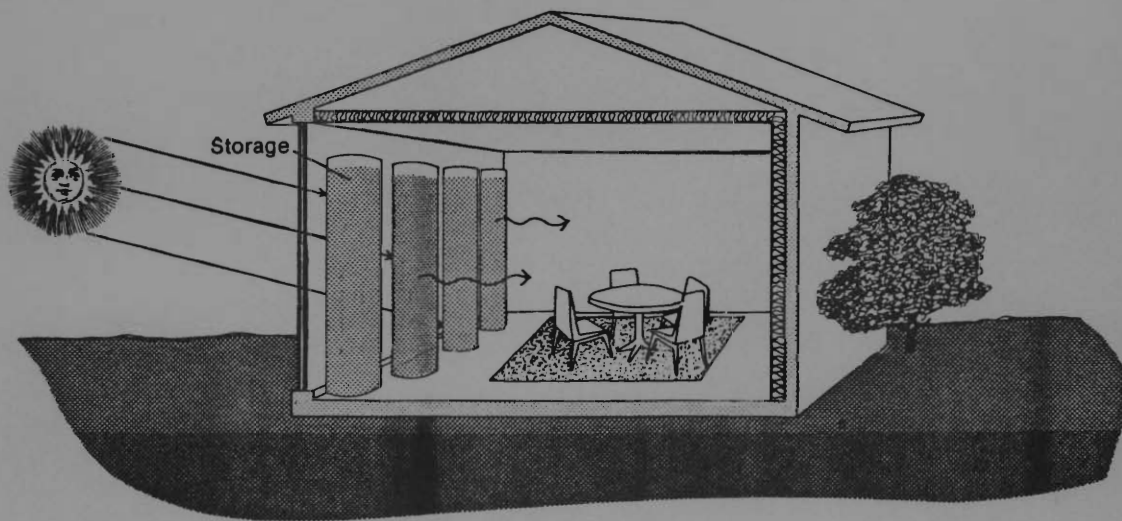


COASTAL ENERGY CONSERVATION POLICY GUIDELINES



NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF COASTAL RESOURCES

JUNE 1982

COASTAL
ENERGY CONSERVATION
POLICY
GUIDELINES

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
DIVISION OF COASTAL RESOURCES
BUREAU OF COASTAL PLANNING AND DEVELOPMENT
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TABLE OF CONTENTS (continued)

<u>Title</u>	<u>Page</u>
Chapter Five	
Energy Conservation Checklist.....	27
Appendix I	
Energy Conservation Agencies.....	33
Appendix II	
Annotated Bibliography on Energy Conservation.....	35

INTRODUCTION

Purpose

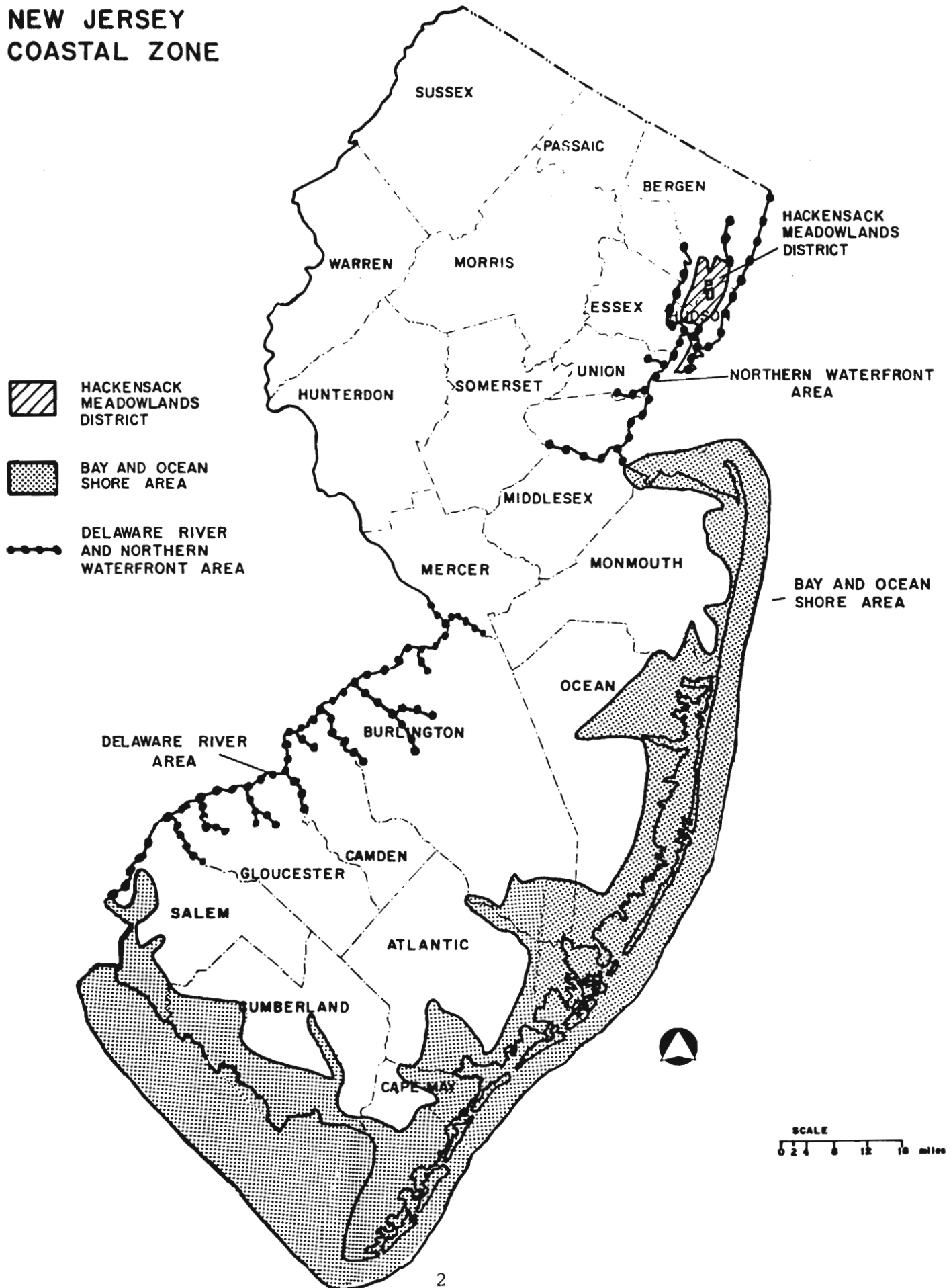
This booklet presents energy conservation guidelines prepared by the New Jersey Department of Environmental Protection, Division of Coastal Resources (DEP-DCR) to aid builders in making developments energy efficient. THE GUIDELINES ARE NOT NEW REGULATIONS OR REQUIREMENTS, but are primarily intended to aid applicants and government officials in complying with the New Jersey Coastal Management Program's Energy Conservation Policy (N.J.A.C.7:7E-8.17), the New Jersey Energy Master Plan, the New Jersey Energy Conservation Plan, the New Jersey Recycling Plan, the Municipal Land Use Law, and the Energy Subcode of the State Uniform Construction Code. As more technical information about energy conservation and solar technology becomes available, the guidelines will be revised.

The New Jersey Coastal Management Program, approved in 1980 by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Coastal Zone Management, and administered by DEP-DCR, aims to manage the natural resources and future development of New Jersey's coastal zone. It obtains its principal legal authority from State laws and agencies that existed prior to its creation. Specifically, the Waterfront Development Law (N.J.S.A. 12:5-3), passed in 1914, the Wetlands Act of 1970, and the Coastal Area Facility Review Act (CAFRA), passed in 1973, require developers to obtain permits from DEP-DCR before commencing certain types of coastal construction. Under these laws, DEP has the authority to regulate and approve the location, design, and construction of major facilities including housing developments of 25 or more units within the boundary of the coastal area designated on Figure 1.

How to Use the Guidelines

The guidelines, which it must be emphasized, ARE NOT NEW REGULATIONS, contain many techniques for energy conservation. It is not possible to incorporate all of the described techniques into one structure. Rather, a range of energy conservation techniques is discussed as examples of possible techniques a developer could use, where suitable. Nor are the guidelines meant to provide detailed engineering principles for energy conservation and solar design. A large body of technical literature regarding energy conservation now exists which developers are advised to consult. Appendix II contains a list of some of the available literature. These guidelines in general discuss the principles of various energy conservation techniques as suggestions for developers. Most of the principles discussed apply to residential structures, although some have non-residential applications as well.

NEW JERSEY COASTAL ZONE



Organization of the Guidelines

The guidelines begin with a discussion of State energy conservation policies and statutes. Chapter II discusses both active and passive solar designs. Chapter III describes building techniques that conserve energy, and Chapter IV details passive solar construction techniques that use natural processes for heating and cooling. The guidelines conclude with an energy conservation checklist as Chapter V.

Appendix I lists solar information agencies that provide professional assistance concerning energy conservation construction techniques. Appendix II contains an annotated bibliography on energy conservation.

STATE ENERGY CONSERVATION POLICIES AND STATUTES

Coastal Management Program

DEP requires energy conservation review as part of the Coastal Management Program permitting process.

The Energy Conservation Policy in the New Jersey Coastal Management Program (7:7E-8.17) is as follows:

(a) Definition

Energy Conservation is the use of techniques which minimize the amount of non-renewable energy used by a facility and maximize the productivity of the energy that is used.

(b) Policy

Coastal development shall incorporate energy conservation techniques and alternative sources of energy, including passive and active solar energy and wind turbines, to the maximum extent practicable.

The technical and economic feasibility of employing such measures shall be evaluated in an energy plan prepared by the applicant. The plan shall specify the energy conservation techniques and alternative sources of energy to be utilized as well as anticipated energy requirements for space heating, cooling, ventilation and lighting, industrial processes and other uses.

New high rise buildings shall be situated and designed to minimize shadows on existing potential active and passive solar energy systems, to the maximum extent practicable.

(c) Rationale

This policy assists the Departments of Energy and Community Affairs in implementing New Jersey's State Energy Master Plan, Recycling Plan, Energy Conservation Plan, the Energy Subcode of the Uniform Construction Code (N.J.S.A. 52:27D-119 et seq.), and the Municipal Land Use Law.

The Energy Master Plan supports energy conservation for four reasons: conservation produces a new energy supply; conservation keeps energy prices low; conservation programs contribute to the State's economic health; and conservation improves environmental quality. Conservation techniques could save nationwide 12.5 million barrels of oil a day by 1990. The Recycling Plan states that energy conservation will save New Jersey 1.9 million barrels of oil per year by 1986.

A 1980 amendment to the Municipal Land Use Law adds an energy conservation plan as an item to be included in a municipality's master plan.

The Department of Community Affairs is responsible for the implementation of the energy subcode of the state building code. Possible energy conservation techniques include the siting of buildings with an understanding of the micro-climate conditions of a site, use of clustering, provision of bicycle paths, and the location of housing close to public transportation.

New high rise buildings should be situated and designed, using techniques such as reduced floor space on higher floors, to minimize shadows on existing solar collectors. It is recognized that it may be impossible to use a site for high rise construction without reducing sunlight to some solar collectors. In this case, the project would be acceptable if designed to minimize impacts on solar collectors to the maximum extent practicable.

An active solar energy system is a system for space heating and cooling and domestic hot water that uses outside energy to transfer collected solar energy and distribute it for use. An active system consists of a solar collector, transfer medium and storage device.

A passive solar energy system is a system of collecting, storing, and using solar energy with a minimal use of low power fans and pumps. Energy is collected through south-facing glazing, stored in the building mass, and distributed by natural means such as conduction, convection or radiation.

Municipal Land Use Law

In 1980, the New Jersey Legislature added an amendment to the Municipal Land Use Law requiring that an energy conservation plan be included in each municipality's master plan. Since all New Jersey communities are required to have master plans, energy conservation plans will soon proliferate throughout the State as the master plans undergo statutory periodic revision. The New Jersey Departments of Energy and Community Affairs have prepared Planning the Energy Efficient Community,² a guidebook for planning officials, to help municipalities complete an energy conservation plan, according to the Municipal Land Use Law,

which systematically analyzes the impact of each other component and element of the master plan on the present and future use of energy in the municipality, details specific measures contained in other plan elements designed to reduce energy consumption, and proposes other measures that the municipality may take to reduce energy consumption and to provide for the maximum utilization of renewable energy sources.

The New Jersey Energy Subcode governs the energy consumption of new construction and is part of New Jersey's Uniform Construction Code (N.J.S.A. 52:27D-119 et seq.). The Subcode is part of a model construction code developed by the Building Officials and Code Administrators International (BOCA), which specifies the minimum standards or performance criteria that new construction must meet, but does not specify the materials and methods which can be used to meet them. The Energy Subcode minimum standards, however, which were designed to prevent the construction of inefficient structures rather than to encourage highly efficient ones, have become the maximum standards a builder can be required to provide. Nevertheless, exceeding the BOCA standards will allow builders to conserve energy cost-effectively.

