 90B-1980.

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In 1985, DOE issued its Energy Master Plan, which identified the requirements of the Farmers Home Administration (FmHA) as meeting its thermal efficiency goals for new residential construction. Accordingly, DOE amended the energy subcode to incorporate the thermal transmittance (U_o) value equivalents of the FmHA prescriptive R-values for insulation levels. The FmHA had required that, to be eligible for FmHA loans, a building be constructed to certain specifications. They included requirements for insulation of a particular R-value in walls and ceilings.

Prior to this proposal, DOE compared the operating costs of a typical home built to FmHA standards against a home meeting the then-existing subcode as well as other codes. A computer model analyzed the BOCA Basic Energy Conservation Code of 1984, the Proposed Energy Subcode contained in the 1985 Draft Energy Master Plan, and the FmHA Code. Each code was modeled for a typical home heated by the following equipment: gas furnace, electric heat pump, electrical resistance, and fuel oil furnace. For each of the computer runs, a design heating and cooling load was calculated based upon a 1,800 square foot house. DOE determined that the U_o values derived from FmHA were economically justified based upon a payback period of four years for all assemblies, except the ceiling/roof assembly which required a slightly longer payback.

In 1986, when responsibility for adopting the energy subcode was returned to DCA by Reorganization Order No. 001-1986, DCA essentially agreed with DOE's approach, i.e., a nationally recognized code could be adopted and amended as deemed appropriate. With minor modifications, DCA incorporated DOE's amended U_o values into N.J.A.C. 5:23-3.18 "Energy Subcode."

Present Situation

On June 30, 1988, as a result of a lawsuit, the Appellate Division of the Superior Court of New Jersey ruled in favor of the New Jersey Builders Association (NJBA), which challenged regulations adopted by DCA that amend the energy subcode. NJBA argued that: [1] under the Uniform Construction Code Act, DCA's authority is limited to adopting the entire model code of nationally recognized organizations as a subcode; and [2] DCA does not have the authority to amend the model code it adopts. This decision resulted in a retreat to the thermal standards in place in 1982 for all new construction and major renovations in the residential sector.

The lawsuit did not affect the energy subcode as it applies to commercial and other nonresidential buildings because all of the upgrade amendments applied only to housing. As noted, DCEED has concentrated its energy subcode efforts on residential buildings because they far outnumber commercial and other nonresidential buildings. In addition, commercial buildings may be designed specifically for more knowledgeable owners who are aware of the effect of energy cost. Another factor that greatly affects energy costs is the method of operation of the building, which cannot be controlled by the energy subcode. Still, there may be potential for cost effectively saving energy in the commercial sector through the energy subcode.

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Analysis

DCEED has reviewed the model energy codes of several nationally recognized organizations. The 1988 Model Energy Code of the Council of American Building Officials (CABOMEC) closely approximates the performance standards of the energy subcode that was invalidated by the court while meeting the court's requirements for a nationally recognized model code maintained by a national organization.

The CABOMEC can be adopted in its entirety by DCA without amendments. This action would restore New Jersey's Energy Subcode by requiring nearly the same efficiency for residential building as before the lawsuit. Adoption of the CABOMEC in 1989 would result in about 5.7 TBtu savings per year by the year 2000.

DCEED's analysis shows that it is cost effective to have U_O values somewhat lower than those of the BOCA or CABOMEC, i.e., higher thermal performance. Table IV-1-B-1 compares these levels.

There is general agreement that the energy subcode should provide a maximum economically feasible building standard. There is disagreement as to whether a change from the BOCA Standard would result in energy efficiency that is cost effective. Given the requirement that a nationally recognized standard be adopted, the Energy Master Plan makes no recommendation. However, public comment is sought on the analysis and conclusion of the DCEED with respect to the utility of adopting the CABOMEC.

Table IV-1-B-1[1]

	Current Energy Subcode	CABO MEC	Cost Effective
	Maximum U_O		
Wall	0.185	0.140	0.102
Roof/Ceiling	0.045	0.033	0.030
Floor	0.080	0.050	0.048
	Equivalent Composite R-Value (R_O)		
Wall	5	7	10
Roof/Ceiling	22	30	30
Floor	12	20	21

The R_O values in the table reflect the composite of individual R-values of each of the components for a home in a location with a 5,000 degree day heating season. For example, a wall is made up of framing, insulation between the framing members, plasterboard, sheathing, siding, windows, and doors - each with its own R-value. One way to meet the CABOMEC standard for walls in a typical house is to use storm windows, an uninsulated full wood door, and 3 1/2 inch fiberglass batts (R-11) in the wall cavity. When the R-11 of the fiberglass is combined with the R-values of all of the other components, the wall has a composite R-value of 7.25, which is an equivalent U_O of 0.138.

Savings in today's energy costs, assuming natural gas for heating and only the U_O value differences between the current Energy Subcode and CABOMEC, are about $140 annually for a two-story 2400 square foot house. The increase in cost of construction is about $400. The investment in a thermally efficient structure via a reasonable energy subcode is compatible with economic development. The goal is to minimize life cycle costs. By investing a little more in construction, energy bills can be remarkably reduced. For the customer, the ultimate "bottom line" is not the mortgage payment, but the sum of the mortgage and the energy bill.

For the Energy Subcode to require as much efficiency as is cost effective, it must also address air infiltration. This area is not covered quantitatively in any of the model codes. For example, the CABOMEC states that "the...envelope shall be caulked, gasketed, weatherstripped or otherwise sealed in an approved manner." The code does not require that a performance test be made to determine if the prescribed sealing has been effective. A performance test can be easily made, however.

One type of tightness test used for single and multi-family units is a blower door test. With the use of a fan in a doorway, a positive or negative pressure differential develops in the structure, which in turn causes air to flow at an increased rate through any leaks. These air leaks can be located with the use of a smoke stick or infrared device and then corrected. Separate tests check fireplaces, exhaust fans, bottoms of doors, and ceiling stack-driven leaks. Another tightness test uses a tracer gas, which is injected and dispersed into the interior of the building. A gas detector measures the concentration of the tracer gas at various interior locations while natural leakage takes place. This test is more precise because it measures leakage conducted under natural conditions, but has less diagnostic value, since it does not help locate specific sites of leakiness.

These same tests can also assure that the house has not been sealed too tightly. Legitimate health concerns arise about the adverse consequences of reducing a home's natural air infiltration below the level necessary to remove indoor pollutants. If natural ventilation is insufficient, a heat recovery mechanical ventilator can be installed to keep the indoor air healthy without energy losses of natural ventilation via air leaks.

Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89 now in press, sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of four microcuries per liter. These and other codes set minimum but not maximum ventilation standards. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Utilities and private sector companies have implemented several programs to improve quality of construction. Typically, these programs directly address both infiltration and air duct deployment. Some programs utilize plastic vapor barriers on walls and ceilings, while others rely more on effective caulking. Most use blower doors or other measurements to evaluate the tightness of the structure. Programs such as "Super Good Cents" and the Philadelphia Electric "EEE" system are described in Chapter IV-2-B, along with Home Energy Rating Systems, but are noted here as market-driven methods that offer consumers the option of seeking out houses that perform beyond code.

A major drawback of all of the current model energy codes, including the BOCA and CABOMEC, is in the mechanical equipment requirements. The CABOMEC specifies furnace, boiler, water heater, and air conditioner efficiencies that are lower than the efficiencies of commonly available equipment on the market.

Code evolution is important enough to warrant additional effort. Therefore, DCEED will encourage BOCA and ASHRAE to promote the most cost-effective and energy efficient construction, appliances, and equipment. Such changes may result in an improved energy subcode.

Findings

- Current judicial interpretation of the law does not permit amendment of the energy subcode.
- There is a technical debate as to which national model energy subcode is economically practicable and feasible.
- Equipment and air infiltration requirements of both BOCA and CABOMEC are inadequate.

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Policy

- The Master Plan Committee shall review the testimony and technical exhibits and decide which energy subcode meets the energy efficiency requirements of the state.

- The New Jersey Energy Subcode requirements shall minimize life-cycle costs; that is, prescribe the maximum cost-effective levels at current energy prices.

- New Jersey shall adopt air infiltration/ventilation standards for residential buildings and procedures to measure compliance.

Implementation

- The DCA shall adopt the energy subcode recommended by the Master Plan Committee.

- A joint task force consisting of DCA, DCEED and the Department of Health should study the issue of air infiltration/ventilation in residential buildings and recommend appropriate standards and procedures.

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FOOTNOTES

1. The Department of Community Affairs' analysis differs from DCEED's. DCA interpolation of the CABO maximum U_O column based on a 5,500 degree day heating season is as follows:

Wall	0.130
Roof/Ceiling	0.027
Floor	0.050

The DCA's analysis of the CABO maximum U_O finds that in practice the required roof/ceiling insulation standard would be R-38 or better. In all forms of construction, the installation of the R-38 imposes certain framing and ventilation constraints that significantly raise the cost of the unit far beyond the material cost of the thicker insulation.

UTILITY PROGRAMS

HESP, CACS

Introduction

The state's seven gas and electric utilities administer several major conservation programs to increase energy efficiency in the residential and commercial sectors. The utilities implemented these conservation programs to comply with federal and state regulations enacted in the years following the energy crisis of the 1970s. Allowable program costs, reviewed and approved by BPU, are built into each utility's base rate.

Programs must benefit the utility ratepayers who ultimately absorb program costs. By promoting residential and commercial energy conservation, these programs aim to reduce or stabilize consumption so that utilities can continue to provide an uninterrupted supply of energy at a reasonable cost to their customers.

Utility programs focus on improving building stock efficiency through the Home Energy Savings Program, residential loan and rebate programs, low-income direct investment programs, the Commercial and Apartment Conservation Service (CACS), and commercial sector financial incentive programs.

Legislative Authority

Several pieces of federal and state legislation have propelled development of utility-sponsored residential and commercial energy conservation programs. In January 1975, the Department of the Public Advocate petitioned the BPU to adopt a "Residential Insulation Program." In May 1977, the BPU ordered the state's public utilities to finance cap insulation, attic ventilation fans, and automatic day/night thermostats for customers living in one- to four-family homes.[1]

The 1978 federal Residential Conservation Service (RCS) legislation[2] required gas and electric utilities to sponsor residential energy savings programs and also mandated that states devise conservation plans and require covered utilities to comply with those plans. In addition, USDOE offered states funds to implement RCS programs. New Jersey instituted its RCS program as the Home Energy Savings Program (HESP) under regulations adopted in January 1981.[3] HESP derives its continuing authority from N.J.S.A. 52:27F as amended by P.L.1987, c.365.

In 1982 the BPU ordered each utility to develop comprehensive conservation, cogeneration, and load management plans.[4] Public Service

Electric and Gas (PSE&G) obtained approval of its plan in November 1982 and six other utilities received approval in the following years.

In June 1984, DOE adopted the Commercial and Apartment Conservation Service (CACS) regulations, N.J.A.C. 14A:22-1 et seq., requiring utilities to conduct energy audits for small-scale commercial energy users and multi-family dwellings not eligible for HESP. New Jersey modeled its program after an existing federal CACS program established by the Energy Security Act of 1980. DCEED revised regulations in May 1988 to expand CACS-eligibles to include farm and industrial facilities.

In the 1985 New Jersey Energy Master Plan, DOE proposed to adopt regulations governing utility conservation plans under the department's enabling legislation.[5] DOE proposed and adopted the regulations, N.J.A.C. 14A:20-1.1 et seq., requiring the seven investor-owned utilities in the state to submit energy conservation plans biennially to DOE for review and approval.

The regulations specified that each utility's plan must address the following programs geared toward creating a more energy efficient building stock: the Home Energy Savings Program (HESP); direct investment, subsidized loan, and appliance rebate programs; and the Commercial and Apartment Conservation Service (CACS).

The utilities supplied proposals for conservation programs under the new regulations in June 1987. Pending DCEED and BPU approval, conservation plan programs will take effect in 1989.

Present Mode of Operation

Home Energy Savings Program (HESP)

Increasing the efficiency of residential building stock requires major upgrades to both existing housing stock and new construction specifications.

Through HESP, the seven utilities, in cooperation with the DCEED Division of Energy, offer energy audits to owners and occupants of one- to four-family homes, multi-family dwellings, mobile homes, and townhouses, who directly pay a heating bill. Utilities may charge customers up to $15 for the audit, but in 1988, six utilities offered the energy survey free of charge. Oil-heated homes also require a furnace combustion efficiency test performed by an oil dealer for which they may be charged up to $10 to be deducted from the maximum $15 audit cost. Lifeline recipients and low-income households may obtain the audit without charge.

State-certified energy auditors conduct a basement-to-attic energy survey to analyze a home's thermal shell and heating system and recommend cost-effective energy conservation measures (ECMs) that will enable a homeowner to increase comfort and reduce energy consumption and costs.

During the survey, the auditor identifies and explains no-cost and low-cost maintenance and behavioral practices a homeowner can implement immediately to begin saving energy.

Within two weeks of the survey, the utility provides the homeowner with a detailed written summary of survey findings that estimates potential dollar savings as well as contractor and do-it-yourself installation costs for each recommended ECM. The report specifies each measure's payback--the number of years required for the measure to pay for itself in avoided energy costs--and offers information on a variety of financing methods and incentives available to HESP participants.

HESP enables the homeowner/occupant to make informed home energy improvement decisions and to evaluate the cost-effectiveness of investing in a specific measure for his/her home. To motivate audit recipients to take action, utilities offer financial incentives to defray the cost of energy retrofits. Direct grant, loan subsidy, and appliance rebate programs provide aid tied to the level of need of various income groups.

Direct Investment

Direct investment programs provide weatherization services to customers with household incomes below 150 percent of the federal poverty guidelines or those who qualify as Lifeline recipients. This population spends a disproportionate amount of total income on energy and has little or no disposable income to invest in energy retrofits.

A large part of the low-income population is also a rental population. A Minneapolis study[6] noted that renters accounted for more than 50 percent of low-income conservation workshop attendees. A loan program, even subsidized to 0 percent, is often unmanageable for this population because they possess insufficient means to repay the principal on a loan.

Prior to 1987, utility low-income sector programs assumed two forms. Low-income seal-up programs delivered $200 worth of basic low-cost weatherization measures such as weatherstripping, caulking, low-flow showerheads, faucet aerators, water heater insulation, and plastic storm windows. Eligibles could also apply to utility direct grant programs to obtain an additional $250 worth of energy retrofits.

In view of the target population's severely limited resources, the state increased the allowable expenditure for utility direct investment programs under the revised 1986 HESP regulations. These regulations require the utilities to fund up to $1,000 worth of ECMs in low-income homes effective with the anticipated 1989 approval of the new utility conservation plans. All participants must receive a HESP audit prior to work to ensure that only cost-effective measures with a 10-year maximum payback are installed.

Loans

Utilities offer their heating customers no-interest and low-interest loans to finance HESP-related energy improvements. Loans range from $500 to $4,000. Depending on the utility, a family with an annual income below either a $30,000 or $35,000 cap may qualify for a no-interest loan. Families with incomes above these caps may obtain loans at half the current consumer interest rate.

DCEED coordinates the loan subsidy programs to ensure that only cost-effective energy conservation measures are subsidized. HESP guidelines require that subsidized measures pay back within 10 years as determined by a HESP survey.

Rebates

Depending on the individual utility, appliance rebate programs address either the retrofit market or the new housing market. Utilities offer rebates on electric or gas appliances ranging from air conditioners to ranges. Rebate programs encourage customers to purchase high efficiency appliances by partially or completely offsetting the incremental cost of purchasing a high efficiency model. These programs have no income criteria and are available to all customers.

In the new housing market, utilities frequently offer rebates to builders to encourage the installation of high efficiency appliances in a market where the construction industry traditionally installs the least costly (and less efficient) appliances to reduce construction costs. In some cases, gas utilities offer "package deals" to builders to install a complete set of high efficiency gas appliances in new homes.

Commercial & Apartment Conservation Service (CACS)

Through CACS, owners of apartments with five or more units, family-owned farms, small businesses, manufacturing plants, nonprofit organizations, houses of worship, and municipalities may obtain an energy audit. Tenants of commercial/industrial buildings may also obtain an audit. To be eligible, a building must have had a certificate of occupancy at least two years prior to the date of the audit request and must average less than 4500 MBtu in annual energy use. The service enables recipients to cut energy costs and increase profits. Regulations require each utility to target 5 percent of its commercial customer base an as annual goal for CACS penetration.

A DCEED-qualified energy specialist conducts a detailed structural and mechanical energy audit of owned or leased buildings. The customer then receives a detailed report, prepared specifically for his/her building, pinpointing areas of energy loss, and specifying estimated costs, savings, and paybacks for recommended improvements. The cost of the audit ranges from $25 to a maximum of $75, depending on the structure's size. The energy audit is performed free of charge for nonprofit organizations, including houses of worship, local governments, housing authorities, and multi-family buildings where 66 percent of the households have incomes below 150 percent of the federal poverty guidelines.

Analysis

HESP

Methods used to calculate conservation program savings differ among the utilities and government agencies. According to utility figures compiled for DCEED's Annual Residential Conservation Service Report to USDOE, state residents save approximately 23.8 MMBtu/year as a result of 60,567 audits performed during reporting year 1987/88. Utilities used several methods to estimate these savings. One utility used studies of similar programs in other states with a comparable number of heating degree days. Two utilities analyzed their own programs; two utilities made assumptions about savings and one of these plans in the future to do a study to establish savings.

The utility studies showed extremely varied savings per participant. Two of the seven utilities felt that since HESP is an evaluation tool, no savings could be attributed. Of the remaining five, the savings estimates ranged from 0.15 MBtu to 12 MBtu per participant per year. In every case, savings are projected, but no established practice of obtaining and comparing before/after measurements (or billing analysis) exists to verify savings.

A document prepared by USDOE[7] provides a sampling of eight studies that estimate energy savings per participant in RCS programs in different climates. Choosing the calculation for a climate most like New Jersey's, DCEED projects that 12 MBtu/year per participant best expresses HESP savings in the state. Using this figure as a basis for calculation, DCEED estimates that residents saved 727 MMBtu from actions taken through HESP during the 1987/88 reporting year. This figure reflects a thirty-fold increase over utility estimates. DCEED conservatively translates dollar savings associated with this figure to be approximately $5.7 million.

Table IV-2-A-1 shows that since the program's inception in 1981 through March 1988, utilities conducted HESP audits on 294,061 dwellings, or 15 percent of the total eligible customer base.

Applying the 12 MBtu/participant/year savings figure to the entire body of audits completed, DCEED estimates that HESP audits have enabled aggregate annual energy savings of 3,500 MMBtu/year in the state's residential sector. DCEED further estimates the potential for an additional 20,400 MMBtu in annual savings should the 1.7 million remaining HESP-eligible households in the state participate in the program.

Table IV-2-A-1

HESP Audit Program

Year*	Audits Performed	Utility Primary Heating Customers	% Primary Heating Customers Audited	Eligible Customers	% Eligible Customers Audited
1981	5,308	1,132,596	0.5	2,298,088	0.2
1982	14,676	1,144,088	1.3	2,158,657	0.7
1983	30,786	1,185,304	2.6	2,237,314	1.4
1984	49,797	1,207,808	4.1	2,129,504	2.3
1985	73,925	1,205,298	6.1	2,215,928	3.3
1986	59,002	1,418,182	4.2	1,805,737	3.3
1987	60,567	1,170,876	5.2	1,710,506	3.5
Total	294,061				

*Year refers to annual RCS reporting period April 1 to March 31st.
Source: DCEED Division of Energy Planning and Conservation

The diverse savings estimates attributed to HESP illustrate the need for a valid and uniform method of calculating program savings to conduct meaningful cost/benefit analyses. In 1982, the utilities, together with the BPU, DOE and the Department of the Public Advocate, organized the New Jersey Conservation Analysis Team (NJCAT) to develop a uniform methodology to evaluate conservation programs.

The seven state utilities have contracted with a private consulting firm to survey HESP participants and nonparticipants on behalf of NJCAT. The research will seek to determine the effects of the audit on the conservation behavior of the participants, as well as what actions they would have taken had they not participated in HESP. The NJCAT study will also present data on program costs and associated savings to assess the relative costs and benefits of utility conservation programs. NJCAT plans to present the study results in February 1990 so that the state and utilities can assess the effectiveness of current residential conservation programs and identify the most cost-effective means of reducing residential energy consumption in the future.

The scope of this study is ambitious and heavily dependent on massive data validation by the consultant. Rather than view the NJCAT recommendation as a proven analytical tool, it is best to view it as an initial step to more rationally manage conservation programs.

A study of 3,527 HESP survey evaluation forms filed with DOE by audit recipients between 1983 and 1986 revealed that 86 percent of respondents reported either satisfaction or a very high level of satisfaction with the thoroughness of the HESP audit. More than 91 percent indicated that they received all information necessary to make informed decisions on conservation improvements to their homes.

An average 55 percent of the respondents planned to implement low-cost, rapid-payback measures as a result of the audit. An average 45 percent planned to implement more costly recommended measures such as attic, wall, and floor insulation based on the suggested savings these ECMs could generate. The survey results indicate that HESP audits effectively inform and motivate residents to increase home energy efficiency.[8]

PSE&G-sponsored focus groups with HESP participants, conducted in January 1988,[9] also highlighted the importance of the auditors' interaction with homeowners and the follow-up written report to educating and motivating the HESP participant to take action. PSE&G-territory audit recipients stated that they relied heavily on weatherization and retrofit advice offered by the auditor on-site and often waited for the final report to reinforce the auditor's verbal recommendations to take action.

Comments offered by focus group participants reinforced the importance of the customized on-site HESP audit in increasing residential building stock efficiency in the state. They further supported the significance of the auditor's role as educator and primary motivator to spurring homeowners to take action.

Direct Investments

Table IV-2-A-2 summarizes direct investment program activity through 1988 as reported to DCEED by the utilities. Through March 1988, utilities invested almost $19 million in weatherization and retrofit measures delivered to 100,677 low-income households statewide, spending an average of almost $230 per home in the most recently reported year.

In addition to increasing the level of utility investment in low-income sector housing, the revised 1986 regulations allow DCEED to monitor utility conservation programs more closely and thus help coordinate utility-sponsored low-income programs with the Weatherization Assistance Program (WAP) administered by the Department of Community Affairs (DCA) to ensure the most cost-effective use of funds.

DCA's WAP program serves the same low-income population that utility programs target, except that WAP allows a greater expenditure per unit (up to $2,000 for architectural conservation measures) and provides for complete heating system replacement (no cost limit). Low-income residents can request services from both DCA and a utility. DCA recently adopted the HESP audit as the evaluation tool for WAP as a first step towards solving some of the problems associated with coordinating the efforts of utilities and DCA in providing weatherization services to this population. Even greater coordination is necessary to eliminate the possibility of the state and utilities delivering duplicative or conflicting services to this sector.

Table IV-2-A-2

Direct Investment Program

Year*	Number Performed	Dollars Invested	Eligible Customers	% Eligible Customers Serviced
1984	15,685	2,612,636	681,441	2.3
1985	25,955	4,616,284	709,096	3.7
1986	25,922	4,123,484	577,835	4.5
1987	33,115	7,581,841	548,044	6.0
Total	100,677	18,934,245		

*Year refers to annual RCS reporting period April 1 to March 31st.
Source: DCEED Division of Energy Planning and Conservation

The use of the HESP audit tool to identify appropriate ECMs in all low-income weatherization programs suggests modifying the HESP report to generate a prioritized work order that DCA and utilities could use to coordinate low-income investment efforts and delineate which low-income program should fund each measure.

This report could also enhance program efficiency by streamlining program administration and ensure that energy conservation efforts in the state yield the maximum savings possible.

Loans

The 1987/88 Annual RCS Report estimates statewide energy savings of 9,224.2 MBtu enabled by 373 loans issued that year. As with HESP savings estimates, utilities used a variety of calculation methods to arrive at these savings figures. Table IV-2-A-3 summarizes historic program activity.

Historically the program has not attained the level of participation expected. The $50,000 income cap and 10-year payback proviso for program and project eligibility may contribute to the low level of program utilization. The revised 1986 regulations removed the upper income cap from loan eligibility criteria, thus increasing the pool of eligibles and extending low-interest loans to a segment with sufficient disposable income to carry a loan and invest in conservation.

The HESP 10-year payback provision may also inhibit greater program participation. A number of more capital-intensive retrofits, such as window or heating system replacement, may not quite meet the required payback for HESP financing, yet these measures could contribute to increased residential building efficiency in the state. A howeowner planning to maintain a residence for 20 years might consider a measure with a 15-year payback to be a reasonable investment.

Table IV-2-A-3

Low-Interest/No-Interest Loan Program

Year*	Customers Assisted	Utility Primary Heating Customers	% Primary Heating Customers Audited	Total Loan Dollars Per Year	Average Loan Amount Per Customer
1983	38	1,185,304	0.1	$ 38,041	$ 1,001
1984	1,425	1,207,042	0.1	4,713,561	3,308
1985	2,419	1,205,928	0.2	6,897,703	2,851
1986	1,487	1,418,182	0.1	1,031,526	694
1987	373	1,170,876	0.1	653,163	1,751
Total	5,742			$13,333,994	$ 2,322

*Year refers to annual RCS reporting period April 1 to March 31st.
Source: DCEED Division of Energy Planning and Conservation

Regulations state a payback period to ensure that the utilities, and ultimately the ratepayers, finance only cost-effective ECMs. While a project has one payback assigned based on total cost, the actual payback on subsidy funds--only a small portion of total project cost--is much more immediate. The state and utilities could reevaluate the 10-year payback cutoff for this program in the future.

Rebates

Energy-efficient appliance rebate programs can capture significant energy savings in the residential sector. Rebate programs not only help a user to conserve energy but enable electric utilities to shave peak, improving their ability to deliver an uninterrupted supply of energy. New Jersey's electric utilities are summer-peaking companies and must have sufficient capacity to meet their load at peak usage. Commonly used peaking units (e.g., gas turbines) are a very costly way to produce electricity. Conservation programs that help alleviate the need for peaking units by cutting summer demand benefit all ratepayers.

Users may be willingly efficient in times of low demand, temperate weather, and moderate plant utilization. However, the long period of record heat in summer 1988 showed the limited power of utilities to stem high electric demand in extraordinary circumstances. Many residents, too, encountered record bills for energy used to air condition homes. Peak demand climbed to levels not expected to occur for at least several years, possibly a decade. Appliance rebate programs can effectively help to reduce peak load and stretch energy dollars.

Serious issues of how to promote rebates have arisen among the utilities, the BPU, and DCEED. Questions of whether to distribute rebates to the appliance seller or buyer have yet to be resolved.

The replacement of low efficiency air conditioners with high efficiency units and the installation of high efficiency units in new construction reduces peak load and residential energy costs. Table IV-2-A-4 documents a trend towards increasing participation in utility air conditioner rebate programs.

Table IV-2-A-4

Air Conditioner Rebates

Year*	# Customers Assisted	Utility Primary Heating Customers	% Primary Heating Customers Assisted	Rebate Dollars Granted Per Year
1983	17,043	1,185,304	1.4	$ 2,209,986
1984	50,090	1,207,042	6.2	7,457,997
1985	43,130	1,205,928	5.5	5,170,073
1986	53,263	1,418,182	5.6	7,836,483
1987	73,031	1,170,876	10.1	9,574,630
Total	236,557			$ 32,249,169

*Year refers to annual RCS reporting period April 1 to March 31st.
Source: DCEED Division of Energy Planning and Conservation

According to DCEED figures on annual operating costs of air conditioners, replacing a moderately inefficient unit having an energy efficiency rating (EER) of 7.0 with an identically sized unit rated at 10.5 EER can reduce seasonal cooling costs by one-third. Thus, a program that defrays the purchase cost of efficient air conditioners can significantly affect the electric demand in residential building stock.

CACS

Table IV-2-A-5 documents a steady growth in the number of CACS audits delivered annually since 1984.

CACS provides the technical expertise and information crucial to cost-effective commercial sector energy use and improvement decisions. The growing number of CACS participants each year demonstrates this sector's increasing awareness of energy costs and savings opportunities.

The 1988 revised CACS regulations expanded program eligibility to include agricultural and industrial process-dependent businesses, increasing the total program-eligible customer base. The state and utilities have also increased the number and scope of retrofit assistance

Table IV-2-A-5

CACS Program

Year*	# Customers Assisted	# Eligible Customers	$ Per Year	$ Cost per Eligible Customer
1985	2,367	166,150	$ 435,014	$ 184
1986	3,343	172,150	1,063,709	318
1987	3,862	169,650	1,100,503	285
1988	5,231*	135,872	1,298,996*	248
Total	14,803		$3,898,222	$ 263

*Projected through year's end.
Source: DCEED Division of Energy Planning and Conservation

programs. Commercial sector clients may be eligible for no-interest or low-interest loans, loan interest subsidies, rebates, or grants to implement retrofits identified through CACS.

Utilities currently submit monthly reports on residential conservation program activity to DCEED. Incorporating CACS activity into these uniform monthly reports would increase DCEED ability to conduct its mandated monitoring tasks and enhance information sharing and joint efforts among DCEED, the utilities, and the subcontractors who deliver audits to improve the CACS program.

One portion of the commercial sector resists penetration via current programs. The 1988 "Energy Options for the Year 2000" addressed the problem of initiating conservation efforts in the small commercial buildings group. The conference presented a paper summarizing the results of a Princeton University Center for Energy and Environmental Studies survey of businesses under 10,000 sq.ft. in size located in a New Jersey strip mall.[9] USDOE estimates that such small commercial enterprises account for 19 percent of all commercial square footage and 28 percent of commercial energy consumption nationwide.

The Princeton study identified factors that affect small business attitudes towards conservation. Lease-determined flat rate billing for energy use, routing of utility bills--where stores are individually metered--to off-site corporate offices, perceptions that equate conservation with diminished customer comfort or visual appeal in retail and service outlets, the perception of energy costs (typically 0.5 to 1.5 percent of gross sales) as minimal, and lack of control over energy equipment and retrofits in a lease situation all act as disincentives for conservation.

The study suggests that program sponsors revise programs and promotional materials to appeal to this group's concern for comfort and target decisionmakers who select equipment separately from those those who use it. Research indicates that most retrofit actions coincide with major remodeling efforts or changes in tenants. The Princeton paper recommends that conservation program sponsors track public records of building permit applications and utility records of name or service changes on accounts to approach the contractor or building owner in the process of making equipment decisions.

The CACS program has served the commercial sector in New Jersey since 1984, and in that time the scope and quality of the audit has steadily improved. The availability of state-sponsored financial assistance programs for the commercial sector has also helped CACS attract more interest. The continued offering of CACS audits and financial incentives to retrofit will significantly affect the commercial sector's ability to capture energy and cost savings.

Conclusion

While analysis indicates that the HESP, CACS, and other programs are achieving some positive effects, it would be worthwhile to consider adoption of methods that would provide greater incentive to utilities to invest in energy efficient technologies on behalf of their customers. At present, the cost to utilities of conservation measures is expensed, i.e., passed on directly to ratepayers. Therefore, the utilities are financially indifferent to providing such measures; the cost is passed through, but there is no return on the investment.

Instead, the utilities might be allowed to recover the cost of conservation investments in rate base, the assets on which utilities may earn a profit. In this way, they would earn a return on the investment made. This scheme could be implemented in various ways. Rebates could be included in the rate base, as well as the incremental cost of building a superinsulated structure. Further, the program should be extended to all types of appliances and systems, such as refrigerators, lighting, heating systems, etc.

Data presented in Chapter III-1 suggest that New Jersey's residential sector consumption could be reduced by more than one-third by the year 2000 if all home appliances were replaced with the most efficient appliances available on the market today. The USDOE and the Federal Trade Commission have made some progress in educating and motivating consumers to invest in efficiency through the appliance labeling program that requires "EnergyGuide" labels on seven types of major appliances. However, small appliances escape rating under current regulations. To achieve the scale of savings described in Chapter III-1 would necessitate full penetration of the large and small consumer appliance markets.

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The slow process of reorienting consumers to consider efficiency and payback concepts in making appliance purchase decisions and the tremendous potential for savings cited in Chapter III-1 behoove the state and utilities to take a lead role in retooling the state's residential sector. While consumers may not yet fully appreciate the cost and energy savings that high efficiency appliances can afford them, the state and utilities realize the savings potential and its impact on electric load.

To attempt to reduce residential electric consumption by one-third by the year 2000, New Jersey's utilities should replicate innovative programs now used in other states. For example, Massachusetts' Taunton Municipal Lighting Plant leases screw-in fluorescent bulbs that use 80 percent less electricity than standard incandescents while providing virtually the same illumination. Customers obtain bulbs that would cost up to $25 retail for only 20 cents per month through the lease agreement. The use of these bulbs reduces end user costs and utility load. This approach simplifies conservation for consumer and increases the likelihood that utility customers will embrace efficient technologies.

While current conservation programs do yield savings, innovative programs that ease the burden placed on consumers to identify and find the best available technologies merit serious study in New Jersey if the state is to reduce significantly residential energy consumption by the year 2000.

Findings

- By 1988, almost 300,000 households had obtained basement-to-attic home energy surveys through the statewide Home Energy Savings Program cosponsored by the state and its seven public utilities.

- Should the remaining 1.7 million eligible households in the state obtain a HESP audit, the residential sector might save an additional 20,400 MMBtu/year.

- The utilities currently lack uniform methods of calculating and reporting conservation program savings, preventing validated cost/benefit analyses.

- More than 100,000 low-income households have obtained free weatherization services through utility direct investment programs.

- Almost 6,000 residents have obtained no-interest or low-interest loans through utility programs to implement HESP-approved home energy improvements.

- Almost 250,000 residents have obtained rebates for the purchase of high efficiency air conditioners through utility-sponsored rebate programs. Such appliance rebate programs can effectively reduce residential energy costs and shave utility peak.

- Approximately 15,000 commercial/industrial/nonprofit entities have received comprehensive energy audits through CACS to date.

- Current conservation initiatives may be ineffective in reaching the small commercial buildings/renter portion of the commercial sector where utility costs are either fixed or hidden in rental charges.

Policy

- Using least cost planning principles, the state and utilities shall tap potential savings in the state's residential and commercial sectors to ensure the utilities' ability to meet customer demand in the most cost-effective way possible. The state shall develop a mechanism to allow utilities to profit on their investments in conservation.

- The state and utilities must refine the results to be offered in the initial NJCAT report to develop a valid method of conducting cost/benefit analyses on conservation programs to be agreed upon and used by all parties.

- Utilities must carefully weigh the cost of saved energy capturable through conservation programs against the cost of capital expansion and fuel/power importation, and must promote efficiencies wherever such a policy benefits ratepayers.

Implementation

- DCEED and the utilities shall work together to promote aggressively HESP and CACS and to identify ways to help the utilities achieve annual participation goals in each program.

- To provide HESP audit participants with reliable information, all auditors must have access to and use utility billing data.
The BPU, DCEED, and utilities, through NJCAT, must secure on a timely basis valid, uniform formula to analyze conservation programs to ensure that ratepayers receive a benefit equal to or exceeding program costs. Upon the selection of a methodology, these parties should review all programs to determine the need for change, expansion, or elimination.

- The state and utilities should integrate program delivery mechanisms to promote competition to deliver cost-effective services.

D R A F T

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FOOTNOTES

1. BPU Decision and Order, Docket # 767-768. 05/12/77.

2. Code of Federal Regulations, Title 10, Chapter II, Part 456, (CFR10, Part 456).

4. BPU Decision and Order, Docket # 8012-914C, 4/1/82.

5. P.L. 1977, c.146:1, effective 7/11/77.

6. Information provided by Minneapolis Blower Door, Minneapolis, MN, 1988.

7. USDOE Residential and Commercial Conservation Branch, Office of State and Local Programs, Residential Conservation Service Annual Report Guidance, Washington, D.C., 1988.

8. DOE-contracted study of HESP Survey Evaluation Forms, 1986.

9. PSE&G-sponsored focus groups facilitated by Response Analysis, Inc. 1/19 and 20/88.

Chapter IV-2-A

UTILITY PROGRAMS

HERS

Introduction

Building buyers and tenants expect some uncertainty in their decisions but justifiably seek to minimize them. Houses (including townhouses and condominiums) are often the largest expenditures consumers make, and highly variable energy costs are usually the third largest cost of ownership (after mortgage payments and local taxes). New Jersey has no measurement scheme (analogous to the "miles per gallon" ratings of cars) to allow buyers knowledgeably to select more efficient buildings and to enable builders and developers to market better buildings more effectively.

This chapter discusses Home Energy Rating Systems (HERS), which could give consumers this information. HERS programs are also potentially useful to builders who meet standards better than building code requirements. They can advertise more efficient buildings and show the market that operating costs (i.e., mortgage plus energy costs) can be lower with better structures than with code-compliant buildings. In addition, bankers can use energy efficiency information to adjust lending ratios, offering larger loans to those who can show that purchasing better built houses will reduce their monthly costs.

Clearly, the concepts can be extended to commercial buildings, but less work has been done in this area, and it will not be specifically discussed in this chapter.

New Jersey residents now spend more than $3.95 billion a year on energy to heat their homes and power household appliances. Most live in single-family or small multifamily buildings (up to four units) and spend an average of $1,400 to $1,600 per unit each year on electricity, gas, and oil.[1] For the more than 2 million units of that type (see Table IV-2-B-1), energy costs $3.2 billion a year. Other residents live in apartment units in larger buildings and spend an average of $1,000 a year per unit. For the more than 750,000 apartments, energy costs an additional $750 million every year.

At the present rate of residential construction and present level of fuel use, the dollars leaving the economy will rise by $44.1 million every year (40 percent of $1,600/unit x 57,000 units + $1000/unit x 19,000 new units per year).

Table IV-2-B-1

Residential Housing Segments

Residential Housing Segment	Approximate Number	Percent of Total
Existing 1986*	2,784,096	100.0
separately metered		
in single-family unit		
in 1-4 family units	1,948,867	70.0
in greater than 5 family units	835,229	30.0
New construction 1986**	57,074/y	2.0
separately metered		
in single-family unit		
in 1-4 family units	45,142	1.6
in greater than 5 family units	11,932	0.4
Units transferred F87***		
in single-family unit		
in 1-4 family units	183,697	6.6
in greater than 5 family units		

* Number computed from total units given in 1980 census (2,548,594) plus number of building unit permits, minus reported demolitions, from 1981 thru 10/87, times 0.73, an approximate factor for number of units in 1-4 family housing.

** Number of building unit permits issued by municipal government during 1986, as reported to New Jersey Department of Community Affairs (DCA) and New Jersey Department of Labor (DOL), times 0.73, an approximate factor for number of units in 1-4 family housing.

*** Number of residential units (1-4 family) for which buyer paid a realty transfer tax to the New Jersey Department of Treasury in Fiscal Year 87.

Knowing the benefits of alternatives would encourage buyers to choose cost-effective conservation. By reducing energy outlays just 5 percent and spending that money in the state, residents would provide a direct boost for the New Jersey economy of $79 million per year.

It is feasible to build homes in which people can live comfortably and well but spend only one-half or one-third as much for fuel.[2] Those homes are carefully designed, well-built, superinsulated, or solar- and wind-oriented homes. It costs somewhat more to build low-energy consuming-homes, but over the life of the home, large savings due to decreased fuel use will accrue. Innovative construction techniques make it possible to construct and market homes that cost less than $400 a year to heat and supply with hot water, even in northern climates.[3] Even if energy-saving homes cost more (some designs for the superinsulated house could raise its purchase price), the benefits to occupants far exceed the boost to the initial price tag. Annual energy savings up to two-thirds (or $1,000), which rapidly offset the higher cost, await the buyer of such a house. Clearly, the economy would benefit in the long run if builders would construct and buyers would purchase energy efficient housing.

Conversely, the largest part of the housing stock in New Jersey was built before there was an energy code and 65 percent before 1973 when the sharp rise in energy prices began. It is these approximately 1,790,000 housing units that consume the bulk of residential energy. They will continue to require excessive energy and cost their owners increasing amounts for the many years they will stand. Their great demand for gas, oil, and electricity in the coldest part of the winter and in the hottest part of the summer strains the supply system. Their requirements exacerbate problems of load management and create the need, over very short periods of the year and even over short periods of the day, for additional utility power production and distribution facilities.

The reasons are not hard to find. The real estate industry wants to keep sales prices as low as possible and is concerned that energy efficient housing is more expensive. If the focus shifted from minimum sales price (minimum construction cost) to minimum monthly costs or minimum life cycle costs, then the market could change. With appropriate information tools, builders, realtors, and bankers could all help establish the value of energy efficiency.

Houses also contain electrical appliances and equipment. Depending on the heating source, they use 35 percent of the electricity, 5 percent of the oil, and 32 percent of the natural gas consumed nationally.[4] The most important energy-using appliances are heating sources, such as the oil furnace and the water heater, followed by cooling sources, notably the refrigerator and the air conditioner. Each affects both the primary source of power (i.e., the electricity to run the refrigerator), and the secondary or derived source (i.e., the fuel used to create the electricity). Since conservation tactics must be sensitive to a wide variety of cross-cutting factors, it is also important to determine the time of day and season of the year during which the appliance operates.

As with the building shell, the appliance user is not always the person who specified the appliance. The buyer is typically the same home building contractor who wants to keep the initial price low, even though the user will pay wastefully high energy bills. Such an attitude works as badly when applied to appliances as it does in the housing design and construction process.

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Several kinds of Home Energy Rating Systems have been developed. They vary in important respects:

1. The metric employed - a qualitative scale (bronze star, silver star,...), a relative scale (1 - 10), or a quantitative estimate of actual energy used (Btu/square foot - degree day).

2. The source data - walk-through building audit, analysis of blueprints, or analysis of utility or oil consumption bills.

3. The target population - existing or new construction, single-family, or all residential property.

Nonetheless, it is possible to design programs as useful to consumers, builders, and bankers as the "MPG" data for automobiles, and with comparable accuracy. While the MPG rating is only an approximation based on measurements of the miles per gallon sample cars can achieve under carefully controlled testing conditions, it provides a baseline number to assist the purchaser in estimating the operating cost of a new car. It has become a valued and accepted part of the American vocabulary in the energy era that emerged after 1973 and deserves much credit for improvements in overall auto efficiency in this country. HERS would provide a similar rating for dwellings.

Present Situation

Types of Rating Systems

A number of home energy rating systems have been developed nationally for residences, both existing and newly constructed. They vary in design and complexity as well as in accuracy. There are three generic types of home energy rating systems: prescriptive, calculational, and performance.

Prescriptive systems involve the rating of a structure based on the presence of specified energy-efficient features (a pass-fail rating). These features often include the following: wall, ceiling, attic, slab, crawlspace, and basement insulation; duct insulation; caulking and weatherstripping; vapor barriers; window glazing; storm doors and shutters; fireplace dampers, air intakes, and glass doors; lighting systems; heating, ventilation, and air conditioning (HVAC) systems; hot water systems (including pipe insulation and low-flow shower heads); appliances; and active and passive solar features.

Some of these systems are extensions of energy audits. They consider various energy features of a house, such as its level of insulation, and rate the features based on their efficiency levels. The ratings use the assumed or specified insulation properties, the R-values or U-values, of the building surface materials and then calculate, using engineering models, the energy required to maintain specified interior temperatures, given the heat loss and gain through the building surface. The rating number is generally given as Btu per square foot of building floor area or surface area per degree day or is derived for that value. The degree day figure comes from the National Weather Service, which measures the outside temperature throughout the country, usually at airports, and for each area provides the number of degrees per day (Fahrenheit) that the average temperature varies from 65 degrees.

For homes meeting the standard, the homeowner receives a certificate indicating that the house has met the criteria of the rating program. Other prescriptive systems include point score ratings (where the number of points reflects the number of energy-efficient features present), category ratings (e.g., bronze and silver categories, based on presence of particular features), and energy use ratings (where energy use is estimated from point scores).

Calculational systems estimate the energy needs of a structure by primarily considering heating and air conditioning loads and secondarily considering appliance and hot water loads. The aims of the rating system vary by region, with different emphases on heating and cooling loads. The rating itself is likely to be presented in terms of Btu per square foot, per hour, or per degree day. These rating systems may use hand calculator models or slide calculators for the calculations, or detailed computer models, such as the nationally recognized CIRA, DOE-II, and CALPAS.

Performance systems are based on information from past energy bills, which are used to predict future energy bills (in terms of consumption or cost). Houses can be compared to similar housing stock within the same climate zone, controlling for household size. Comparing the energy use for a particular house to average energy use (for a typical house or for a group of similar houses) is often the basis for some type of category certification (such as average, above average, or below average). These systems can give quantitative energy use estimates or qualitative rankings, or data converted to dollars per year.

Analysis

Even with careful measurements and adjustments, it is difficult to provide an accurate prediction of how much energy a dwelling will use. The MPG rating assumes sufficient quality control that tests on a sample of cars will be valid for others cars of the same model. However, quality controls for residential construction are less comprehensive for houses than for cars. Builders may leave openings in the building surface or in the heating/cooling distribution system. Engineering models do not account for excessive infiltration or incorrectly installed distribution systems, but those conditions greatly affect the energy requirements of that building.

Another complicating factor is that appliances may account for one-third to one-half of the total energy cost of a house. Estimating the cost attributable to appliances depends largely on the types of appliances and habits of the residents using them. Some experts indicate that the energy cost of a home may vary by as much as 100 percent depending on the residents' habits.[5]

Table IV-2-B-2

Residential Energy Consumption
For a 1500 ft^2 Single-family Home at 5000 DD
at 1988 fuel rates.

Energy Cost Component	High Amount	% of Total	Low Amount	% of Total
Space heating	1500	50	750	50
Water Heating	50	17	250	17
Appliances	900	30	50	3
Total	3000	100	1500	100

The 1985 Energy Master Plan identified energy rating as a useful program for New Jersey. It proposed adding a rating to the energy audit of existing buildings. However, the slackening of energy cost increases cut interest in both ratings and audits. Several states started rating programs and then abandoned them.[6] Complex questions arose about the validity of the engineering model, about the applicability of the rating for occupants with differing energy use patterns, and about how a buyer could translate the rating into a relevant dollar cost or savings. In addition, no federal requirement exists for an energy rating as it does for energy audits.

Table IV-2-B-3
Rating Programs Present Status

Sponsor/Developer	Type	Started	Status
California	SF Existing	1985	pilot-inactive
Massachusetts	SF Existing	1984	pilot-inactive
Orange & Rockland	SF New	1976	active
Super Good Cents			
E'Town Gas	SF Existing	1985	active
DMC			
Conn-Save	SF Existing & New	1985	active
Cornerstones			
Pennsylvania	SF Exiting & New	1985	active

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In New Jersey, as a result of the 1985 Energy Master Plan, utility interest has risen for rating programs. In 1985, Elizabethtown Gas and, in 1987, Public Service Electric and Gas added rating analyses to their audits of existing homes. Jersey Central Power and Light and Rockland Electric have considered using the Good Cents program developed by a southern utility to rate new construction. That program uses criteria about as stringent as the present state building code.

Some utilities use rating programs to insure that new construction is efficient enough to be comfortable if heated and cooled by a heat pump. Newer designs of heat pumps can both heat and cool dwellings but do not produce heat as quickly as furnaces. Heat pumps cannot heat poorly constructed homes or can do so only at great cost, causing many complaints to builders and to utilities. An innovative program promoted by Philadelphia Electric includes empirical envelope testing in its rating system. The dwelling will achieve a positive rating only if it passes a test for air infiltration, as well as a review of the basic building specifications. Many flaws in housing construction are not visible, where the construction as specified or poor quality construction negates the effectiveness of the specified material.

From a technical standpoint, it makes sense to take the information gained on site during a HESP audit and use it to calculate annual energy use for that dwelling, since the information for both analyses is essentially the same. Several uncertainties make the results of an engineering analysis questionable for existing homes. The Princeton Center for Energy and Environmental Studies (CEES) has found that calculations of potential savings for certain retrofit measures often overstate the savings by as much as 100 percent.[7] Other factors may affect the results, such as lifestyle variations or moderation of temperature setbacks, but the engineering model is not necessarily an accurate predictor of use in existing housing. In the intact house it is impossible to be sure of conditions within the walls such as the type, amount, and quality of application of insulation. To be more accurate, one or more of the following changes must occur: the audit must be more thorough, the engineering model more comprehensive, the adjustments for lifestyle more precise, or the model must incorporate empirical data, such as the blower door test results, into the model.

Another possibility is to use meter readings, which are readily available from billing data, to rate a dwelling against itself with corrections for external changes from year to year, such as degree days and changes in lifestyle. This methodology, using PRISM, was developed by the Princeton CEES. PRISM is a statistical scorekeeping system using regression analysis techniques to evaluate energy consumption from meter readings taken before and after a conservation measure is installed along with average daily temperature. This type of evaluation would be accurate only for one family in one house. It could be difficult to translate into a rating comparing one house to another, where lifestyle and use patterns vary strongly.

In some cases the rating, in combination with the size of the home and other factors, may be translated into estimated annual energy consumption and cost. Often suggestions for home energy improvements are included on the rating form along with a new rating that would be received if the improvements were made.

Findings

- Home energy rating systems can be based on engineering analyses of existing houses, calculations from blueprints for proposed units, or analysis of energy consumption (billing data).

- Ratings can be qualitative (bronze star/gold star), relative (0 - 9), energy estimates (Btu/yr), or economic ($/yr). The selection depends on marketing goals of the program.

- All systems proposed have systematic or random errors, but many systems provide consumers and bankers with useful information and offer builders data that they use for marketing energy efficiency of their products.

- Market-driven programs backed by the credibility of the utilities have advantages over attempts to impose mandatory programs.

Policies

- DCEED, DCA, and the Board of Public Utilities (BPU) shall establish a home energy rating system for New Jersey. Such a system would provide the right incentives to buyers and sellers, by providing unbiased information to all parties.

- The HERS shall be based on voluntary participation by builders.

- The HERS adopted shall be consistent in the state and administered by the state's utilities. Incentives shall be made available to builders based on the avoided cost of energy and demand not used by HERS houses.

Implementation

- Implementation can take one of two forms: a) The adopted Master Plan can state that the BPU shall order the utilities to implement a HERS system. The BPU will initiate a proceeding pursuant to the requirements of the Administrative Procedure Act, or b) DCA as the lead agency with responsibility for the Uniform Construction Code shall propose a HERS system by administrative rulemaking using the Master Plan as basis and background for the rule.

- For quality control and program modification, any process involved should require billing analysis as back-up to the prescriptive or calculation methods.

Chapter IV-2-B

FOOTNOTES

1. New Jersey Annual Energy Profile, 1987.
2. "Passive Solar - A Better Way to Build," pamphlet by Passive Solar Industries Council.
3. J. D. Ned Nisson and Gautam Dutt, The Superinsulated Home Book, (New York: John Wiley and Sons, 1985), p. 63..
4. Energy Information Administration, State Energy Data Report, 1960-1986, p. 22-25.
5. R. Socolow, Saving Energy in the Home, (Cambridge, MA: Ballinger, 1978).
6. Vine, Barnes & Ruschard, "Energy," Vol. 13, Implementing Home Energy Ratings Systems, Lawrence Berkeley Laboratory, p. 404.
7. E. Hirst, "Cooperation and Community Conservation, Final Report," Hood River Conservation Project, DOE/BT-11287-18, June 1987, p. 38.

LAND DEVELOPMENT PATTERNS FOR ENERGY EFFICIENCY

Introduction

Dispersed development patterns have emerged over the past few decades in New Jersey. As a result, more of the state's citizens must travel greater distances to go to work, shop, and run errands. Likewise, opportunities for using efficient mass transportation modes have diminished as people and businesses have moved to more remote, low-density locations that cannot support traditional mass transit. This chapter discusses the energy efficiency importance of opening opportunities for the state's residents to take advantage of transit systems and reduce their need to travel. It also identifies state programs and policies that serve to establish land use arrangements to provide options for reduced and efficient travel.

Compact, mixed land use development requires less energy for transportation. Many factors contribute:

- Travel distances decrease between places where people live, work, shop, and carry out other day-to-day activities.
- Dependence on the private automobile decreases as walking, cycling, and mass transit are more available or feasible.
- Mass transit becomes more cost- and fuel-efficient where there are more potential riders per unit area.
- Traffic congestion is relieved, mitigating the need to widen roads at "hot spots."
- The need to extend the road network to provide access to development in new areas is reduced. At the same time, the existing infrastructure becomes more efficient due to greater utilization.

According to a study by the New York Regional Plan Association, the location of the higher density development is an important factor.[1] Residences, businesses, and other travel destinations must be sufficiently concentrated to support transit routes and facilities.[2] The distribution of offices and businesses to areas where dispersed residential development has already been established may reduce transportation energy consumption. However, these businesses must serve and be staffed by the local population. Conversely, businesses that draw their workforce from regional labor pools and rely on customers from large geographic areas diminish transportation energy consumption when they are sited in central locations served by transit systems.[3]

The Emergence of Today's Land Use Patterns in New Jersey

Since the 1940s the population has been moving away from major urban centers toward the suburbs and beyond. Table IV-3-1 shows the shift. In 1940, 36 percent of New Jersey's residents lived in the state's 10 largest cities. Only 15 percent live in those cities today. Nine of these cities have lost residents since 1940 while the state population has nearly doubled. Large portions of several outlying New Jersey counties had only 50 persons per square mile in 1940 and now have more than 1,000 persons per square mile.[4] Table IV-3-2 shows that the largest population increases have taken place mainly in outlying counties.

Table IV-3-1

Population Comparison of New Jersey's Ten Largest Cities of 1940 Between 1940 and 1987 (in thousands)

Change 1940-1987	1940 Pop.	Percent State Pop.	1987 Pop.	Percent State Pop.	Percent Pop.
Newark	429.8	10.3	315.2	4.1	-26.7
Jersey City	301.2	7.2	217.2	2.8	-27.9
Paterson	139.6	3.4	138.2	1.8	- 1.0
Trenton	124.7	3.0	90.6	1.2	-27.3
Camden	117.5	2.8	81.7	1.1	-30.5
Elizabeth	109.9	2.6	105.8	1.4	- 3.7
Bayonne	79.2	1.9	61.8	0.8	-22.0
East Orange	68.9	1.7	77.1	1.0	11.9
Atlantic City	64.1	1.5	35.4	0.5	-44.8
Passaic	61.4	1.5	53.9	0.7	-12.2
Cities Total	1496.3	36.0	1176.9	15.3	-20.7
State	4159.9		7673.1		84.5

Source: N.J. State Data Center: N.J. Population Trends 1790-1980 Table 6
Official State Population Estimates for: 7/1/87

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Table IV-3-2

Population and Density by Counties
(in thousands)

County	Area Sq. Mi.	1940 Pop.	1940 Density (Pop/Sq Mi)	1987 Pop.	1987 Density	Percent Change Population & Density
Atlantic	568	124.0	218.3	208.5	367.1	68.1
Bergen	237	409.6	1728.3	830.4	3503.8	102.7
Burlington	809	97.0	119.9	388.0	479.6	300.0
Camden	223	255.7	1146.6	496.3	2225.6	94.1
Cape May	263	28.9	109.9	94.2	358.2	226.0
Cumberland	498	73.2	147.0	137.6	276.3	88.0
Eessex	127	837.3	6592.9	844.5	6649.6	0.9
Gloucester	327	72.2	220.8	213.0	651.4	195.0
Hudson	46	652.0	14173.9	547.2	11895.7	- 16.1
Hunterdon	427	36.8	86.1	99.9	234.0	171.8
Mercer	227	197.3	869.2	327.1	1441.0	65.8
Middlesex	316	217.1	687.0	645.7	2043.4	197.4
Monmouth	472	161.2	341.5	553.6	1172.9	243.4
Morris	471	125.7	266.9	419.4	890.4	233.7
Ocean	641	37.7	58.8	403.0	628.7	969.0
Passaic	187	309.4	1654.5	463.7	2479.7	49.9
Salem	338	42.3	125.1	65.4	193.5	54.6
Somerset	305	74.4	243.9	221.6	726.6	197.8
Sussex	525	29.6	56.4	124.3	236.8	319.9
Union	103	328.3	3187.4	502.5	4878.6	53.1
Warren	359	50.2	139.8	87.2	242.9	73.7
State Total	7468	4159.9	557.0	7673.1	1027.5	84.5

Source: N.J. State Data Center: N.J. Pop trends 1790-1980 - Table 5
Official State Pop. Estimates 7/1/1987:
Table #1

In more recent years, the locus of the workplace has been shifting as well from central urban areas to suburban and exurban locations. Data comparing county employment figures between 1970 and 1984 show that most employment growth took place in outlying counties.[5]

Longer commuting distances and reduced reliance on efficient transportation modes are evident. Table IV-3-3 shows a steady decline between 1960 and 1980 in the percentage of workers employed in the same county where they reside, suggesting that workers must travel greater distances to work. Census data in table IV-3-4 show a steady decline in the percentage of workers who walk or use mass transit to commute. However, close to 8 percent more workers shared rides to work in 1980, the year after the Iranian oil crisis, than in 1970.

Table IV-3-3

Changes in Workplace Relative to Place of Residence
(in thousands)

	1960		1970		1980	
	Number	Percent	Number	Percent	Number	Percent
Work in County of residence	1,533	69.2	1,689	64.5	1,861	63.2
Work outside County of residence	682	30.8	928	35.5	1,083	36.8
Workers (reporting place of work)	2,214	100	2,617	100	2,944	100

Source: 1960 Census Data: 32-178 Table 63
1970 Census Data: 32-247 Table 61
1980 Census Data: 32-100 Table 65

Table IV-3-4

Means of Transit to Work
(numbers in thousands)

	1960		1970		1980	
	Number	Percent	Number	Percent	Number	Percent
Alone (car, truck, van)	1,430	61.1*	1,805	63.3	2,075	64.4
Carpool/Vanpool			300	10.5	591	18.3
Public Transit (all forms)	441	18.8	411	14.4	298	9.2
Walked	212	9.1	233	8.2	185	5.7
Worked at home	93	4.0	56	2.0	43	1.3
All Other	41	1.7	43	1.5	31	1.0
Not Reported	120	5.1	-----	------	-----	------
All Forms	2,340	100	2,849	100	3,223	100

*1960 figures combine workers commuting in single occupancy vehicles and those commuting by car/van pool

Source: 1960 Census Data 32-178 Table 64
1970 Census Data 32-347 Table 61
1980 Census Data 32-100 Table 65

Analysis

Comparison of Energy Demand for Travel

Table IV-3-5 compares estimated travel and energy demand differences between two hypothetical individuals who differ in access to mass transit and distances to their destinations. The individual represented in Case #1 resides in an area characterized by compact, mixed use development. Consequently, most destinations are close to home and are conveniently accessible by foot or mass transportation. The individual represented in Case #2 resides in an area characterized by a sprawled development pattern, which requires long travel distances and total auto dependence. The comparisons attempt to reflect conservative travel demands in both cases in response to fuel shortages or high prices. Due to the relatively short round trip travel distances, it is assumed that the individual in Case #1 will opt for more nonessential travel. Therefore, the tables reflect twice the number of trips for entertainment and social visits in Case #1 than in Case #2.

Table IV-3-5

Estimated Comparisons of Energy Demand for Travel

Case #1

Destination	Round Trip Distance	Gal./Trip	Trips/Yr.	Gal/Yr.
Supermarket	4	0.24	52	12.48
Post Office	0	0.00	12	0.00
Place of Worship	0	0.00	52	0.00
Entertainment	4	0.24	104	24.96
Dentist	0	0.00	2	0.00
Doctor	2	0.12	4	0.48
Social Visits	6	0.36	104	37.44
Department Store	4	0.24	12	2.88
Convenience Grocery	0	0.00	156	0.00
Workplace	24	0.61	260	158.25
Total				224.01

Case #2

Destination	Round Trip Distance	Gal./Trip	Trips/Yr.	Gal/Yr.
Supermarket	6	0.36	52	18.72
Post Office	6	0.36	12	4.32
Place of Worship	12	0.72	52	37.44
Entertainment	14	0.84	52	43.68
Dentist	10	0.60	2	1.20
Doctor	10	0.60	4	2.40
Social Visits	18	1.08	52	56.16
Dept. Store	14	0.84	12	10.08
Convenience Grocery	4	0.24	156	37.44
Workplace	36	2.16	130	280.80
Total				492.24

*In both cases automobiles are assumed to have a fuel efficiency of 16.65 m.p.g. Where a round trip distance of "0" is indicated, the individual uses a nonmotorized means of transit. Individual in Case # 1 commutes to workplace via bus. Individual in Case #2 carpools with a co-worker.

The calculations show that the individual living in a location with services, amenities, and workplace accessible by foot or mass transit (Case #1), while more mobile, requires less than half the energy required of the individual (Case #2) who would be totally auto-dependent and would have to travel longer distances. The tables also show that in both cases, transportation energy use is greatest for the commute to workplace, accounting for more than 50 percent of consumption.

Travel between home and workplace account for a significant proportion of trips generated by most families, particularly when two-income households are so prevalent. Consequently, having residences and workplaces located close to each other and/or in places served by mass transportation can greatly diminish energy demand. Development of these land uses in urban areas or nearly self-contained "cluster" communities will maximize the desired close proximity and access to the transit system.

Existing Programs and Policies

A review of existing state programs and policies reveals that many measures foster energy-efficient development patterns (see Appendix IV-3-A). These measures respond to a broad range of concerns, such as urban blight, open space needs, farmland preservation, underutilized utility infrastructure and fiscal assistance to urban municipalities. They help to establish an energy-efficient growth pattern by stabilizing and stimulating development in urban areas, containing urban sprawl, and encouraging a mix of land uses.

Policy

The New Jersey State Planning Commission created by the State Planning Act (N.J.S.A. 52:18A-196 et seq., P.L. 1985, c.398) recently released a Preliminary State Development and Redevelopment Plan (PSDRP) that sets forth 78 strategies and 332 policies to manage growth statewide. The Commission is beginning a one-year "cross-acceptance" process that allows for negotiation and reconciliation of any differences that emerge among the PSDRP and county and municipal plans and regulations. The Commission will release an interim plan after it receives county cross-acceptance reports that compare local plans with the preliminary state plan, and a final plan after six public hearings.[6]

The PSDRP divides the state into seven geographic "tiers";

Tier 1 - Redeveloping Cities and Suburbs
Tier 2 - Stable Cities and Suburbs
Tier 3 - Suburban and Rural Towns
Tier 4 - Suburbanizing Areas
Tier 5 - Exurban Reserve
Tier 6 - Agricultural Areas
Tier 7 - Environmentally Sensitive Areas

The tier system encourages growth in tiers 1 through 4 where existing or planned infrastructure capacity can support it. Concurrently, the strategies and policies of the plan seek to organize future growth in tiers 5 through 7, which will minimize sprawl. The positive effect of the tier system, as it relates to energy efficiency, is that it stimulates growth in areas where mass transportation exists and will be improved by the plan, and encourages a tighter urban form to reduce travel demand.