Why Conserve?

Both economic and environmental factors provide compelling rationales for conserving energy. Economically, it is cost-effective to incorporate energy conservation techniques in constructing new buildings and in retrofitting old buildings. This fact gains strength as the cost of energy rises faster than that of other sectors of the economy. Many energy conservation techniques pay for themselves within one year of their installation.

In 1976, for example, the National Association of Home Builders Research Foundation constructed "Energy Efficient Residence I", a demonstration project which showed that the payback period for certain energy conservation measures to be about five years. "Energy Efficient Residence II" is currently under construction and will incorporate more advanced energy conservation techniques. It is expected to demonstrate that greater energy savings are available using advanced techniques since the cost of fuels has escalated dramatically since "Energy Efficient Residence I" was built in 1976.

A 1981 study published by the U.S. House Committee on Energy and Commerce⁴ reports that increased energy efficiency and conservation can result in both independence from foreign fuel and substantial economic growth for the nation by the year 2000. The National Audubon Society made similar findings in its 1981 study.⁵ Energy conservation, in other words, makes economic sense.

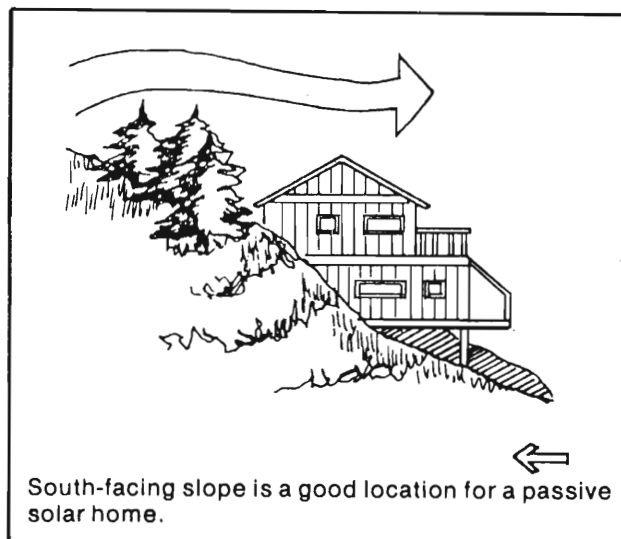
The energy savings attainable through construction techniques are enormous. For example, the CAFRA permit application for the Sahara Boardwalk Casino/Hotel in Atlantic City contained an energy analysis to demonstrate the effects of incorporating energy conservation techniques in constructing the building. The analysis shows that energy conservation techniques, including a hot water preheat system and efficient air conditioning systems will save twice as much energy per year as will be used in a year. In other words, energy consumption is cut to one-third of what it would be otherwise.⁶

Environmentally, an archived copy from the New Jersey State Library
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to consume energy resources rapidly and inefficiently. The earth's combustible hydrocarbon resources are available in limited quantities and are virtually irreplaceable. To alter the environment permanently by removing the resources for use as fuel is an instance of humanity viewing the environment as exploitable and expendable rather than as a storehouse whose goods must be dispensed wisely so that future generations can also partake of them.

What is Energy Conservation?

Energy conservation is simply using less non-renewable energy. The term therefore implies using renewable fuels such as the sun and wind in place of non-renewable fuels such as petroleum and natural gas. Thus, there are many ways to conserve energy, from turning down the thermostat, to insulating buildings, to using solar collectors for heating and cooling. Although "solar energy" connotes using the sun as an energy source, solar energy is provided by any renewable energy source, including wind power and biomass. Building orientation and resource recovery are also forms of solar energy, while insulation is a way of conserving energy.

Most of the techniques described in these Guidelines reduce the use of non-renewable energy by producing passive solar energy gains from building orientation and construction techniques. Both building location and structural techniques for passive solar gain apply equally well to residential, commercial, and industrial facilities. Generally, it is cheaper to incorporate energy conservation techniques in construction than after construction. Designing a building to conserve energy can add little cost for planning and can save the owner money when the building is in use.



WHAT IS SOLAR DESIGN?

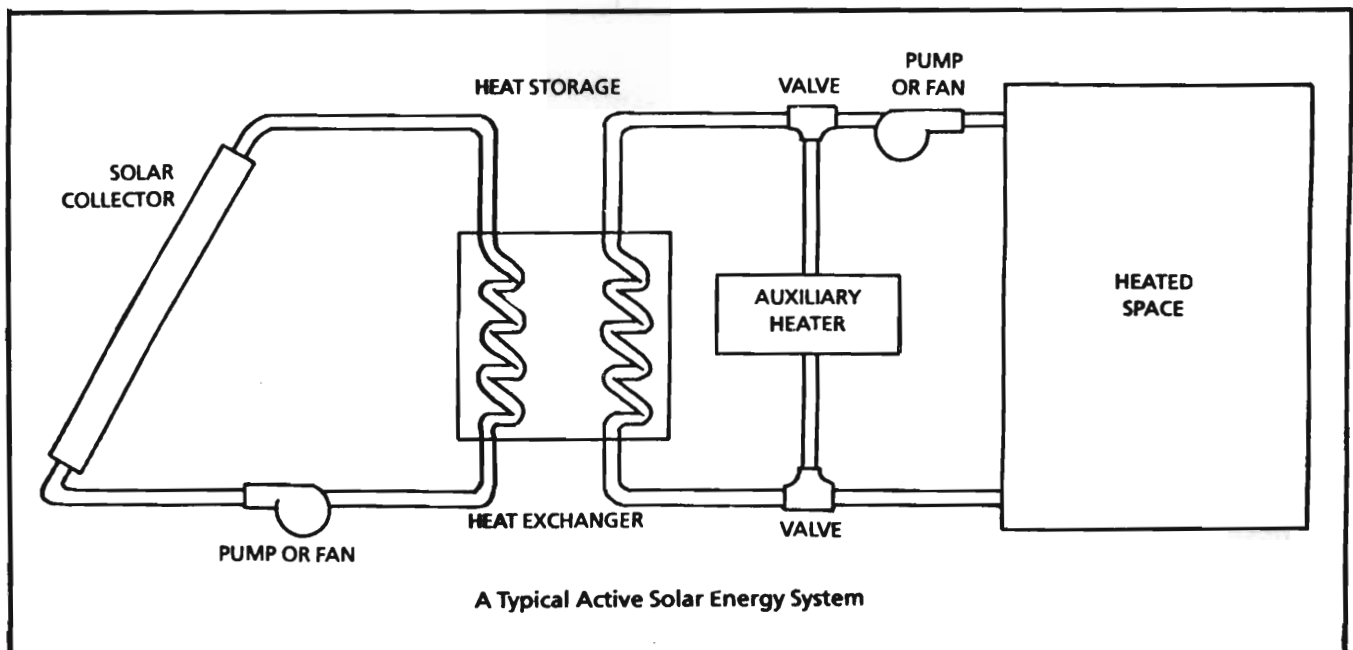
There are two types of solar design, active and passive. This chapter will address both, and conclude with a discussion of the legal right to solar access.

Active Solar Systems⁷

An active solar system uses some mechanical device to distribute the heat energy it has collected. Active solar systems can provide hot water alone or space heating plus hot water. Although both systems can be economical, heating water with solar energy has the shortest payback period. The New Jersey Department of Energy estimates that the payback period for solar hot water system is from 6 to 10 years and from 10 to 20 years or longer for both solar hot water and space heating.

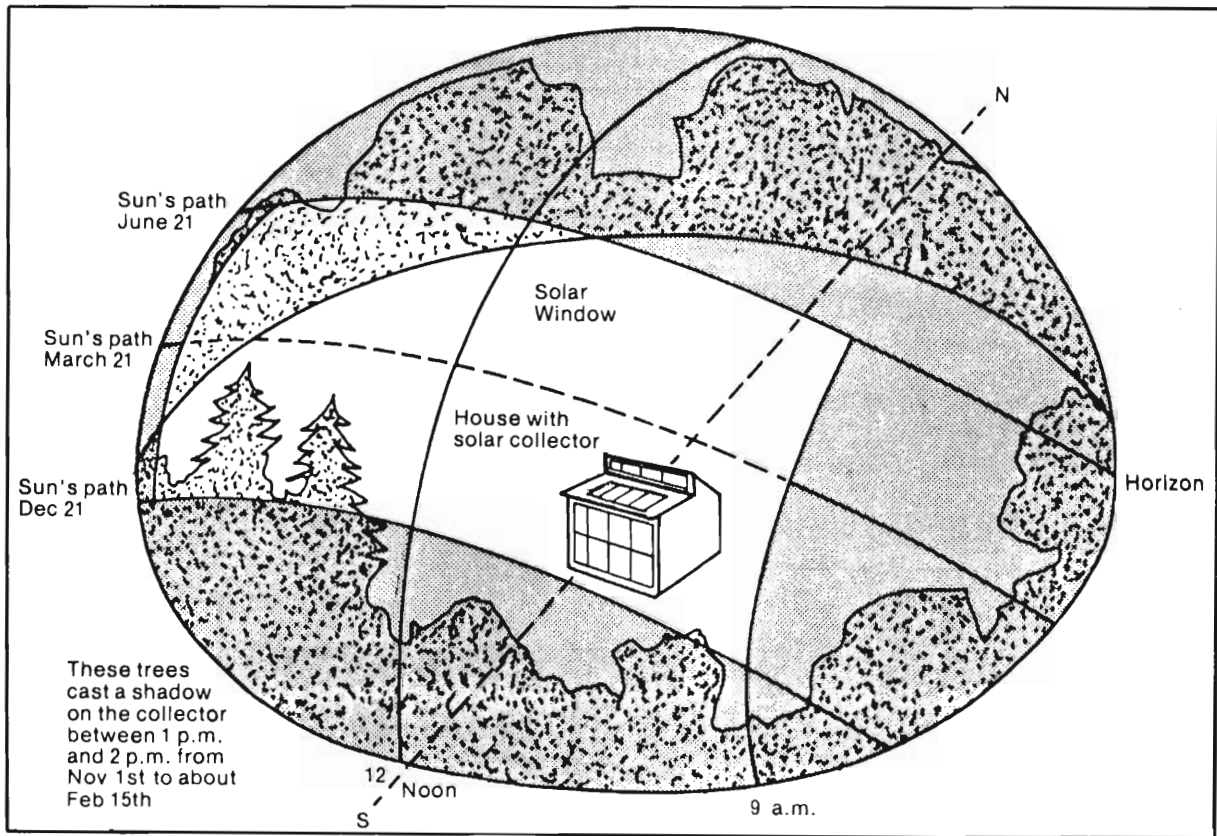
Although there have been some problems with solar collector design and technology, solar collectors are included in the Guidelines because using them can be an important way to reduce non-renewable energy consumption. The Engleside Motel in Beach Haven, N.J. now obtains 52 percent of its domestic hot water from solar energy. The solar system use 45 flat plate solar collectors which provide enough energy to supplant 1,250 gallons of oil annually.

An active solar system consists of a solar collector, heat storage capability, and a heat distribution system. The solar collector is a box which traps sunlight, converts it to heat energy, and transfers this heat to a storage medium such as water, rock or a phase change material. There are three types of collectors: flat plate, evacuated tube, and focusing or concentrating collectors. The heat distribution system can use either forced air or water.



Insulating the bottoms of solar collectors will reduce heat loss. It is important that the insulation chosen have a high meltdown temperature, over 350 degrees farenheit, so that it won't deteriorate at constant high temperature exposure. The solar collector size depends on the climate and the amount of water or areas to be heated.