The PSDRP also proposes the establishment of a regional design system to redistribute regional growth from sprawling settlement patterns into a variety of energy-efficient, compact, mixed-use, central places that include cities, towns, corridor centers, villages, and hamlets. This system recognizes the importance of higher densities and integrated uses to provide accessibility that permits less reliance on the private automobile and enhances the prospects for public transportation.[7]

The tier and regional design systems are complemented by statewide strategies and policies that address major areas of concern that transcend municipal, county, and tier boundaries. They respond to issues such as housing, transportation, natural and cultural resource protection, and economic development. These statewide strategies and policies serve to support energy-efficient development because they stimulate revitalization of urban areas, channel growth to minimize sprawl, and encourage mixed-use development.

Findings

- Population shifts to the suburbs and formerly rural areas have increased reliance on the automobile.
- The subsequent movement out of urban centers by employers who rely on a regional labor market, while reducing travel distances for some commuters, increases travel distances for others and diminishes options for the use of mass transportation.
- A concentrated development pattern is essential to establish and maintain an efficient mass transportation system that provides an alternative to the automobile. Dispersed development does not have the population density required to support traditional mass transit.
- A concentrated development pattern brings residences and destination points closer together to reduce travel distances and enhance opportunities for nonmotorized transportation modes.
- The state has established many programs and policies that serve to promote residential, commercial, and industrial investment in urban areas that will help to establish an efficient land use pattern.

Policies

- The state shall encourage redevelopment and revitalization of urban areas to create and maintain densities necessary to support the use of mass transportation and to provide for reduced travel distances between housing, employment, and services.

- The state shall encourage an appropriate mix of land uses to shorten travel distances and to maximize access to destination points by nonmotorized transportation modes.

- The state shall encourage compact clustered development to improve options for the use of mass transportation and to shorten travel distances.

Implementation

In order to implement the policies outlined the state shall take the following actions:

Encourage development and redevelopment of urban areas through:

- Retaining programs, such as the Urban Enterprise Zone Program, that stimulate urban redevelopment.

- Maintaining policies of the PSDRP that encourage public and private investment in Tier 1 municipalities.

Encourage an appropriate mix of land uses through:

- Maintaining policies of the PSDRP that promote mixed use developments.

Encourage clustered development through:

- Maintaining policies of the PSDRP that establish the regional design system, and encourage economic development and redevelopment in redeveloping cities and suburbs.

Chapter IV-3

FOOTNOTES

1. A study by the New York Regional Plan Association estimated that doubling residential density from five dwelling units per acre to ten dwelling units per acre within one mile of a downtown of 10 million square feet would increase per capita use of public transit trips 17 times as much as if the density were increased by the same degree 10 miles from the central business district. The same study concluded that placement of a high-rise building in an isolated location will not facilitate public transit use. Corbin Crews Harwood, Using Land To Save Energy (Cambridge: Ballinger Publishing Co., 1977), p. 68.

2. Harwood, p. 68.

3. A study that simulated future patterns of development for Washington, D.C., to evaluate the impacts on transportation energy use found the following:

   > A dense center pattern with higher density development concentrated near the metropolitan center and a transit oriented pattern with new housing and employment development concentrated along transit lines were significantly more energy efficient than a pattern of sprawl characterized by low density, scattered fringe growth. "Energy Efficient Land Use", American Planners Association report #341, pp. 9-10.

4. Wallace, Roberts and Todd, Trends and Patterns of Growth, Draft Technical Reference Document prepared for the New Jersey Office of State Planning, 1987. p. 3.

5. George Sternlieb, "From Caboose to Locomotive" in New Jersey Issues: Papers from the Council on New Jersey Affairs. p. 122.

6. The Preliminary State Development and Redevelopment Plan Volume II, pp. 81-83.

7. The Preliminary State Development and Redevelopment Plan Volume II, p. 46.

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Chapter IV-3

Appendix IV-3-A

PROGRAMS STIMULATING URBAN DEVELOPMENT

Program	Affected Sector	Purpose	Description
Urban Enterprise Zone Program	Commercial	To enhance the economic development efforts of the state's economically distressed urban centers.	Provides: Tax credits, exemptions, and reductions; special skill training programs and priority funding to strengthen business development in Urban Enterprise Zones* within qualifying municipalities.
Loan Guarantee Program for NJ Business (N.J.E.D.A.)	Commercial/ Industrial	To stimulate business investment to maintain and expand employment in New Jersey.	Provides guarantees of loan repayment for credit-worthy businesses in need of additional security to obtain a conventional loan. Priority is given to businesses in Urban Aid** or distressed communities.
Direct Loan Program for Businesses (N.J.E.D.A.)	Commercial/ Industrial	To stimulate business investment to maintain and expand employment in New Jersey.	Provides financing for improvements to businesses that are unable to obtain credit. Priority is given to businesses in Urban Aid** or distressed communities.

* Urban Enterprise Zones (UEZs), as allowed by the Urban Enterprise Zone Act of 1983, generally comprise 25 to 35 percent of the land area of a qualifying municipality and usually encompass downtown and peripheral industrial areas.

** Urban Aid municipalities are those receiving state urban aid.

Urban Centers Small Loan Program (N.J.E.D.A.)	Commercial	To encourage merchants to remain in downtown urban areas and upgrade their properties.	Provides loans to urban businesses to renovate, remodel, or expand.
Local Development Financing Fund Program (N.J.E.D.A.)	Commercial/ Industrial	To encourage private investment in the state's Urban Aid communities.	Provides loans for building acquisition, construction, or renovation for equipment and machinery. Grants are provided primarily for development studies. Financing is limited to Urban Aid and other designated communities.
Urban Industrial Parks Program (N.J.E.D.A.)	Industrial	To accommodate growing businesses that want to stay or relocate in urban areas.	Provides affordable improved industrial space and facilities through acquisition, improvement, and subdivision of vacant sites or existing facilities. The program targets small and medium-sized growing companies that have been priced out of traditional industrial markets.
Neighborhood Development Corp. Program (N.J.U.D.C.)	Commercial	To test new techniques in neighborhood development to improve physical and economic conditions of local neighborhoods.	Provides financial and technical resources to assist Neighborhood Development projects to improve neighborhood conditions. Assistance through the program is limited to Urban Aid municipalities or communities that meet specific economic and demographic criteria.

Urban Small Business Incubator Program (N.J.U.D.C.)	Commercial	To assist small businesses to grow and develop.	Creates "incubators" providing small businesses in targeted urban municipalities with a supportive environment that offers affordable rents, access to professional and financial assistance, and shared equipment
Urban Development Program (N.J.U.D.C.)	Commercial/ Industrial/ Institutional	To stimulate revitalization by encouraging new construction and rehabilitation of existing structures that will expand the tax base, create new jobs, and attract additional development.	Provides various types of financial assistance, including: loans, loan guarantees, and equity investments for projects in Urban Aid municipalities or communities that meet specified economic and demographic criteria.
North Jersey and South Jersey Municipal Loan Programs (Casino Reinvestment) Development Authority)	Municipal Government	To reinvest a portion of casino industry revenues in community development projects.	Provides below market-rate financing for community development projects. Priority is given to projects in Urban Aid municipalities.
Business Energy Improvement Program (U.E.Z.) (DCEED)	Commercial/ Industrial	To assist businesses in Urban Enterprise Zones with the implementation of energy efficient improvements.	The program provides grants for energy improvements specifically to businesses that relocate to, or expand in, Urban Enterprise Zones.

Commercial/ Industrial Property Tax Exemption and Abatement (D.C.A.)	Commercial/ Industrial	To attract commercial and/or industrial development in designated rehabilitation areas.	Designates specific areas within eligible municipalities to qualify for tax abatement or exemption.
Small Cities Community Development Block Grant (D.C.A.)	Municipal Government	To develop viable communities through the provision of decent housing, a suitable living environment, and expansion of economic opportunities principally for persons of low and moderate income.	Provides funds to eligible municipalities and counties allocated to New Jersey under the Federal Housing and Community Development Act.
The Buy it & Fix it Program (N.J.H.M.F.A.)	Residential	To encourage low- and moderate-income families to purchase a one- to four-family house, especially in urban areas.	Provides low-interest mortgages and rehabilitation loans. Borrowers purchasing in urban target area neighborhoods are not required to be first time home buyers.
Home Mortgage Program (N.J.H.M.F.A.)	Residential	To assist low- and moderate-income homebuyers with home purchases.	Provides low-interest mortgages to low- and moderate-income first-time homebuyers The requirement of first-time purchase is waived for buyers purchasing in urban target areas.

Special Project Financing (N.J.H.M.F.A.)	Residential	To increase the state's supply of affordable housing for low- and moderate-income homebuyers and to revitalize the housing stock in urban areas.	Provides below-market interest rate mortgage loans with low down payment terms to nonprofit and private housing developers for low- and moderate-income homebuyers. Broader paramaters for mortgages are offered for homes in targeted urban areas.

PROGRAMS STABILIZING URBAN AREAS

Program	Affected Sector	Purpose	Description
Urban Aid Program (D.C.A.)	Municipal Government	To enable eligible municipalities to maintain and upgrade services.	Provides financial assistance in the form of grants to communities that meet specific economic and population criteria.
Supplemental Safe Neighborhoods Program (D.C.A.)	Municipal Government	To assist eligible municipalities in employing full-time uniformed police officers.	Provides state aid on a formula basis to eligible municipalities waiving the requirement for matching funds from Urban Aid municipalities.
Supplemental Fire Services Program) (D.C.A.)	Municipal Government	To assist eligible municipalities in employing uniformed fire fighters and/ or the purchase of emergency equipment.	Provides state aid on a formula basis to eligible municipalities and fire districts.

Safe and Clean Neighborhood Program (D.C.A.)	Municipal Government	To expand public safety in urban neighborhoods.	Provides financial assistance to Urban Aid municipalities for upgrading urban neighborhoods and increasing the total numbers of police and firefighters.
Community Services Block Grant Program (D.C.A.)	Community Action Agencies	To assist New Jersey's most disadvantaged citizens in all counties and major cities.	Provides funds to eligible nonprofit service-oriented community groups for the delivery of services such as job training, educational projects, emergency food, clothing, and shelter.
N.J. Green Acres Program (N.J.D.E.P.)	Municipalities & Counties	To increase and preserve permanent outdoor recreational areas and the public's use and enjoyment of such lands.	Provides low-interest loans for the development of parks. For urban aid municipalities grants are also provided to cover up to 25% of costs.
Urban Education Programs (Dept. of Education)	Urban School Districts	To help urban districts overcome difficulties facing urban schools.	These programs provide funding, training, technical assistance, and incentives geared to assist urban school districts.

PROGRAMS CONTAINING URBAN SPRAWL

Program	Affected Sector	Purpose	Description
N.J. Farmland Preservation Program (Dept. of Agriculture)	Agricultural	To preserve the state's agricultural land base	Enrolls prime agricultural land in areas where farming is the preferred land use. This voluntary program compensates landowners for development easements that prohibit nonfarm development for a given period of time.

POLICIES STIMULATING DEVELOPMENT IN URBAN AREAS OR GROWTH NODES

Entity	Policies
Board of Public Utilities (B.P.U.)	Utilities may provide lower rates to commercial and industrial customers moving to or expanding operations in areas where infrastructure is underutilized.
Hackensack Meadowlands are proposed. Commission (H.M.D.C.)	Transportation centers with office buildings to facilitate the use of mass transportation Development
Department of Environmental Protection - Division of Coastal Resources (D.E.P./DCR)	Development proposals must guide growth toward designated growth areas and specific urban areas areas and concentrate development to facilitate public transportation.

POLICIES STABILIZING URBAN AREAS

Entity	Policy
Department of Treasury	Urban Aid municipalities receive a higher allocation of revenue from the Gross Receipts and Franchise Taxes (G.R.& F.T.).

POLICIES CONTAINING SPRAWL

Entity	Policies
H.M.D.C.	A logical filling out and extension of existing development is proposed.
The Pinelands Commission	Pineland Communities must establish a mechanism to cluster development.

POLICIES ESTABLISHING MIXED LAND USE PATTERNS

Entity	Policies
H.M.D.C.	Residential communities with pedestrianways connecting various land uses and facilities are proposed.
H.M.D.C.	Residential clusters with neighborhood shopping and schools are proposed.

POLICIES CONTAINING SPRAWL AND ESTABLISHING A MIXED LAND USE PATTERN

Entity	Policies
The Pinelands Commission	Mixed use development that fills in undeveloped locations is appropriate for villages and towns while rural and agricultural areas should limit development.

D R A F T

Chapter IV-4

ENERGY EFFICIENCY AND THE ENVIRONMENT

Introduction

Environmental impacts of using fossil and nuclear fuel occur at several stages: drilling or mining, transport, processing, and combustion or extraction. In New Jersey the major impacts arise from fossil fuel combustion, the source of 92 percent of the state's nonrenewable energy.[1] Products and by-products of combustion become air pollutants. The state can moderate local environmental impacts of energy use by increasing use efficiency. Broader impacts--atmospheric warming and its consequences, and acid rain--require national and international action. Investments in energy efficiency/productivity as outlined in this Plan can reduce the amounts of pollutants generated by fossil fuel combustion in New Jersey 10 percent by 1992, 22 percent by the year 2000.[2] Chapter VI gives the potential for New Jersey.

Environmental impacts of energy use occur at global, national, regional, state, local, and building levels. This chapter analyzes impacts directly related to use.

The energy in fossil fuels--natural gas, petroleum, and coal--derives from combustion of carbon compounds and produces usable heat, waste heat, water, carbon dioxide, carbon monoxide, nitrogen oxides, and particulate matter. Combustion of coal or oil, chemically heterogenous mixtures, produces numerous other compounds as well. Natural gas, as distributed, is principally methane, a compound easily combustible into carbon dioxide and water.[3]

Fossil fuel combustion produces two compounds contributing to global warming trends, carbon dioxide and nitrous oxides.[4] Combustion of sulfur-containing fuel produces sulfur dioxide and sulfuric acid, substances linked to acid rain.[5] Combustion in internal combustion engines produces carbon monoxide, unburned hydrocarbon particles, and nitrogen oxides, substances contributing to local ozone.[6] Combustion products mix with air, becoming components or pollutants. Prevailing winds carry them until they move to the upper atmosphere, fall out as particles, or wash out in rain.

Crude petroleum consists of numerous complex carbon compounds that refining separates into usable fractions such as jet fuel, kerosene, distillate fuel or home heating oil, heavy boiler fuel, and gasoline.[7] Processing can derive methane, other synthetic gases, complex cyclic hydrocarbons, and sulfur compounds from coal.[8] All fossil fuels, as they come from the ground, contain compounds that combustion cannot oxidize into carbon dioxide and water and consequently become air contaminants.[9] Some contaminants are particles or attach to particles that eventually fall or that rain washes onto soil, becoming soil pollutants. Some travel through the soil into groundwater, becoming groundwater pollutants. Others react with water or other air constitutents to form secondary pollutants.[10]

Nuclear fuel environmental impacts can arise from mining, transport, releases, and accidents. The energy in nuclear fuel comes from disintegration of radioactive atoms. The products are low-level radioactive waste, useful heat, waste heat, and spent nuclear fuel.[11] Nuclear generating stations release minute quantities of radioactive material daily in several forms. Operators may release liquid waste, after monitoring and required dilution, to the cooling water source and send solid waste for burial in out-of-state facilities.[12] The gaseous releases, continuously monitored for level of radioactivity, travel with prevailing winds from out-of-state or in-state facilities.[13]

Regulations on radioactive releases from nuclear generating stations limit concentrations of liquid releases and potential human exposure. A monitoring plan for each reactor measures releases and alerts both plant operators and state authorities if releases exceed specified limits.[14]

Disposal of spent nuclear fuel presents a critical problem. Now plant operators are storing spent fuel on site. The storage is an interim solution until the federal government constructs storage facilities for high-level radioactive waste at a national disposal site in Nevada.[15]

Disposal of low-level radioactive waste produced in New Jersey, one-half of which arises from nuclear plant operations, occurs at three out-of-state sites. Under federal legislation New Jersey has joined with Connecticut to identify disposal sites within the two states for low-level wastes. In 1987, the state legislature passed the Regional Low-Level Radioactive Waste Disposal Facility Siting Act, which sets up a siting board and advisory committee to select sites.[16]

Environmental Impact of Energy Use Today

Over the past two decades combustion of fossil fuels has supplied nearly all of the state's nonrenewable energy. Figure I-1-2 in Chapter I shows the percentages from 1960 to 1986.[17] Even now, in 1989, when the state's utilities own 4,017 MW of nuclear generating capacity, fossil fuels supply over 92 percent of energy for the state.[18]

Combustion Emissions

For 1986, the Energy Information Administration (EIA) estimated fossil fuel used for combustion within the state, both utility and nonutility, at 1388.8 TBtu. New Jersey utilities import an additional 310.9 TBtu from out of state, mostly from coal- or oil-burning generating stations. The total, excluding petroleum used for feedstocks, products, waxes, asphalt, and lubricants, amounts to 182,517 thousand barrels (947.9 TBtus) of petroleum fuels, 353 billion cubic feet (363 TBtus) of natural gas, and 2961 short tons (77.9 TBtus) of coal.[19] Table IV-4-1a and Appendix IV-4-1 give details.

Table IV-4-1b shows the amount of carbon dioxide, calculated at standard conversion efficiencies, New Jersey fuel combustion would produce. Annual carbon dioxide production amounts to 31.21 million metric tons (10^6 metric tons), a small fraction of the approximately 5 gigatons (10^{18} metric tons) of carbon released globally each year.[20] Table IV-4-1c shows the National Acid Precipitation Assessment Program (NAPAP) estimate of sulfur dioxide and nitrogen oxides. NAPAP estimates for 1985, the best documented data available, are 348,138 tons SO_2 and 166,555 tons NO_X.[21] The CO_2 is an unavoidable product of carbon fuel combustion. CO, SO_2, and NO_X are controllable, and the federal Clean Air Act and state regulation set limits for their release.[22]

Table IV-4-1a

Fossil Fuel Comubstion -1986*

Fuel Source	TBtus	Percent of Fossil	Percent of Total
Natural gas	363.0	26	17
Combusted oil	947.8**	68	43
Coal	77.9	6	4
In-state Subtotal	1388.7	100	64
Imported Electric	310.9		14
Total Fossil Fuel	1699.6		
N.J. Nuclear	159.6		7
N.J. Hydro	-3.0		0
other oil[x]	194.1		9
	2050.3		
N.Y. jet[z]	131.2		6
EIA N.J. 2181.5			100
Asphalt, RO		36.9	
Lubricants		12.8	
Feedstocks		144.4	
subtot	194.1[x]		
aviat gas**		0.8	
EIA jet		221.8	
N.J. jet**	90.6		
N.Y. jet	131.2[z]		
distillate**		261.9	
kerosene**		3.5	
LPG**		20.5	
motor gas**		423.9	
residual**		146.6	
EIA P-total		1273.1	
Combusted	947.8**		

*Based on EIA Fuel Consumption Estimates excluding fuel for product or out-of-state use.

EIA Petroleum TBtu, separating combusted** from product[x] or non-state[z] components

Table IV-4-1b

Estimate of Carbon Dioxide Emissions
Released by Fossil Fuel Combustion
in New Jersey in 1986

Fuel	Est. '86 TBtu	Carbon Est. '86* Million Metric tons
Total Gas	363.0	5.18
Total Oil	1273.1	24.08
Total Coal	77.9	1.95
Totals-TBtu	1714.0	31.21

Sources: Fuel TBtu from EIA, Report DOE/EIA-0214(86) pp. 207-211. Carbon dioxide emissions estimates from Sheila Machado and Rick Piltz, Reducing the Rate of Global Warming, The States' Role, Renew America, Washington, November 1988.

Table IV-4-1c

Estimate of Sulfur Dioxide and Nitrogen Dioxide
Emissions Released by Fossil Fuel Combustion
in New Jersey in 1985

Sector	Sulfur Est. '85x tons	Nitrogen Oxides Est. '85y tons
In-state Utility	75,799	63,510
Industrial fuel combustion	37,847	32,875
Industrial processes	17,585	17,320
Commercial and Residential	23,237	29,797
On road vehicles	14,187	190,315
Other transportation	13,482	28,300
Incineration	2,007	3,341
Other sources	3	325
New Jersey Total	184,147	365,783

Sources: National Acid Precipitation Assessment Program (NAPAP) Inventory Report, 1985

Chapter IV-4

Air Quality Standards

The New Jersey Department of Environmental Protection (DEP) Division of Environmental Quality summarizes the 1987 air quality, as measured by federal standards for criteria pollutants, in Table IV-4-2. All these pollutants result directly or indirectly from fossil fuel combustion. DEP is responsible for enforcing the federally set National Ambient Air Quality Standards (NAAQS) for certain (criteria) pollutants.[23] Table IV-4-2 lists those criteria pollutants related to fossil fuel combustion and the number of NAAQS violations at New Jersey's air quality monitoring sites.[24]

Table IV-4-2

Criteria Pollutants
Description and 1987 Comparison with Federal Standards
adopted from DEP, Division of Environmental Quality

Pollutant	Descript.	Health Effects	Main Source(s)	Control Methods	Primary Standards	NAAQS Violations
Sulfur dioxide (SO_2)	Pungent gas	Decreases lung capacity	Burning fossil fuels for electric generatn, industry	Lower sulfur content of fuels.	24-hr avg. 0.14 ppm (365ug/m^3)	0
				install scrubbers	12-mo avg: 0.03 ppm (80ug/m^3)	0
Nitrogen Dioxide (NO_2)	Reddish-brown pungent gas	NO_2 affects the respiratory tract.	High-temperature burning of fossil fuels in vehicles and industry.	Lower combustion temperature. Catalytic converters in autos.	12-mo avg: 0.05 ppm (100ug/m^3)	0
Ozone (O_3)	Gas, odorous at high concentrations	Irritates eyes, nose, throat	Not emitted, but forms in the air from NO_2 and hydrocarbons.	Reduce NOx & hydrocarbon emissions through improved combustion and vapor recovery.	Maximum daily 1-hr avg: 0.12 ppm	32*

Table IV-4-2 (con't)

Criteria Pollutants
Description and 1987 Comparison with Federal Standards

Pollutant	Descript.	Health Effects	Main Source(s)	Control Methods	Primary Standards	NAAQS Violations
Carbon monoxide (CO)	Odorless, colorless, tasteless gas.	Interferes with blood's ability to carry O_2	Auto exhaust	Better combustion: auto tuneups.	1-hr avg: 35 ppm ($40mg-/m^3$)	0
					8-hr avg: 9ppm ($10mg/m^5$)	
Lead (Pb)	Suspended metal particle	Accumulates in the body; can lead to nervous system disorders.	Leaded gasoline; some industrial processes.	Remove from gasoline.	3-mo arth. mean: $1.5ug/m^3$	0
Total Suspended Particulates (TSP)	Particles of ash, soot, dust small enough to be carried through the air.	Smaller particles can go deep into the lung carrying toxins, and injuring tissue	Burning fossil fuels; incineration; industry.	Better combustion; collect particles before emitting.	12-month geometric mean: $75ug/m^3$	2*
					24-hr avg; $260ug/m^3$	0**
Inhalable particulates (PM-10)	Particles of ash, soot, dust, carried through the air that are 10 micrometers in size or smaller.	Particles can be inhaled deep into the lungs carrying toxics, and injuring lung tissue.	Burning fossil fuel; incineration industry.	Improve combustion and controls.	24-hr avg: $150ug/m^3$	0
					Annual arithmetic mean $50ug/m^3$	0

* This is the number of days in which a violation was measured at any one of the DEP monitors. More than one violation could have occurred in one day.

** This represents the number of monitors where the standard was violated. More than one violation could have occurred at each site.

Table IV-4-2 (con't)

Primary standards define air quality levels designed to protect the public health with an adequate margin of safety. Secondary standards define levels of air quality designed to protect the public welfare from any known or anticipated adverse effects of a pollutant (e.g. soiling, vegetation damage, material corrosion).

The averaging times used in reporting the standards vary from one pollutant to another. Standards are based on the average concentration for the following periods: 1 hour (ozone, carbon monoxide), 3 hours (sulfur dioxide), 8 hours (carbon monoxide), 24 hours (sulfur dioxide, particulates), and 12 months (nitrogen dioxide, sulfur dioxide and particulates). A 3-month arithmetic mean is used for reporting lead.

The concentrations of the gaseous pollutants are usually expressed in parts per million (ppm). Particulates and lead are measured as mass per unit volume, i.e., micrograms per cubic meter (ug/m^3).

Source: DEP, Division of Environmental Quality, New Jersey Air Quality 1987.

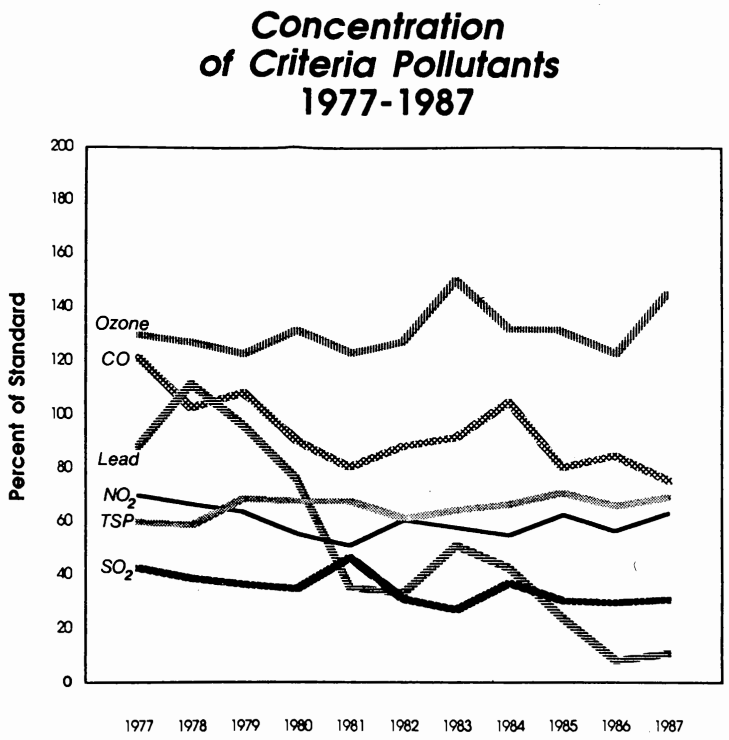
New Jersey's air quality in 1987 complied with the primary standards for all of the criteria pollutants except ozone and total suspended particulates. In 1986 air quality violated standards for four of the criteria pollutants: carbon monoxide, lead, particulates, and ozone.[25]

In 1987, for the first time since the DEP began its monitoring program, the primary ambient air quality met standards for carbon monoxide at all monitoring sites. DEP attributes the improvement in ambient levels of carbon monoxide to the effectiveness of New Jersey's Inspection/Maintenence Program and the Federal Motor Vehicle Control Program.[26] Figure IV-4-1 shows the levels of criteria pollutants in New Jersey since 1977. The levels of nitrogen oxides, total suspended particulates, sulfur dioxide, and recently, of lead and carbon monoxide, remain below 100% of standard. Ozone levels remain above federal standards. Only lead levels have substantially decreased over the period.

Unregulated Pollutants Related to Fossil Fuel Combustion

No federal ambient air quality standards (air concentration standards) exist for other air toxics related to fossil fuel combustion.[27] New Jersey has been monitoring many of these compounds to determine their present distribution and concentration. Scientists are carrying out risk assessments for several of these pollutants to determine their effects on human health and what dosages are reasonably safe. For several substances the state has already established emissions

Figure IV-4-1



Source: DEP, Division of Environmental Quality, New Jersey Air Quality 1987.

standards, based on the potential risk, and may eventually establish ambient air quality standards.[28] The air toxics include:

1. Volatile Organic Substances (VOS). Volatile organics include petroleum, petrochemicals, solvents, and other organic compounds that vaporize easily at normal atmospheric temperatures and pressures. They are present in the air primarily in gaseous form and may react with other chemicals to form new compounds, such as ozone. Many organic compounds, like benzene and formaldehyde, are toxic to humans.[29]

2. Particulate Organic Matter (POM). POM consists of airborne particulates with organic compounds adhering to them and usually results from incomplete combustion. Diesel engine emissions, for example, contain particulates with benzo(a)pyrene, which is a carcinogen.[30]

The state already has regulations limiting the emissions of some noncriteria pollutants from many industrial and commercial sources. The regulations, subchapter 17, of the New Jersey Air Quality Regulations, cover 11 toxic volatile organic substances.[31]

Other Impacts

Impacts of centralized large-scale electric generation include damage to aquatic resources, such as entrainment and impingement of aquatic organisms in cooling and make-up water intakes, and habitat modification.

Analysis of Environmental Impacts

Carbon Dioxide and Global Atmospheric Change

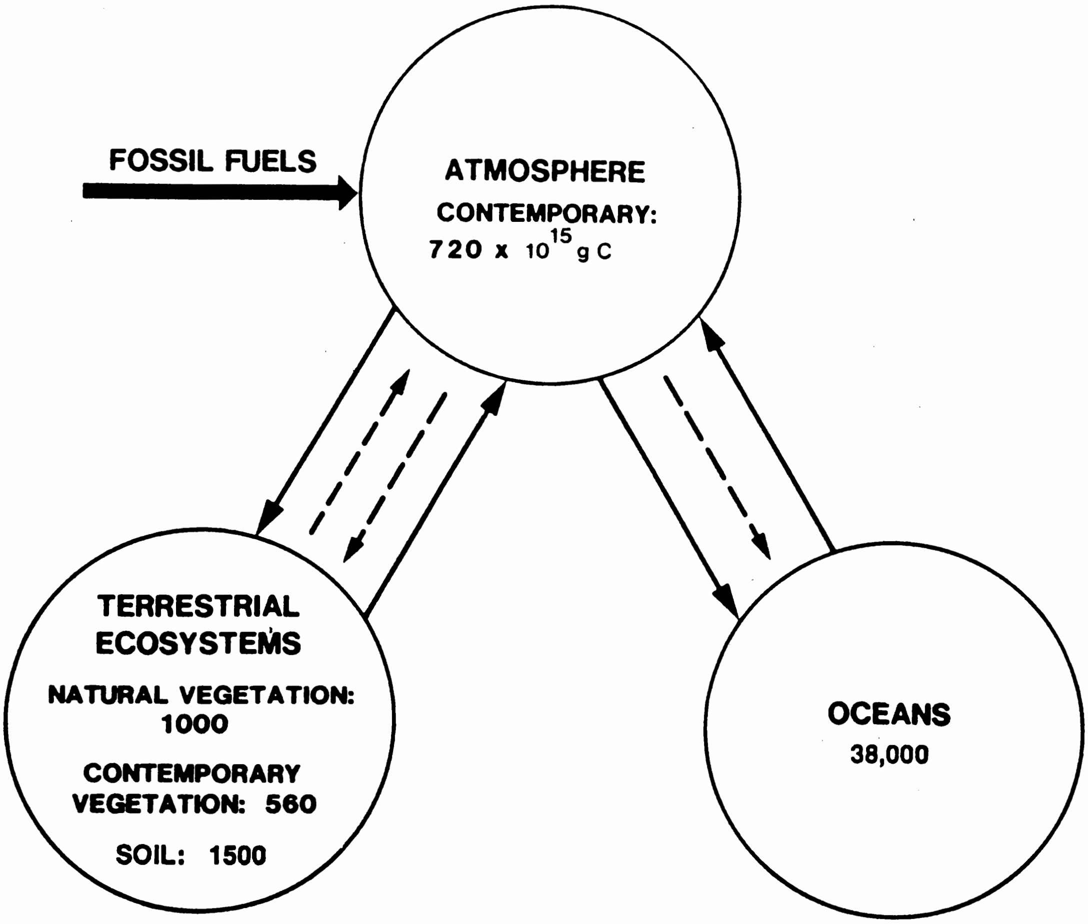
Combustion's primary products, carbon dioxide and water, are normal air constitutents. However, fossil fuel combustion releases vast quantities of carbon dioxide to the atmosphere, levels that scientists believe are already affecting global climate. Carbon dioxide and other compounds, naturally occurring like methane or synthetic like fluorocarbons, affect heat exchange in the atmosphere. Scientists believe the added compounds, generically called greenhouse gases, have the potential to raise the temperature of the earth by absorbing infrared radiation and altering the radioactive balance of the present earth.[32]

Predicted climate changes due to increased greenhouse gases include, in approximate order of current scientific confidence: large stratospheric cooling (virtually certain), global-mean surface warming (very probable), global-mean precipitation increase (very probable), reduction of sea ice (very probable), polar winter surface warming (very probable), summer continental dryness/warming (probable), high latitude precipitation increase (probable), rise in global-mean sea level (probable), regional vegetation changes (uncertain), and tropical storm increases (uncertain). Details of change during the next 25 years are uncertain because initially oceans absorb excess heat and scientists expect the interaction between atmosphere and oceans to introduce additional effects on a decadal scale.[33] Figure IV-4-2 illustrates the major reservoirs, exchanges, and the kind of interactions scientists consider in modeling the global carbon cycle.

Figure IV-4-2

Major Reservoirs and Exchanges in the Global Carbon Cycle

The oceans, the largest pool of carbon, are the primary sink for excess carbon from the atmosphere. Because of disturbances by human activities, primarily land-use change, carbon storage in vegetation and soil has decreased. The timing of terrestrial releases is complex, and different regions have likely been net sources or sinks at different points in time. In models, this carbon cycle is viewed as closed except for the input from fossil fuels. Many models consider primarily the atmosphere and oceans and handle terrestrial sources as an additional input to the atmosphere. The inventory of carbon in each major reservoir ca. 1980 is given in 10^{15} g Carbon.



Source: USDOE, Carbon Dioxide Research Division, Office of Basic Sciences. Atmospheric Carbon Dioxide and the Global Carbon Cycle, Washington, December 1985. DOE/ER-0239. p. 144.

Figure IV-4-3, a graph of global mean surface temperatures over the past century, shows the warming trend. Within the wide variability in surface temperatures are many exceedingly warm summers. Beyond the variability, however, is a general upward trend of the data range over the past 90 years. The warming trend is more pronounced in northern latitudes.[34] Figure IV-4-4 graphs the national temperature trend over the past century. Though partially masked by variability, the trend in temperature, shown by the five-year running average, has risen. The trend in precipitation has risen slightly over the same period. More recent reviews of the data have shown the rising trends to be insignificant within the United States.[35]

While the change in average temperature over the past century shown in Figures IV-4-3 and IV-4-4 is relatively small, a matter of a few degrees, that change could indicate disruptive changes in the earth's weather patterns. Major national research organizations, such as Geophysical Fluid Dynamics Laboratory, National Oceanic and Atmospheric Administration (NOAA) in Princeton, NASA/Goddard Institute of Space Studies in New York, and the Oak Ridge Laboratory in Tennessee, as well as international and university laboratories, are studying the evidence of change and its implications. The studies involve building computer models of interactions among the many variables affecting atmosphere and weather. They require integration of principles and information from a wide range of scientific fields, atmospheric chemistry, ocean dynamics, hydrology, agriculture, meteorology, and biology.[36]

Figures IV-4-5 shows increasing concentration of atmospheric carbon dioxide at one Observatory site over the past 30 years. Figure IV-4-6 shows the increasing concentration of carbon dioxide measured in glacier ice over the last 200 years.

Even at this early stage of understanding potential interactions and effects, scientists point out that the potential for change is great and that even small changes in weather can have major impact on living conditions. Organizations studying the potential effects point out that burning of fossil fuel has already caused some degree of change and that our task now is to moderate that change.[37]

Recapturing carbon dioxide requires more energy than the combustion that caused its release. Therefore, recapture is only feasible using free renewable sources, such as the sun's action on plant matter. One recently publicized effort to compensate for carbon dioxide release from a Connecticut coal-burning facility is a reforestation program in Central America.[38] The reforestation can theoretically incorporate an amount of carbon dioxide equivalent to that released by the facility and can have additional economic and social benefits. Reforestation is not a general solution, however, because sufficient land is not available for forest growth equivalent to all projected additional fossil fuel combustion over the next decades.[39]

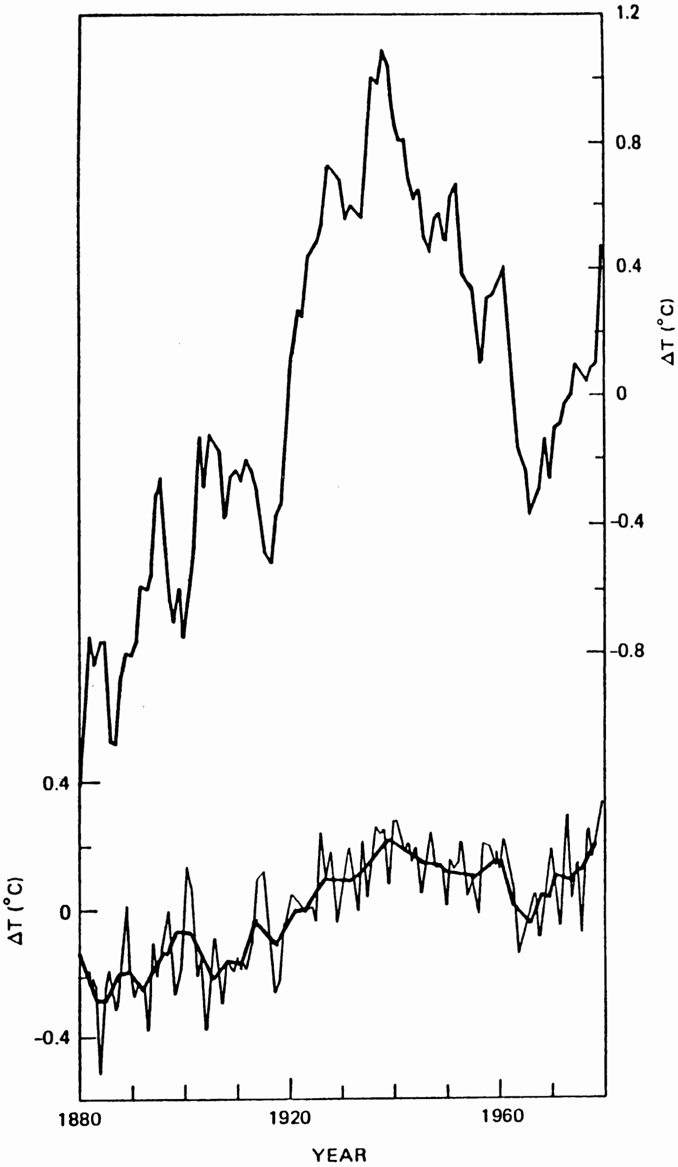
D R A F T

Chapter IV-4

Figure IV-4-3

Measured Surface Temperature Trends 1880 - 1980

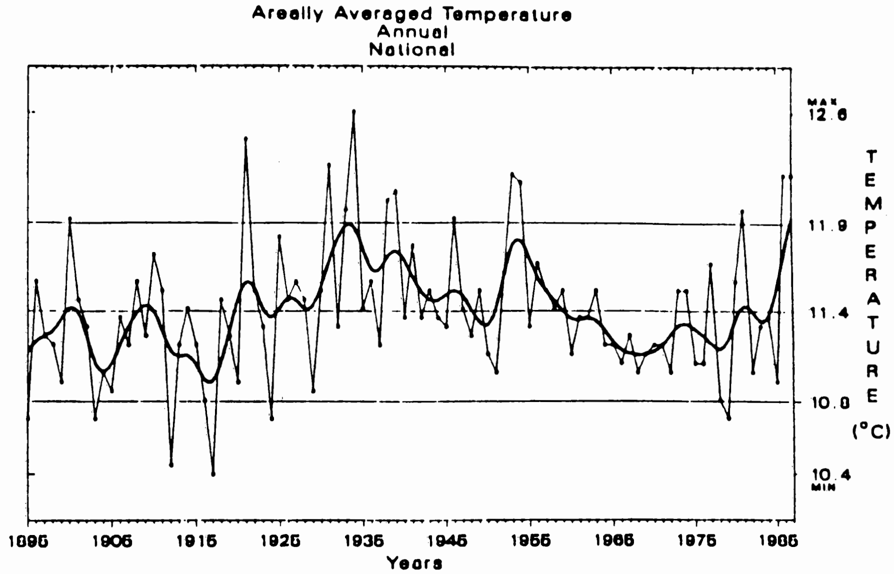
Trends in degrees Celsius, as a global mean (lower curves, annual and 5-year running mean) and for stations poleward of latitutde 64° N (upper curve, 5-year running mean). After Hansen et al., 1983.

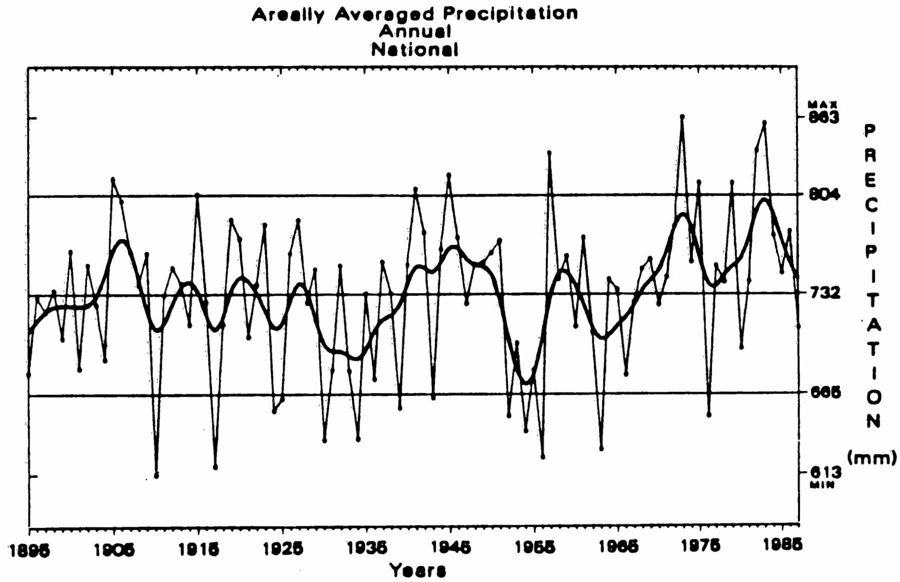


Source: U.S. Committee for an International Geosphere-Biosphere Program (IGBP), Commission on Physical Sciences, Mathematics and Resources, National Research Council, Global Change in the Geosphere-Biosphere, National Academy Press, 1986, p. 8.

Figure IV-4-4

Annual Average Temperature (top) and Precipitation for the contiguous U.S., 1895 to 1985 (from the NOAA National Climatic Data Center)

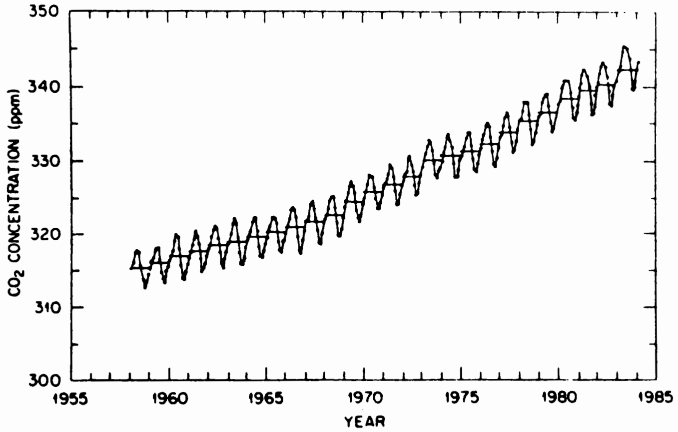




Source: U.S.Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), U.S. Drought, 1988, Washington, 1988, p. 10.

Figure IV-4-5

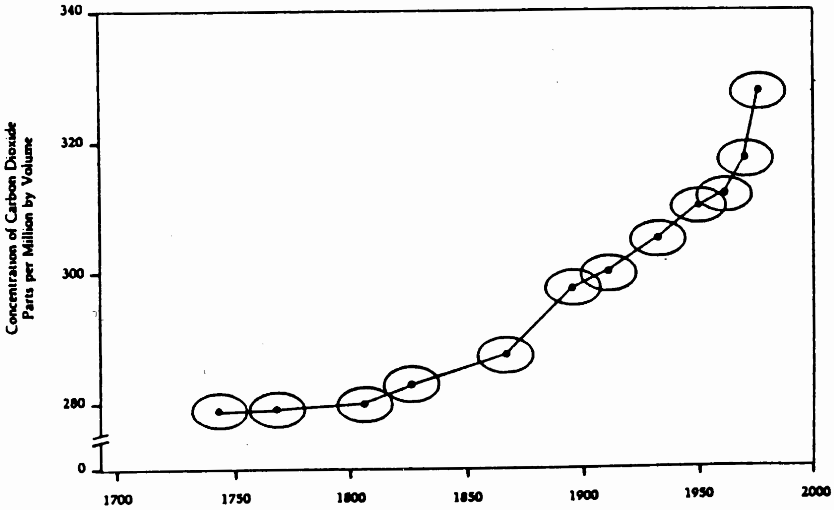
Concentration of Atmospheric Carbon Dioxide at Mauna Loa Observatory, Hawaii. The dots depict monthly averages of visually selected data adjusted to the center of each month. The horizontal bars represent annual averages. Data obtained by C.D. Keeling, Scripps Institute of Oceanography, and from Carbon Dioxide Information Center, Oak Ridge National Laboratory.



Source: USDOE, Carbon Dioxide Research Division, Office of Basic Sciences. Atmospheric Carbon Dioxide and the Global Carbon Cycle, Washington, December 1985, DOE/ER-0239, p.38.

Figure IV-4-6

Concentration of CO_2 Measured in Glacier Ice Formed During the Last 200 Years in Parts per Million by Volume



Source: Neftel, et al., "Evidence from Polar Ice Cores for the Increase in Atmospheric CO_2 in the Last Two Centuries," Nature, Volume 315, May 2, 1985 from Mintzer, WRI, 1987.

If, as the studies suggest, biological reincorporation of carbon dioxide cannot match the rate of increase in fossil fuel use and thus cannot stem the potential for global warming, the remaining opportunity for control is through reducing fossil fuel combustion. Other chapters in this Plan, III-1, III-2 and III-3 in particular, detail the opportunities to use efficiency to maintain living standards while reducing combustion.

It is possible to reduce CO_2 releases by changing fuel source. For equivalent amounts of energy gained, natural gas releases least and coal most CO_2. Table IV-4-3 shows the relative amounts of CO_2 emitted by burning various fuels. If on-going research confirms the projected trends in CO_2 levels and the projected consequences of increasing levels of atmospheric CO_2, the high relative CO_2 emissions from coal combustion would make it a less desirable fuel.

Table IV-4-3

Carbon Dioxice Emissions from
Direct Combustion of Various Fuels

Fuel	CO_2 Emission Rate ($kgC/10^9J$)	Ratio Relative to Methane
Methane	13.5	1
Ethane	15.5	1.15
Propane	16.3	1.21
Butane	16.8	1.24
Gasoline	18.9	1.40
Diesel Oil 19.7	1.46	
No.6 Fuel Oil	20.0	1.48
Bituminous Coal	23.8	1.73
Subituminous Coal	25.3	1.87

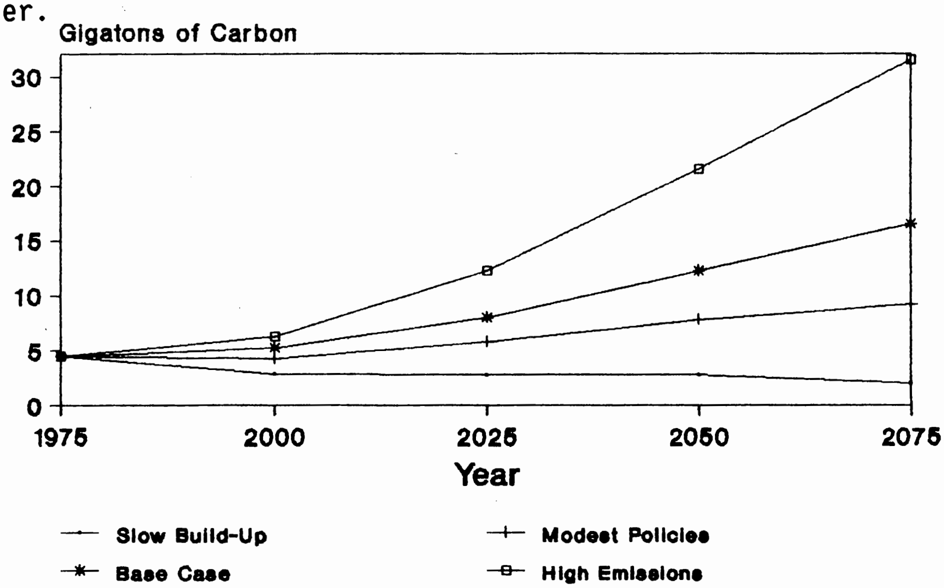
Source: Dr. Gordon MacDonald, MITRE Corp. from Mintzer, Public Power, November-December 1988.

Figure IV-4-7 shows one study's estimate of the possibility of reducing carbon dioxide emissions through increasing fuel use efficiency and thus controlling global warming.[40]

Figure IV-4-7

Scenarios for World-Wide Carbon Emissions
Developed by World Resources Institute, Washington, D.C.

This organization has described four possible scenarios for future fossil fuel use world-wide and the resultant carbon dioxide emissions. The scenarios range from a slow build-up in which annual emissions would drop from today's level through a high emissions scenario in which annual emissions would increase by 2000 and grow considerably every year thereafter.



Source: Irving Mintzer, A Matter of Degrees, The Potential for Controlling the Greenhouse Effect, World Resources Institute, 1987

Acid Deposition: Sulfur Dioxides and Nitrogen Oxides

Acid Deposition consists of dry and wet deposition, the latter known as acid precipitation or acid rain.[41] Both result from sulfur dioxide and nitrogen oxide emissions, which react in air to become sulfates and nitrates and ultimately return to the ground as dry or wet acid deposition. Acid aerosol (fine particulates) may aggravate respiratory ailments, but it is better known for being harmful to some freshwater and forest ecosystems. High acidity in certain bodies of water has destroyed many of the species that lived there. Acid precipitation also affects building materials, such as stone and metal.[42]

Rain in New Jersey in 1987 was the most acidic on record. Precipitation samples from 71 storm events in 1987 at Washington Crossing State Park had an average pH of 4.06, the most acidic annual average concentration recorded in New Jersey since the DEP began sampling in 1982. In 1986, the average pH of samples from the Washington Crossing site was 4.24. Average annual precipitation acidity increased at all sites in 1987 with the greatest increases observed during the summer when, for the first time on record, all sites had average pH values below 4.0.[43]

Nitrogen oxides: High temperature combustion oxidizes nitrogen in combustion air to nitrogen oxides. They are precursors of ozone and respiratory irritants. Further oxidation forms nitrates, which may contribute excess nutrients to some aquatic systems, leading to algae blooms and oxygen depletion in surface waters.

Sulfur oxides: Combustion oxidizes sulfur compounds found in oil and coal to sulfur dioxide. Further oxidation forms sulfates. The release of sulfur dioxide correlates with increasing acidity of rainfall, dry deposition of sulfates, and, in turn, with acidification of surface waters.[44] Acid rain causes damage to forests and other vegetation, as well as potential leaching of heavy metal ions from soil into groundwater.[45]

DEP regulates the level of sulfur emitted from major new, expanded, or reconstructed steam generating units. DEP also regulates the amount of sulfur in fuel oil and solid fuel in trade, sold, or used in the state.[46] The regulation applies to fuel burned in the state but not to fuel burned for electric generation in out-of-state plants owned by New Jersey utilities.

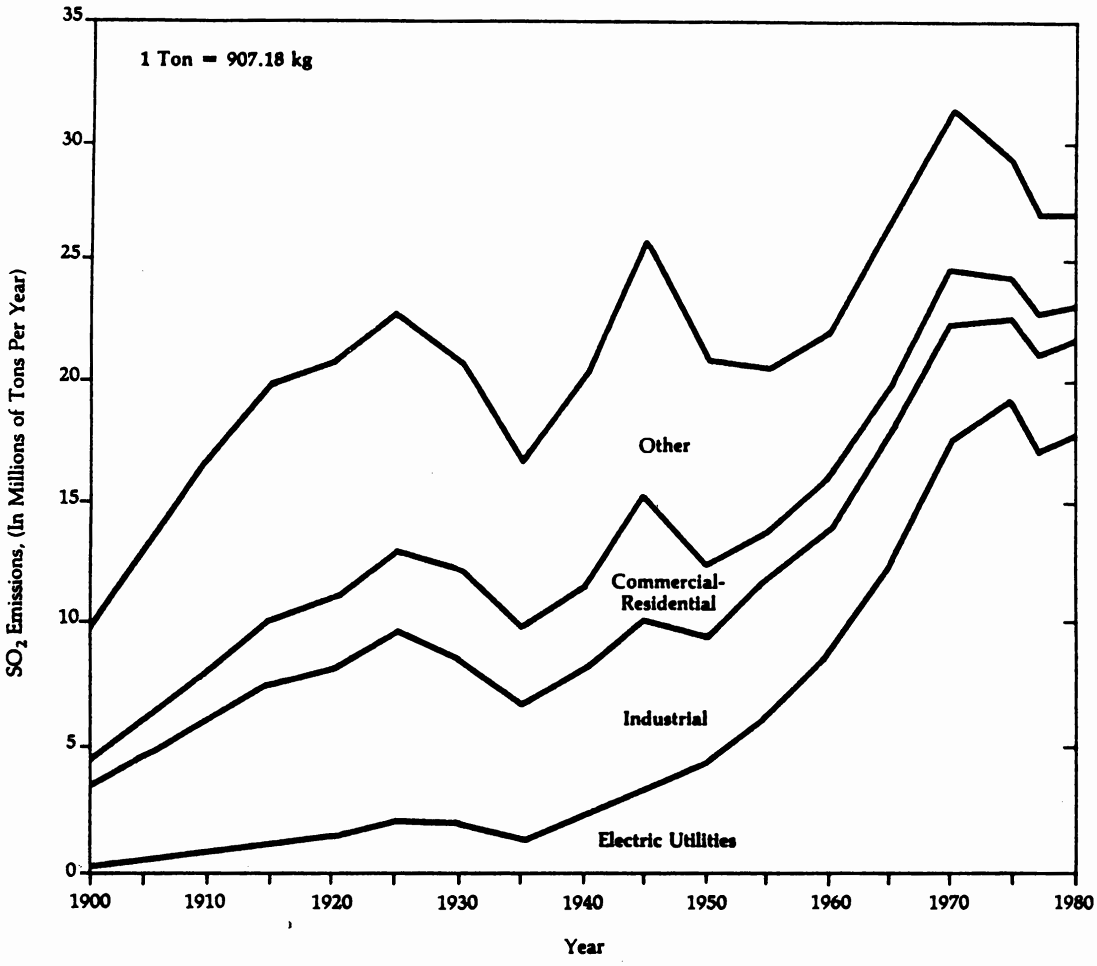
For the past decade New Jersey electric utilities have brought 25 to 35 percent of electricity from out-of-state plants and utilities, principally the coal-burning Keystone and Conemaugh plants in Pennsylvania. Pennsylvania does not regulate sulfur content of oil or solid fuel and the combustion products reach New Jersey via the prevailing winds.[47] Figure IV-4-8 shows the national trend and amounts of sulfur dioxide emissions, as well as the large amount of emissions from electric utilities.

Utility plant emissions are a major identifiable and controllable source of sulfur dioxide and acid deposition. The density of sulfur dioxide emissions from non-natural sources is high throughout the Midwest, particularly in states west of New Jersey. New Jersey utilities and industries burn relatively little coal (coal is source for only 4 percent of in-state generated electrical energy). However, coal-producing states to the west--Pennsylvania, Ohio, Indiana, West Virginia, and Kentucky--burn large amounts of coal for electric generation and industry. Sulfur emissions from that burning reach New Jersey by the prevailing winds.[48]

West Virginia, Pennsylvania, Indiana, and Kentucky were the largest eastern US net exporters of electricity in 1986 and generated most electricity from coal. Like most other coal-producing states, these states place no upper limits on sulfur in fuel for utility generation.[49] New Jersey, to the extent that it imports electricity

Figure IV-4-8

Historical Trends in Sulfur Dioxide Emissions in the United States by Source Category



Source: G. Gschwandtner <u>et al.</u>, "Historical Emissions of Sulfur and Nitrogen Oxides in the United States from 1900 to 1980," <u>Journal of the Air Pollution Control Assoc.</u>, February 1986, from MacKenzie and El-Ashry, WRI, 1988.

from states having no limits on sulfur in fuel, shares responsibility for the acid deposition resulting from emissions from those generating units.

Table IV-4-4 shows the source of energy for electric generation within New Jersey and the amount of imports. New Jersey utilities import nearly half the electricity distributed here from Pennsylvania, neighboring, and midwestern states. Out-of-state environmental impacts of generation raises state jurisdiction and user responsibility issues. The impact of CO_2 emissions raises the same issues.

Table IV-4-4

Generation of Electricity for Use in New Jersey - 1986
Fuel Source and In-state/Out-of-state Generation Ratio

In-state generation fuel source in TBtu				
Coal	69.8			
Natural Gas	38.2			
Petroleum	57.4			
Fossil fuel total	162.4	162.4		
Nuclear electric		159.6		
Total in-state generation		322.0	322.0	50.9
Total out-of-state generation			310.9	49.1
Total New Jersey Electric Use			633.0	100.0

Source: EIA, DOE/EIA-0214(86), p. 207-211

New Jersey utilities distribute electricity purchased from the PJM power pool which, in turn, may purchase power generated by midwestern utilities. PJM and those utilities generate electricity with units having lowest running cost, generally the coal-fired units. Without federal or state limits on sulfur emissions or content of fuel, the Pennsylvania and midwestern units burning high sulfur coal have low running costs.

Without federal legislation New Jersey would have to depend on regional mechanisms to control sulfur emissions. Legislators have yet to reach an agreement balancing the high sulfur coal producer interests against the environmental protection requirements. A difficult question is the assignment of costs for cleaning coal, installing scrubbers, or using alternative fuels among utilities, all ratepayers, user ratepayers, or taxpayers.

The power pools now purchase electricity based on "economic dispatch," bringing units on line as needed, in order of cost efficiency subject to transmission constraints. A possible technical mechanism for reducing sulfur emissions would require power pools to bring generating units on line in order of least emissions, using "environmental dispatch." An alternative economic mechanism would include in the economic dispatch model a proxy cost representing environmental costs. The problem would be establishing an agreed-upon value for environmental costs.[50]

In 1982, DEP examined the role of national acid rain policy as it affected the state's acid deposition problem and reported on possible economic impacts of an acid rain-control problem. In 1983, with Governor Kean as chair, the seven-state Coalition of Northeastern Governors (CONEG), focused on acid rain policy. In December 1983, the group passed the Governor's regional policy resolution with only Pennsylvania opposed.[51]

The CONEG plan would reduce SO_2 emissions by 10 million tons per year nationwide through two phases ending in 1995, through whatever means each state would choose. Financing for two-thirds of the capital costs of controls would be through a combination of a tax on SO_2 emissions and a generation tax on electric consumption. The generation tax could finance no more than 50 percent of the total cost of controls. Each state would choose the source of any additional funding necessary for the controls. New Jersey developed a more detailed financing plan depending initially on federal interest-free loans and establishing a nationwide tax on electricity for six years to pay the bond interest and half the principal. According to DEP calculations the tax would have increased the average household's electricity bill by less than 1 percent.[52]

Control of out-of-state sulfur dioxide emissions could come through federal legislation. The legislation would need to address jurisdictional, technical, and fiscal issues. The major issues are the pollutants targeted for reduction, the target amount for SO_2 reduction, the timetables for reductions, the states where control should occur, the degree of flexibility states will have in deciding which sources to control, the technical requirements for control, and which entities will pay the cost of controls.

DEP supports a reduction of 10 million tons of SO_2 in two phases, with an interim target giving an opportunity to evaluate effectiveness of the program, and then a final target. Making the target a statewide tonnage reduction would allow states flexibility in choosing which combustion sources to control and which control methods would best fit each state's economy and fuel supply situation. Fair allocation of control cost would need to balance consideration of affected areas against costs to particular ratepayers.[53]

While no immediate prospect exists for passing federal acid deposition control legislation, state action is possible. New York's Department of Environment and Conservation has set a wet sulfate deposition standard under requirements of the Acid Deposition Control Act.

The Environmental Defense Fund, a national public interest group, has petitioned the New Jersey Board of Public Utilities, the DEP, and DCEED to adopt an acid deposition standard and implement regulations for the state of New Jersey. The petition asks for 1) setting the standard at a level that, if attained, would protect water quality and public welfare from impairment due to the effects of acid deposition and acid rain in the state, and 2) a public hearing to evaluate the sources of pollutants over which the state may exercise control and feasible courses of action for their control.[54] The state response has determined that the DEP and BPU should be responding parties to the petition. The Division of Energy Planning and Conservation within DCEED will intervene in the proceeding to address issues affecting the Energy Master Plan.

Figure IV-4-9 shows the acidity of rain nationally for 1986. Figure IV-4-10 shows the historical and projected trends for emissions of sulfur dioxide and nitrogen oxides from 1900 through 2030. These trends indicate acid rain and ozone problems will become considerably more severe over the next decade and beyond.