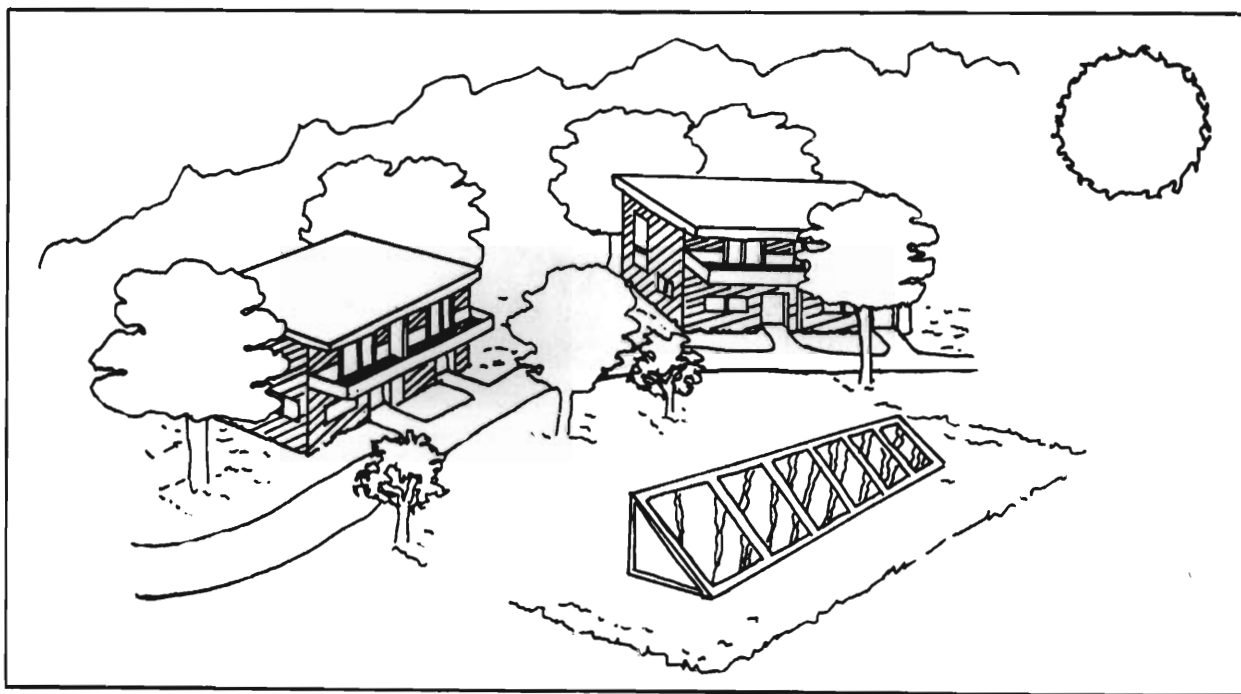
A large solar system with adequate storage could provide heat to last through several cloudy days. For one day heat storage, two to four gallons of water are needed for each square foot of collector surface. For longer storage, 1,000-2,000 gallon tanks can be used. If the storage medium is rock, a bin filled with gravel should contain one cubic foot of material per square foot of collector area for one day's storage capacity. Any storage component should be well insulated.



Collectors that are properly oriented perform best. In New Jersey, best orientation is due south or within 20 degrees of true south. In fact, a slightly better performance may result if the collector is placed slightly west of south, because this angle receives more of the afternoon sun. The best angle of a collector used for hot water and space heating is equal to the site latitude which in New Jersey ranges from 39 to 41 degrees plus 15 degrees. The collectors should not be shaded between the hours of 9 and 3, the peak hours of sunshine.

If it is not possible to include a solar system at the time of construction, plans for new development can provide for easy accommodation of one in the future by placing the angle of the south facing roof within 10 degrees of the site latitude. If the house is not situated on an east-west axis, a portion of the roof could be made flat, and a solar collector array mounted in the proper angle. Unnecessary roof shading by chimneys and parapets will decrease solar access.

If the roof structure is entirely unsuitable, a solar array can be placed on the ground near the building. A tank of water or masonry can serve as a storage medium. The disadvantages of this setup are the amount of land required and the increased chances for collector interference, but this system may be used with some structures not otherwise suited for a solar system. Solar systems may be used to heat structures not traditionally deemed suitable for solar heating, such as swimming pools.

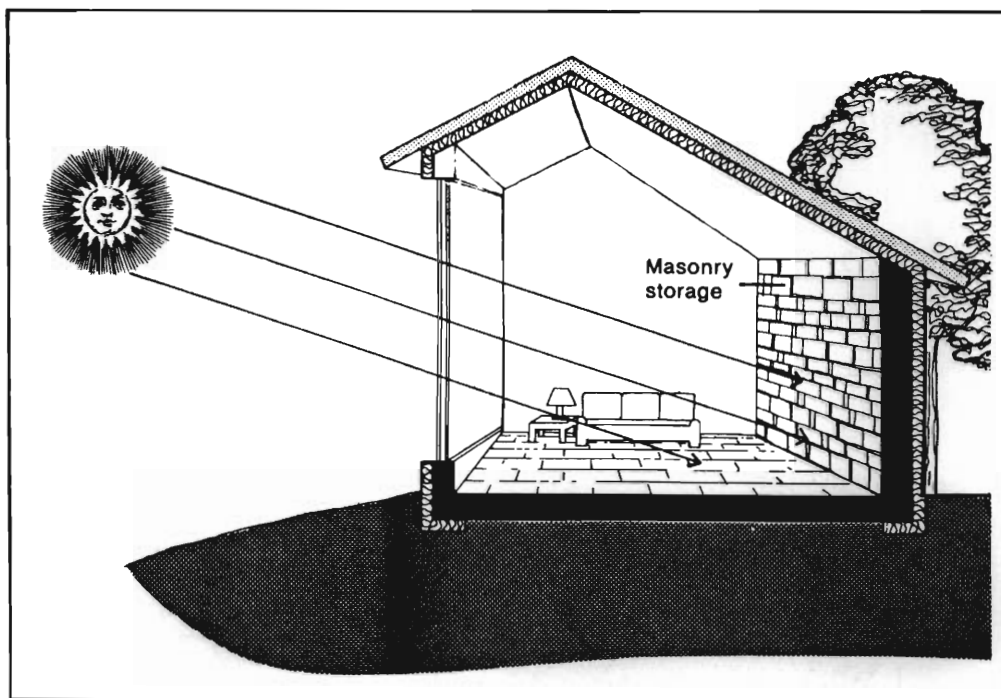


Passive Solar Systems

The New Jersey Energy Master Plan defines a passive solar system as "one which relies on natural energy flow without the assistance of mechanical devices to transfer thermal energy into, through, and out of a structure". A structure may not contain any special elements, yet still be able to take advantage of the solar energy available to it due to its architectural design and building components. Most of the elements of a passive system are simply good building principles, and can be used with all planned structures.

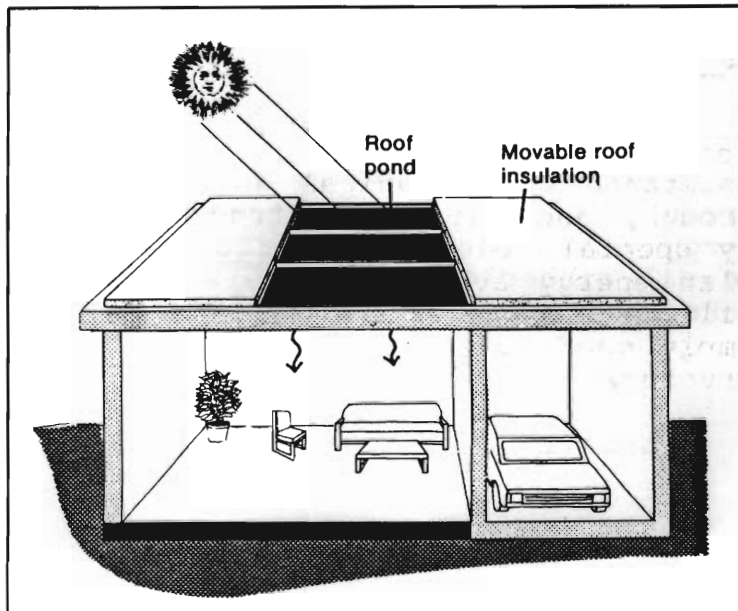
Passive solar systems can gain heat in one of four ways:

1) Direct gain,



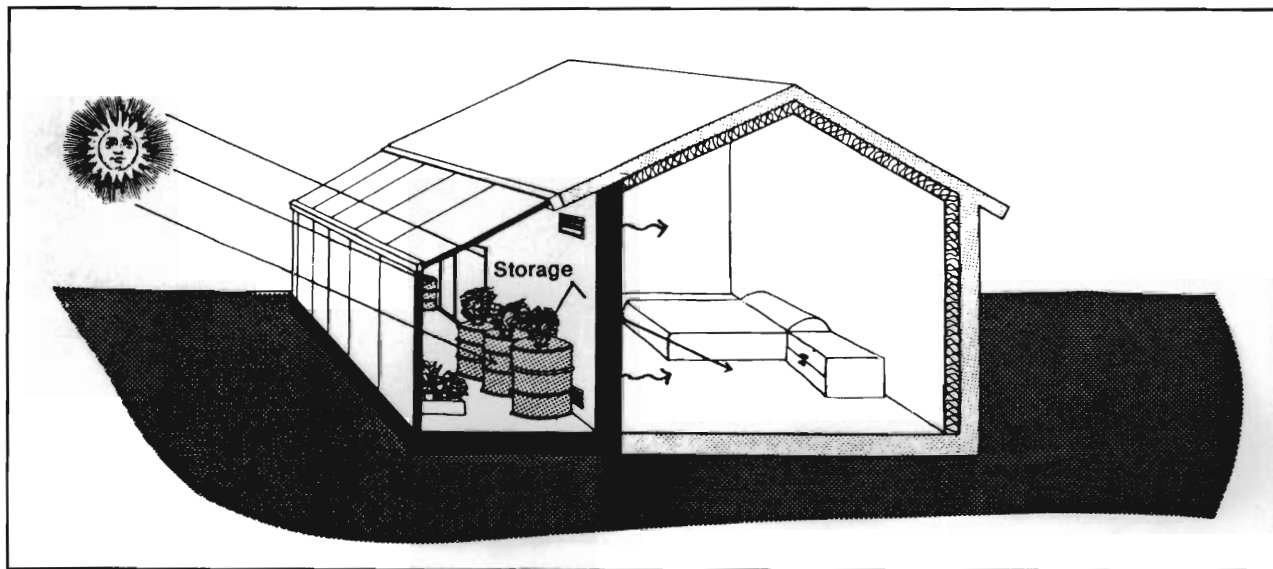
Direct gain means that solar radiation enters a room directly through south-facing glass. Dark colored walls and floors will absorb the sun's heat, store it in the masonry, and radiate it back to the room at night.

2) Indirect gain,



Indirect gain occurs when solar radiation is intercepted by an absorber and storage element such as a collector. The heat is then transmitted to the room.

3) Isolated gain,



In isolated gain, solar radiation is captured by a separate space such as a greenhouse which conducts the collected heat to the adjoining room.

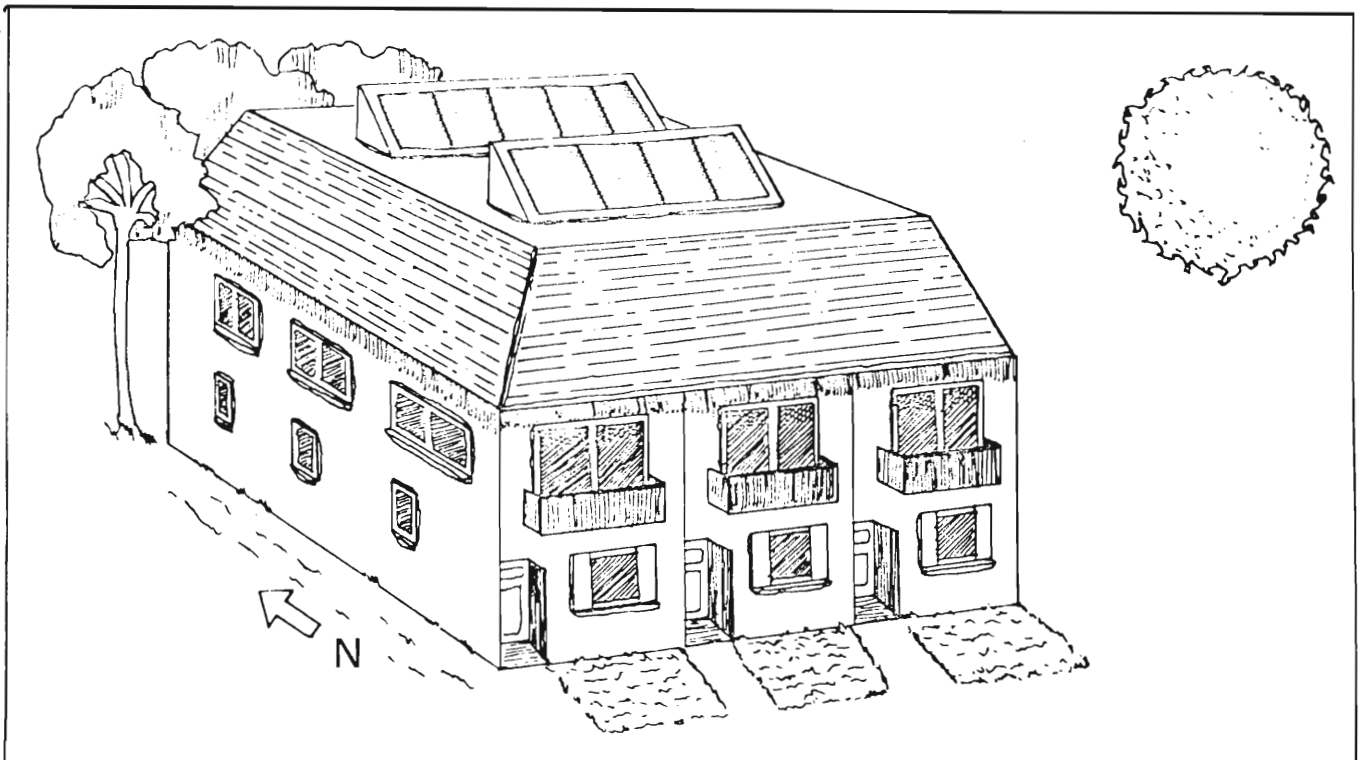
4) Sun-tempering.