The interactions among air constituents, both natural and synthetic, of oxides of sulfur and nitrogen, ozone, water, and hydrocarbons are complex. It is important to integrate the study of these interactions, of the cycling of the various constitutents and the effects to which they contribute, into global change studies.[55]

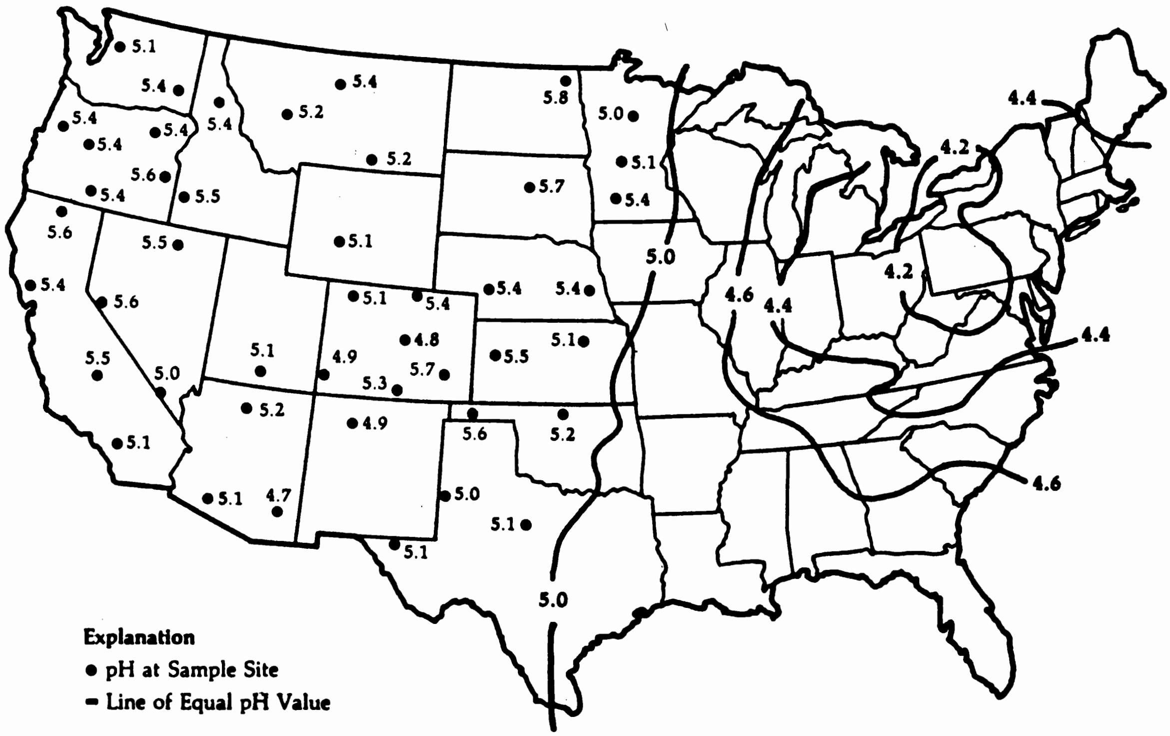
Ozone

New Jersey's most persistent air pollution problem is ozone. Unlike most other pollutants, ozone is not directly emitted by a source. Instead it forms in the atmosphere from nitrogen oxides (NO_X) and volatile organic substances (VOS) that react in the presence of strong sunlight and warm temperatures. Its formation and destruction result from reactions of oxygen, depending on processes that control levels of atmospheric carbon monoxide, hydrocarbons, and nitrogen oxide.[56] Air currents can transport these precursor compounds, along with ozone itself, over great distances; they do not necessarily originate within New Jersey.

Ozone is a powerful oxidant and reacts readily with a wide range of substances. Exposure to ozone in concentrations greater that the federal NAAQS limit, 0.12 parts per million, causes a significant decrease in human pulmonary function and affects the lungs' ability to resist infections. It is a respiratory irritant seriously affecting those with chronic respiratory illnesses. Damage to plant leaves is one of the earliest and most obvious results of high ozone levels. Subsequent effects include reduced plant growth and decreased crop yield.[57] Table IV-4-5 shows an aspect of the biological results of ozone pollution today. One study estimates that present ozone levels probably lead to yield losses in U.S. crop production of 5 to 10 percent.[58] Ozone also causes degradation of natural rubbers and synthetic polymers. These materials become hard and brittle at a faster rate as a result of the oxidizing ability of ozone.

Figure IV-4-9

Acidity (pH) of Wet Deposition for 1986

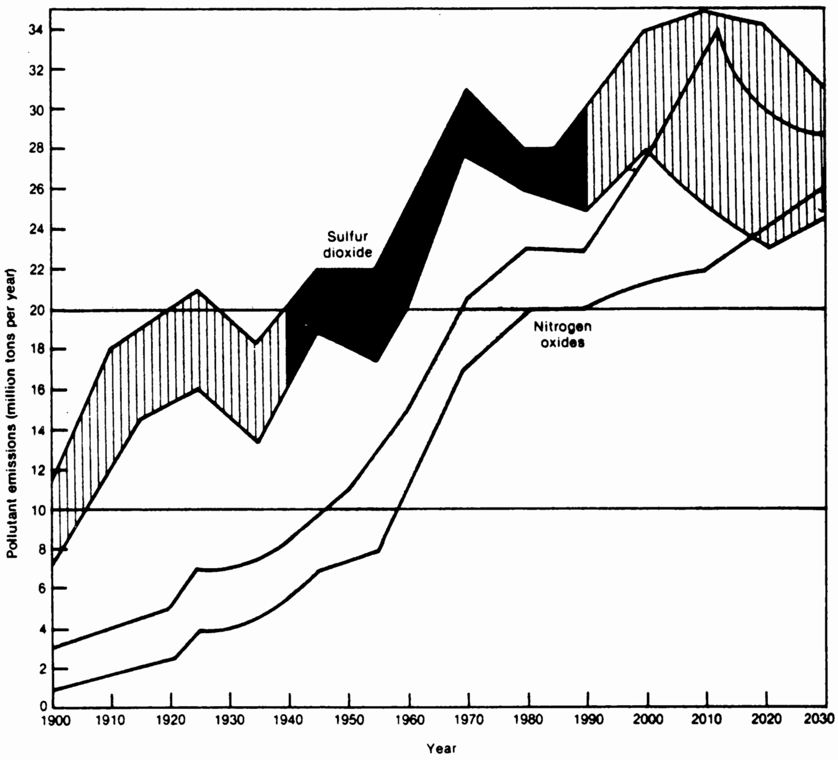


Source: 1986 Annual Report, National Acid Precipitation Assessment Program, p.78, from MacKenzie and El-Ashry, 1988.

Figure IV-4-10

Sulfur Dioxide and Nitrogen Oxides
Emissions Trends - National Totals, 1900-2030

The graph displays estimates of historical emissions and projections of future emissions of sulfur dioxide and nitrogen oxides. Pre-1940 estimates and post-1990 projections are subject to considerable uncertainty. Projections of future emissions incorporate a wide range of assumptions about future economic growth, energy mix, and retirement of existing facilities; they assume no change in current air pollution laws and regulations.



Source: Office of Technology Assessment, from USDOI, Fish and Wildlife Service, and USEPA, Office of Research and Development, Acid Rain and Fisheries: A Debate of Issues, Biological Report 80(40.21), October 1985.

Table IV-4-5

Predicted Yield Losses
(percent at several seasonal 7-hr/day mean concentrations)

Species	Concentration (ppm)			
	0.04	0.05	0.06	0.09
Barley	0.1	0.2	0.5	2.9
Bean, Kidney	11.0	18.1	24.8	42.6
Corn	0.6	1.5	3.0	12.5
Cotton	4.0	6.9	10.0	20.0
Peanut	6.4	12.3	19.4	44.5
Sorghum	0.8	1.5	2.5	6.5
Soybean	7.3	12.1	17.0	30.7
Tomato	0.7	1.7	3.6	16.0
Winter Wheat	3.5	6.9	11.1	27.4

Source: Walter W. Heck, 1989, from MacKenzie and El-Ashry, 1988.

DEP regulates ambient air concentrations of nitrogen oxides through Subchapters 13, motor vehicles through Subchapters 14 and 15, and volatile organics through Subchapter 16 of N.J.A.C. 7:27. Subchapter 8 has a "state of the art" provision applied to NO_x during permitting of stationary (industrial, commercial, and utility) sources. The subchapters have controlled emissions to the atmosphere of nitrogen dioxide since 1973 and of volatile organic substances since 1976, but ozone has remained a problem. Figure IV-4-1 shows that the concentration of ozone has remained above 120 percent of the NAAQS standard for all of the last 10 years.

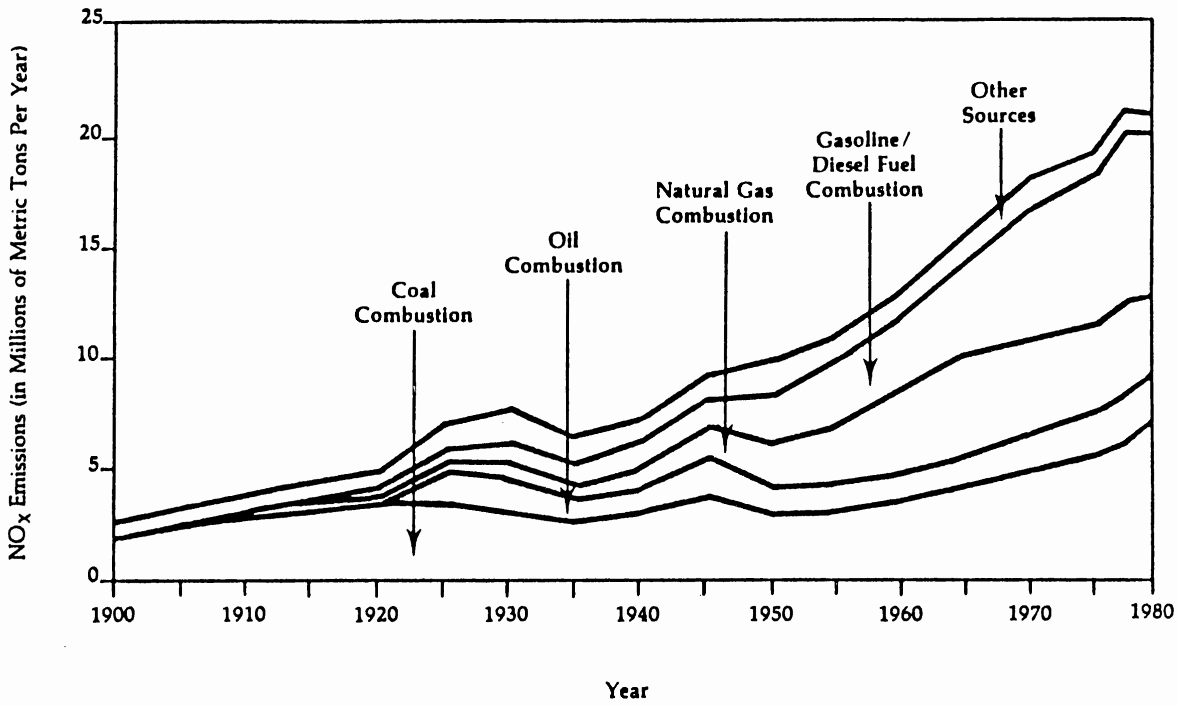
The ozone concentration in New Jersey ambient air in late spring and summer often exceeds the NAAQS federal standards. Ozone concentrations exceeded this standard on 45 days between May and September of 1988. Exceedences[59] of the primary ozone standard in New Jersey have increased over recent years, from 45 in 1986 to 119 in 1987, to 212 during the period April 1 through August 31, 1988. In Camden the primary ozone standard was exceeded on 23 days, and an ozone concentration over twice the standard was recorded on one occasion at a site near Trenton. This unusually poor air quality was associated with the extended number of hot, sunny days in June and July 1987 and again in 1988.[60]

The state regulates nitrogen oxides emissions through standards for automobiles and stationary sources. Figure IV-4-1 shows that state levels have remained about 60 to 70 percent of the NAAQS standard over the last 10 years. However, with increases in vehicle miles traveled, the projection is for only temporary decrease in nitrogen oxides.[61]

Figure IV-4-11 shows the historical trends in nitrogen oxide emissions in the United States. The fuel sources showing an increasing trend are coal, natural gas, and gasoline/diesel fuel combustion. Figure IV-4-10 shows the historical and projected trends for emissions of sulfur dioxide and nitrogen oxides, the precursors of acid rain and ozone.

Figure IV-4-11

Historical Trends in Nitrogen Oxide Emissions
in the United States by Fuel Type



Source: Interim Assessment, Vol. II, National Acid Precipitation Assessment Program, Sept 1987, from MacKenzie and El-Ashry, 1988.

Recent amendments to state regulations aim to further reduce emissions of volatile organic substances. The Stage II vapor recovery regulations, effective in January 1988, require installation of special nozzles on service station pumps at facilities with more than 10,000 gallons average monthly throughput. The regulations are phased in, for stations with throughput above 40,000 gallons, by the end of 1988, and for the remaining affected stations by the end of 1989.

DEP estimates that the vapor recovery regulations, when completely in effect, will prevent 13,500 tons of gasoline vapor and 270 tons of benzene from evaporating into the atmosphere annually, based on the volume of gasoline dispensing in 1984. Most of the reduction, 76 percent, is in the first stage when the approximately 2,000 facilities having 40,000 gallons or greater monthly throughputs must install vapor recovery equipment.[62]

Benefits of the vapor recovery regulations include substantial expected savings in gasoline. DEP estimates that New Jersey can save over 3.7 million gallons of gasoline annually, otherwise vaporized during motor vehicle refueling, once the program is fully implemented. Health benefits include reduction of emissions of benzene, a known human carcinogen, and ethylene diobromide and ethylene dichloride, both regulated by DEP as hazardous air pollutants under Subchapter 17.[63]

Additional regulations DEP has proposed to control VOS include requiring more commercial and manufacturing VOS users to control VOS evaporation in storage and in processes. DEP estimates that, on full implementation, strengthened regulations on architectural coatings will prevent emissions of 5,250 tons of VOS, on household products 3,300 tons, on surface coatings and storage tanks 8,190 tons.[64]

Airborne Particulates

Total suspended particulate (TSP) levels have decreased over the past two decades, but problems still occur in heavily industrialized and heavily trafficked areas. In 1987, air quality violated the 24-hour TSP secondary standard on one occasion in New Brunswick and four times in Newark. In Newark and Perth Amboy particulate levels exceeded the 12-month primary standard.

In 1987 the Federal government changed the indicator for the standard for particulates from total suspended particulates to inhalable particulates, or PM-10, particulate matter ten microns in size or smaller. No violations of PM-10 standards were recorded in New Jersey in 1987.[65]

Carbon monoxide

Fossil fuel combustion with insufficient oxygen produces carbon monoxide, a respiratory inhibitor fatal in small concentrations.[66] Operators of large boilers carefully monitor and control combustion to prevent carbon monoxide formation because of its lethal effect. However, most fossil fuel combustion occurs in automobile engines (52 percent) and home furnaces or boilers (17 percent).[67] U.S. Environmental Protection Agency (USEPA) estimates that, for the nation, transportation sources produce 70 percent of total carbon monoxide emissions.[68]

<u>Carbon monoxide outdoors</u>: The state monitors carbon monoxide concentrations in areas of vehicular congestion, primarily urban centers, where most high levels occur. The state has made progress in reducing carbon monoxide exceedences at its monitoring stations. However, exceedences still occur in metropolitan areas. A recent study by the Northeast States for Coordinated Air Use Management (NESCAUM) listed seven exceedences of the air quality standard for carbon monoxide in New Jersey in 1986, and one in 1987. Two were in the Bergen-Passaic Metropolitan Statistical Area (MSA), two in Jersey City MSA, and four in the Newark MSA. Exceedences in New York City were 40 in 1986 and 86 in 1987. DEP regulates carbon monoxide and hydrocarbon emissions through the motor vehicle inspection program.[69]

Carbon monoxide indoors: Recent Canadian studies found sublethal concentrations of carbon monoxide in insufficiently ventilated houses or furnace rooms.[70]

Studies of health effects of sublethal levels of carbon monoxide show "that low levels of carboxyhemoglobin (COHb) produce significant effects on cardiac function during exercise in subjects with coronary artery disease."[71]

Provisions to supply adequate air to combustion equipment can prevent buildup of carbon monoxide in residences. However, residents often close up air supply openings, not realizing their purpose or necessity. Foundation and window air leaks are the usual source of outside air for combustion equipment. If those leaks are closed during basement renovation or weatherizing and no air source remains, combustion will pull air from other areas of the house, making the house drafty. Exhaust fans in bathrooms and kitchens may overcome natural drafts providing air to combustion equipment or to fireplace flues. Either of these situations may reduce oxygen supply to the combustion equipment or fire and may pull normally exhausted carbon monoxide back into the building.[72]

Two approaches can eliminate the possibility of carbon monoxide poisoning from fuel-fired heating equipment in residences: public education, or sealed combustion units that control the path supply and exhaust air. Since human activity plays a large role in determining the flow of air within a building, more effort should go to public awareness of the need for a proper air flow to combustion equipment in existing buildings. A technical, health, and economic evaluation would be necessary to determine the cost benefits of requiring sealed combustion units.[73]

Outside air introduced into buildings by natural infiltration or mechanical ventilation costs money for heating and cooling but dilutes indoor air pollutants. To balance economic and pollution control needs, ventilation standards or maximum allowable pollutant concentrations can be prescribed. National standards include those from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Its most recent update of ventilation codes, entitled 62-19-89 now in press, sets a minimum of 0.35 air changes per hour (0.35 ACH) or 15 cubic feet per minute per occupant (15 cfm/occupant), whichever is greater. The amended code limits for indoor radon are a maximum of four microcuries per liter. These and other codes set minimum but not maximum ventilation standards. The most effective means of maintaining and improving indoor air quality is reduction of pollutant sources, smoking, and aerosol or solvent use, among others.

Nuclear Energy Impacts - Releases and Waste

Since 1969 nuclear energy has supplied electricity for state use. For most of the years since 1974, nuclear energy has supplied over one-quarter of electricity produced by the state's utilities. Even at that level, nuclear supplied less than 10 percent of TBtu used in the state.[74]

Table IV-4-6 lists the state's four nuclear electric generation units and units that state utilities own. The units are either boiling water or pressurized water reactors. From both types gaseous radioactive releases are predominantly noble gases (xenon and krypton). The liquid effluents from pressurized water reactors contain primarily tritium. Boiling water reactors release little radioactivity in liquid form. The amount of radioactivity a reactor releases depends upon the amount of time the reactor is operating at full power.[75]

The utilities report effluent releases to the Nuclear Regulatory Commission (NRC) semiannually. The reports, published by the NRC, contain information on the regulatory limits, measurement techniques, summaries of effluent releases, solid radioactive waste from the plant, radiological impact to humans, and meteorological data.[76]

The operators dilute the liquid wastes to allowable levels, then release it to the cooling water source. They ship the solids to one of three nuclear waste facilities: Barnwell, South Carolina, Hanford, Washington, or Beatty, Nevada for burial. The plants release gaseous radioactive material into the air where it is carried downwind by prevailing winds. Potential impacts within the state include any relating to transportation of solids and any resulting from liquid or gaseous releases.[77]

The regulatory limits are stated in terms of human exposure. There is no specific limit on volume or quantity of releases. Table IV-4-7 gives the amount of Curies released by each of the in-state nuclear plants in 1986 and 1987. It also gives the number of units of radioactivity released in relation to the number of kilowatthours generated during those years.

Off-site releases from each New Jersey nuclear plant were well within the NRC regulatory limits for the plants.

Table IV-4-6

Nuclear Electric Generating Units
Owned by New Jersey Utilities

Unit, date	Location	Plant Type	Capacity Owned	Utility
In State				
Salem 1 1977	Lower Alloways Creek, Salem	PW	80 MW 460 MW	AE PSE&G
Salem 2 1981	Lower Alloways Creek, Salem	PW	82 MW 471 MW	AE PSE&G
Oyster Creek 1969	Lacey Twp. (Forked River) Ocean County	BW	630 MW	JCP&L
Hope Creek 1986	Lower Alloways Creek, Salem Salem County	BW	1067 MW	PSE&G
N. J. utility in-state capacity			2790 MW	
Out-of-State				
Peach Bottom 2 1974	Lancaster, PA	BW	79 MW 446 MW	AE PSE&G
Peach Bottom 3 1986	Lancaster, PA	BW	78 MW 440 MW	AE PSE&G
Three Mile Is.1	Middletown, PA		194 MW	JCP&L
Three Mile Is.2	Middletown, PA		220 MW*	JCP&L
N.J. Utility owned out-of-state nuclear capacity			1237 MW*	

Notes: BW - boiling water reactor, PW - pressurized water reactor
*currently out of service not included in total

Table IV-4-7

Nuclear Electric Generating Units
Curies Released per kwh Produced

Unit, Date	Plant Type	MW Capacity	Year	MWh Generated	Waste Type	Curies Released	PicoCuries Released/kwh Generated
Salem	PW	combined	1986	5,285,300	liq	869.0	164,418
1- 1977		996.6			gas	2,899.0	584,502
2- 1981							
			1987	5,253,426	liq	1,053.0	200,441
					gas	5,510.0	1,048,839
Hope	PW	1111.5	1986	1,021,526	liq	under 1.0	under1,000
Creek					gas	42.6	41,702
1969							
			1987	6,894,821	liq	11.2	1,624
					gas	2,832.0	410,743
Oyster	PW	628.0	1986	1,299,311	liq	1.1	846
Creek					gas	76,700.0	59,031,286
1969							
			1987	3,111,307	liq	1.9	610
					.gas	3400.0	1,092,788

Notes: BW - boiling water reactor, PW - pressurized water reactor

Source Federal Energy Regulatory Commission (FERC) Form No. 1 for Public Service Electric & Gas and Jersey Central Power & Light, for years ending December 31, 1986 and 1987; Summary of Effluent Releases and Solid Waste for 1986 and 1987 developed from utilities Semi-annual Effluent release Reports to the Nuclear Regulatory Commission (NRC).

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Use Efficiency Can Bring Improvements

Although extensive regulation controls emissions in New Jersey, over the last decade most pollutant levels have not decreased. What measures, then, can New Jersey take to influence energy-related pollutant levels?

Efficiency, utilized at the level of today's best available technologies, can reduce total energy use. Chapter VI, Scenarios for New Jersey 2000, provides estimates for emissions reductions within the state, based on potential energy use reductions.

The technology now available to provide energy services, heat, light, motor power, and transport using far fewer TBtus can enable the state to reduce energy related radioactive releases and fossil fuel-related emissions or, at least, to reduce a projected increase.

Findings

- CO_2 released by fossil fuel combustion is building up in the earth's atmosphere. The implications of this buildup are critically important in the mid- to long-term. While New Jersey alone cannot control the buildup, it can prepare to meet scientific and public concerns that are now surfacing.

- Nitrogen oxides and sulfur dioxide emissions cause acid precipitation. Acid precipitation contributes to the acidity of lakes and streams, and the resulting adverse effects on those living organisms. Acid precipitation may harm plant life. It has the potential to affect soil acidity that controls the movement of toxic heavy metals through soils and into aquifers.

- Ozone, formed in the atmosphere from nitrogen oxides and organic substances, results, at least in part, from fossil fuel emissions. Exceedences of the ozone standard are increasing, possibly as a result of hot summer weather. The number of days with poor air quality has increased because of high ozone levels.

- Volatile organic substances, petroleum, petrochemicals, solvents, and other organic compounds are released into the air in part from fuel use. Gasoline vapor released at gas pumps is a major source. These compounds are precursors of ozone. Many are suspected of causing cancer.

- Particulate matter resulting from incomplete combustion of fossil fuel, particularly diesel fuel, contains particulates with the carcinogen benzo(a)pyrene.

- DEP has already instituted the most cost-effective technically available controls for the controllable pollutants. Ozone formation remains a problem.

- Carbon dioxide release is a problem uncontrollable by technical solutions such as emissions controls. The alternatives are increased use of nuclear electric generation, alternative energy sources, or greater end use efficiency.

- Energy efficiency, in addition to its other advantages, is the single most effective means of reducing combustion-related emissions.

Policy

- The state shall encourage energy efficiency to the greatest extent consistent with cost-effective investment.

- The state shall review its own investments in infrastructure, its influence on land use decisions, and its own operations to find opportunities for fuel efficiency.

- The state shall encourage use of renewable energy, biomass, landfill gas, and photovoltaics to the maximum extent technically feasible, at least in demonstration projects.

- The state shall encourage research on energy storage, use of biomass, photovoltaics, and other promising technologies that might reduce dependence on fossil fuels, particularly imported petroleum.

- The state shall encourage inclusion of environmental costs and benefits in energy planning cost/benefit analyses. It shall foster the development of appropriate methodology and design of means to internalize environmental costs.

Implementation

Administrative

- Target motor vehicle emission for more stringent enforcement.

- Require new residential construction using combustion heating equipment to install high-efficiency sealed combustion units or to insure adequate ventilation of indoor spaces not sealed from the combustion unit.

- Petition Board of Public Utilities to commission a study of the effect of New Jersey utilities using power generated in states having no upper limits of sulfur in fuel.

- Petition Board of Public Utilities to commission a study of the effect of requiring New Jersey utilities to purchase from the power pool on the basis of environmental dispatch.

- Petition Board of Public Utilities to require electric utilities to incorporate into their least cost planning internalization of environmental costs.
- Employ life-cycle costing for all government-purchased energy-consuming equipment to guarantee consideration of energy savings benefits.

Legislative

- Support federal legislative proposals to reduce sulfur dioxide emissions nationwide by at least 10 million tons. Phase in reduction, to allow for mid-term evaluation.
- Support financial arrangements by which each electric user would pay its share of emissions reduction costs, based on its share of use.
- Support flexibility in reduction of sulfur dioxide emissions within a statewide reduction target amount. Support state choice of method of reduction, whether fuel switching, technological controls, or conservation.
- Support energy efficiency and conservation.

DRAFT

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FOOTNOTES

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4. J.D. Mahlman, "Trace Gases and Climate Change," Testimony prepared for Hearings on Climate Change by the Congressional Subcommittee on Natural Resources, Agricultural Research, and Environment. Presented 07/22/87.

5. New Jersey Department of Environmental Protection, Division of Environmental Quality (NJDEP, DEQ),"New Jersey Air Quality 1987," p. 5. and James S. Cannon, Acid Rain and Energy: A Challenge for New Jersey (New York: INFORM, Inc., 1984), p. 2.

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8. Acurex Corporation, Report for the California Energy Commission, Clean Coal Fuels: Alternate Fuel Strategies for Stationary and Mobile Engines (Mountainview, Ca: January 1982), p.3.

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11. Telephone discussion with Duncan White, NJDEP, Nuclear Environmental Engineering Section, 12/15/88.

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15 Telephone discussion with Duncan White, NJDEP, Nuclear Environmental Engineering Section, 12/15/88.

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18. Commercial Nuclear Power: Prospects for the United States and the World. (Washington: Energy Information Administration, (EIA) 1986) DOE/EIA-0438(86), Appendix C, p. 71.

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20. Sheila Machado and Rick Piltz, Reducing the Rate of Global Warming: The States' Role (Washington: Renew America, November 1988), p. 19., provided estimates of New Jersey carbon dioxide emissions. Atmospheric Carbon Dioxide and the Global Carbon Cycle (Washington: USDOE, Carbon Dioxide Research Division, Office of Basic Sciences, December, 1985), p. 72, provided national estimates of New Jersey carbon dioxide emissions.

21. U.S. Environmental Protection Agency, National Emissions Data System State Emissions Report. 09/27/88.

22. Federal Clean Air Act and N.J.A.C. 7:27.

23. Ibid., Criteria pollutants are those for which the federal government has set National Ambient Air Quality Standards (NAAQS) under authorization of the Clean Air Act.

24. NJDEP, DEQ., p. 2.

25. Ibid., p. 3.

26. Ibid.

27. Ibid., p. 4.

28. N.J.A.C. 7:27 - 6.1 et sec. establishes emissions standards for particulates, sulfur, carbon monoxide, hydrocarbons, volatile organics and nitrogen oxides, benzene, tetrachloroethylene, total volatile organics, substances contributing to ozone formation. The regulations also require modeling of criteria pollutants that new sources might emit.

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30. Ibid.

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32. U.S. Committee for an International Geosphere-Biosphere Program (IGBP), Commission on Physical Sciences, Mathematics and Resources, National Research Council, Global Change in the Geosphere-Biosphere (Washington: National Academy Press, 1986), p. 58.

33. J.D. Mahlman, p. 7.

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53. Ibid., p. 27.

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57. NJDEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances: Stage II Vapor Recovery, Docket No.052-87-10. 1987, p. 4; Proposed Regulations amending N.J.A.C. 7:27-16.1, 16.2, 16.5, and 16.6, p. 6.Docket No. 044-88-11

58. Walter W. Heck "Assessment of Crop Losses from Air Pollutants in the United States, in Multiple Air Pollutants and Forest and Crop Damage in the U.S.," (working title) Yale University Press, Spring 1989.

59. Exceedence includes violations at any monitor. Exceedences may have occured at several monitors in any one day.

60. NJDEP, DEQ, p. 5.

61. Northeast States for Coordinated Air Use Management (NESCAUM), Critical Analysis of the Federal Motor Vehicle Control Program, July, 1988, p. 10.

62. NJDEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances: Stage II Vapor Recovery, Docket No.052-87-10. 1987 amending N.J.A.C. 7:27-16.1 and 16.3.

63. Ibid.

64. NJDEP, Proposed Regulations on Control and Prohibition of Air Pollution by Volatile Organic Substances, Docket No. 044-88-11, amending N.J.A.C. 7:27-16.1, 16.2, 16.5, and 16.6; Docket No. 030-88-07, amending N.J.A.C.7:27-23.

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67. Amounts of fossil fuel burned in NJ in 1986, in small engines or burners with the potential for producing carbon monoxide if improperly controlled.

Fuel Use	TBtu	Percent
Residential natural gas	162.4	10%
Residential petroleum	106.3	7%
Transport petroleum	656.7	52%
Small burner and internal combustion engine total	925.4	69%

68. NESCAUM, p. 7.

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70. Hatch Associates Ltd., p. 9.

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72. Roscoe J. Clark, presentation at Excellence in Housing 88, Portland Maine, April 28, 1988.

73. Personal communication with Joseph W. Lstiburek, B.A.Sc., M.Eng., P.Eng., President, Building Engineering Corporation, Downsview, Ontario, at Excellence in Housing 88, Portland Maine, April 28, 1988.

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APPENDIX IV-4-1
Energy Sources for New Jersey Energy Use

The New Jersey Energy Data System and federal Energy Information Administration compile information on the source of energy used in New Jersey. The source for each sector, in TBtu of each fuel used during 1986, is as follows:

Total TBtu			Electric Generation TBtu				
Sector	Energy Source	TBtu	Electric TBtu	Heat Losses TBtu	Out-of-State TBtu	In-state Nuclear TBtu	Total Electric TBtu
Residential	coal	0.9					
	gas	162.4					
	oil	106.3					
	elec	61.6	61.6				61.6
Generation losses		142.8		142.8			142.8
Residential subtotal:		474.0					
Commercial	coal	0.6					
	gas	88.0					
	oil	67.0					
	elec	75.6	75.6				75.6
Generation losses		175.4		175.4			175.4
Commercial subtotal:		406.6					
Industrial	coal	6.6					
	gas	71.5					
	fuel oil	56.7					
	feed stock oil	194.1					
	elec	53.2	53.2				53.2
Generation losses		123.4		123.4			123.4
Industrial subtotal:		505.6					
Transport	coal	0.0					
	gas	2.9					
	oil	569.5					
	N.Y. jet fuel	131.2					
	N.J. jet fuel	90.6					
	asphalt,road oil	49.7					
	elec	.3	.3				0.3
Generation losses		.7		.7			0.7
Transport subtotal:		795.5					
TBtu	Totals	2181.5	190.7	442.3	310.9	159.6	633.0

ELECTRIC GENERATION in-state, fuel sources		
coal	69.8	
natural gas	38.2	
petroleum	57.4	
Hydro	-3.0	
nuclear	159.6	
Generation in-state, fuel input total TBtu:	322.0	
Generation for NJ use, fuel input total TBtu , 310.9 +	322.0	= 633.0

Sources: NJEDS and Energy Information Administration, (EIA), <u>State Energy Data Report</u>, DOE/EIA-0214(86), tables 198-203, p 207-212.

D R A F T

Chapter IV-5

EMERGENCY PLANS

Introduction

This chapter describes the development of energy emergency planning in New Jersey and outlines the procedures to be followed during an energy emergency. The energy emergency plans currently in place have evolved over the years to address possible problems with the state's major energy sources, namely petroleum, natural gas, coal, and electricity, within the context of a supply-oriented emergency.

Responsibility for energy emergency planning has resided with the Division of Energy Planning and Conservation (DEPC) since the Arab oil embargo of 1973-74 with the promulgation of the Federal Energy Guidelines by the then-federal Energy Office and later its successor, the United States Department of Energy. An Executive Order of the Governor created two offices -- the State Office for Petroleum Allocation (SOPA) and the State Energy Office (SEO). SOPA implemented the state set-aside mandated by federal regulations.