Sun-tempering is an incomplete passive system, similar to a direct gain system, except that there is no storage capacity. The energy conservation techniques discussed in Chapters III and IV are all either direct gain, indirect gain or isolated gain passive techniques.

Solar Access

Under present law, property owners do not automatically have legal right to the sunlight falling on their land. Nevertheless, structures which shade adjoining buildings or developable lots can inadvertently raise their neighbor's energy costs significantly. Any structure which shades over 50 percent of an adjoining structure, for at least one hour between the hours of 9 to 3, infringes on its solar rights. The most promising technique for insuring solar access in residential developments is through the use of restrictive covenants such as clauses in mortgages that prohibit any addition that would shade a neighbor's home, particularly vegetation.

The Municipal Land Use Law now gives communities the ability to protect solar access through provisions in their Master Plans.



ENERGY CONSERVATION TECHNIQUES

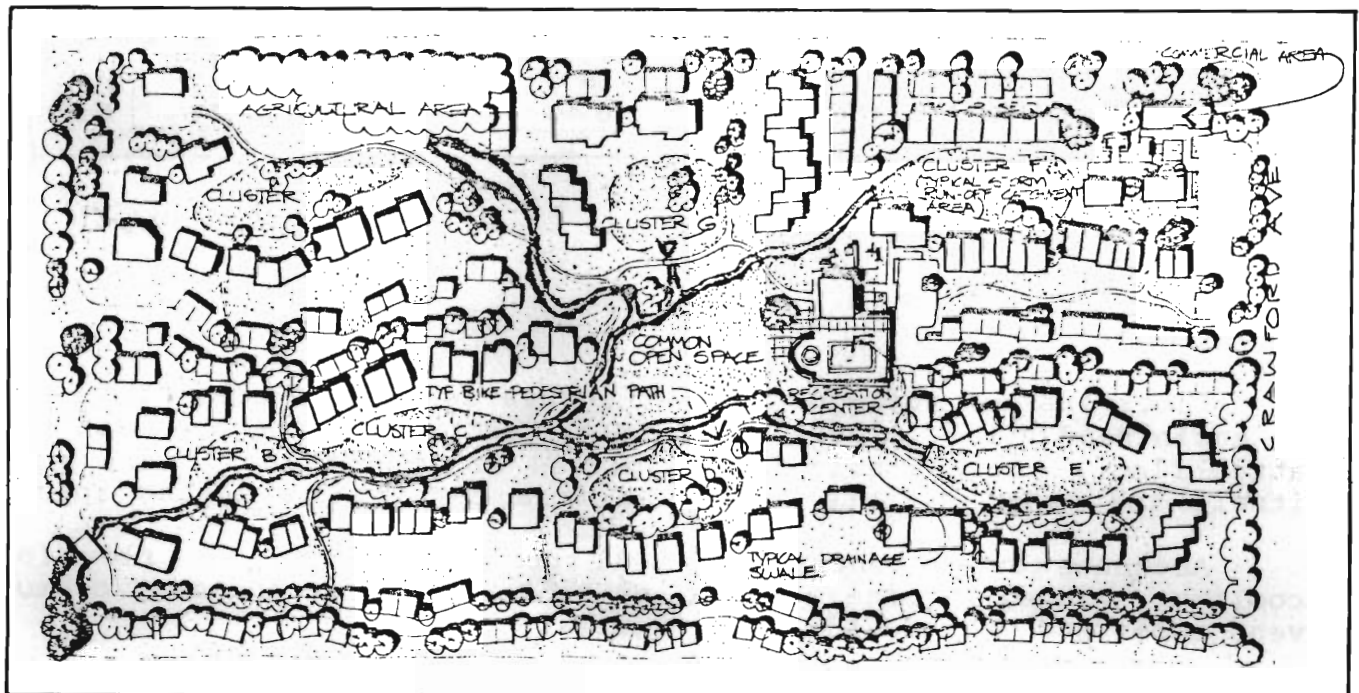
This chapter contains techniques for reducing the amount of non-renewable energy used. Chapter IV contains techniques for using solar energy to provide energy. Although energy conservation and solar energy techniques often overlap, the two are separated to simplify the Guidelines.

The greatest energy savings are possible through simple means. Almost all of the measures explained in this and the next Chapter are inexpensive, unobstrusive, and readily adaptable to most new buildings. The success of these techniques has been already demonstrated in other areas of the country. For example, the City of Davis, California has adopted a conservation ordinance which has succeeded in reducing the energy demand of new residential units by 50 percent. The added construction costs have amounted to less than one percent of the total cost of the house. Although New Jersey's climate is different from that of California, it is clear that properly designed energy conservation techniques in any location can result in enormous savings for the homeowner.

Land Use Planning

Buildings, especially residential developments, located near available public transportation will conserve energy used for transportation. Providing bus shelters or easy access to public transportation routes by street design is often an inexpensive way to reduce energy consumed in transportation.

Cluster housing or planned unit developments which include shopping facilities, schools, and services within their confines conserve energy by reducing the need to use the automobile for day to day business. New development and redevelopment in urban areas can cut automobile use per person even more dramatically.



Roofs

A structure loses heat primarily through the roof and attic. The New Jersey Energy Subcode specifies that the minimum "R" rating (resistance to heat flow) of ceiling structures be 19. Higher R ratings, however, are possible and will retain more heat. R-38 rating, for example, is easily obtained with two layers of 6-inch batt or sheet insulation. Insulation used on both the roof itself and on the attic floor will work most effectively.

A vapor barrier added to the interior or heated side of the insulation prevents condensation within the material. If insulation becomes damp, it loses some of its effectiveness because air pockets are reduced. A vapor barrier which usually is a reflective material like aluminum foil also reduces heat loss through radiation. Using two reflective surfaces, on both sides of the insulation, further reduces heat loss if the cold side of the insulation is perforated so that it does not act as a vapor barrier. Also, the form of the insulation affects its R value. For example, 9 inches of fiberglass in loose-fill form has an R value of 20, while the same thickness in batt, or sheet, form gives an R value of 30.

THICKNESS OF INSULATION PER R-VALUE									
R-VALUES									
	BATTS or BLANKETS		LOOSE FILL (POURED-IN)			RIGID PLASTIC FOAMS			
	Glass Fiber	Rock Wool	Glass Fiber	Rock Wool	Cellulosic Fiber	Urethane	U-F	Styrene	
R-11	3½"-4"	3"	5"	4"	3"	1½"	2"	2¼"	R-11
R-13	4"	4½"	6"	4½"	3½"	2"	2½"	2¾"	R-13
R-19	6"-6½"	5¼"	8"-9"	6"-7"	5"	2¾"	3¾"	4¼"	R-19
R-22	6½"	6"	10"	7"-8"	6"	3"	4"	4½"	R-22
R-26	8"	8½"	12"	9"	7"-7½"	3¾"	5"	5½"	R-26
R-30	9½"-10½"	9"	12"-13"	10"-11"	8"	4½"	5¾"	6½"	R-30
R-33	11"	10"	15"	11"-12"	9"	4¾"	6½"	7¼"	R-33
R-38	12"-13"	10½"	17"-18"	13"-14"	10"-11"	5½"	7½"	8½"	R-38

Attics

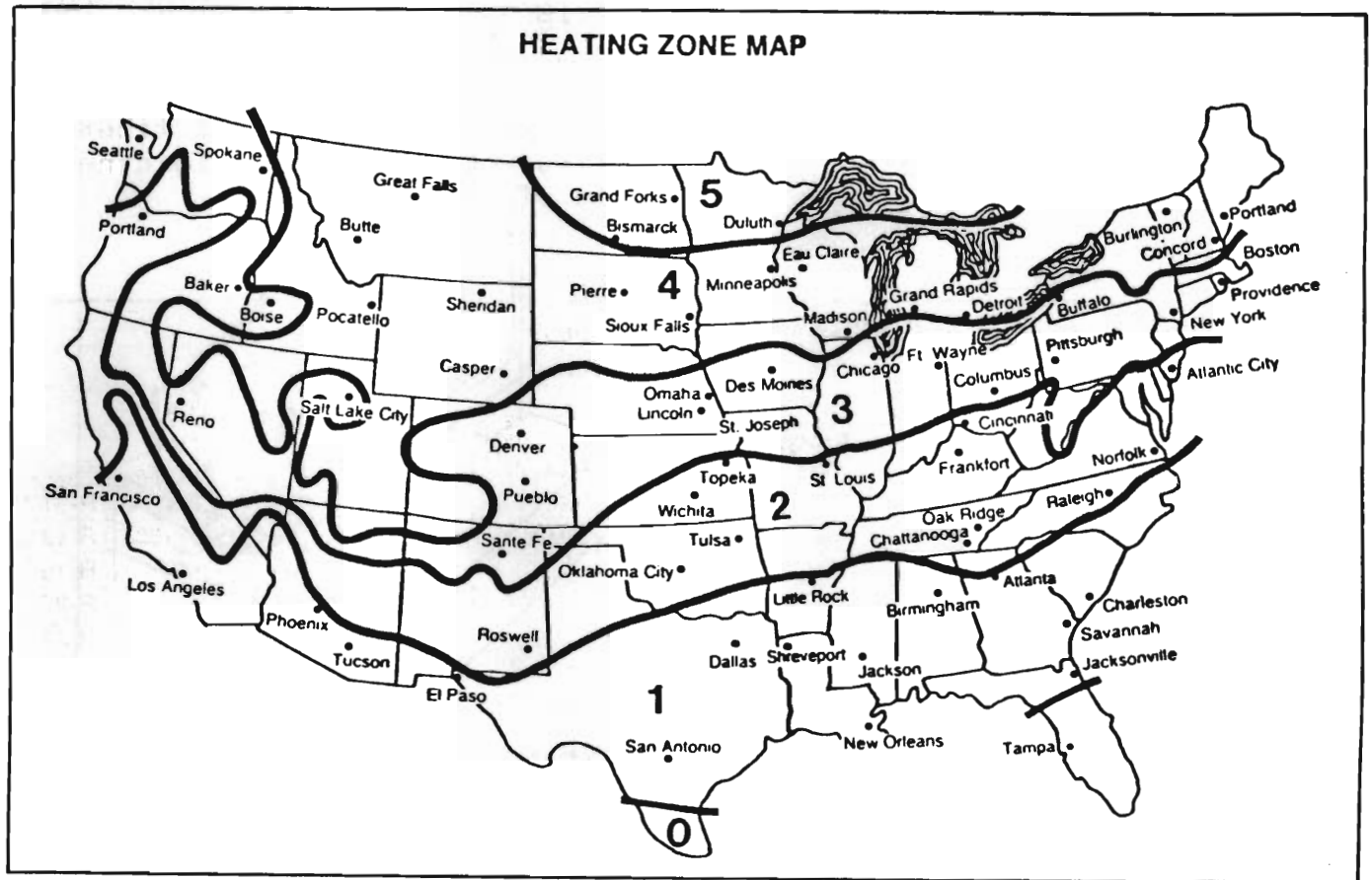
Fiberglass or rockwool blanket insulation is the easiest to use in unfinished attics. Usually it is placed between the beams on the attic floor. When insulation is placed on the inside of the roof itself the owner may use the attic as a comfortable living space.

Adequate attic ventilation will provide natural air flow for cooling. Ridge, turbine, rotary, or gable vents are the most common vent types and provide adequate ventilation.

Walls

Insulating walls both reduces heat transfer and reflects radiant heat within the building. Uninsulated walls absorb radiant heat and transfer it to the outside. The Energy Subcode requires wall insulation of at least R-11 value. Using more, or better quality, insulation will increase the R value. An R value of 19 will prevent substantial heat loss.

Mineral wool or fiberglass insulation is often used between studs and joists, while rigid insulation is often attached to exterior masonry walls.¹⁵ Either type of insulation, when properly installed and of a high enough R value, is a good insulator.



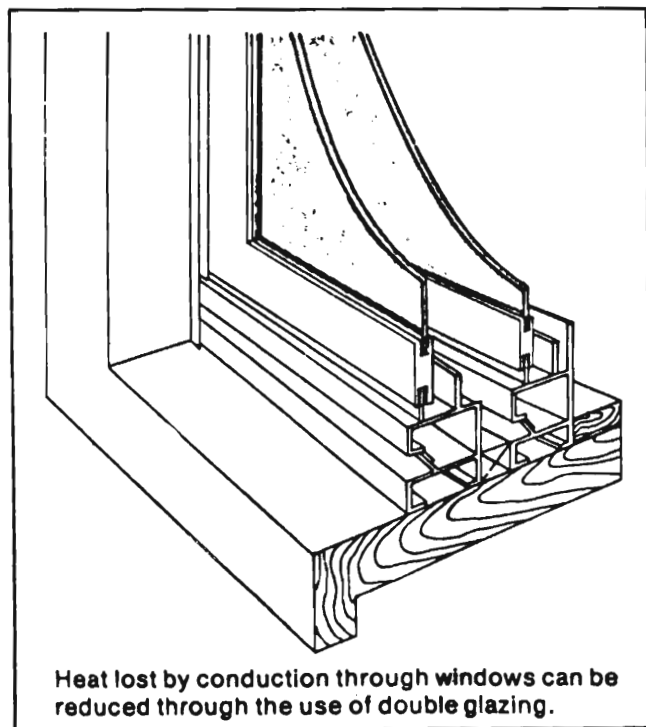
HEATING ZONE	RECOMMENDED FOR		
	CEILING	WALL	FLOOR
0,1	R-26	R-13	R-11
2	R-26	R-19	R-13
3	R-30	R-19	R-19
4	R-33	R-19	R-22
5	R-38	R-19	R-22

Sources for R-value data include Federal Housing Administration, American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), and insulation manufacturers.

Windows

Windows are areas of large heat losses. Even a double paned window has an R value of only about 2. Minimizing the number of windows on the north side will prevent substantial heat loss through windows. All windows should be double or triple paned to reduce heat loss. Wood frames are better insulators than aluminum frames, unless the aluminum frames are thermally broken. Thermal break windows have two pieces of aluminum with insulating material between them.

Insulated, operable window shutters such as "window quilt" will reduce a home's heating costs by preventing heat loss through the windows at night. Heavy window shades and curtains perform the same function. They provide a dead air space between the window and the interior. Closing the shutters or lowering the shades either manually or mechanically at night is important to retain heat.



Closets

Closets located against exterior walls can serve as free insulating barriers. A problem with this technique is that clothing may become uncomfortably cold.

Basements

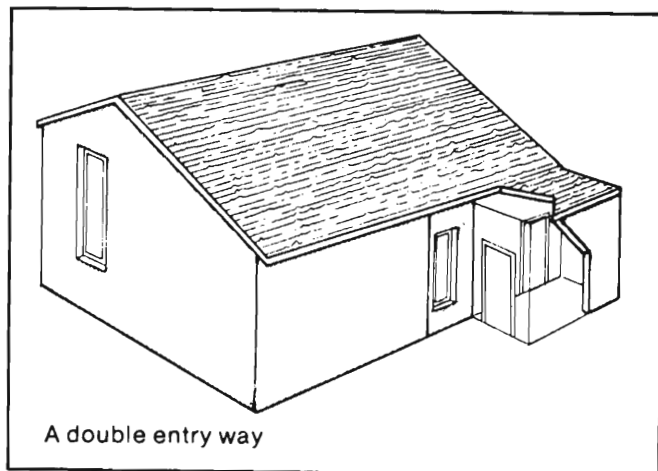
Insulating unheated basements reduces heat loss. The Energy Subcode requires that exposed masonry walls be covered with R-11 insulation and gypsum boards. Plugging the gaps between the foundation and the wooden building envelope with insulation also reduces heat loss.

Infiltration

Most of the measures explained thus far aim at reducing heat loss by limiting conduction. Air infiltration, however, is just as important. A single small gap running under a door will have the same effect as a hole in an exterior wall. Weatherstripping and caulking will reduce this loss. Vinyl foam strips can be attached to sliding windows. Magnetic seal and vinyl strips can be used together on doors. Clear silicone caulking used around moldings and window frames give an unobtrusive, long lasting seal. Weatherstripping and caulking thoroughly applied around doors, window frames, outside water faucets, and areas where masonry and wood meet will provide a good seal. The builder or owner should however, be aware of the problem of indoor pollution, which may occur when buildings are sealed too tightly to reduce infiltration. Noxious fumes emitted by common household cleaning agents can create health problems if interior air does not circulate.

Providing an outdoor air source for fireplaces is important because it decreases infiltration.

Air lock entries are small enclosed areas like foyers. Located at a building's main entrance, they reduce energy consumption, particularly in retail stores, by creating a zone of dead air space to prevent mixing cold and warm air.



Heat and Hot Water

Instead of using only one central water heater in a building, it is more energy efficient to use several smaller units near the point of use that can be switched on and off when needed. In this way, water is only heated when it is needed and in smaller amounts.

A heat pump is an energy efficient reversible refrigeration machine that pumps heat from one location to another. Because a heat pump moves heat instead of creating heat, it is more efficient than conventional heating systems.

Furnaces and boilers are required to meet efficiency standards prescribed in N.J. DOE's State Energy Conservation Regulations. In addition, a heat exchanger flue removes waste heat which would normally escape through the chimney, redirecting it to any area where it is needed. Gas pilot lights for all appliances are now banned in new construction; electronic ignition devices must be used.

A clock-controlled timer or thermostat lowers the temperature of a room when it is unoccupied or at night. These can be used in all heating systems. A related device controls lighting signs and parking lots. In multi-unit housing developments, individual heating and cooling meters will reduce energy consumption because residents can regulate the amount of heat or cooling for their own comfort.²³ In addition, since residents pay for the energy they use, there is an economic incentive for conservation.

Used hot water can be circulated through a heat exchanger to pre-heat cold water before it enters the domestic hot water system. The system design must ensure that the gray or used water does not mix with the potable water. The Engleside Motel in Beach Haven reports success with its solar hot water preheat system.

Steam and Hot Water Heating Piping

The Energy Subcode specifies that steam and hot water piping must have at least 1 to 3 inches of insulation. More insulation will reduce heat loss. Further reductions can be achieved by insulating all heat ducts and piping.

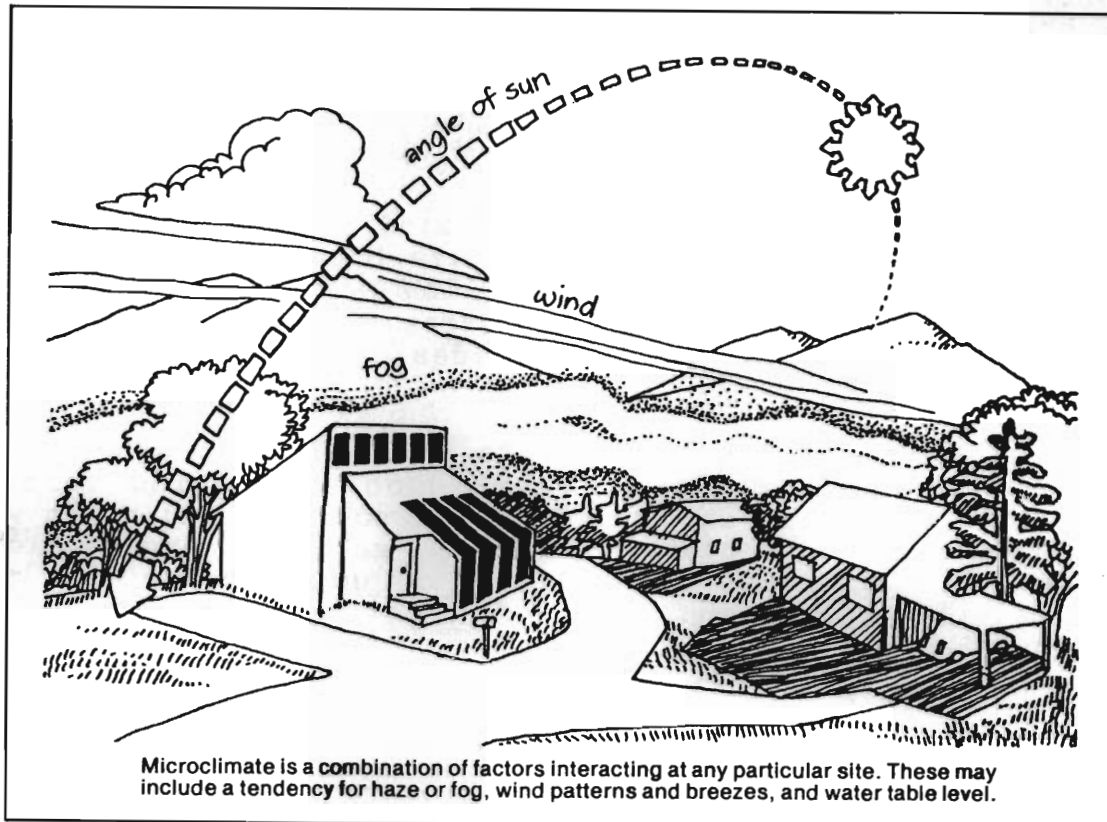
Wrapping water heaters with 2 to 4 inches of foil backed insulation keeps water hotter longer. Setting water heaters to 110 degrees, rather than to 140 degrees, reduces the amount of energy required for heating. Some dishwashers, however, require 140 degree water for sterilization. In general, the temperature of the water heater is dependent on the size of the heater and the number of people using it.

Resource Recovery

On-site resource recovery, including the collection of recyclable materials, is a technique for large-scale energy conservation. Providing within a housing complex or other facility a site for collecting recyclable materials and mandating that residents recycle will aid in reducing the need for using New Jersey's limited landfill space. Requiring recycling on a large scale will push the State closer to meeting the resource recovery goals established by the New Jersey Office of Recycling. Recovering energy from the waste stream that remains after the recyclable glass, metals, and paper have been removed depends on the availability of a waste-to-energy plant.²⁴

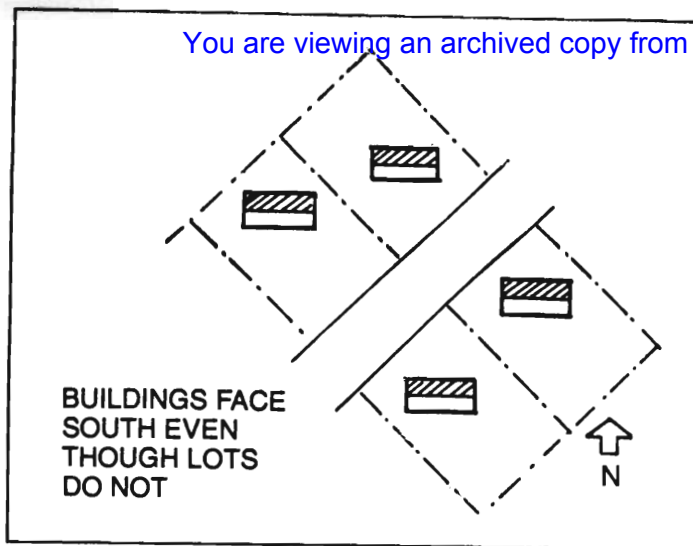
SOLAR ENERGY TECHNIQUES

This chapter contains techniques for using solar energy instead of non-renewable energy sources for heating and cooling. Designing buildings to take advantage of a site's microclimate is one of the most effective ways of construction. Microclimate analysis examines the effects of a site's temperature range, humidity, amount of sunlight and cloudiness, direction and velocity of prevailing winds, and heating and cooling degree days on energy requirements. It is most useful when done before site design.