SEO issued a report, Energy: A Report to the Governor From the Task Force on Energy, May 1974, which recommended that five pieces of legislation be drafted to organize an energy department and to manage emergencies. Concerns raised in this report have been addressed over the years by incorporating the recommendations into the Department of Energy Act (N.J.S.A. 52:27F-1 et seq.), the Energy Emergency Preparedness Act (P.L. 1983, c. 599), and New Jersey Energy Emergency Regulations (N.J.A.C. 12A:52).

The Energy Emergency Preparedness Act recognizes the occurrence of periodic energy emergencies due to the volatility and unpredictability of energy markets. Systematic preparation for such emergencies is essential. Energy emergency planning during the past 16 years has been popularly identified with catastrophic political events, such as the Middle Eastern oil embargoes of 1973 and 1979, the massive electricity blackouts suffered by New York City in 1965 and 1974, and the natural gas curtailment experienced by New Jersey in the winter of 1976-77.

Any approach to energy emergency planning at the state level must possess four common features:

- Ability to monitor emergency situations and obtain valid energy data.
- Integration with existing emergency plans for natural disasters, civil emergencies, etc.
- Direct communication between the emergency coordinator and the affected constituencies.

- Flexible response capability.

Ability to Monitor Energy Emergency

The Department of Energy Act (N.J.S.A. 52:27F-1 et seq.) recognizes the role of energy data management for both long-term planning and emergency management in two major sections: Section 2, the legislative findings; and Section 11, powers of the Commissioner, in seven subsections. The most significant mandates are subsections of Section 11:

(a) "Manage the department as the central repository within state government for the collection of energy information"

(f) "Establish an energy information system which will provide all data necessary to insure a fair and equitable distribution of available energy and to provide the basis for long-term planning related to energy needs."

Since 1977, energy emergency management and the gathering of energy information have been the responsibilities of the state. In the past, when petroleum allocation based on federal estimates seemed to affect some states adversely, most states were unable to provide independent estimates of their own consumption. In 1979 during the Iranian oil cutoff, New Jersey had a functioning energy information system that allowed for systematic management of petroleum supplies.

The New Jersey Energy Data System (NJEDS) meets emergency and long-term planning goals. Each month, reports are generated directly from data retrieved from the system. Prices for a complete range of oil products, as well as electricity and natural gas, are used for up-to-date analyses as well as historical comparisons. In addition, regularly collected energy consumption data provide a basis of comparison with federal statistics for crisis situations as well as for long-term planning.

Energy emergency planning by the three principal energy industries reflects the extent of government regulation of the respective industry. The natural gas and electric industries are regulated public utilities, subject to specific requirements of state law. The electric utility industry ranks first in terms of scope and detail of its emergency planning. The petroleum industry, almost totally unregulated in the area of planning, ranks third in scope and detail of state-level emergency planning.

The dissemination of accurate, up-to-date energy emergency information is essential during crises. Therefore, DCEED must be the single point of contact for energy emergency information in state government. All related information released from other state agencies should be cleared through the DCEED Public Affairs Director to ensure consistency and accuracy.

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Energy emergency planning and response measures must be specific to provide general direction, and individual response measures must be goal-oriented. However, a workable plan should also be flexible enough to allow emergency response personnel to use sound judgment in the field. This element is particularly vital in the areas of electricity and natural gas.

Present Method of Operation - Energy Emergency Response Plans

The Energy Emergency Response Plans, N.J.A.C. 12A:52-2, respond to shortages of petroleum products, electricity, or natural gas with specific measures necessary for any one or a combination of energy sources. While some of these measures will have more economic impact than others, sound policy requires a progressive implementation from the least action deemed necessary toward the more severe measures as circumstances warrant. All of these measures have been effective in the past, and therefore should be viable if an energy emergency develops in the near future.

Common to all energy emergency plans is a finding by the DCEED Commissioner that an energy emergency exists, based upon evaluation of an evolving situation by the emergency coordinator. The Commissioner then recommends that the Governor declare an energy emergency by Executive Order, which activates the energy emergency regulations. Interpretation of the regulations is the responsibility of DEPC.

Petroleum Energy Emergency Response Plan

The Petroleum Energy Emergency Response Plan addresses problems associated with inadequate supplies of crude oil and refined petroleum products in the absence of federal price and allocation controls. It provides a framework for dealing with various petroleum supply shortage situations.

The existence and severity of a projected petroleum shortage can be estimated, but not calculated precisely, because the oil market is international. In 1987, the United States imported approximately 40 percent of its petroleum requirements.[1] Further, the country participates in an international agreement, the International Energy Program, to share its petroleum supply in the case of an international petroleum supply interruption of a certain magnitude. While such an interruption will not affect our national petroleum supplies immediately, its impact must be anticipated.

One factor that moderates oil vulnerability is the U.S. Strategic Petroleum Reserve (SPR). Congress authorized the SPR in the 1975 Energy Policy and Conservation Act (P.L. 94-163), which mandated establishment of SPR with up to 1 billion barrels of petroleum products. Goals of the SPR are to reduce the impact of petroleum supply disruptions and to meet the country's obligations under Agreement of the International Energy Program.[2]

The SPR contained more than 540 million barrels at year end 1987, and with moderate federal funding will reach 750 million barrels by the mid-1990s. These stocks are large enough to provide a cushion in the event of a short-term supply disruption, significantly reducing the adverse effects that might otherwise by felt.[3]

Upon determination by the President to use the SPR, the primary method to distribute SPR oil is competitive sale and delivery to the highest bidders. However, the Secretary of Energy, at his/her discretion, may direct the distribution of up to 10 percent of the volume of oil sold in a given month in any manner.[4] Under the present physical drawdown/distribution capability, the SPR can be utilized for almost one year. Distribution would be as follows: about 51 percent of the reserve in 90 days, 95 percent in 180 days, and 100 percent in 350 days.[5]

For its recommendations to the Commissioner, DEPC assesses any potential petroleum shortfall based on:

1) perception at time of disruption concerning both the magnitude and the probable length of the petroleum supply shortfall;

2) availability of excess petroleum production capacity;

3) potential military petroleum requirements;

4) level of petroleum stocks in the US and worldwide and whether such stocks are or will be drawn down; and

5) the volume of petroleum imports destined for the terminals and the drawdown of the strategic petroleum reserve.

Upon finding that any combination of domestic and international conditions may adversely affect all or any part of the state, the Commissioner places DEPC on an internal petroleum supply alert.

If the petroleum supply situation would result in a supply of less than 100 percent of the estimated volume of each covered product to be sold for consumption within the state in the next several months (N.J.A.C. 12A:52-5.3), and would endanger the public health, safety, or welfare, the Commissioner recommends that the Governor declare a petroleum energy emergency.

The Petroleum Energy Emergency Regulations, N.J.A.C. 12A:52-3.1 *et seq.* (to regulate and control the sale of motor gasoline) and/or N.J.A.C. 12A:52-5.1 *et seq.* (state set-aside for all petroleum products listed therein), can be activated only by Executive Order of the Governor.

Upon the Governor's declaration of a petroleum energy emergency, the Commissioner designates the emergency coordinator (EC), information officer, allocation officer and monitor. As needed, additional personnel come from current DCEED staff, other state departments, and new or temporary hires.

By Administrative Order of the Commissioner, the following mandatory response measures commence:

Coping and demand restraint measures:

- Public information
- Ridesharing expansion options
- Revised work schedule options
- Reduced staff travel
- Fleet management

Measures to be implemented by other agencies:

- Speed limit enforcement
- Public transit augmentation
- Preference lane
- Parking management
- Preferential toll and fare

These measures reduce motor fuel consumption and are both economically and technically viable. Some measures, e.g., ridesharing expansion options, revised work schedule options, and public transit augmentation, are more appropriate for long-term problems. These would take some time to implement but would allow employees to continue to earn normal income without undue inconvenience while reducing usual transportation costs. Others, such as reduced staff travel, speed limit enforcement, preference lane, preferential toll and fare, can be implemented immediately for even short-term problems.

In addition, the Commissioner may establish a state set-aside for any petroleum product. Set-aside volumes allow DEPC to meet hardships and emergency requirements of wholesalers, purchasers, retailers, and end-users. From the petroleum set aside each month, DEPC calculates percentages and assigns a prime supplier to eligible applicants.

Natural Gas Energy Emergency Response Plan

The Natural Gas Energy Emergency Regulations (N.J.A.C. 12A-52-2) have been in effect since 1977. The four gas distribution companies serving New Jersey obtain more than 51 percent of their supplies from two major interstate pipelines--Transco and Texas Eastern--which provide approximately 23 percent and 28 percent, respectively. Purchases directly from producers account for about 44 percent of total gas supplies. (See Chapter II-1-A.)

The organization of gas utility customer classes protects the residential consumer. Certain commercial and industrial customers, as part of their service contracts, receive lower rates because they are subject to service interruptions. The utilities have established procedures for load shifting among customer classes. If the state's gas distribution companies experience curtailment of natural gas supplies, DEPC personnel implement the regulations in concert with the gas distribution companies. During the early stages of a natural gas curtailment, individual consumers would experience slight impact. However, as the curtailment continues, business operations and customers' lifestyles are more severely affected.

Curtailment of natural gas for general business and residential customer classes is extremely disruptive, since utility personnel must relight pilots on appliances in most buildings to restore service.

If an emergency condition threatens, the emergency coordinator works with the gas utilities to evaluate the supply situation. In addition, DCEED makes public appeals requesting that consumers reduce their use of natural gas.

If a natural gas supply shortage results in the curtailment of firm customers, which would endanger the public health, safety, or welfare, and voluntary customer load curtailment cannot provide sufficient relief, the Commissioner recommends that the Governor declare a natural gas energy emergency and activate the Natural Gas Energy Emergency Regulations, N.J.A.C. 12A:52-2.1 et seq., by Executive Order.

Electric Energy Emergency Response Plan

The Electric Energy Emergency Regulations have been in effect since 1977. New Jersey's three major electric utilities are members of the PJM Interconnection, which coordinates the dispatch of electricity in most of New Jersey, Pennsylvania, Maryland, Delaware and Washington, DC and a small section of northeastern Virginia. DEPC personnel implement the regulations in concert with PJM and the utilities when a problem is imminent. The procedures are well-defined and effective. The early stages of an electric emergency involve little impact on individual consumers. However, if the emergency becomes more severe, the measures become more intrusive on customers' lifestyles and use of electrical equipment.

The Electric Energy Emergency Regulations are adequate to meet any contingency related to a deficiency of electricity and/or the primary fuel sources used to generate electricity.

If an electric energy emergency condition threatens, the emergency coordinator contacts the electric utilities and PJM, if necessary. The emergency coordinator monitors the evolving electric supply situation for the possibility that a 5 percent voltage reduction will be implemented.

If the electric energy emergency may ultimately result in a voltage reduction of 5 percent, which would endanger the public health, safety, or welfare, the Commissioner recommends that the Governor declare an electric energy emergency and activates the Electric Energy Emergency Regulations (N.J.A.C. 12A:52-4.1 et seq.) by Executive Order.

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Radiological Emergency

One special area of concern is nuclear electric generating stations. The New Jersey State Police, Office of Emergency Management (OEM), has overall responsibility for managing a radiological emergency and has formulated the Radiological Emergency Response Plan (RERP). DCEED has the responsibility under RERP to assure motor fuel supplies to service stations that will remain open to provide motor fuel for evacuation.

To assess the adequacy of the RERP, OEM conducts exercises semi-annually. Although only a drill, procedures are followed to uncover any oversights. In general, the Federal Emergency Management Agency specifies the drill scenarios. No prior notification of the type of emergency is given to simulate conditions that would occur during an emergency situation.

Natural Disaster Operations Plan

The Governor has directed that OEM be responsible for the coordination of emergency response activities of all state agencies in the event of a natural disaster. Under the Natural Disaster Operations Plan, DEPC assures adequate supplies of electricity, natural gas, heating oil, and motor fuel if normal distribution channels fail. The procedures to carry out these responsibilities are contained in the individual emergency plans in N.J.A.C. 12A:52-2.

Analysis

With the exception of the RERP, exercises or drills to determine the adequacy of energy emergency plans are not formally conducted. In contrast, California holds regular emergency exercises.[6]

On December 17, 1980 Executive Order No. 101 established an Office of Emergency Management in the Division of State Police, Department of Law and Public Safety. Under its auspices, OEM publishes an "Emergency Procedures Directory," which identifies each state department's designated emergency coordinator and a concise statement of each agency's emergency response functions. This directory also refers to the Governor's Advisory Council on Emergency Services whose responsibilities include the review, evaluation, and periodic recommendation of changes to existing emergency master plans.[7] The Council membership is specified in N.J.S.A. 52:14E-4 and does not include the Commissioner of DCEED.

Findings

- Among the various emergency plans, drills are conducted only with the RERP. Some other states, more sensitive to other disaster possibilities, hold regular emergency drills.

- While responsibility for energy emergency planning resides with DCEED, the Commissioner is not a member of the the Governor's Advisory Council on Emergency Services.

Policy

- Greater emphasis shall be placed on maintaining, updating, and drilling in the various energy emergency response plans.
- The Governor's Advisory Council on Emergency Services shall include Commissioner DCEED.

Implementation

- The Legislature shall amend N.J.S.A. 52:14E-4 to include the Commissioner of DCEED.
- OEM shall require at least annual exercises of emergency response plans, in addition to the RERP drills.

D R A F T

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FOOTNOTES

1. Energy Information Administration (EIA), Petroleum Supply Annual, 1987, Volume 1, May 1988, p. xiv.

2. Strategic Petroleum Reserve, Annual/Quarterly Report, USDOE February 15, 1988, p. 1.

3. EIA, Annual Energy Outlook 1987, p. 1-4.

4. *Ibid.*, p. 14.

5. *Ibid.*, p. 15.

6. Charles Imbrecht, Chairman, California Energy Commission with Harvey M. Sachs, Assistant Commissioner, DCEED, personal correspondence.

7. Emergency Procedures Directory, Office of Emergency Management, p. 3.

Part V

Tools for Change

IMPLEMENTATION OF LEAST COST PLAN

Introduction

In accordance with the requirements of the 1985 Energy Master Plan, New Jersey utilities must employ an integrated least cost planning strategy to minimize the cost of providing service to their customers. The Board of Public Utilities (BPU) has judicially recognized the need for least cost planning. In its Hope Creek Proceeding, April 6, 1987, Decision and Order, BPU Dkt. No. ER 85121163, the Board served notice on the electric utilities that it would pursue an administrative rulemaking proceeding to require least cost planning for all future electric utility rate cases. What follows are both generic and specific elements that the BPU should incorporate into any rule proposal pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq. Although the Hope Creek decision is binding only with respect to the electric utilities, least cost planning can be equally applied to the natural gas utilities.

This chapter defines the guidelines and requirements for implementing a least cost plan.

The Least Cost Plan

A utility's least cost plan should satisfy economic, regulatory, financial, and reliability criteria in an uncertain environment. This plan must identify:

- the needed services in the utility's service territory;
- supply and demand options needed to provided such services;
- financial, regulatory, economic, reliability, and risk criteria for evaluating the desirability of these options;
- a schedule for a periodic review and adjustment of such plan.

A framework for preparing the least cost plan for a utility will therefore consist of the following elements:

1. forecast of load shape, peak load, and energy consumption by customer class--first without demand-side options--to show a base system load shape, then adjusted for the effects of demand-side efforts.
2. a demand-side planning analysis that includes:

a. analysis of the utility's conservation efforts with a reference to its obligation under the applicable conservation plans and including the cost-benefit characteristics of the utility's conservation efforts under the conservation plans of the DCEED and the BPU. The utility-sponsored Conservation Analysis Team (CAT) study may be included if completed.

b. a comprehensive review of demand-side management programs in other states and of cost recovery mechanisms employed for these investments.

c. analyses of the utility's efforts via tariffs or rebates to promote load shaping demand for its services and the consequent adjustments to the utility's load shape. (Demand and energy reductions due to these efforts must be clear).

3. a supply-side planning analysis that includes:

a. For the gas utilities:

i. an analysis of gas availability (long-term, short-term, and spot);

ii. the LDC's gas purchase strategies supported by detailed analyses of the risks and benefits of the choice of long-term pipeline supply and capacity contracting and/or spot gas purchases. This analysis should also show efforts and impediments to diversification of supply and capacity and the utility's estimates and projections of the potential availability of diversified sources.

iii. the LDC's supply planning strategy indicating:

1) the criteria for scheduling purchases and operation of storage to reduce system cost while maintaining reliability;

2) an analysis of the pros and cons of acquiring new sources of supply;

3) the criteria for renegotiating capacity contracts with the pipelines;

4) the criteria and justification for the duration of pipeline supply contracts;

5) a strategy for response to changes in pipeline rate structures.

b. For the electric utilities:

i. an analysis of the utility's power generation options indicating existing and planned power generation resources, such as nuclear plants, combined cycle and combustion turbine generation, hydro power generation, purchased power options (including the impact of the state's cogeneration stipulation and policies) as well as nonconventional options such as geothermal, solar, and wind-generated power.

ii. a catalog of existing units and a schedule for construction of new plants.

iii. "mortality analysis" for existing units, identifying opportunities for life extension, costs of environmental retrofits that may be required, and threats (economic, environmental, or operational) to continued high availability of each plant.

iv. an analysis of the cost/benefit, load, and energy impact of new or existing power generation units and criteria for acquiring new generation units.

Given these demand and supply criteria and data, an integrated utility planning model is then utilized to choose a least cost resource plan that achieves a desired objective, such as minimizing the present value of revenue requirements. A financial analysis is performed on the alternative choices using a financial planning model to determine the financial risks to which the utility is exposed for a given choice.

The least cost plan must also be subjected to uncertainty analysis using decision analysis techniques to evaluate the sensitivity of the plan to the effects of uncertain variables. This analysis will help identify the sensitive variables that affect the least cost plan.

The results of the least cost plan must be accompanied by a schedule of contingency plans on revenue requirements, system reliability, and financial integrity of the utility if the chosen least cost plan proves undesirable following its implementation.

DCEED will require that each utility present data and other supporting evidence that:

1. in preparing its least cost plan, it has used to the fullest extent possible all economical means of conservation, cogeneration, and other load management techniques as an initial source of energy supply;

2. it has taken into account its assessments of all economic and demographic parameters that may affect its energy service;

3. it has prepared a least cost mix of supply options, taking into account reliability criteria to meet system load;

4. a) for gas utilities;

    i. its supply forecasts include estimates of available gas supplies (production [propane], pipeline, storage), their costs, capacities, delivery rates and contract provisions (such as flow minima and/or maxima), minimum bill provisions;

    ii. a description of the LDC's distribution system network and its capabilities (receipt and delivery points, interconnections); future pipeline extensions and construction and their impact on the LDC distribution network.

   b) for electric utilities,

    i. forecast and analysis of projections and uncertainties concerning load growth; its schedule of capital additions, operating cost, lead times of generating technologies, construction lead time, purchased power requirements and costs, and fuel prices;

    ii. presentation of optimized choices of fuel contract mix.

5. the proposed plan is a least cost plan in accordance with proposed methodology supported by:

   a) a demonstration that the plan fully considers all available, practical, and economical conservation, renewable resources, load management alternatives, and improvements in energy efficiencies;

   b) a discussion of how the utility has determined the appropriate level of reliability and its influence on estimates; a discussion of the operating and capital costs of planned facilities and expected financial impacts and requirements of construction and operation;

   c) a demonstration that the utility's rate design accurately reflects the long-term cost of service for each customer class or group and provides adequate incentives for each customer class or group to conserve energy.

DCEED will consult with each utility to ensure that the utility's least cost plan is consistent with the state's goals and objectives.

The utility must prepare a schedule for implementing its least cost plan together with a review procedure and a schedule for monitoring the chosen plan.

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Each utility must present a least cost strategy every two years or at the succeeding rate case, whichever comes first. DCEED, at its discretion, will require that a utility's rate request be denied (or delayed) if it has not presented a satisfactory least cost plan in accordance with these requirements.

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Chapter V-2

LEGISLATIVE INITIATIVES TO IMPLEMENT THE 1989 ENERGY MASTER PLAN

This chapter reviews existing legislative authority and proposes new legislation or amendments to existing statutes to promote energy efficiency and sound planning. The proposed legislative language will be included in the adopted New Jersey Energy Master Plan.

Existing Authority

DCEED's Division of Energy Planning and Conservation derives its authority to draft and implement the policies of the Energy Master Plan from several statutes. N.J.S.A. 52:27 F-1 et seq., the Department of Energy Act, is largely unchanged from the original 1977 authorizing legislation, with the following exceptions:

P. L. 1987, c. 365, abolished the Department of Energy as a principal agency of state government and transferred its functions to other departments. The largest part of the old Energy Department was renamed the Division of Energy Planning and Conservation and transferred to the Department of Commerce, which was itself renamed the Department of Commerce, Energy and Economic Development. The Master Plan function is now the responsibility of a seven-agency committee that drafts, proposes, and adopts the Master Plan. However, enforcement of the plan and advocacy of the policies before the Board of Public Utilities (BPU) has been left to the Division of Energy Planning and Conservation. Chapter 365 transferred the promulgation of the Energy Subcode to the Department of Community Affairs.

The responsibilities for data reporting, co-extensive energy facility siting, and energy emergency preparedness reporting remain with the Division of Energy Planning and Conservation (DEPC).

P. L. 1983, c. 559, required the Department of Energy to prepare every three years a report for the Governor and the legislature on the state of energy emergency preparedness in New Jersey. The first report was issued at the end of 1985 and a second report is being finalized now by DEPC.

P. L. 1983, c. 115, N.J.S.A 48:7-16, the Certificate of Need for Electric Generating Facilities Act, remains with the Division of Energy Planning and Conservation.

Chapter V-2

Legislative Initiatives

The following proposed legislation offers significant initiatives whose adoption would substantially affect energy use patterns in New Jersey.

Petroleum (Chapter II-1-A): Alternative-Fueled Government Fleet Act

Through Executive Order of the Governor to the Department of the Treasury, the state government can require that the state vehicle fleet be powered by alternative fuels, such as methane, hydrogen, alcohol, and electricity. However, no such order is binding on the independent agencies, such as the New Jersey Turnpike Authority, or on local government units (counties, municipalities, etc.). The adoption of an Alternative Fueled Government Fleet Act would increase the number of vehicles required to use alternative fuels, thereby increasing the possibility that one or more of such fuels could be successfully introduced in the commercial market in New Jersey. Timetables should be established through legislative hearings to determine what percentage of a given fleet can be practicably converted to alternative fuels. Experience with alternative fuels is required if the United States and New Jersey are to reduce dependence on petroleum. Equally important, many alternative fuels cause less pollution than gasoline.

Coal (Chapter II-1-C): Coal Use and Coordination Act

To increase the environmentally safe use of coal in New Jersey as an alternative fuel for the utility and industrial sectors requires that issues concerning transportation, storage, waste disposal, and air pollution resulting from coal combustion be dealt with in a coordinated and timely manner. The Coal Use and Coordination Act would provide for the resolution of existing regulatory questions through an interagency body.

Electricity (Chapter II-2): Electric Facility Capacity Planning and Certificate of Need for Electric Generating Facilities Act Amendments of 1989

The current process for evaluating the need, site, and technology of applications for energy facilities needs to be more precisely defined. The process is a reactive one for state government. The growth of the nonutility sector in electric generation warrants certain adjustments to the planning for generation and transmission facilities.

The purpose of these amendments is to create a pro-active planning process for the utility and nonutility sector wherein government and the private sector would participate in a comprehensive evaluation of capacity planning for energy facilities of all types, including gas and electric transmission, storage and generation facilities. These amendments would, as part of the Energy Master Plan's siting element, create an annual review of energy facilities planning in the state and are needed for two reasons:

1. The Not-In-My-Backyard (NIMBY) syndrome affects both the private and public sector with respect to siting of energy facilities in this state. A proactive evaluation for needed facilities allows longer lead times to address technical and community concerns.

2. The Stipulation of Settlement on Cogeneration signed in 1988 allows the electric utilities to continue to plan for generating facilities without any evaluation of the process by state government. The Division of Energy Planning and Conservation would not formally approve these plans but would be limited to review and comment.

The sections of the DEPC statute that would be ammended are N.J.S.A. 52:27F-14 and 15(c). However the Certificate of Need for Electric Generating Facilities, a separate statute, would be unaffected by these proposed amendments.

Gross Receipts and Franchise Tax Amendment

The present public utilities Gross Receipts, Franchise and Excise Taxes (GR&FT) on the revenues of electric and natural gas companies should be replaced by a proportional unit tax on the energy sold by such companies. The uncoupling of energy taxes from energy prices will not only remove the inflation-driven tax increase, but will provide predictable tax yields. Such a proposal could stimulate economic development by making New Jersey's energy prices more competitive with those in other states, while maintaining acceptable municipal revenues. The proposal avoids cross-subsidies within various classes of customers, as well as cross-subsidies among utilities, and therefore provides a fair and equitable solution in moving our energy taxes toward the national average. Since the unit taxes would be computed on the basis of the GR&FT for a base year, total revenue collection by the state would be at least that collected in the base year. Increase in GR&FT revenues would then be solely based on increase in energy use.

Transportation (Chapter III-3): Vanpool/Rideshare Promotion Act

Of first priority in the transportation sector, the state should encourage vanpooling and ridesharing through its fiscal powers because these measures can quickly get cars off the road, thereby cutting congestion, fuel use, and pollution. Such measures should include (1) removing the state sales tax for all U.S. manufactured vans purchased by eligible vanpool sponsors, (2) providing state vanpool funding through mass transportation funds based on avoided costs associated with building new roads or expanding existing roads, (3) encouraging third-party (leasing) vanpool organizations to provide service, and (4) providing specific criteria for accountability of traffic management associations

(TMAs) in reducing congestion, promoting ridesharing, reducing energy use, and reducing costs of programs.

New Jersey Transit Funding Act

It is important to provide stable funding for mass transit through the enactment of a formula for the state contribution to NJ Transit. Also mass transit operators should be exempt from paying the gross receipts and franchise tax on energy purchased for their operations.

Sales Tax Act Amendment of 1989 (Motor Vehicles)

The adoption of a revenue-neutral gas sipper rebate/gas guzzler tax in place of a standard sales tax on new car purchases would provide a clear signal to New Jersey citizens of the state's commitment to energy efficient cars.

Gasoline Tax Act Amendments of 1989

Raising the gas tax to the same level as surrounding states would provide an incentive to drive less. Increasing gas taxes when gasoline prices rise as the result of shortages would reinforce the inclination to conserve petroleum fuels.

Building Code: Uniform Construction Code Act Amendments of 1989

The Uniform Construction Code Act (N.J.S.A. 52:27D-123) should be amended to authorize the Department of Community Affairs to modify any model energy code already adopted as the Energy Subcode.

Utility Conservation Plans and Least Cost Planning (Chapters IV-1-A and V-1): Public Utilities Act Amendments of 1989

Energy efficiency must be part of the statutory basis upon which the utilities maintain their franchise service territories. Least cost planning has been identified as the best way to meet society's need for energy services. In general, least cost planning studies lead to recommendations for greater investment at the customer side of the meter rather than in power plants. Under traditional regulatory schemes, utilities have little incentive to make these investments, which typically have been expensed instead of capitalized. Legislation to deal with this problem could take several forms: (1) Direct BPU to consider the effectiveness of utility least cost plans in setting rates of return. Effective implementation would win higher allowable rates; inactivity or ineffective efforts would result in lowered allowable rates. (2) Allow utilities to capitalize cost-effective conservation expenditures so they earn a return on investment for shareholders. (3) Amend N.J.S.A. 48:2-23, which states that each utility must provide safe, adequate, and proper service, to require implementation of least cost planning as a franchise condition. P. L. 1979, c. 86, which amended the statute, sets a precedent by providing that the utilities must render service in a manner that will preserve and conserve the environment. A similar amendment mandating energy efficiency considerations should be added.

Energy Emergency Preparedness (Chapter IV-5): Energy Emergency Preparedness Act Amendments of 1989

N.J.S.A. 52:14E-14 should be amended to include the Commissioner of the DCEED on the Governor's Advisory Council on Emergency Services.

D R A F T

Chapter V-2

DEVELOPING AN ENERGY-LITERATE SOCIETY

Introduction

Our energy consciousness has grown enormously since the early 1970s when we generally expected--when we thought about it at all--to have abundant and cheap energy into the future.

With the shocks of the 1970s, oil became expensive and politically vulnerable, and our energy awareness received a jolt. Conservation became the watchword, as we were "freezing in the dark" and doing without.

The 1980s have held their own surprises. Oil prices fell instead of continuing to rise; deregulation and competition are changing the power industry; and environmental concerns demand increased attention. As important, we have redefined the objective from doing without to doing the job better with less energy through energy efficiency.

To attain the goals of this Energy Master Plan of energy efficiency, least-cost services, and improved environmental quality requires the attention and education of all New Jerseyans. Only by striving to develop an energy-literate society can we insure that our future energy decisions will be made thoughtfully by informed citizens.

New Jerseyans had a crash course in energy with the ups and downs of the '70s and '80s, and they reacted vigorously. Business and industry had to move quickly to develop more efficient processes and improve buildings simply to stay competitive. Some even began generating their own electricity. Residents weatherized their homes as they began buying energy efficient appliances and driving smaller, more fuel efficient cars. Government policymakers strove to forecast and plan for the future.

From 1985 to 1988, DOE (and then DCEED) sponsored an energy curriculum program for New Jersey schools that reached more than 185,000 students in some 435 schools. Offered at first in middle school science classes, the program was soon being used by students ranging from gifted fifth grade classes to senior high school general science as well as in the areas of social studies, economics, and vocational-technical education. In a survey of teachers using the curriculum, 91 percent of the respondents found the materials effective or extremely effective in terms of student learning and motivation, and 99 percent rated the program components useful in their courses.[1]

Energy Education in New Jersey: Present Situation

The energy curriculum program goes on, but it now operates on a much smaller scale. The major source of funding for the curriculum came from federal oil overcharge monies, which are no longer available for this program. Several utility companies and Exxon USA, who were also sponsors, continue their support through the purchase of materials, while DCEED funds a series of teacher workshops.

At teachers' conferences and conventions, the demand for energy information and materials is high. DCEED's annual energy design contest for New Jersey students grew from 1,600 entries in 1987 to 6,500 entries in 1988.[2]

DCEED is an active participant in public/private partnerships that open many opportunities to learn about energy for students and teachers alike. A consortium of state agencies and energy companies, the New Jersey Energy Education Council provides energy education seminars, tours of energy facilities, and other programs for teachers that served some 500 educators in the 1987-88 school year. The New Jersey Chapter of the National Energy Foundation sponsors an energy project competition, essay contest, and other activities for students.

In addition, the Critical Environmental Issues Seminar, held at the Hackensack Meadowlands Environment Center, offers 25 teachers an in-depth two-week course on energy and the environment each summer. The Department of Education's Technology Network has an energy education component that is easily accessible statewide to teachers through their own computer terminals.

New DCEED projects are underway as well, such as a package of energy activities for students in kindergarten to grade three that address the science proficiencies recommended by the Department of Education, and the proposed establishment of an Energy Resource Center for teachers at a state college. DCEED works closely with an advisory board of educators and the state's only elementary science magnet school to test materials and energy education concepts.