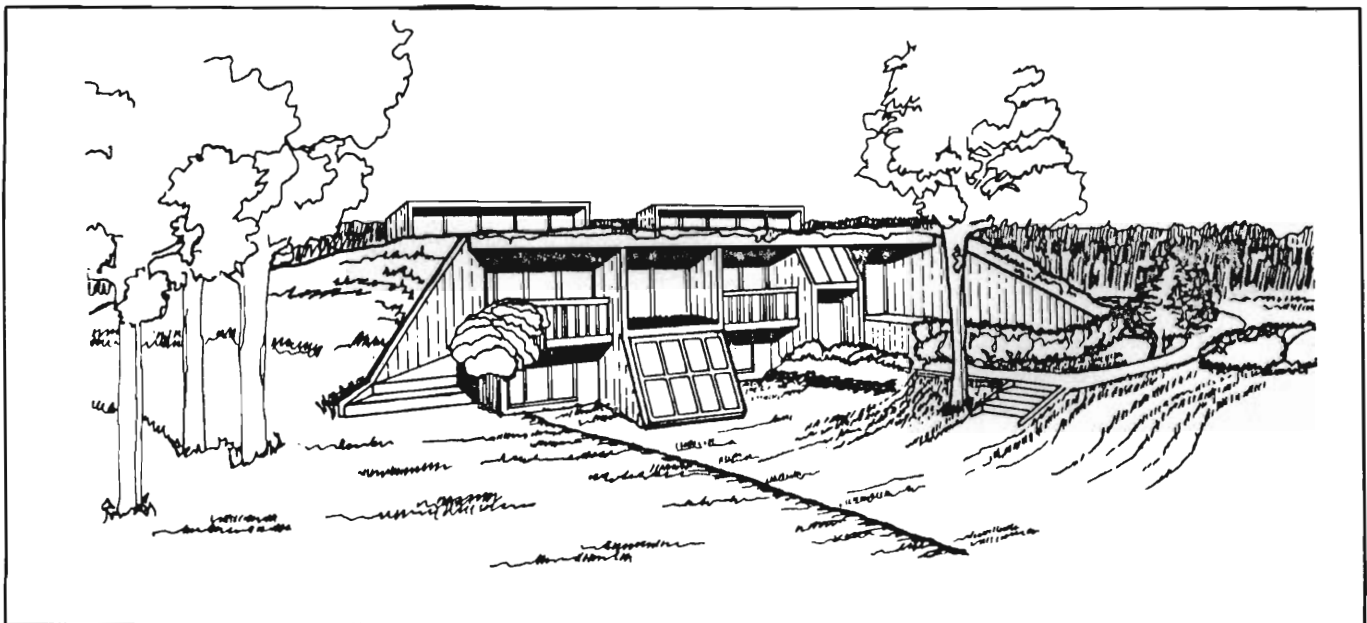
Siting

Properly siting a building is of paramount importance to passive solar gain. Generally, when the largest side of a building faces south the sun's rays strike the greatest surface area possible for exposure to the sun. Housing oriented on an east-west axis will allow the greatest amount of solar access. It is important to plan the road grid to permit houses to have southern exposure. If houses are planned on existing streets that are not oriented for solar gain, each house within its lot can be placed on an east-west axis.



Buildings can also be oriented for maximum wind gain. Structures exposed to the southwest will catch cooling summer breezes, and be sheltered from winter winds coming from the northwest. Because the two variables of sun and wind are so different, it is difficult to site a building to maximize both solar and wind gain. In general, locating the facade to allow prevailing summer breezes to enter at an angle of 20 to 70 degrees between the wall and wind direction creates turbulence and provides better ventilation for the occupants.

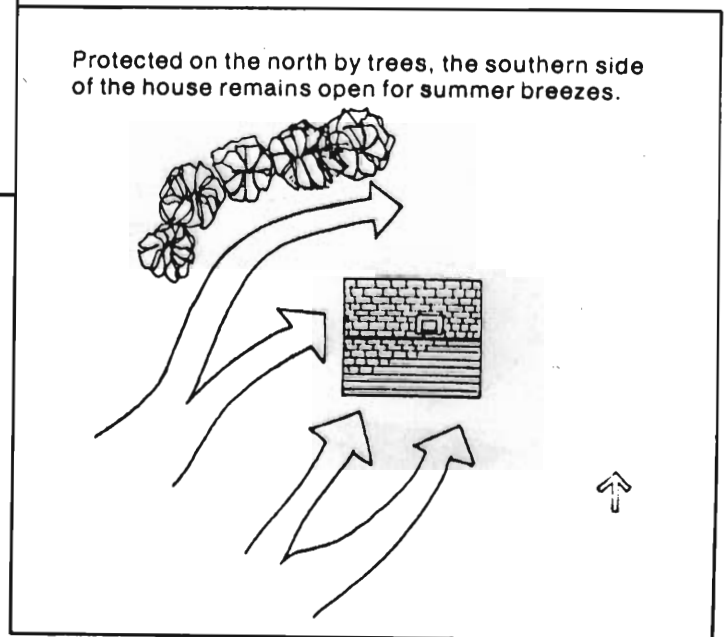
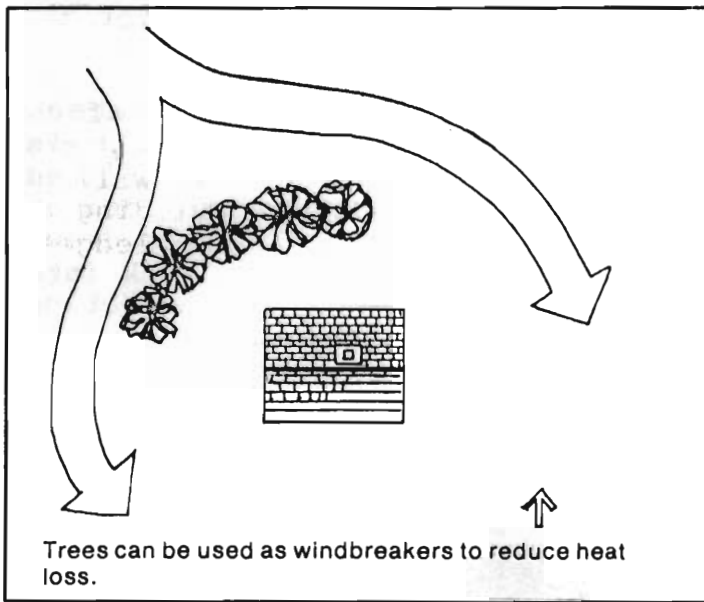
Great energy savings are also possible through use of an extremely cheap material which has good insulating value, the earth. Structures built into the sides of south-facing hills will be able to retain a lot of heat. Similarly, earth berming, building up earth around a structure's foundation or up to the window ledges, will promote heat retention.



Vegetation

Vegetation is an important element of a passive system. When properly used, vegetation can both shade the structure in the summer and protect it from harsh winds in the winter. High branching deciduous trees can be planted on the east and south sides to allow light to pass through during the winter, while blocking it during the summer. The honey locust, gingko, mulberry, birch, linden and sycamore permit between 60 and 85 percent solar penetration.²⁶ Evergreens may be planted in rows on the northwest corner close enough to the house to prevent winds from whipping around the trees. Holly, pine, and laurel are appropriate choices.

Vines planted on western walls will cut down on excessive sunlight. Paving a minimum amount of road area and thereby increasing the amount of vegetation reduces outdoor temperature buildup because vegetation absorbs summer heat and releases moisture, cooling the air.²⁷ Keeping existing vegetation instead of clearing a site prior to development reduces the energy needed for clearing, reduces the amount of energy to mow lawns,²⁸ and is aesthetically pleasing, adding to the value of the home.²⁸ Vegetation also prevents erosion.



Design

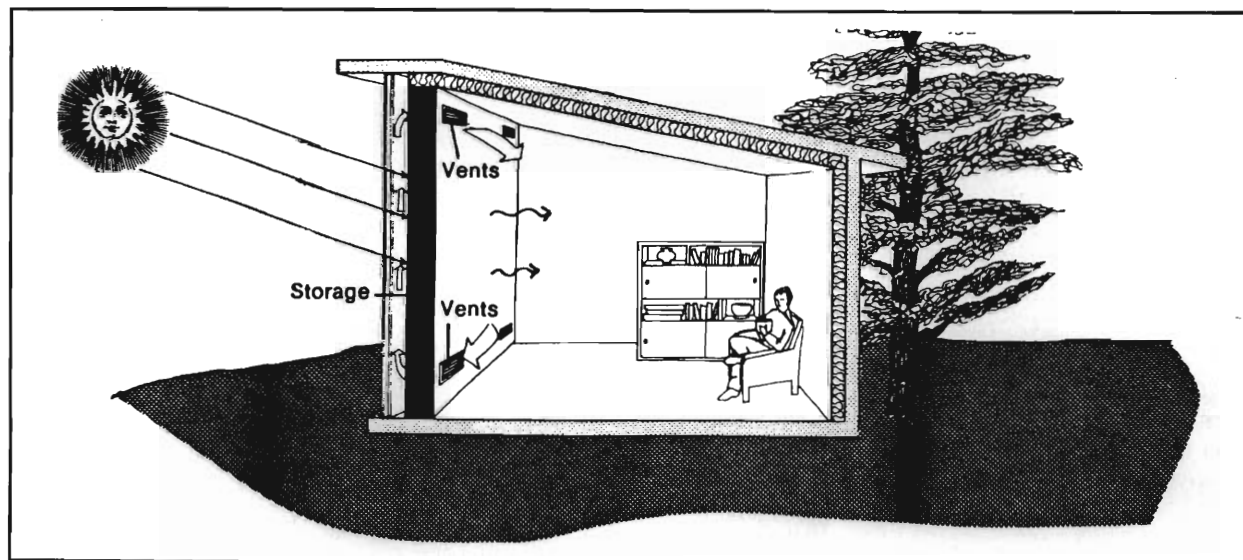
A structure will retain energy through the use of design techniques which minimize the structure's surface area to volume ratio. Therefore long, thin houses are less energy efficient than square ones. Domed structures have the lowest surface area to volume ratio. Attached houses which share walls, such as those used in townhouse arrangements, can use 30 to 60 percent less energy than detached houses by preventing the escape of a significant amount of heat.

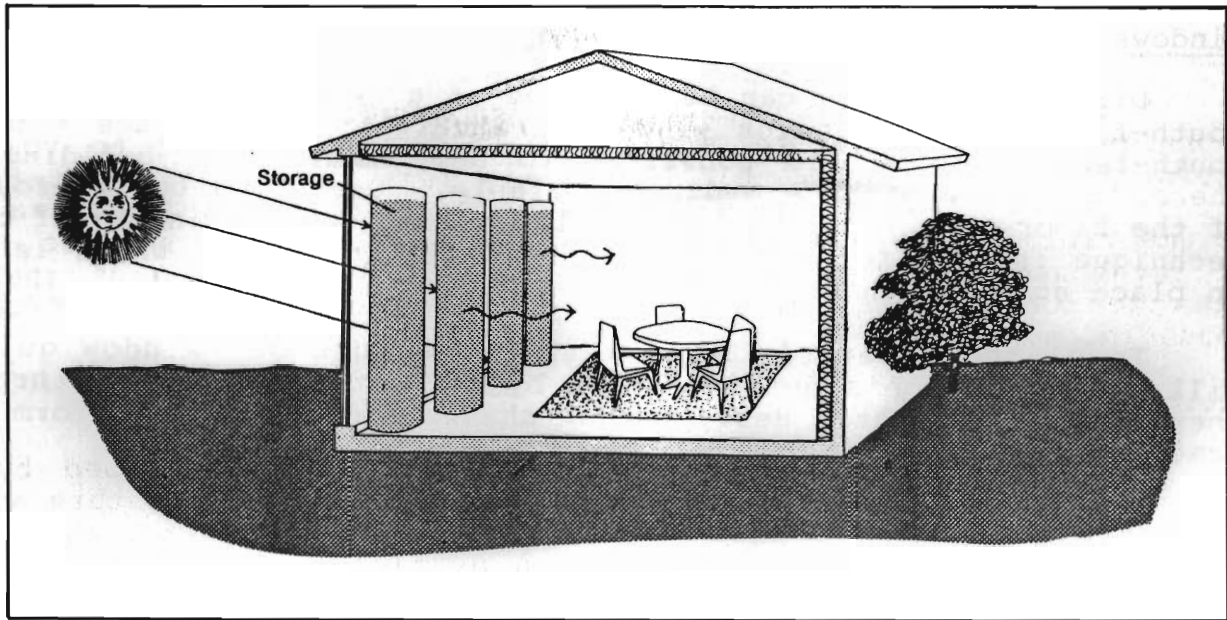
Thermal Mass

When sunlight enters a window, it must be absorbed by a mass which stores the heat. Otherwise, the air temperature will rise quickly during sunlight hours and fall rapidly in the evening. All the fixed building elements, such as floors and walls, may be thermal mass. In addition, water-filled barrels, earth-filled planters, or heavy furniture will store the heat energy. In general, 30 pounds of water or 150 pounds of masonry for each square foot of south-facing glass will serve as adequate storage material. The ratio of building floor area to storage mass surface area should be at least 1:1.

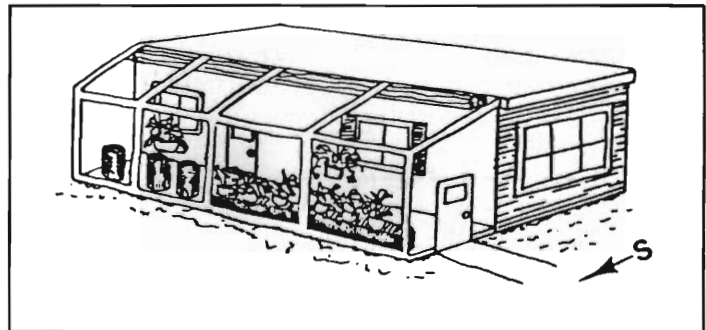
Trombe Wall

The "Trombe wall", invented by Felix Trombe and architect Jacques Michel of France, is a passive heating system. It is a 12 inch thick concrete exterior wall facing south, that is painted black and covered with glass. Vents to the interior are provided at the top and bottom of the wall. Cold air along the floor is drawn into the area between glass and wall, heated, and expelled back into the house through the top vent by the natural process of convection in which cold air falls and hot air rises. The Trombe wall is an example of indirect solar gain, where solar radiation is intercepted by an absorber and storage element.





A water wall is a variation of the Trombe wall. A method of indirect gain, it uses water-filled containers in place of the Trombe wall's masonry walls.



Greenhouses

An attached greenhouse placed contiguous to an outside wall will serve as a passive solar collector to provide substantial heat gain, as well as a desirable feature of the house and garden, if desired. Plant beds, a thick masonry wall or floor or water filled containers will serve as thermal mass needed for solar heat storage. The heat gained in the greenhouse can be transmitted to the rest of the building by opening the door that connects the two or by a venting system. Vents at the top and bottom of the wall separating the greenhouse from the building proper cause heat transfer through the process of convection.²⁹ Two to three gallons of water per square feet of glazing will maintain a temperature difference of about 30 degrees farenheit above outdoor lows overnight.³⁰ A greenhouse is an example of isolated passive solar gain.

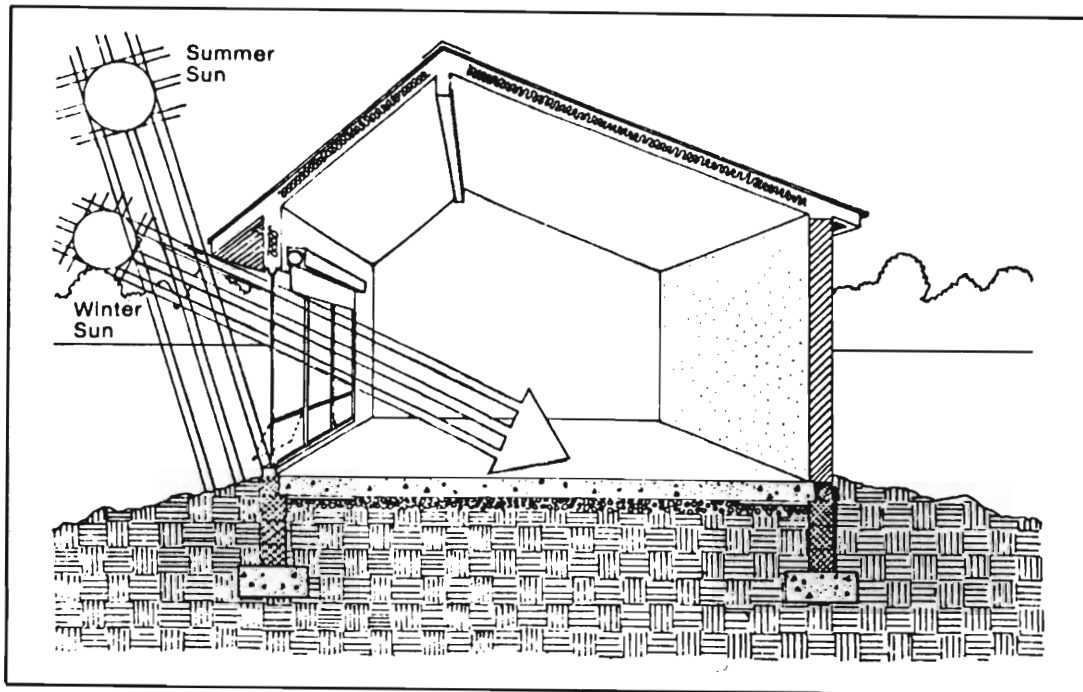
Windows

Direct solar gain can be achieved if a large percentage of the south-facing wall contains windows. Sunlight which passes through south-facing windows is converted to heat inside the building if there is a heat storage medium available. One-third to one-fourth of the floor area to be heated should be included as windows if this technique is used for solar gain. Moveable insulation which is put in place at night ensures against heat loss.

Insulated, operable window shutters such as "window quilt" will reduce a home's heating costs by preventing heat loss through the windows at night. Heavy window shades and curtains perform the same function.

Awnings and Overhangs

Summer solar gain can be reduced by using exterior shading devices on south-facing windows that are either removable, such as awnings, or built in, such as overhangs.³¹ A fixed overhang will not interfere with possible solar gain in the winter if it is of the proper length.



ENERGY CONSERVATION CHECKLIST

1. Is the building sited along the east-west axis? yes___ no___

Siting a building along the east-west axis will provide southern exposure to the sun and the greatest amount of solar radiation.

2. Is the building located within a planned unit development or in an urban area? yes___ no___

Creating a planned unit development conserves energy by locating housing, shopping areas and schools within walking distance of each other. Building in urban areas can take advantage of similar existing support facilities.

3. Is the building earth-bermed? yes___ no___

Earth is a good insulator which reduces the amount of energy needed to heat and cool the building.

4. Are deciduous trees planted on the east and south sides and evergreens on the north? yes___ no___

Deciduous trees planted on the south side allow solar access in the winter and block the sun in the summer. Evergreens act as windbreaks.

5. Does the building have a low surface area to volume ratio or does it share walls with other buildings? yes___ no___

A low surface area to volume ratio prevents substantial heat loss. Buildings in the shared walls conserve 30 to 60 percent more energy than detached buildings.

6. Does the building meet or exceed the BOCA standards for insulation? yes___ no___

Properly insulating a building roof, attic, ceiling, walls, and floors is an effective and inexpensive way to conserve energy.

7. Is there adequate attic ventilation? yes___ no___

Attic ventilation will cool the attic and the entire building in the summer.

ENERGY CONSERVATION CHECKLIST (continued)

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8. Are the windows double or triple paned and placed in wood or aluminum thermal break frames?

yes___ no___

Double or triple paning will reduce heat loss through windows. Wood or thermal break frames are good insulators.

9. Do the windows have insulated, operable shutters or shades?

yes___ no___

Closing the shades or shutters at night prevents substantial heat loss. Raising them in the morning allows winter solar gain.

10. Does the building have exterior awnings or overhangs?

yes___ no___

An awning or overhang of the proper length will prevent solar gain in the summer while allowing solar gain in the winter.

11. Are all or most closets on exterior walls?

yes___ no___

Closets on exterior walls act as insulation.

12. Is there thermal mass to absorb and store the solar heat gained?

yes___ no___

Without a storage medium, the solar heat gained will dissipate rapidly.

13. Does the building have an attached solar greenhouse? yes___ no___

An attached greenhouse acts as a passive solar collector, and a place to grow vegetables during the winter.

14. Does the building contain several small water heaters near the point of use instead of one large water heater?

yes___ no___

Having several small water heaters allows water to be heated only when it is needed and in smaller amounts than with one large water heater. The hot water retains more heat if it travels a shorter distance through pipes.

15. Does the building have solar collectors for hot water and/or space heating?

yes___ no___

Solar hot water and/or space heating is a cost-effective way to increase energy efficiency.

16. If the buiding does not have solar collectors, is it suited for the future addition of solar collectors? yes ___ no ___

Siting a building along the east-west axis and installing the proper plumbing systems will permit solar retrofitting in the future.

17. Is there a water pre-heat system? yes ___ no ___

Preheating cold water with used hot water will save energy needed to heat the water.

18. Are windows and doors weatherstripped? yes ___ no ___

Weatherstripping and caulking will reduce air infiltration and lessen energy requirements for heating and cooling.

19. Does the building have an air lock entry like a foyer?

yes ___ no ___

An air lock entry reduces energy consumption by preventing cold air from reaching the heated areas.

Footnotes

1 N.J.S.A. 40:55D-2. The New Jersey Department of Community Affairs oversees the implementation of the Municipal Land Use Law.

2 Edlund, C. and G. Ridzon, Planning the Energy Efficient Community (Boston, MA: Northeast Solar Energy Center, 1981).

3 NAHB Research Foundation, Inc. Energy Efficient Residence Research Results (Washington, DC: U.S. HUD, 1981)

4 Solar Energy Research Institute, Report on Building a Sustainable Future (Washington, D.C.: U.S. Government Printing Office, 1981).

5 National Audubon Society, The Audubon Energy Plan (New York: National Audubon Society, 1981). Although this report recommends massive investments in energy efficient equipment, the amount of money required is a small fraction of the amount already invested in energy, and will yield an attractive return on the investment.

6 See CA #79-0320-5 file, filed with DEP-DCR (Energy Analysis received August 22, 1979). The total energy savings will be 1085×10^9 BTU/yr., while the total energy input, after savings, will be 534×10^9 BTU/yr.

7 Photovolotaic cells, which convert sunlight directly to electricity, will not be discussed here because their high cost makes them economically infeasible at the present.

8 See CA #80-0436-5.

9 New Jersey Department of Energy, New Jersey Energy Master Plan (1978) p. G-1.

10 See CA #79-0372-5.

11 The Elements, The Davis Experiment: One City's Plan to Save Energy, (Washington, D.C.: Public Resource Center, 1977).

12 See CA #79-0334-5.

13 See CA #80-0373-5, CA #79-0372-5, CA #79-0357-5, and CA #79-0352-5.

14 See CA #79-0372-5 and CA #79-0357-5.

15 See CA #80-0412-5, CA #80-0373-5, CA #79-0357-6, and CA #79-0334-5.

Footnotes (continued)

16 See CA #80-0412-5, CA #79-0372-5, CA #79-0352-5, CA #79-0334-5, CA #79-0332-5, and CA #79-0322-5.

17 See CA #80-0428-5, CA #80-0388-5, and CA #79-0371-5.

18 See CA #80-0441-5, CA #80-0430-5, CA #80-0428-5, CA #80-0411-5, and CA #79-0334-5.

19 See CA #80-0400-5, CA #80-0388-5, and CA #79-0332-5.

20 See CA #80-0383-5, and CA #79-0372-5.

21 See CA #79-0372-5, and CA #79-0348-5.

22 See CA #80-0436-5, CA #80-0428-5, CA #80-0400-5, CA #80-0392-5, CA #80-0388-5, CA #79-0372-5, CA #79-0371-5, CA #79-0347-5, CA #79-0334-5, CA #79-0327-5, Ca #79-0322-5, and CA #79-0320-5.

23 See CA #79-0334-5.

24 See CA #80-0436-5, CA #80-0428-5, CA #80-0412-5, CA #80-0392-5, CA #80-0388-5, CA #79-0347-5, CA #79-0322-5, and CA #79-0320-5.

25 See CA #80-0411-5, CA #80-0383-5, CA #80-0379-5, CA #80-0373-5, and CA #79-0332-5.

26 U.S. HUD, Protecting Solar Access for Residential Development (Washington, D.C.: U.S. Government Printing Office, 1980) pp 136ff.

27 See CA #79-0357-5.

28 See CA #80-0441-5, CA #80-0430-5, CA #80-0411-5, CA #80-0388-5, CA #80-0383-5, CA #80-0373-5, CA #79-0372-5, CA #79-0357-5, CA #79-0352-5, and CA #89-0340-5.

29 See CA #79-0332-5.

30 Northeast Solar Energy Center, "Solar Greenhouses," (Cambridge, MA: Northern Energy Corporation, undated).

31 See CA #80-0388-5, CA #80-0383-5, CA #79-0371-5, and Ca #79-0322-5.

For more information about energy conservation please contact the following agencies:

GENERAL ENERGY CONSERVATION:

Atlantic City Electric Company
Customer Service Office
1600 Pacific Avenue
Atlantic City, New Jersey 08804
(609) 645-3500

Jersey Central Power & Light
Ms. Marguerite Welden
Consumer Relations Department
Madison Avenue at Punchbowl Road
Morristown, New Jersey 07960
(201) 455-8783

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, Maryland 20850
(800) 523-2929 or (800) 523-4700

New Jersey Department of Energy
Office of Alternate Technology
101 Commerce Street
Newark, New Jersey 07102
(201) 648-6293

New Jersey Department of Environmental Protection
Ms. Jessica Winslow
Bureau of Coastal Planning and Development
CN 401
Trenton, New Jersey
(609) 292-9762

Northeast Solar Energy Center (NESEC)
470 Atlantic Avenue
Boston, Massachusetts 02110
(617) 292-9250

Public Service Electric and Gas
Marketing Department
80 Park Place
Newark, New Jersey 07101
(201) 430-5698

APPENDIX I (continued)

Solar Energy Research Institute (SERI)
1617 Cole Boulevard
Golden, Colorado 80401
(800) 525-5000

U.S. Department of Energy
Office of Consumer Affairs
1000 Independence Avenue, S.W.
Washington, D.C. 20585
(202) 252-6480

COMMUNITY ENERGY PLANNING:

New Jersey Department of Community Affairs
Bureau of Local Planning
329 West State Street
Trenton, New Jersey 08625
(609) 292-6486

New Jersey Department of Energy
Community Energy Planning Office
101 Commerce Street
Newark, New Jersey 07102
(201) 648-3277

RECYCLING:

New Jersey Departments of Energy
and Environmental Protection
Office of Recycling
101 Commerce Street
Newark, New Jersey 07102
(201) 648-6295

ANNOTATED BIBLIOGRAPHY ON ENERGY CONSERVATION

General

American Retail Federation, Energy Cost Reduction in Retailing, Washington: American Retail Federation, 1981.