At the same time, DCEED works to educate and inform all New Jerseyans through its outreach activities at conferences and conventions, by developing and distributing energy-related literature and providing a toll-free energy information line that averages 1,000 requests for information per month. In 1987, major areas of inquiry were DCEED's Oilheat Loan Program, weatherization, home energy assistance, and energy education, though the subjects of callers' questions vary widely from month to month.[3]

For many years the state sponsored and nurtured the Energy Exposition for Business and Industry and, in 1988, DCEED turned it over to a private, nonprofit board. DCEED continues its support of this endeavor as part of its commitment to business and industry. Likewise, the Energy Management Workbook assists this sector with information on the latest energy-efficient technologies.

Analysis

Today, many will "buy in" to energy efficiency simply to reduce their monthly utility bills or to cut the cost of doing business. In a time of relative stability of price and supply, however, pro-active efforts to heighten energy awareness are critical. For long-term effectiveness and a permanent change in thought and lifestyle, we must learn from the past and look to the future: we must develop an energy-literate society.

Energy education in the schools is a place to begin. A substantial, intentional effort must be made to provide New Jersey teachers and students with the best possible energy information and education. The broad acceptance of energy education that has been demonstrated suggests a ready avenue for future actions.

Such efforts would begin with supplemental curriculum materials in elementary schools to lay the groundwork for more advanced concepts offered at appropriate levels in later years. Energy concepts can be taught in science classes but can also be used to build both quantitative and critical thinking skills in many other disciplines, all leading to the goal of equipping New Jersey students with an energy consciousness.

Findings

- DCEED's energy curriculum program was well-received by educators throughout the state. Because federal funds are no longer available, the program now operates only on a reduced scale.
- DCEED cooperates with utility companies and other public and private agencies in energy education.
- Interest in energy information and energy education materials is high.

Policy

- To insure that future energy decisions will be made by informed citizens, the state shall encourage and promote energy education in its schools.

<u>Implementation</u>

- The state shall provide funding to reinstate the successful energy curriculum program at the middle school level.
- Elementary schools shall receive energy education materials appropriate for the various grade levels.

DRAFT

Chapter V-3

FOOTNOTES

1. Enterprise for Education, Survey of Teachers Using Energy 80 Curriculum, January, 1987.

2. Department of Commerce, Energy and Economic Development, Office of Community, Education and Information Services, Monthly Reports, 1987 and 1988.

3. Ibid.

D R A F T

Chapter V-3

RESEARCH & DEVELOPMENT NEEDS

Introduction

New Jersey _can_ choose its energy future. Technology now available would build a more economic, efficient, and environmentally benign energy future than our past. Implementing the best available technologies today would save 450 TBtu/yr in 2000, based on the assumptions of the 1989 New Jersey Energy Master Plan:

- For all sectors except residential, the best technology commercially available in 1988 is used as a proxy for the average efficiency that could be attained in 2000.
- For the residential sector, we assume that the best available new construction and retrofit strategies are used and that the current expansion rate of the housing stock continues.

Of course, even better technology can be developed and will begin to penetrate the market, offsetting some less-than-optimal uses that will persist and further improving New Jersey's future.

This chapter outlines some promising areas for research to meet New Jersey's needs. In addition to the view by sector, we touch on both "hard" research that leads to technology improvements and "soft" studies on infrastructure, policy, and delivery needs.

We divide research and development needs into use-associated categories, as follows:

Buildings: Envelope, thermal storage, controls, performance measurement, policies to assure life cycle cost minimization.

Transportation: Fuel efficiency improvements, alternative fuels for security and environmental protection, development and employment patterns that decrease transportation intensity.

Industrial: Reinvestment meant to increase competitiveness as well as energy efficiency, development of processes that provide equivalent or better goods at lower cost with less energy content.

Supply: New electricity technologies (photovoltaics, microcogeneration, fuel cells, fluidized bed combustion).

Electric Utilities: Integrating, controlling, and dispatching a system with many more sources (with much smaller average size and more nonutility owners); policies to enable utilities to profit by providing services instead of raw power.

Chapter V-4

The Buildings Sector

In light frame construction of single-family and small multi-family structures, high energy performance can be achieved cost-effectively at today's energy prices. Residential construction is craft-dominated, rather than "manufactured." More economical means of producing saved energy are needed, including improved foundation systems (*e.g.*, insulated wood), panelized walls, better ventilation distribution systems, new means to assure thermal integrity, and better window systems. Manufactured components assembled on site may have potential.

These improvements will lower building energy consumption by lowering heat loss/heat gain rates. In turn, this change in building "thermal capacitance" can strongly affect utility load factors: buildings that gain heat slowly could be "precooled" with night-time electricity at lower rates. For light frame structures, how do the economics compare with alternatives? In particular, two strategies are available which may be complementary.

On-site thermal storage includes several alternatives: Concrete floors or similar structural elements passively add thermal capacitance. Active systems are available as well. European and some domestic utilities are promoting time-clocked resistive heaters, often placed in rooms and taking roughly the space of old fashioned-radiators, that are heated at night and use thermostat-controlled fans to discharge their heat into the living space during the day. Analogous cooling systems use off-peak power to cool water or make ice at night. The resulting cool reservoir absorbs air conditioning loads during the day. Although such diurnal systems are commercially available, market penetration is limited. Experience with seasonal ice storage has not been promising.

The complementary strategy is direct appliance control, in which a utility shaves peak load by using remote activators (*e.g.*, radio) to operate customer-site controllers that cycle appliances such as electric water heaters and air conditioners. This technology can significantly lower peak demands.

For the foreseeable future, electricity peak management will be critical to avoid brownouts. Additional study is required to determine tariff structures that minimize ratepayer costs and stimulate customer peakshaving strategies, such as thermal storage. In addition to ice/cold water diurnal storage, eutectic salts may have potential as heat or cool storage media.

Utility customer information flows are rudimentary. Meters give the utilities information on cumulative energy use in kwh (and for commercial electric accounts, monthly peak demand). Bills provide energy data but little assistance for customer feedback. Improved two-way data flows, providing feedback, would give many opportunities for greater efficiency.

Photovoltaics have great potential and should be stimulated. From being competitive only for space satellite applications in the '60s, they are now used for convenience (calculators) and for their favorable economics where grid connections are expensive (remote telecommunications repeaters, rural road signs). At this time, "remainder of system" costs for inverters and mounting drive photovoltaic economics.

The development of architectural components, such as roofs, wall panels, or glazing, that incorporate photovoltaic systems could minimize costs. In particular, transparent photovoltaic glazing, if developed, could offer both electricity and sun control.

The concept of an industry standard "Interactive Demand Management Interface (IDMI)" has promise. It would have two functions: the ability to accept a dichotomous (off/on) signal to interrupt or restart an appliance (air conditioner, refrigerator, water heater); and the ability to signal the state of the controlled appliance.[1] The concept has not been tested. The IDMI would facilitate utility demand side management programs by minimizing labor and capital required for controllers. Appliance controllers would handle signals only at low voltage, so safety issues are of less concern than with time voltage controls. The IDMI would also facilitate control by local computers or even by third-party energy service companies. The signal leads proposed for IDMI provide local or remote controllers with important information on controllable load. Further, by cycling the IDMI, installation integrity could be tested nonintrusively.

Additional work on characterizing building performance will facilitate application of concepts like HERS (Home Energy Rating System), PRISM (utility bill-based analysis of energy performance of houses), or sliding scale hook-up fees for commercial buildings[2] to stimulate life-cycle costing.

Many forces affect critical intermediaries whose decisions determine building standards. One example is the banking industry, which could allow larger loans for more efficient houses if it had tools that would allow real life-cycle or cash-flow models to be applied. Architects and engineers often do not see examples of energy efficiency successes. Commercial and residential developers both create and respond to pressures for visual amenities instead of energy performance, leading to installation of low-capital, high-energy-intensity systems.

Health and energy efficiency concerns demand attention to ventilation and air infiltration in light frame structures, such as houses. In this context, ventilation refers to mechanically-induced air change with the outside, while infiltration refers to natural changes.

Low air change rates save energy by obviating the need to condition the air (i.e., heat, cool, increase or decrease humidity, filter, etc.) On the other hand, since the concentration of an "ideal," or noninteracting, pollutant is the quotient of its source strength divided by the rate at which fresh air is introduced, lower air change rates mean higher pollutant concentrations.

The problem is compounded because the natural ventilation rates of conventional houses are variable, increasing with indoor/outdoor temperature difference, wind strength, and other factors. Clearly, peak demands for heating ventilation air occur on days of peak energy demand, so controlling natural ventilation rates helps solve the peak supply problem. This would offer savings to utilities, equipment buyers, and energy bill payers.

The research and development challenge is twofold: cost-effectively controlling the variability of infiltration and finding economically attractive ways to provide minimum supplies of fresh air at all times.

There is some measure of consensus on maximum acceptable concentrations of pollutants and minimum acceptable ventilation rates, but less agreement on when measurements are needed, as well as the technologies required to achieve clean indoor air at the lowest cost.

Additional research is required to evaluate interactions between energy efficiency and other societal goals, including the following:

- A strong correlation exists between water conservation and energy efficiency. Substantial work shows that efficiency improvements such as low-flow, high-pressure showerheads that are cost-justified by energy savings may have much larger value for their water savings in many areas.[3]

- Controlling indoor air pollution without wasting energy on excessively high ventilation rates requires greater understanding of sources of pollutants and their control. It might, for example, be less expensive to formulate low-formaldehyde carpet backing and European-standard particle board than to increase ventilation rates.

- Researchers agree that local soil and bedrock are more likely to lead to excess radon than building materials. Additional research is required to identify susceptible regions and develop improved ways to keep radon out, find its entry points, and mitigate problems.

Transportation

The concept of "avoided cost" has stimulated energy efficiency by steering investment to efficiency improvements where they are less expensive than new capacity. This concept is more widely applicable, particularly in transportation. Research can determine the cost to society of adding the incremental lane mile of new or improved roadway to a now-congested road system, as compared to the incremental cost of an additional vanpool or program to stimulate use of mass transit. Only such a perspective will allow a true comparison of the available alternatives.

The great challenge is to increase efficiency of the automobile and light truck stock at least twofold. This improvement would be cost-effective and would strongly affect reliance on imported petroleum.[4]

The record of the last 15 years shows that market forces generally work but that large price swings can result when supplies are tight and the market is quasi-monopolistic. Supply countries sometimes try to manipulate prices by withholding oil from the market. Governments in consuming nations have played a large role in manipulating demand. In particular, fuel economy standards in the United States and road taxes in Europe have led to more efficient fleets, which in turn moderate demand and keep prices down. We do not yet know the best combination of taxes and efficiency standards to achieve national security interests in minimizing fuel imports.

Another effective impact on energy use, as well as on the environment and the economy, is likely to come from research that leads people to choose alternatives to single-occupant vehicle use. These options may represent continuation of present trends (shop-by-mail), evolving practices (home offices and "telecommuting," or working from home with computer and telephone), or expansion of vanpooling, carpooling, and mass transit.

It is also important to explore and demonstrate alternative fuels, particularly natural gas and gas-derived methanol, which have the potential to diversify our fuel use and to help control pollution in urban areas. These fuels are particularly suited to fleet applications ranging from delivery vehicles to buses. This work must consider the relative contribution of different fuels to increasing the carbon dioxide burden of the atmosphere, a particular challenge for coal and coal-derived fuels because of the high carbon-to-hydrogen ratio of coal. Per unit of useful work, methanol from coal will produce twice as much carbon dioxide as natural gas (with petroleum intermediate).

Industry

Large-scale opportunities for energy efficiency improvements exist in industry along with many barriers. The field is heterogeneous and complex. One of the few generalities is the large potential of cogeneration and of more efficient motors and motor control systems. Though paybacks are often quite rapid, the investments may not be made. Research is required not only on motor/controller technology but on how to give plant engineers and managers the information they require to make optimum decisions.

Many opportunities also lie in cooling and cooling control. Under what conditions is the increased capital cost of gas air conditioning justified? Do opportunities exist for better controllers and commercial chillers? Can advanced desiccant systems be energy-efficient adjuncts for industrial air conditioning and humidity control?

Finally, just as waste minimization is being engineered into industrial processes, energy efficiency must become part of the design process because it is a significant component of direct costs and the manufacturer cannot directly control its price.

Supply

Ongoing research and development may dramatically change electricity supply. Current work may lead to cost-effective and highly efficient fluidized bed boilers fueled by coal or organic wastes. Defense technology may lead to near-term application of aircraft-derivative steam-injected intercooled gas turbines (ISTIGs), which have efficiencies near 48 percent and may have acceptable emissions.[5]

There are also opportunities for advanced-design, "inherently safe" nuclear reactors (typically gas-cooled, graphite-moderated), if the monitoring and waste problems common to all uranium cycle machines can be addressed.

"Dispersed" electricity generating methods also offer new possibilities. The 1980s have seen regulatory evolution that stimulated the application of off-the-shelf industrial technologies for cogeneration. Many research and development opportunities, some near commercialization, would enable end users to own their own "power plants." These include photovoltaic cells and advanced cogeneration, including fuel cells.

Utilities

If research indeed leads to increased electric supply options, then the 1990s will require enormous efforts by electric utilities to maintain economic viability as value-added service providers. Services utilities could provide include engineering, design, construction, and maintenance of generating equipment located on the customer's premises, just as AT&T, a long-distance telephone company, also sells private branch exchanges to provide call-switching services on the premises of commercial and other large users.

The concept of service "unbundling" is being implemented in the gas industry and proposed for electric utilities. Just as customers are now separately charged for unbundled local and long distance telephone service, electric utilities might offer tariffed services to large customers for generation ("busbar power"), transmission, back-up, or wheeling of third-party power.

Because customer loads typically vary with season and time of day, utilities may be able profitably to offer peaking as well as back-up service. They will certainly serve as wholesalers/brokers, controlling the network and providing interconnection services.

These changes require research and development now, in areas ranging from economics to law to control theory, as we expect that dispatch of systems with thousands of "generators" that range widely in size and contract terms will necessitate sophisticated control algorithms and software.

Research and Development Funding

Of course, research and development require money, and two classes of funding mechanisms can be identified: "pull" mechanisms, in which perceived market opportunities lead the private sector to make direct investments in targeted areas; and "push" situations, in which public (tax or ratepayer) funds are used to fund R & D in the belief that it will lower the barriers to investment and lead to products and services that the market will embrace.

The United States invests less than its competitors in energy efficiency research and development, and the 1980s have seen dramatic reductions in federal efforts--the traditional "push" mechanism.[6]

Remaining "push" activities are heavily concentrated in utility consortia, such as the Electric Power Research Institute (EPRI) and the Gas Research Institute (GRI). EPRI's funding concentrates heavily on the supply side--improved generation and distribution methods, with much less effort on demand side mechanisms. We anticipate little change in this situation until regulators find mechanisms that provide utilities with stronger incentives for cost-effective investment on the customer's side of the meter.

During this decade, several states have undertaken innovative programs to sponsor energy efficiency research and developement. Of these programs, the New Jersey Energy Conservation Laboratory (NJECL) at Princeton University is a standout. For a five-year period (1985 through 1989), approximately $900,000 per year is being spent. The money is largely ratepayer-derived, through the state's seven investor-owned gas and electric utilities, with approximately $200,000 per year of state and oil overcharge funding. Governance of NJECL is by a board representing utilities, the Board of Public Utilities (BPU), DCEED, and outside experts, and projects are formulated to meet research needs of the state and its utilities. The utilities have expressed their intentions to let the program lapse after the five-year commitment, which ends December 31, 1989. According to Professor Robert Socolow, NJECL Director, both Texas and California are now implementing programs modeled on NJECL.

New York created an Energy Research and Development Agency (NYSERDA), which also carries out collaborative programs involving utility cosponsorship. NYSERDA is funded by a millage tax on utility transactions. Public and investor-owned utilities in North Carolina voluntarily fund the North Carolina Alternative Energy Corporation (NCAEC) to direct a variety of research and development programs of particular value to their state. Minnesota is now establishing a buildings science research program at the University largely funded by oil overcharge monies.

New Jersey's decisions--or failures to make decisions--soon will greatly affect our energy consumption, environmental quality, and economic health in the year 2000. All of these factors require government and the private sector to commit the most efficient future that can be economically justified.

Chapter V-4

This is change, and change requires research and development. We know the cost of mature technologies like central power plants. We can only guess the mature costs of today's new opportunities, from photovoltaics to better houses. By beginning now to send the right policy signals, New Jersey will stimulate the research and development that will assure New Jersey leadership in fields as diverse as manufactured housing and photovoltaics. By not acting, leadership will pass to others, and New Jersey will be a technology consumer, as we are now fuel consumers.

Findings

- Across many sectors, higher efficiency products, services, and systems are now available. These are not being installed at rates commensurate with their cost-effectiveness. Research is required on the barriers to these cost-effective improvements.

- In all sectors studied, "hardware" research and development offer opportunities to bring to market new products that would use much less energy than present approaches.

- For the last several years, stable to declining energy prices have led to reductions in public and private energy efficiency research and development.

Policy

- Because New Jersey is an energy-consuming state with a large research and manufacturing base, mechanisms shall be developed to foster research and development that would build on current strengths in universities and industry to make New Jersey a national leader in energy efficiency products and services.

- New Jersey shall develop tax policies that foster energy efficiency investments, to help shield the state from future "price shocks," and to provide a local market for the developers of energy efficiency products and services.

Implementation

- Using the experience gained with state/utility sponsorship of the New Jersey Energy Conservation Laboratory and with Science and Technology Commission sponsorship of innovation in other areas, the Board of Public Utilities, perhaps with assistance from the Science and Technology Commission, shall develop a New Jersey Energy Foundation to sponsor research and development in New Jersey, using ratepayer funds.

- The New Jersey Legislature shall enact programs that reward energy efficiency investment up to cost-effective limits to stimulate a market for products and services of benefit to the state. Such programs could include:

  A. extension of the Business Energy Improvement Program using state funds;

  B. tax credits for energy efficiency investments, with the amount of the credit based on energy saved rather than dollars invested.

FOOTNOTES

1. Harvey M. Sachs, in preparation, The Standard Interactive Demand Management Interface (IDMI): The next step in better appliances?

2. Arthur H. Rosenfield and Jonathan G. Koomey, Promoting Efficiency Investments in New Buildings: A New Policy to Improve Building Efficiency, Reduce Pollution, and Avoid Power Plan Construction (Berkeley: Lawrence Berkeley Laboratory, 1988).

3. Final Report: Governor's Emergency Water Rationing Order - Executive Order # 97 - April 17, 1985. Office of Operations, July 26, 1988.

4. William U. Chandler, Howard S. Geller, Marc R. Ledbetter, Energy Efficiency, A New Agenda, (Washington, DC: American Council for an Energy Efficient Economy, 1988), p. 28.

5. Robert H. Williams and Eric D. Larson, "Expanded Roles for Gas Turbines in Power Generation," in Electricity by Thomas B. Johansson, Birgit Bodlund, and Robert H. Williams, Stockholm, Vattenfall, Swedish State Power Board, April 1989.

6. Chandler et al., p. 45.

Part VI

New Jersey 2000

Chapter VI

CHOICES FOR NEW JERSEY 2000

New Jersey has choices. By the year 2000, energy use could exceed 3,500 TBtu a year or could be half that amount. This chapter presents alternative scenarios. Each would have different impacts on New Jersey's future economy and environment. The choices are complicated, but they are ours.

Scenarios of annual increases in energy use will mean substantial highway congestion or many additional roads, frequent brown-outs or much new generating capacity and transmission rights-of-way, acid rain and ozone or more regulation and capital investment in environmental control, energy dependence or alternative energy sources.

A scenario of moderate annual decrease through using the best technology available today will mean getting the same services while spreading out peak period use on roads and on utility grids and getting better economic value from these high cost infrastructures. It will also mean reduced environmental impacts.

These scenarios are based on projections by DCEED and other organizations. They are straight line extrapolations of historical rates of change. The scenarios are thus not forecasts, but changes based on specific assumptions. In terms of this Plan we explore how changes in state policy might affect the underlying assumptions and thus increase the likelihood of the projected change occurring.

A <u>projection</u> postulates a future condition based on certain rules and assumptions. Projections may assume continuations of past conditions, present conditions, or trended changes in historical conditions. The number of projections is infinite.

A <u>forecast</u>, on the other hand, is a projection based on a judgment that specific conditions will occur. It is a prediction. All forecasts are projections, but not all projections are forecasts.[1]

New Jersey Energy Use And Electric Peak Demand Scenarios

Two aspects of energy use are of concern to New Jersey: aggregate use (use) and peak demand. Use is the total of fuel, tons of coal, cubic feet of natural gas, barrels of petroleum, and tons of uranium that provide energy for New Jersey use. To present an overall picture of use, we convert amounts of the various fuels to a common fuel value, TBtu.

The other aspect is highest use at any time--peak use--referred to as peak load or peak demand. Peak demand is most significant for delivery of electric power because few means are available for storing electric power. The capacity to deliver that power must be available at the time of peak demand. The summer of 1988, with its long hot periods and need for air conditioning, was a critical one for meeting electric peak demand and showed the necessity to plan for and control that demand.

Peak demand is also important to gas utilities because pipeline and distribution limitations force curtailment of some large users on the coldest days to meet the demands of other "firm delivery" customers.

Electric Peak Demand Scenarios

The following are three scenarios for change in peak demand through 2000. Table VI-1 gives projected peak demand for the three scenarios for 1990, 1995, and 2000.

The utility expected growth peak scenario derives from projections developed by AE, JCP&L, and PSE&G, as described in their September 1988 white paper, "New Jersey's Electric Energy Future . . . Issues and Challenges." It projects peak demand rising at over 6 percent annually in the early years, the rise then dropping off to 2 percent annually to reach 18,300 MW by 2000.

The historical high growth peak scenario shows peak demand rising at the rate that occurred from 1987 to 1988, from 13,726 MW to 14,337 MW, 4.5 percent annually. Growing at that rate, by the year 2000, peak demand would become 24,300 MW, nearly double the 1988 peak. This growth rate is below the 7 percent rate of peak demand growth in the 1960s. The straight line projection does not take into account the potential for installing new demand-spreading technology.

Table VI-1

Peak Demand Projections Under Three Scenarios

Year	Utility Expected Peak in MW	Historical High Growth Peak in MW	Best Available Technology Peak in MW
1988 Actual	14,337	14,337	14,337
1990	16,100	15,600	13,400
1995	17,500	19,500	10,900
2000	18,300	24,300	8,500

Source: Utility Expected: New Jersey's Electric Energy Future, Issues and Challenges, AE, JCP&L/GPU, PSE&G, September 1988, p. 8; Historical High Growth, NJDCEED; Best Available Technology, DCEED, see Part III.

The best available technology peak scenario (BAT) projects peak demand falling at a rate controlled by weatherization of buildings and steady replacement of existing appliances and equipment with the most energy efficient models available today. Chapters III-1 and III-2 define the specific assumptions and provide the numbers underlying this projection. Reduction of peak demand at that rate could reduce year 2000 peak demand to 8,500 MW, 40 percent below the 1988 peak, less than half the utility expected growth scenario peak, and just over a third of the high impact scenario.

Electric Peak Demand Scenario Impacts

Generating Capacity Requirements: These three scenarios have significantly different generation capacity requirements. Table IV-2 sums up the capacity New Jersey utilities would require in 2000. The state's electric utilities expect to have 14,700 MW of capacity available in the year 2000. They add 2,000 MW of nonutility capacity representing currently signed contracts for nonutility generation. The combined capacity would be 16,700 MW.[2]

The utilities expected growth peak scenario with 15 percent reserve margin is over 4,000 MW above the generating capacity for year 2000. The high growth scenario peak is more than 11,000 MW above projected installed capacity. Only the best available technology scenario peak would be lower than projected year 2000 installed capacity, and lower than 1988 installed capacity. Only that scenario would not require additional generating capacity.

Table VI-2

Year 2000 Projected Peak Demand
as Related to Projected Installed Capacity
Megawatt (MW) Capacity Requirements
with a 15 Percent Reserve Margin

Year 2000	Utility Expected Growth Scenario MW	Historical High Growth Scenario MW	Best Available Technology Scenario MW
a) Projected utility capacity	14,700	14,700	14,700
b) Proj. non-utility capacity	2,000	2,000	2,000
c) Combined installed capacity	16,700	16,700	16,700
d) Scenario peak demand	18,300	24,300	8,500
e) Reserve margin at 15%	2,750	3,650	1,280
f) Total required capacity	21,050	27,950	9,780

Notes: Reserve is defined as the difference between the installed capacity and the peak load, divided by the peak load: i.e., (f-d)/d, at 15% reserve margin f=1.15d; numbers in table are rounded to nearest 50 MW.

Source: Items a) and b) and Utility Expected: New Jersey's Electric Energy Future, Issues and Challenges, AE, JCP&L/GPU, PSE&G, September 1988, p. 8; Historical High Growth, DCEED; Best Available Technology, DCEED, see Chapter III.

Generating Capacity Construction Needs: The difference between the utilities projected installed capacity for the year 2000 and total required capacity requirements equals the construction needs. Table VI-3 identifies those needs. For reference, we also express capacity in equivalent Hope Creek nuclear generating plant units at 1,067 MW/plant.

The difference between the projected needs and projected installed capacity is 4,350 MW, equivalent to the capacity of four Hope Creek facilities. The difference for the DCEED high growth scenario would be 11,250 MW, more than 10 large nuclear reactors, Hope Creek equivalent facilities. The best available technology scenario would require no additional generating capacity.

Table VI-3

Alternative Ways to Provide for Generating Capacity to Meet Year 2000 Projected Peak

Type of Impact	Utility Expected Growth Scenario	Historical High Growth Scenario	Best Available Technology Scenario
a) Total required capacity -MW	21,050	27,950	9,780
b) Proj. installed capacity -MW	16,700	16,700	16,700
c) Capacity needs (a - b) -MW	4,350	11,250	none
Providing megawatts with central generating station capacity			
d) Hope Creek equivalents - 1067 MW units	4	11	none
e) d) x $4,000,000,000 cost of Hope Creek $3.75 million/MW[x]	$16 billion	$44 billion	incremental investment in BAT.*
f) Lead times to operation	10-15 yrs	10-15 yrs	incremental under 1 yr
g) Land requirements Hope Creek equivalents	2000 acres	6000 acres	no added
Providing megawatts with Non-utility generating capacity:			
h) Non-Utility facilities average size 200 MW	22	56	none
i) average cost $0.4-0.5 million/MW	$2 billion	$5 billion	incremental investment in BAT.*
j) Lead times to operation	2 years	2 years	incremental under 1 yr
k) Land requirements @ 40 acres/facility	880 acres	2240 acres	no added

Note: * - Incremental investment in BAT. means that amount above normal replacement costs necessary to purchase most efficient equipment and appliances available.
x - Hope Creek at 1067 MW, cost approximately $4.6 billion to complete. The estimate of about $4,000 per kilowatt is used as a reasonable proxy for future nuclear powerplant construction costs in New Jersey.

Source: DCEED

The prospect of multiple new generating stations equivalent to Hope Creek brings out the myriad problems of financing, siting, constructing, and operating large centralized generation and transmission facilities to deliver power to load centers in a densely populated, environmentally conscious state.

Financing Needs: Table VI-3 summarizes the needs. Multiplication of the $4 billion construction cost of Hope Creek (in 1986 dollars) by the number of additional Hope Creek equivalents required under the different scenarios gives some measure of the financial impact of the alternative construction needs. If utilities were to provide capacity for their expected growth scenario through constructing central generating stations equivalent to Hope Creek, the cost would be $16 billion, computed in 1986 dollars, at 1986 construction costs. For comparison, the electric utilities total embedded investment in presently existing physical infrastructure is $14 billion.[3]

The nonutility capacity alternative costs only a fraction as much. If, instead of constructing central generating capacity, utilities were to fulfill capacity needs by contracting with nonutility generators at an average cost of $400 to $500 per kilowatt, the financial burden drops to $2 billion for the utility expected growth, and $5 billion for the high growth scenario. Nonutility capacity would be gas turbine or combined cycle cogeneration.

The best available technology scenario would require no utility investment in generating capacity to meet the year 2000 peak. It would require incremental investment by utilities or consumers in weatherization of buildings and steady replacement of equipment and appliances with the most efficient models available. It would substitute payment for utility capital construction through utility rates with direct costs to utilities or consumers for improvement to customers' property. The utility or consumer investment would be the normal cost for equipment and appliance replacement plus a marginal additional cost for purchase of the most efficient equipment and appliances available at the time of replacement.

Operating costs: Capital costs for the nonutility generation are lower than for central power stations, However, operating costs for the nonutility generation are higher. Operating costs for the highest efficiency equipment and appliances must include maintenance adequate to maintain their operating efficiency.

For each of these scenarios, the Board of Public Utilities regulators would have to decide how utilities will finance such projects and any ancillary transmission upgrades or construction.

Siting requirements: Tables VI-3 and VI-4 summarize the requirements. The remaining open areas in the state near an adequate supply of cooling water are near or within environmentally sensitive, protected zones. The Hope Creek, Salem I, and Salem II generating stations have 2,000 uninhabited acres and open water of Delaware Bay surrounding them. Additional nuclear central generating facilities would need comparable space or more stringent engineering measures to keep radiation releases within required parameters.

Both nuclear and fossil fuel-powered central generating facilities require sufficient water to reduce discharge temperatures to acceptable levels. Nuclear facilities require, in addition, water to dilute their liquid radioactive releases. On average, centralized electric generation facilities capture only 30 percent of the heat value of fuel as electric energy. The facilities release the remaining 70 percent of the fuel Btu as heat.

Table VI-4

Summary of Electric Utilities' 1988 Generating Capacity Within and Beyond Normal Service Life in Years 2000 and 2010

Plant type	MW capacity operating in 1989	MW capacity 2000	MW capacity 2010
Fossil fuel steam	5,889	2,907	384
Nuclear	4,017	3,397	1,620
Hydro	330	330	330
Other	4,044	-0-	-0-
Capacity within normal service life	14,280	6,634	2,334
Capacity beyond normal service life	531	7,646	11,946

Note: Normal operating service life for the plant types are: fossil steam fac.- 40 years, nuclear facilities - 30 years hydro facilities - 50 years, other facilities - 25 years.

Source: DCEED

Emissions: Emissions of both nuclear and fossil fuel generating facilities are related to the amount of energy produced rather than to the capacity of the plant. If we assume that electric use will rise or fall at the same rate as peak use, then emissions will rise or fall as a function of use.

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The placement of nuclear power stations in open areas allows greater dilution of the airborne radioactive releases by air currents before the releases might reach the off-site population. Emissions from central fossil fuel plants are likewise diluted by release from high stacks. However, scientists can show the negative downwind effects of fossil fuel plant emissions and provide a basis for regulations to control emissions from new facilities. As scientific ability to demonstrate public health and environmental effects of fossil fuel plant emissions increases, the air quality standards may become more stringent. A short-term possibility is action to limit acid deposition in New Jersey.[4]

Lead times: Table VI-3 summarizes lead time requirements. Consideration of the environmental aspects of siting by the public and regulators adds to construction lead times for coal-fired or nuclear baseload capacity. Public concern results in lengthy appraisal of any major new facility by legislators and the media as well as by regulators. Recently lead times have been 10-15 years for central generating facilities. Permit applications would be necessary for each proposed facility or site.

Lead times for bringing nonutility generating capacity on line have been less, about two years. These facilities also require permits, but since the impacts are small, public discussion, media attention, and time for granting permits are relatively short. A new 165 MW cogeneration facility in Bayonne required two years to obtain permits. Less time is required for ancillary transmission construction because small facilities may be located closer to the load centers, reducing the need for the construction of significant transmission facilities.

Longer term considerations: Calculations using projected capacity for the year 2000 are misleading because they do not take into account the aging of utilities' existing generating capacity beyond that period. Table VI-4 gives the megawatts of utility capacity existing today that will be within its normal operating life span in 2000 and in 2010.

By the year 2000, some 3,000 MW of steam electric production will be more than 40 years old (see Chapter II-2). By year 2000, 2,410 MW of nuclear baseload capacity will be beyond 20 or more years of its normal 30-year operating license life. Oyster Creek (620 MW) will have been in service for 31 years; Peach Bottom 2 (524 MW), Peach Bottom 3 (519 MW), and TMI-1 (194 MW) will have been in service for 26 years; and Salem 1 (553 MW) will have been in service for 23 years.

In summary, almost one-third of the utilities' installed capacity will be approaching and/or exceeding its service life by 2000. The 1988 utility study states that utilities will retire or phase out 5,800 MW of capacity and purchases by 2010.[5]

Advantages of the Best Available Technology Peak Scenario

By 2000 less than half of today's electric generating capacity will be within its normal service life. Considering the long lead times and environmental limitations on building new central generating station capacity, clearly the state will need to reduce peak demand or utilities will need to contract for other generating capacity. Since the best available technology peak demand scenario has the shortest lead time and requires the least investment, it offers the best alternative for meeting the state's needs for capacity.

The means of achieving the best available technology peak demand scenario is through the best available technology use scenario. The state could not achieve the low peak without replacing the majority of today's equipment and appliances.

Our calculation of this peak demand derives from the analysis in Chapter III. That projected use, if spread over the year as in 1987, at a load factor of 52.5 percent, would mean a peak demand of 8,500 MW. This reduction in watthours is nearly 33 percent from the 1987 level.

Energy Use Scenarios

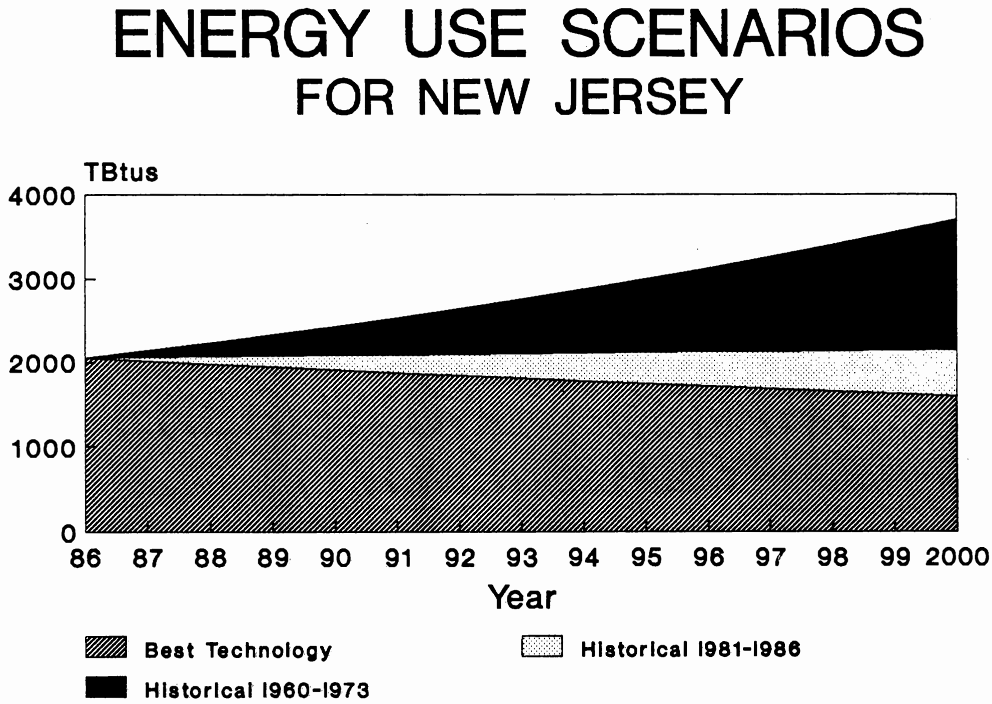
Figure VI-1 presents three energy use scenarios for the state. The scenarios are projections of potential rates of change for energy use through the year 2000.

The historical high growth projection shows energy use increasing as it did over the periods 1960-73 and 1986-88, both periods of relatively low energy prices. The rate of change in each of those periods was a 4.5 percent annual increase.

The historical low growth projection shows energy use changing at the rate it did during the years 1981-1986, a period of high energy prices. The rate during that period, as shown in Figure I-1, was a 0.2 percent annual increase.

The best available technology projection (BAT) shows the savings possible, assuming no other changes, if, between now and year 2000, users weatherized buildings and replaced all today's appliances, equipment, and motor vehicles with the most energy efficient models available today. Chapter III defines the specific assumptions and includes the numbers underlying this projection.

Figure VI-1



Electric Use Scenarios

In 1987, New Jersey electric utilities sold nearly 58,000 gwh to their residential, commercial, and industrial customers. If these customers over the next decade weatherized their buildings and replaced existing appliances and equipment with the most energy efficient models available today, these same customers would use only 39,000 gwh. Table VI-5 summarizes the savings projected for each customer class.

These numbers are the base for the peak demand (load) BAT scenario described in the previous section and Table IV-1-1. If the customers used these watthours in the same time pattern as they did in 1988, at a load factor or 52.5 percent (see Chapter II-2, Electricity), the peak load associated with these customers would be only about 8,500 MW.[6]

Table VI-5

Year 2000 Electricity Savings by Customer Class
in Gigawatthours
Assuming 0 Percent Customer Growth

Customer Class	1987 GWH	2000 GWH	GWH Saved	Percent Changed
Residential	19,044	12,300	6,744	35.4%
Commercial	23,183	13,424	9,759	42.0%
Industrial	15,610	12,696	2,915	18.0%
Total	57,837	38,420	19,418	34.0%

Note: Number of customers has risen 1.48% annually 1970-1987 use/customer has grown 1.22 % annually over that period, NJEDS

Source: DCEED, NJEDS Data Base, Residential: Part III.1, Table R-8; Commercial: Part III.2, Table NR-10; Industrial: Part III.2, Table NR-11

The resource and environmental impacts of increasing and decreasing electric use are summarized in Table VI-1-6. Without dramatic technological change or improvement in generation efficiency, environmental impacts increase or decrease directly with use of electricity.

Table VI-6

Air and Water Impacts of Alternative Year 2000
Electricity Use Scenarios

	Impact Type	1986 Impact*	Utility Expected Growth Scenario 2000 Impact	Historical High Growth Scenario 2000 Impact	Best Available Technology Scenario 2000 Impact
a)	Sales-gwh	55,616	80,000	112,000	39,000
b)	Output-gwh	59,836	86,069	120,497	41,959
c)	Input TBtu	633	911	1,275	444
d)	Instate TBtu	311	447	626	218
e)	Instate				
	Fossil TBtu	151	217	304	106
	Nuclear TBtu	160	230	321	112
	Elec.Utility Instate Emissions				
f)	CO_2 10^6MTC	2.3	3.4	4.7	1.6
g)	SO_2 tons S	259,466	373,221	522,510	181,945
h)	NO_2 tons N	217,400	312,713	437,798	152,447
i)	Radioactivity releases in Curies				
	liquid	870.1	1,253.0	1,754.2	610.8
	gaseous	79,641.6	114,558.3	160,381.6	55,847.2

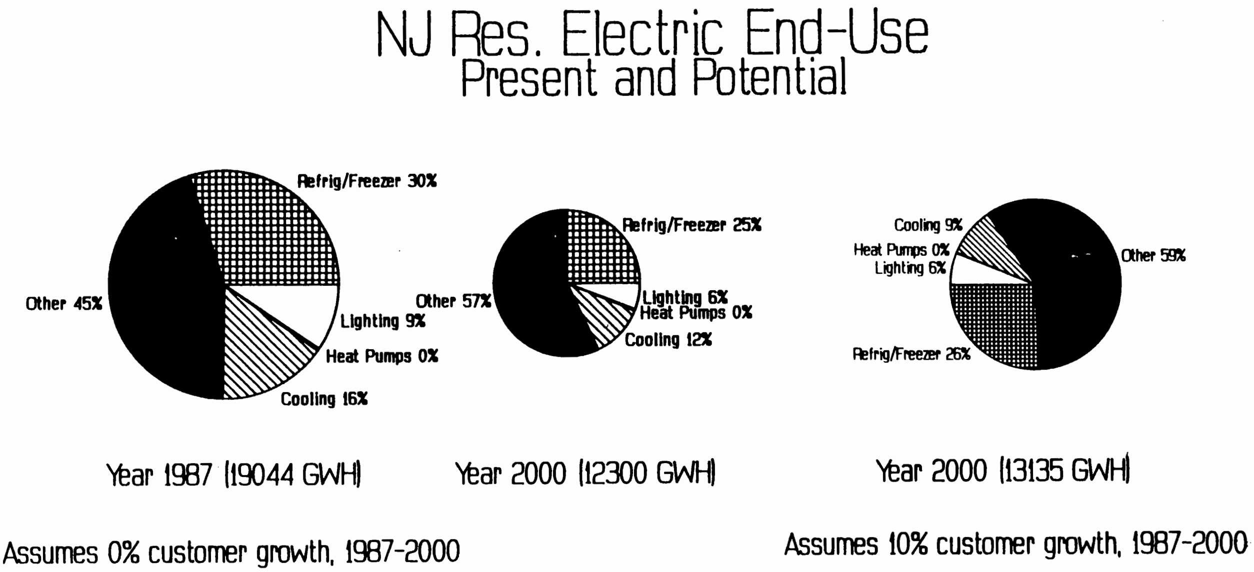
Notes: 1986 Impact* - gwh from NJEDS; 1986 TBtu from EIA State Energy Data Report; The ratio of input MBtu to gwh is 10,600; Instate emissions: CO_2 emissions derive from Renew America calculations, SO_2 and NO_2 emissions derive from USEPA state 1985 data with the same ratio applied to 1986 TBtu use. Radioactivity releases derive from utilities semi-annual reports to NRC. The ratios of numbers in 1986 Impact are carried across the scenarios.

Source: DCEED

Best Available Technology Residential Electric Energy Use

Figure VI-2 shows the potential for reducing residential electric use if, steadily over the next decade, residential electric customers weatherized all their buildings to use 25 percent less space heating electricity than today and replaced existing equipment and appliances with the most efficient equipment and appliances available. Figure VI-2 shows the potential, assuming existing number of residential electric customers and appliance saturation per customer remain at the level reported by PSE&G.[7]

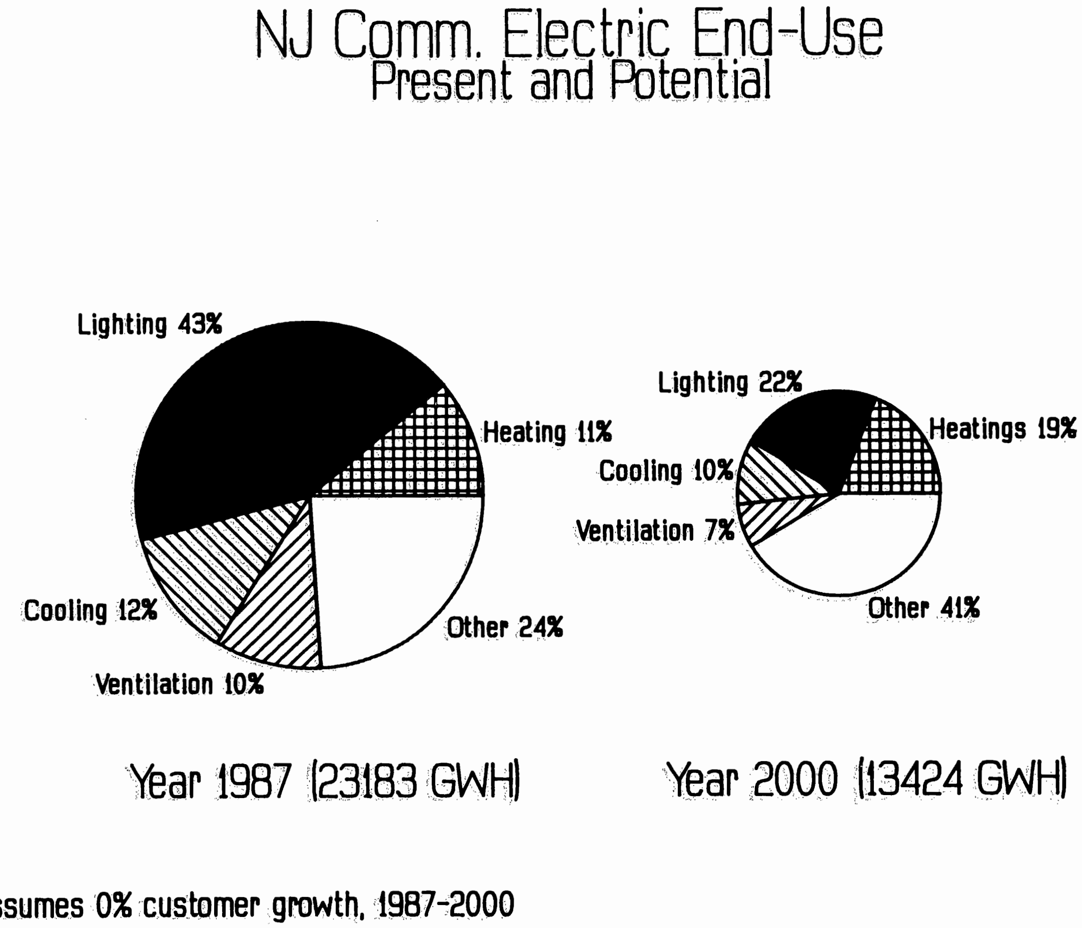
Figure VI-2



Best Available Technology Commercial Electric Energy Use

Figure VI-3 shows the potential for reducing commercial electric use if, steadily over the next decade, commercial electric customers weatherized all their buildings to use 25 percent less space heating electricity than today and replaced existing equipment and appliances with today's best available use efficient equipment and appliances. Figure VI-3 shows the potential, assuming existing number of commercial electric customers and appliance saturation per customer remain at the level reported by PSE&G.[8]

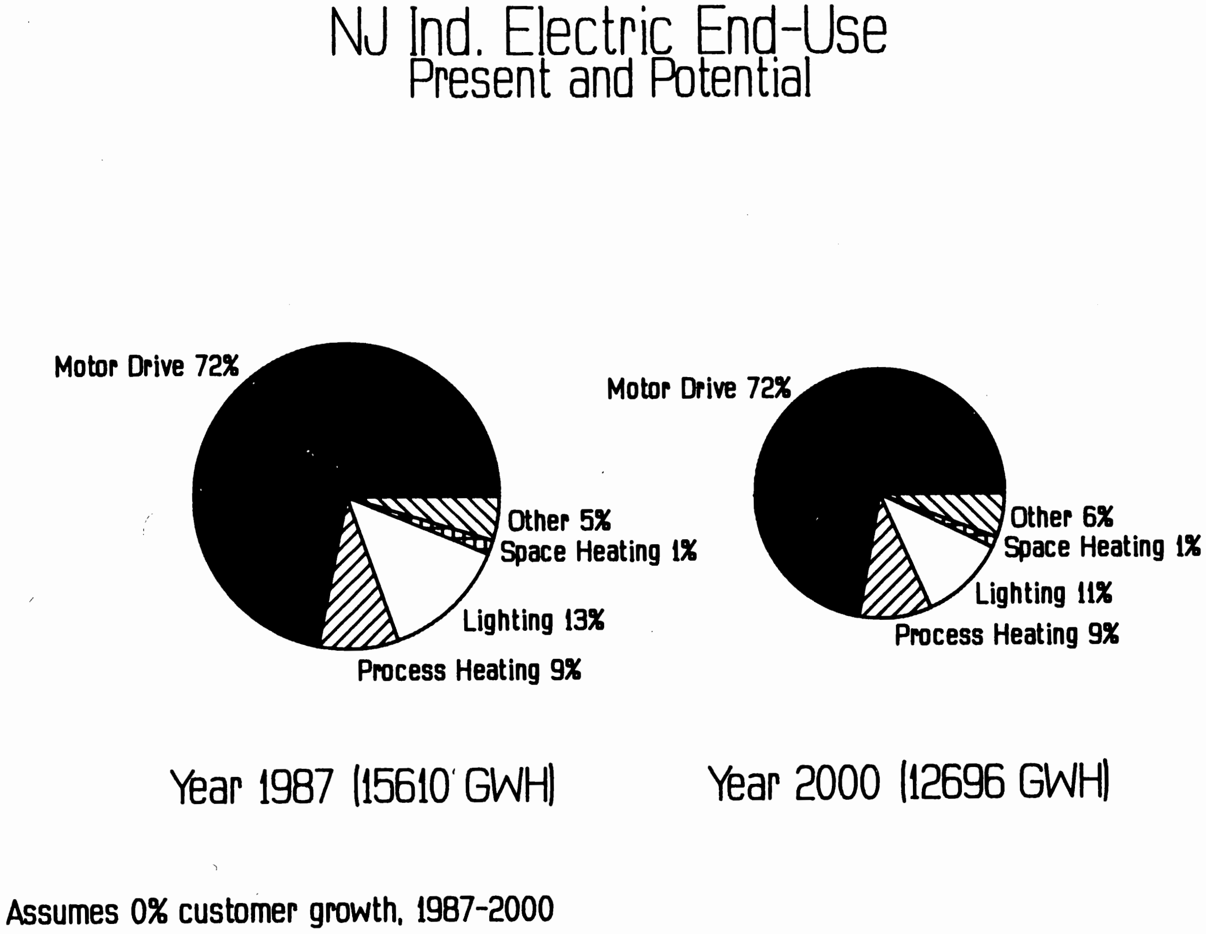
Figure VI-3



Best Available Technology Industrial Electric Energy Use

Figure VI-4 shows the potential for reducing industrial electric use if, steadily over the next decade, industrial electric customers weatherized all their buildings to use 25 percent less space heating electricity than today and replaced existing equipment and appliances with today's best available use efficient equipment and appliances. Figure VI-4 shows the potential, assuming existing number of industrial electric customers and appliance saturation per customer remain at the level reported by PSE&G.[9]

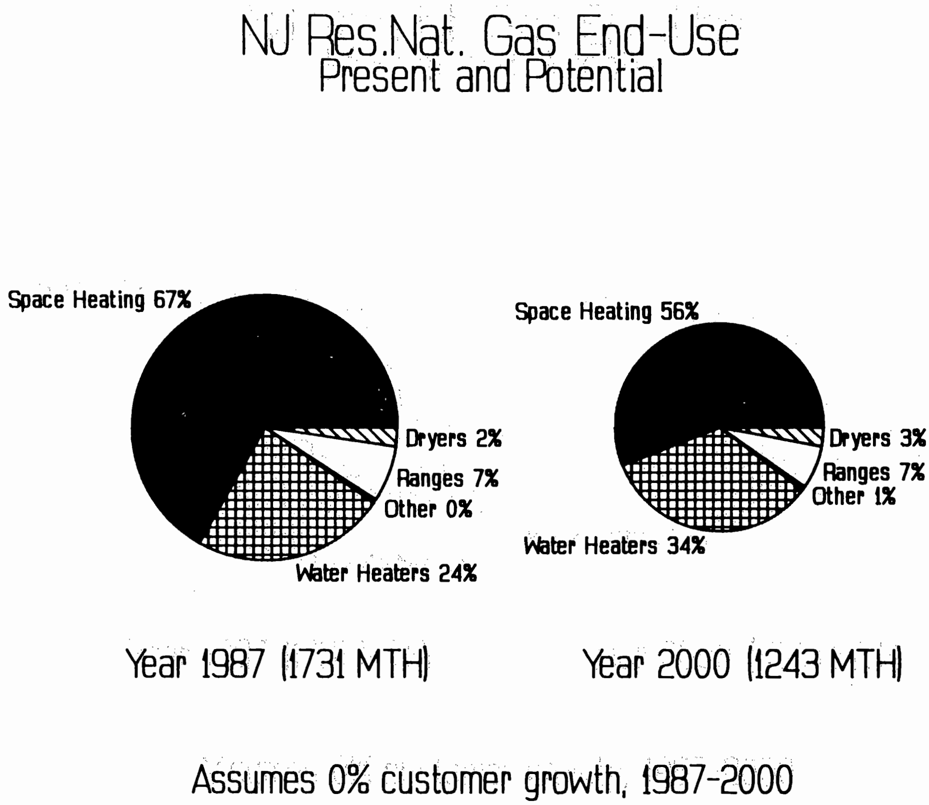
Figure VI-4



Best Available Technology Residential Natural Gas Energy Use

Figure VI-5 shows the potential for reducing residential natural gas use if, steadily over the next decade, residential natural gas customers weatherized all their buildings to use 25 percent less space heating natural gas than today and replaced existing equipment and appliances with today's best available use efficient equipment and appliances. Figure VI-5 shows the potential, assuming existing number of residential natural gas customers and appliance saturation per customer remain at the level reported by PSE&G.[10]

Figure VI-5



Best Available Technology Transportation Petroleum Energy Use Scenarios

Energy use in transportation is expected to grow at a slower rate than the overall rate of growth of energy use through 2000, because the efficiency of the vehicle fleet will improve as a result of the replacement of older less efficient cars by newer cars and light trucks that must meet the CAFE standard, thereby offsetting some of the increased energy use due to greater vehicle miles traveled. However, the potential for further improving the efficiency of auto travel through technological improvements and more intensive use of cars in vanpools and ridesharing remains still greater than in any other area of energy use in transportation. As motor fuels account for almost two-thirds of transportation energy use, improvements in motor vehicle efficiencies can significantly affect total state energy use.

Figure VI-6 presents three scenarios for motor fuels consumption. The first one projects fuel use to rise at the same rate which it has been rising since the end of 1985, when oil prices declined precipitously. It is thus based on an assumption of consistently low oil prices. The second projection assumes a rate of change based on the trend experienced from 1973 to 1985, which was essentially flat. During this period energy prices first rose and then remained fairly stable. The third scenario presents motor fuel use through 2000 based on policies that would speed the introduction of vehicles embodying the best available technology and that would promote vanpooling and ridesharing.

While the fuel efficiency of cars and light trucks has been increasing, prospects are for the rate of increase to fall off as we approach 2000, because oil prices have fallen and the federally mandated CAFE standard is not scheduled to increase beyond 27.5 mpg.

In spite of recent oil price changes, the technology for increasing auto fuel efficiency has been progressing apace. The 50 miles per gallon level incorporated in the best available technology projection reflects a considered judgment inasmuch as manufacturers are producing today cars that can attain that efficiency.

The implementation of an effective vanpool/rideshare program could displace one out of 20 workers commuting in a single occupancy vehicle and save an estimated 26-28 million gallons of gasoline a year, while simultaneously reducing air pollution emissions and traffic congestion during peak driving hours. Such an upgraded vanpool program would require 6,000-7,000 vanpools in the state where we now have about 1,000, and a like increase in the number of rideshare participants. Connecticut, a state with less than half the population of New Jersey, had 1,274 vanpools registered as of September 1988.[11]

Figure VI-6

NJ Motor Fuel Use Scenarios

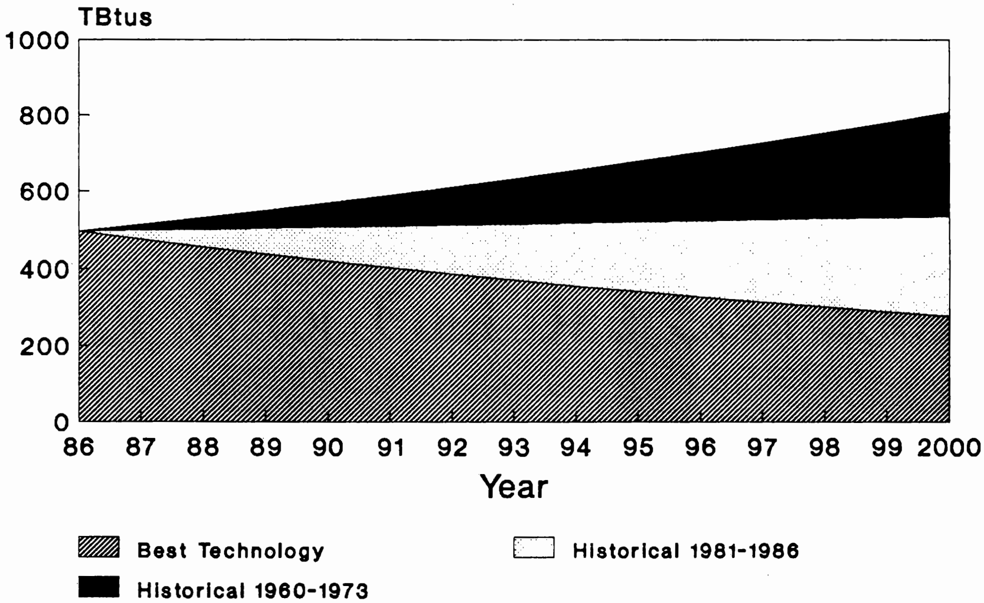


Table VI-7 shows some of the differing consequences of the three motor fuel use scenarios.

Table VI-7
Impacts of Scenarios of Motor Fuel Consumption in 2000

Scenario	NO_x Emitted (tons/yr)	CO Emitted (tons/yr)	Capital Costs (1000 t/y)	CO_2 Emitted (1000 t/y)	Congestion (vehicles/ (road mile/day)
1987	*205,193	*786,029	884,560	27,155	4,593
High Growth	332,125	1,272,267	1,423,240	43,953	7,248
Low Growth	246,231	943,234	1,060,800	32,586	5,328
BAT	114,529	438,722	493,272	15,152	4,295

Note: * - 1986, BAT. - Best Available Use Efficiency Technology
Source: DCEED

Chapter VI

Advantages of the Best Available Technology Use Scenario

Under present market conditions the best available technology will not reach 100 percent saturation by 2000. Conversely, at that time, equipment and appliances with even higher efficiency will be available. Thus, the best available technology scenario is a proxy for a mix of persisting inefficiency and newer technology.

Scenario Impacts on the Economy and Environment

The scenarios outlined above would have different effects on the state's ability to attain its economic development, security, and the environmental energy goals.

Balance of Payments Impacts

The health of New Jersey's economy is tied to that of the country as a whole. Too great a dependence on foreign oil imports adversely affects both. Oil imports are increasing and make up a significant portion of the U.S. balance of payments deficits (see Table VI-8). Large balance of payments deficits can seriously impair the nation's ability to pursue policies conducive to growth and result in an outflow of national wealth to other countries.

Table VI-8

U.S. Balance of Payments and Petroleum Imports
(millions of current dollars)

	1984	1985	1986	1987	1988 *
Balance on Current Account	-107,077	-115,103	-138,828	-153,964	-101,571
Petroleum and Products Net Imports	-57,847	-50,559	-33,170	-41,020	-29,052
Net Petroleum Imports as Percent of Deficit	54.0	43.9	23.9	26.6	28.6

* - through the third quarter 1988.

Source: U.S. Department of Commerce, "Survey of Current Business," June and December 1988.

Oil imports have been rising for the past few years, and domestic oil production has been falling. In addition, domestic oil consumption has turned up again. Many analysts are therefore forecasting a steady increase in oil imports, which will be a continuing drain on the balance of payments and a continuing threat to the economic prosperity of the nation and the state.

Energy Dependence Impacts

Closely related to the issue of economic growth is that of dependence: the greater its dependence on energy sources from outside the state, the more vulnerable New Jersey's economy will be to price volatility, unanticipated surges in demand, and supply disruptions.

New Jersey is dependent for its energy supplies in a number of ways. The state produces only about 75 percent of the electricity it uses, an amount far less than most other states. Of the electricity produced within the state, less than 200 MW are produced from an indigenous resource, hydropower. It imports the balance from other members of the PJM grid, other states, and Canada. It imports all of the petroleum it uses, 78 percent of which comes from outside the country. It imports all of the natural gas that it uses. The system of interstate pipelines that transport the natural gas to New Jersey begins over 1500 miles away in the Southwest where the gas is produced, and a few giant corporations are increasingly dominating the pipeline industry.[12]

The policies set forth in this Energy Master Plan aim to foster economic growth and reduce dependence through more intensively using the energy resources we have and more efficiently using the resources we consume. Methane from landfills, waste-to-energy plants, and methane from sludge could contribute to New Jersey's energy needs.

The money spent on designing, engineering, constructing, operating, and monitoring the facilities to extract energy from wastes will likely be spent in New Jersey instead of being paid out to a foreign oil producer or western coal miner.

Environmental Impacts

The three scenarios have markedly different environmental impacts. The historical high growth scenario would require for central station nuclear plants three times the acreage in environmentally sensitive areas as today's nuclear plants require. Nonutility generation would lower the requirement to an additional 2,240 acres in scattered sites over the state. The BAT scenario, in contrast, would require no additional land. Replacement of existing generating capacity could occur at existing sites.

Emissions of carbon dioxide, sulfur dioxide, and nitrogen oxides from fossil fuel plants could increase by 30 percent under the utility expected scenario or drop under the BAT scenario.

Cooling water requirements could rise by 30 percent under the utility expected scenario or drop under the BAT scenario. If replacement generating capacity is cogeneration, the cooling water requirements could drop further, as the waste heat becomes a valuable product.

Choice of Scenario

We can also cut down on our dependence by using energy more efficiently. Efficiency is the most cost-effective way to find new energy supplies. Advanced heat pumps, boiler optimization, vanpool programs, and school bus fleet management are a just a few of the ways that will repay their costs in the value of energy saved in a short time period. The possibilities for implementing efficiency are many and require a modest investment from the state to pay off.

As the activity of the federal government in the energy area has been diminished in the 1980s, state governments have a correspondingly greater opportunity and responsibility to ensure that energy policies conducive to economic growth and reducing dependency are adopted. For New Jersey the scenario called best available technology describes a level of energy used that is achievable and embodies consequences for the economy, the transport network, and the electric generating system that its citizens generally perceive as desirable.

DRAFT

Chapter VI

FOOTNOTES

1. New Jersey Department of Labor, Division of Planning and Research, Office of Demographic and Economic Analysis Population Projections for New Jersey and Counties 1990 to 2020, Vol. 1, Nov. 1985.

2. Atlantic Electric, Jersey Central Power and Light/ General Public Utilities, and Public Service Electric and Gas, New Jersey's Electric Energy Future, Issues and Challenges, September, 1988.

3. Ibid., p.2.

4. Environmental Defense Fund, Petition Before the New Jersey Department of Environmental Protection and Board of Public Utilities, March 29, 1988.

5. AE, JCP&L, PSE&G, N.J. Electric Future, 1988.

6. Load Factor is the ratio of the average load in kilowatts supplied during a designated period to the peak or maximum load in kilowatts occurring in that period.

7. PSE&G Electric Appliance Residential Forecast, 1987-2017.
   Based on 1987 New Jersey total residential sales of 19,044 gwh, NJEDS.
   New England, Power to Spare, New England Energy Policy Council, July 1987, unless otherwise indicated.

8. New England, 1985, Power to Spare, New England Energy Policy Council, July 1987, Table D-3.
   Based on 1987 New Jersey total commercial sales of 23,184 gwh, NJEDS.
   New England, Power to Spare, New England Energy Policy Council, July 1987, Table C-1.

9. New England, 1985, Power to Spare, New England Energy Policy Council, July 1987, Table D-4.
   Based on 1987 New Jersey total industrial sales of 15,111 gwh, NJEDS.
   New England, Power to Spare, New England Energy Policy Council, July 1987, Table C-1.

10. PSE&G residential gas Appliance Model Forecast: 1987-2017.

11. Conservation Update, September 1988.

12. Wall Street Journal, February 6, 1989.