Retailers can net 20 to 30 percent reductions in energy costs by applying the recommendations in this handbook. Many energy conservation techniques recommended have payback periods of less than one year.

General Public Utilities, Conservation and Load Management Master Plan, 1980.

General Public Utilities is proposing a load management plan for its customers in New Jersey and Pennsylvania to reduce energy consumption by shifting demand to off peak hours.

Hayes, Denis, Rays of Hope: The Transition to a Post Petroleum World, New York: W.W. Norton & Co., 1977.

A global perspective on the energy crisis and the search for solutions to it including conservation, solar, wind, and biomass power.

Leckie, Jim, et al., More Other Houses and Garbage: Designs for Self-Sufficient Living, San Francisco: Sierra Club Books, 1981.

A how-to guide for building energy-efficient houses, with technical details for construction.

National Audubon Society, The Audubon Energy Plan, New York: National Audubon Society, 1981.

Demonstrates that by the year 2000 the United States can increase economic growth to 3 percent per year without consuming more energy than consumed today, by using energy more efficiently and using solar energy.

N.J. DCA & N.J. DOE, Small Dwelling Energy Subcode Compliance Manual, Trenton: N.J. DCA, undated.

An aid for one and two family buildings' compliance with the Energy Subcode of the Uniform Construction Code. Manual contains the Code, standards for compliance, and supplemental information.

N.J. DOE, What to do: N.J. Home Energy Savings Workbook #1, Newark: N.J. DOE, undated.

Checklist of conservation techniques.

Shashaty, Andre, "Major Test of Solar Heating is Set in Maryland House," The New York Times, June 21, 1981.

The National Association of Home Builders Research Foundation is building Energy Efficient Residence II, a demonstration project to show the extent of dollar savings available.

Solar Energy Research Institute, Report on Building a Sustainable Future, Washington: Government Printing Office, 1981.

Analyzes the ability of the United States to enjoy high economic growth while reducing energy consumption 25 percent by the year 2000.

Wade, Alex, A Design and Construction Handbook for Energy-Saving Houses, Emmaus, Pa: Rodale Press, 1980.

A how-to-guide for constructing energy efficient houses with plans and information about plumbing, electricity, solar systems and materials.

Insulation

Gladstone, Bernard, "Using Window Shades to help Conserve Heat," New York Times, January 27, 1980.

Discusses the advantages of using shades to retain heat.

"Insulate your Home," Greenfield, Massachusetts: Channing L. Belco, 1977.

Techniques to make your home more energy efficient by insulation. Methods include developing vapor barriers, stopping drafts, and controlling moisture.

N.J. DOE, "Guide to Residential Insulation," Newark: N.J. DOE, 1978.

Describes insulation techniques for many types of residences.

Laws, ordinances, and Regulations

Executive Office of the President, The National Energy Plan, Washington: Government Printing Office, April 29, 1977.

President Carter's Energy Plan proposes to initiate incentives to reduce the demand for energy, among other things.

N.J. DOE, "Energy Conservation Regulations, N.J.A.C. 14A:3-1.1 et seq. 1978.

Establishes standards for large boiler combustion efficiency, oil-fired heating unit maintenance, thermal efficiency, thermostats in public buildings, gas pilot lights, individual metering, lighting efficiency, and air conditioners and heat pumps.

_____, N.J. Energy Conservation Plan: A Necessary Commitment, Newark: N.J. DOE, 1977.

Contains energy conservation techniques for residential commercial, industrial, transportation, utility uses, along with methods of implementation.

_____, N.J. Energy Master Plan, Newark: N.J. DOE, 1978:

The N.J. Energy Master Plan established the following three goals: (1) to assure uninterrupted energy supplies to all New Jersey users; (2) to promote economic growth while safeguarding environmental quality; and (3) to encourage the lowest possible energy cost consistent with conservation and the efficient use of energy.

N.J. Municipal Land Use Law, as amended, "Promotion of Conservation of Energy," N.J.S.A. 40:55D-2.

An act to promote the conservation of energy, amending the Municipal Land Use Law.

U.S. House of Representatives, "National Energy Conservation Policy Act," October 10, 1978.

Act includes general energy conservation provisions for residences, local governments, and public care institutions.

Resource Recovery

Kupper, Charles J., "Preliminary Feasibility Study for Solid Waste Disposal/Facility System," Dover Township Municipal Utilities Authority, 1980.

This follow up feasibility study for a proposed solid waste/energy recovery facility in Dover Township analyzes where the energy recovery sources would be purchased, how much, and by whom. The report shows existing parameters and the proposed program.

_____, "Solid Waste Disposal Energy Recovery Facility,"
Dover Township Municipal Utilities Authority, 1979.

Report on an application for a permit to construct and operate a new solid waste facility, describing the facility, input and output data, environmental factors, types of waste, and permit requirements.

N.J. DOE, Recycling in the 1980's, Newark: N.J. DOE, 1980.

Establishes 3 recycling goals attainable by 1986 if Plan's recommendations are adopted: (1) increase source separation and recycling of glass, metal, and paper from 0.5 million tons per year to 1.3 million tons per year; (2) increase recycling of used motor oil to 18 million gallons per year; and (3) increase recycling of food costs, tires, plastics, and yard wastes to 0.5 million tons per year.

Plan proposes legislative, administrative, business and public actions to implement recycling strategy such as working with industry and municipalities.

_____, "Solid Waste: Its Energy Conservation and Production Potential," Newark: N.J. DOE, 1978.

The problem of solid waste in New Jersey is explained with facts and figures. The report includes legislative authority, policies, benefits of conservation, calculations of energy impact of recycling, energy savings and environmental impacts, and 1988 employment potential from resource recovery.

_____, "Energy Recovery From Wastes: An Overview,"
Washington: Government Printing Office, undated.

Discussion of the technological and institutional constraints on resource recovery.

_____, "Summary: The Department of Energy Program for the Recovery of Energy and Material from Urban Waste," Washington: Government Printing Office, 1979.

Summary of technologies and U.S. DOE policy for resource recovery. DOE espouses the development of technology for and removal of institutional impediments to resource recovery.

_____, "Waste-to-Energy Program," Washington: Government Printing Office, undated.

Brief description of waste-to-energy technologies: mechanical, thermal, and biological; types of fuel: RDF, methane, and pyrolysis-produced; and current demonstration projects.

U.S. EPA, "Resource Conservation and Recovery Current Reports," Washington: Government Printing Office.

A list of articles and reports evaluating all phases of resource recovery of solid wastes products.

Solar Energy

Central Naugatuck Valley Regional Planning Agency, Overcoming Land Use Barriers to Solar, Waterbury, Ct.: Central Naugatuck Regional Planning Agency, 1980.

Analysis of legal and institutional barriers to the installation of solar energy systems, with recommendations for overcoming land use barriers and promoting energy conscious building in Connecticut.

Edlund, Campbell and Gerard Ridzon, Planning the Energy Efficient Community, Boston: Northern Energy Corporation, 1981.

A guidebook for New Jersey municipal officials, planners, and developers to incorporate energy conservation measures into the land use planning and regulatory processes.

National Solar Heating and Cooling Information Center, "Factsheet," Washington: Government Printing Office, October, 1978.

Discussion of insulation including efficiency ratings, installation, standards thickness per R-value, and a chart on insulation materials.

_____, "Selected Solar Buildings in New Jersey," Washington: Government Printing Office, undated.

List of selected solar buildings in New Jersey.

_____, "Solar Status," Washington: Government Printing Office, 1980.

Update on solar activities nationwide, including local government activities with building codes and planning and zoning. Information on Davis, California's local regulations for energy efficiency and state solar information programs.

N.J. DOE, "Preliminary list of solar dealers in New Jersey," Newark: N.J. DOE, undated.

N.J. DOE preliminary list of solar equipment manufacturers, dealers, distributors, and contractors, and installers in New Jersey.

_____, "Reuse, Recycle, Recover," Newark: N.J. DOE.
Brief discussion of energy potential of N.J.'s solid waste.
_____, "Solar Energy in New Jersey," Newark: N.J. DOE,
1978.

A policy statement prepared as part of the N.J. Energy Master Plan, consisting of limitations, opinions, legislative background, administrative background, and educational background.

Northeast Solar Energy Center, *An Introduction to the Use of Solar Energy in New Jersey*, Newark: N.J. DOE, 1981.

A guidebook for incorporating solar technology in new and existing housing, including active and passive systems, design calculation, and economics.

_____, "NESEC Update," Vol. 1, Nos. 4, 5, 6, 7, 8, 9, 10;
Vol. 2, Nos. 2, 3, 4, 5, 6, 7.

Monthly update of the solar activities of the NESEC area, serving Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

_____, "Solar Greenhouses," Cambridge, Massachusetts:
Northern Energy Corporation, undated.

How solar greenhouses work to reduce heat loss. Low cost construction and added resale value make solar greenhouses desirable. 2 to 3 gallons of water per square foot of glazing will maintain a temperature difference of about 30 degrees fahrenheit above outdoor lows overnight.

Public Service Electric & Gas, "The Electric Heat Pump," Newark: Public Service Electric & Gas, 1978.

Description of the principles behind and operation of heat pump are included with efficiency ratings and a list of the advantages of a heat pump.

Solar Energy Applications Center at Polytechnic Institute of New York. "Solar Domestic Hot Water System Installation Guidelines," 1977.

A list of guidelines for installing solar systems, such as site selection, building considerations, and health and safety. General information about collector installation, moisture and thermal protection, and storage tanks is presented.

APPENDIX II (continued)

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A domestic policy review conducted at the President's request of May e, 1978, it contains nine findings, including that there is significant potential for expanding the nation's use of solar energy and that many solar technologies are already economic.

U.S. HUD and U.S. DOE, The First Passive Solar Home Awards, Washington: Government Printing Office, 1979.

162 passive solar designs, divided into three general categories: direct solar gain, indirect solar gain, and solarium.

_____, "Installation Guidelines for Solar DHW Systems in One and Two Family Dwellings," Washington: Government Printing Office, 1980.

A report on better solar installation techniques. It is written for the professional installation contractor and the skilled homeowner.

_____, New Energy-Conserving Passive Solar Single-Family Homes, Washington: Government Printing Office, 1981.

Discusses the needs of the home builders who have to satisfy the general market. The projects selected were from builders who were already experienced in the market place; technical issues were addressed during the design phase and attention is directed to the marketability of the various designs.

_____, Protecting Solar Access for Residential Development: Guidebook for Planning Officials. Washington: Government Printing Office, 1980.

This manual shows planner how to use conventional land use controls to protect solar access in new residential development for space heating and cooling and domestic hot water.

_____, Site Planning for Solar Access: Guidebook for Residential Developers and Site Planners, Washington: Government Printing Office, 1980.

Discusses the importance of site planning for solar buildings to establish and preserve access to the sun.

_____, June 1980, "Solar Energy and Your Home," Washington: Government Printing Office, 1980.

APPENDIX II (continued)

Answers to the most frequently asked questions about how solar energy can be put to work at home. Includes bibliography.

_____, "Solar Factsheets," Nos. 101, 103-122.

A series of pamphlets discussing all aspects of solar energy.

_____, "Solar Hot Water and Your Home," Washington: Government Printing Office, 1979.

Discusses the conversion of solar radiation to thermal energy and use of that energy.

_____, "State Solar Legislation," Washington: Government Printing Office, 1979.

Listing of state solar legislation on taxation, grants and loans, land use standards, and building codes, as of January, 1979.

_____, June 1980, "A Survey of Passive Solar Homes," Washington: Government Printing Office, 1980.

A compilation of constructed, residential passive solar buildings, showing the state of the art as of June, 1980.

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NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION