New Jersey Energy Master Plan
Alternatively Fueled Vehicles Work Group

The Board of Public Utilities (BPU) established the Alternatively Fueled Vehicle Work Group and charged it with developing recommendations regarding how best to identify the optimal fuels for differing applications and how best to develop the refueling capabilities within the state for both fleet vehicles as well as privately owned vehicles. The specific questions that the BPU has tasked the Work Group with are as follows:

- Within the vehicle categories of freight, mass transit and passenger vehicles, what are the most cost-effective and environmentally friendly alternatives?
- What are the opportunities and barriers to developing an infrastructure to support various alternative fuel supplies for vehicles?
- For State owned vehicle fleets, how can the state increase its energy efficiency and decrease its reliance on petroleum-based fuels?
- Are there any legislative or regulatory barriers to increasing the state's use of alternatively fueled vehicles across all sectors?

Inclusion of transportation fuels in New Jersey's Energy Master Plan is an important development. The 2008 New Jersey Greenhouse Gas Inventory Report identified the transportation sector as the largest source of the State's greenhouse gas (GHG) emissions, accounting for about 35% of the total emissions in the baseline year of 2004. Transportation is also the fastest growing sector. This is due to both the increase in the number of miles driven each year by New Jersey motorists (otherwise known as vehicle miles traveled or VMT), and the fact that fuel efficiency gains from cars over time have been negated by the increased use of light trucks (e.g., sport utility vehicles). Without significant changes in fuel efficiency and/or increased usage of alternate fuels, along with a reduction in vehicle miles traveled, it will be difficult to meet the GHG reduction goals of the Global Warming Response Act (P. L. 2007, c 112).

Through this Energy Master Plan and other initiatives, the State should assume a leadership role in facilitating major changes to New Jersey's motor vehicle fleet and transportation infrastructure. This Plan calls for maximizing the reduction of criteria pollutant and greenhouse gas (GHG) emissions by promoting the use of alternative fuels and advanced vehicle technologies by employing three complimentary strategies:

- **Replace** petroleum with alternative and renewable fuels
- **Reduce** petroleum use through the encouragement of smarter driving practices, idle reduction, and fuel-efficient vehicles
- **Eliminate** petroleum consumption through the use of mass transit, trip-elimination measures, and congestion mitigation.

One of the state's policy objectives is to increase the energy efficiency of vehicles currently on the road while decreasing reliance on imported petroleum-based fuels. Because of the high startup costs in transitioning to the use of alternative fuels, the

competitive marketplace may not have the wherewithal on its own to make the appropriate investment to meet the policy objectives of the state in a timely manner.

Just as the State successfully leveraged the utilities and provided market incentives to the private sector to promote the development of a vibrant solar industry in New Jersey, it can also do so to promote New Jersey's transition to alternatively fuel vehicles. In doing so, the State will move forward towards achieving its energy and environmental objectives, as well as stimulate private sector job growth.

This report represents the consensus opinions of the members of the Alternatively Fueled Vehicles Work Group. Any questions or comments on the report should be directed to Work Group Chair, Chuck Feinberg at chuck.feinberg@gmail.com.

Within the vehicle categories of freight, mass transit and passenger vehicles, what are the most cost-effective and environmentally friendly alternatives?

Millions of light-, medium- and heavy-duty alternatively fueled and advanced technology vehicles are used by state and federal agencies, private companies, and consumers across all modes of transportation and goods movement in the United States. The vehicle industry is changing rapidly with fleets adopting alternative fuels and advanced technologies to reduce petroleum use and comply with the 2010 U.S. Environmental Protection Agency (EPA) and other emission standards. Among the reasons for the move to an alternative fuel are environmental benefits, reduced reliance on imported fuels, and domestic job creation. Alternative fuel and advanced technology vehicles come in an increasing variety of makes and models and run on a number of different domestically-produced fuels.

New Jersey's transportation energy goals can best be achieved through carefully balancing the utilization of all available clean technologies through the creation of various incentives and programs that subsequently let the marketplace operate to utilize the best and most cost effective fuel solutions. At this point, unlike for much of the past 100-plus years, there is no longer a "one-size-fits-all" when it comes to fuel options. Based upon the current state of technology and market deployment, over the short- and mid-term, there will remain an increasing opportunity to utilize a variety of alternative fuels and advanced technology vehicles, some of which will work well only in specific situations, while others that may have broader application. The Energy Master Plan should be fuel-neutral and allow for, in fact encourage, those fleets and individual consumers most affected to make the choice that works best for them. In addition, other petroleum reduction options such as idle reduction and measures to increase fuel economy must be part of the mix.

The following provides a brief summary of the following "market-ready" petroleum reduction opportunities available:

- Electric Drive Vehicles
- Natural gas vehicles (NGVs), including compressed natural gas and liquefied natural gas
- Propane Autogas Vehicles
- Biodiesel fuel
- Ethanol
- Hydrogen

Electric Drive Vehicles: Most of the major global automobile Original Equipment Manufacturers (OEMs), as well as several start-ups, are in the process of bringing a variety of light-, medium- and heavy-duty electric vehicles to market. Several models are already available in various markets across the country, including New Jersey. Despite the progress currently being made in the global electric vehicle market, substantial barriers to widespread electric vehicle adoption still exist. While competitive in performance to internal combustion engine vehicles, the initial electric vehicle (EV) batteries have a more limited range compared to gasoline and diesel vehicles, will take

hours to charge, and have added significantly to the vehicle cost. Public electric vehicle charging infrastructure is developing slowly in New Jersey, and may be a factor in wide spread consumer acceptance of this new technology. The ability of battery and vehicle manufacturers to scale up production quickly is also a key challenge. Overcoming these barriers will require innovative business models and the support of effective public policy at both the Federal and State levels.

Operation of an electric vehicle is significantly less expensive (and electricity pricing more stable) than that of a gasoline or diesel fueled conventional vehicle. Over the life of that vehicle, this should offset the vehicle's initial capital cost to the consumer. (Note that the initial cost of electric vehicles currently is higher than comparative conventional vehicles due primarily to the cost of current battery technology; this is expected to change over time as battery technology evolves and becomes less costly.) This holds true across a wide range of electricity rates. For example, assuming a conventional vehicle efficiency of 25 miles per gallon, a plug-in electric vehicle efficiency of 5 miles per kWh, an electricity cost of approximately $0.168/kWh, and a gasoline cost of $3.00 per gallon, the cost per mile for a plug-in vehicle in all-electric mode is approximately $0.034 compared to the $0.12 for a gasoline vehicle. Off peak vehicle charging with presumed lower priced electricity during those hours will result in even lower costs per mile for EVs.

Hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery-electric vehicles (BEVs)—also called electric drive vehicles collectively—use electricity either as their primary fuel, or to improve the efficiency of conventional vehicle designs. These vehicles have many benefits compared with conventional vehicles: better fuel economy, lower emissions, lower fuel costs, increased energy security, and more fueling flexibility.

- HEVs are powered by conventional or alternative fuels as well as electrical energy stored in a battery. The battery is charged through regenerative braking and the internal combustion engine and is not plugged in to charge.
- PHEVs are powered by conventional fuels and electrical energy stored in a battery. The vehicle can be plugged into an electric power source to charge the battery in addition to using regenerative braking and the internal combustion engine.
- BEVs - A battery stores the electrical energy that powers the motor. BEV batteries are charged by plugging the vehicle into an electric power source.

Emissions attributable to EVs are lower than emissions for comparable models of conventional gasoline or diesel vehicles. Nighttime electric load in general is met by a combination of generation assets including nuclear, renewable energy, and coal. Even assuming such load is met 100% by coal, the EV is still cleaner than gasoline or diesel on a lifecycle GHG emissions basis. If charged during the daytime, the incremental EV load will most likely be met by natural gas combined cycle, which is a lot cleaner than gasoline or diesel. For light-duty plug-in hydrid vehicles, the percent reduction in GHG

emissions compared to gasoline vehicles is about 32% and for BEVs about 50% based on "Northeastern US" average generation mix.

PJM's generation fleet will get cleaner over the next 5 years and beyond. To comply with state RPS targets, renewable generation sources will supply greater and greater amounts of clean energy, and especially during off-peak hours (wind displacing coal); and many PJM coal plants will have to retrofit with environmental controls or retire between now and 2015.

Light-duty HEV, PHEV, and BEV models are currently available from a number of auto manufacturers, with additional models expected to be released in coming years. Chevrolet and Nissan introduced the first mass produced EVs for sale in the U.S. in December 2010. Other major manufacturers are following shortly; there are over 30 additional EV models planned for introduction in the next several years. While much popular press has been devoted to electrification of the light duty, passenger vehicle sector, there are also a variety of medium- and heavy-duty options available. As the global economy begins tentative steps toward recovery, truck manufacturers are looking to technologies that can help mitigate the rising cost of diesel fuel while meeting increasingly strict emissions requirements. Trucks that utilize electricity to meet these goals come in four variations: hybrid electric, plug-in hybrid, battery electric, and plug-in electric power take-off (EPTO) to operate equipment onboard without using fuel. As the technology costs fall and diesel prices increase, the value proposition for hybrid trucks is particularly strong.

There is extensive Federal support for the development and deployment of electric vehicles across all sectors and vehicle classes. As an indication of this, the US Department of Energy recently announced awards for 16 electric vehicle community readiness projects supporting activity in 24 states and the District of Columbia. Through the regional Transportation Climate Initiative (TCI), the State of New Jersey and the New Jersey Clean Cities Coalition will be participating on this program. The Federal assistance will help prepare communities to adopt plug-in electric vehicles. These technologies will reduce petroleum dependence and build the foundation for a clean transportation system. Through the $8.5 million Clean Cities' Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure awards, local public-private partnerships will collaborate to develop EV deployment strategies. Activities under this grant will include updating permitting processes, revising codes, training emergency personnel, educating the public, and developing incentives.

Natural Gas: Natural gas vehicles (NGVs) are a good choice for high-fuel use fleets—such as buses, garbage trucks, and taxis—that are centrally fueled. The advantages of natural gas as an alternative fuel include its domestic availability, widespread distribution infrastructure, low cost compared with gasoline and diesel, clean-burning qualities, and its ability to power most classes of vehicles. A NGV emits approximately 50% less CO2, 50% less NOx, 90% less CO and 90% fewer particulates compared to diesel fuel.

Natural gas is a mixture of hydrocarbons, predominantly methane (CH_4). Natural gas has a high octane rating and excellent properties for spark-ignited internal combustion engines. As a fuel, it presents no threat to soil, surface water, or groundwater, however environmental issues have been raised regarding various techniques used in the production of unconventional natural gas reserves.

Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous (compressed natural gas, CNG) or liquefied (liquefied natural gas, LNG) state. To provide adequate driving range, CNG must be stored onboard a vehicle in tanks at high pressure—up to 3,600 pounds per square inch. A CNG-powered vehicle gets about the same fuel economy as a conventional gasoline vehicle on a gasoline gallon equivalent (GGE) basis. A GGE is the amount of alternative fuel that contains the same amount of energy as a gallon of gasoline. A GGE equals about 5.7 lb (2.6 kg) of CNG. To store more energy onboard a vehicle in a smaller volume, natural gas can be liquefied. To produce LNG, natural gas is purified and condensed into liquid by cooling to -260°F (-162°C). At atmospheric pressure, LNG occupies only 1/600 the volume of natural gas in vapor form. A GGE equals about 1.5 gallons of LNG. About 97% of the natural gas consumed in the United States is domestically produced. The United States has a vast natural gas distribution system, which can quickly and economically distribute natural gas to and from almost any location. Gas is distributed between and within states by 300,000 miles of transmission pipelines.

LNG and CNG are mature technologies that can have a substantial impact in the short to mid-term. They are not tied to oil supply or prices, have sufficient domestic supply to avoid the transportation fuel price increases the public has become accustomed to, and have a positive environmental impact. In addition, the establishment of a natural gas fueling infrastructure has already begun with NJ Clean Cities, state utilities, and others in the public and private sectors, leading the way with the opening of four new publically available CNG stations across the state in 2011.

Using CNG as a motor fuel could save the end-user 40-60% in fuel cost compared to the cost of gasoline or diesel. For this reason, the most impactful segments for CNG vehicles in the short term are high fuel-use public and private fleets. There has been significant development (in New Jersey as well as across the country) in the transitioning of fleets of commercial vehicles, like trash trucks, and transit vehicles such as buses and jitneys. Currently only one “off the line” passenger car exists in CNG, the Honda GX, which makes the personal passenger vehicle market less viable in the short term.

In the intermediate term, as a regional/national CNG fueling infrastructure begins to evolve, residential CNG vehicle use may begin to grow. The economics of residential vehicles work, and with an increase in vehicle choices and more certainty of fueling locations all factors will be in place to positively influence the use of CNG vehicles in this segment.

Renewable Natural Gas (RNG) is a cleaned-up form of “biogas” or “biomethane” emitted from decomposing organic wastes at landfills, sewage treatment plants, farms, and elsewhere. RNG can be cleaned up to pipeline quality and fuel-grade natural gas. As

such, it is the lowest carbon fuel available for medium- and heavy-duty trucks and buses, which consume 23% of highway fuel while comprising only 4% of road vehicles. N.J. could reportedly produce enough RNG to replace diesel fuel in one out of every five medium and heavy-duty trucks and buses in the state. A crucial first step in developing RNG fuel markets is to expand the number vehicles powered by natural gas (CNG or LNG), because these vehicles are fully equipped to drive on RNG or an RNG-CNG/LNG blend.

Biodiesel: Biodiesel is a renewable alternative fuel produced from a wide range of vegetable oils, animal fats and recycled restaurant grease. Pure biodiesel or biodiesel blended with petroleum diesel can be used to fuel diesel vehicles, providing energy security and emissions and safety benefits. Consumption of this fuel has dramatically increased over the past decade. Its production and consumption was almost non-existent in the early 2000's but now production is expected to exceed 900 million gallons in 2011, reflecting a vastly expanding market. Biodiesel is generally blended with petroleum diesel in quantities ranging from 5% (B5) to 20% (B20). According to a recent USEPA publication, biodiesel can provide significant greenhouse gas (GHG) emission reductions. B100 reduces lifecycle greenhouse gas emissions by more than 50 percent, while B20 reduces GHG emissions by at least 10 percent. Biodiesel can be used in most diesel engines making the conversion to biodiesel inexpensive and easy. Biodiesel improves fuel lubricity and raises the cetane number of the fuel. Several studies have shown that biodiesel performs comparably to petroleum diesel but with greater benefits to the environment and human health. Biodiesel contains virtually no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. A U.S. Department of Energy study showed that the production and use of biodiesel, compared to petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. Biodiesel is the most cost-effective alternative to diesel fuel available today since the infrastructure necessary for its distribution is relatively inexpensive and few, if any modifications to vehicle engine systems are required for its use.

Ethanol: Ethanol plays a fairly significant role in the current US transportation system. At the present time, nearly half of U.S. gasoline contains up to 10% ethanol (E10) to boost octane or meet energy and air quality requirements. E10 can reduce carbon monoxide, hydrocarbons and particulate matter compared to gasoline. Low-level blends (E-10 for all vehicles and up to E-15 for 2007 and newer passenger cars) require no special fueling equipment and can be used in any gasoline-powered vehicle. Flex-fuel vehicles (there are currently about 6 million FFVs in the US and more than 100,000 registered in NJ), can use E85, a blend of 85% ethanol and 15% conventional gasoline, however few E85 pumps are available in NJ (one public). FFVs designed to run on E85 are becoming more common each model year, and FFVs are typically available as standard equipment with little or no incremental cost. Also, because FFVs can be fueled with gasoline as well as E85, drivers have the flexibility to travel outside of areas served by E85 fueling stations. While much of the current ethanol supply comes from corn-based feedstocks, it is important that the production of ethanol transition to sustainable feedstocks (i.e. biomass) to reduce GHG impacts and avoid any potential issue regarding food-supply.

Propane: Propane is a clean burning, domestically produced fuel that is also far more attractively priced than conventional gasoline and diesel fuels. Propane, also known as liquefied petroleum gas (LPG) or Autogas, is used by an increasing number of fleets across the country. It has a high energy density, giving propane vehicles good driving range, and propane fueling infrastructure is widespread.

Propane as a transportation fuel is a market segment largely focused upon medium and light duty fleet vehicles. From an environmental perspective the carbon "footprint" matchup of natural gas and propane represent two very similar fuels. Propane "Autogas" is a non-toxic, clean burning fuel. When compared to conventional gasoline vehicles, propane powered vehicles generally experience substantial emissions reductions in particulate matter and greenhouse gases including carbon monoxide, carbon dioxide and nitrogen oxide. Propane can have (depending on its production pathway) emission benefits comparable to compressed natural gas and ethanol and produces significantly lower emissions than gasoline and diesel. Overall, propane fleet vehicles produce an average of 19% lower greenhouse gas emissions than gasoline.

More specifically, automobile emissions from propane reduce carbon monoxide by 23% over gasoline and reduce carbon dioxide by about 11%. Significantly, nitrous oxides produced by automobile emissions utilizing propane are fully 42% less than conventional gasoline. Significant results are obtained from larger truck and fleet transportation vehicles where fully 78% less nitrous oxides are created.

In 2010, the average price for gasoline was $2.60 per gallon while at the same time the propane energy equivalent to 1 gallon of gasoline ran $1.92 (not including the $.50 per gallon federal tax credit that currently applies for the use of propane as a transportation fuel). In summary, propane enjoys about a 40% cost advantage over gasoline when used as a transportation fuel.

As much as 60% of all US propane supply is derived from natural gas, this percentage is expected to increase alongside the growth of natural gas production from unconventional sources such as domestic shale-based resources like Marcellus Shale.

Overall, medium duty, light duty and passenger vehicles represent the greatest potential for the use of propane as an alternative fuel. Currently, engines utilizing propane for heavy-duty construction purposes are still in the research and development stage of production. Therefore, the focus in the short to mid-term should be light duty and medium duty trucks, school buses, vans, light duty construction vehicles, passenger vehicles, as well as lawnmowers, forklifts and other similar functions.

Hydrogen: Hydrogen has the potential to revolutionize transportation. The simplest and most abundant element in the universe, hydrogen can be produced from fossil fuels and biomass or by electrolyzing water. Producing hydrogen with renewable energy and using it in fuel cell vehicles holds the promise of virtually pollution-free transportation and independence from imported petroleum. While there are currently demonstration

vehicles available (at high production cost), hydrogen fuel cell vehicles (FCVs) remain a mid- to long-term alternative due to remaining technical barriers, high costs, and fuel cell durability concerns. A recent study concluded that large-scale use of FCVs is unlikely in the short term, stating "it is highly unlikely that hydrogen FCVs will have significant impacts on LDV (light-duty vehicle) energy use and CO_2 emissions by 2030". However, a number of manufacturers, including Daimler and Honda, are targeting model-year 2015 for the introduction of limited numbers of commercially available fuel cell vehicles.

There are several major suppliers and vehicle companies based in NJ involved with hydrogen production, distribution and its use as a vehicle fuel. As such, the State has an interest in promoting the further development of hydrogen production pathways that minimize cost, energy use, and lifecycle GHG emissions.

Idle Reduction: Petroleum reduction in the transportation and goods-movement sectors is not just about the use of alternative fuels. A short-term strategy involves implementation of policies that encourage driver education and better fleet management practices. One method in particular, idle reduction, can have significant impacts in emissions reduction, while saving owners money. Idling vehicles use billions of gallons of fuel each year and emit large quantities of air pollution and greenhouse gases. Idle reduction technologies and practices are an important way to cut petroleum consumption and emissions, and should be incorporated in this Energy Master Plan.

Reducing idling time has many benefits, including reductions in fuel costs, emissions, and noise. Drivers idle for a variety of reasons, such as keeping vehicles warm, operating radios, or powering equipment. Using a variety of strategies and technologies, idling can be reduced without compromising driver comfort or vehicle equipment operations. Increased enforcement of existing anti-idling laws, along with driver education programs need to be encouraged.

What are the opportunities and barriers to developing an infrastructure to support various alternative fuel supplies for vehicles?

With any of these alternative fuels/energy sources there is a great opportunity for the United States to lessen its dependence on foreign sources of energy. Currently, the U.S. imports at least sixty percent of our petroleum and fuel. By bringing that investment back into the United States, and specifically to NJ, we can boost our economy and provide jobs for citizens within our nation and our state. Increased employment is not the only opportunity that presents itself from transitioning to alternative transportation fuels, but also reduced fuel costs since, in most cases, alternative fuels are cheaper than the prices that consumers are currently paying for petroleum based fuels. Fuel cost savings can translate into more disposable income for consumers to spend in other areas, thus further boosting the economy. Of course with opportunity always comes challenge. As with any new technology there can be high startup costs, and the competitive marketplace may not have the appropriate incentive and wherewithal to make the necessary investment to meet the policy objectives of the state. As such, there must be clear government policy support, direction and other incentives, and the public (as well as public officials) must be properly educated on the opportunities, benefits and pitfalls of investing in alternative fuels. Fleets and individuals must have the information needed to make comparisons of the full life-cycle costs and environmental benefits of alternative fuels vs. conventional fuels.

Over recent years, New Jersey has made progress but is still in the early stages in the development of a state-wide alternative fuel fueling infrastructure. According to information maintained by the NJ Clean Cities Coalition and presented on the Department of Energy's Alternative Fuels and Advanced Vehicles Data Center (afdc.energy.gov/tools), New Jersey's current infrastructure for alternative fuels consists of a total of 51 fueling locations, broken down as follows:

- Compressed Natural Gas - 20 locations (3 public)
- Propane - 10 locations (all public)
- E-85 - 5 locations (1 public)
- Electric - 13 locations (all public, 10 level 2, 13 level 1)
- Biodiesel - B20 or above - 3 locations (1 public)
- Hydrogen – 0
- Liquefied Natural Gas - 0.

Private industries and many public entities have shown increasing interest in alternative fuels to save on fuel cost, diversify fueling infrastructure, reduce vehicle maintenance and reduce emissions. Firms with both light duty and heavy duty fleet operations are likely early adopters and will be interested in hosting their own fueling stations, or being an “anchor” customer at a facility open to the public. County and municipal operations are also eager to transition their fleets for the aforementioned reasons. Several town/cities throughout the state already have CNG or hybrid powered vehicles and/or utilize contracted trash collection fleets that are CNG fueled, and a number of other county and

municipal governments have expressed interest in transitioning their fleets to CNG or other alternative fuels.

Barriers to entry include the pace and location at which fueling stations are established and the incremental costs associated with the more expensive alternative fuel or vehicles. Counties and municipalities in particular, are looking for ways to cover the costs associated with both the initial incremental cost of the alternative fuel vehicles, and of the fueling infrastructure. While the federal government currently offers various corporate tax incentives (which are due to expire), local government entitles are not able to take advantage of the tax credits. There is clearly an opportunity for the State to establish programs that provide incentives for the creation of additional publicly available fueling stations, as well as for offsetting the incremental cost of the alternative fuel (if applicable), and of the alternative fuel vehicle. For example, among the programs that could be established are the following:

- **Revolving Loan Program**
  The initial capital cost associated with construction of fueling infrastructure, the incremental cost of deploying alternatively fueled vehicles, and the difficulty many entities have in obtaining credit for major investments (even if they have reasonable pay-back periods), represent significant financial obstacles for public and private fleet managers. The State of NJ should explore the creation of revolving loan (or some other no-interest) program that would help businesses and governments smooth the transition and reduce capital outlay, and increase the pace of deployment of alternative fuel infrastructure and vehicles. Such a program could be housed within the New Jersey Economic Development Authority, the Board of Public Utilities, or its management could be outsourced, perhaps to an appropriately qualified non-profit entity. The concept could operate similarly to the New Jersey Environmental Infrastructure Trust, and projects would be evaluated based on a to-be-developed set of technical and financial criteria.

- **Leverage Private Capital**
  Private capital could be leveraged for the public good with the encouragement of innovative contractual arrangements involving public/private partnerships. Public entities (i.e. NJ Transit) in particular could benefit from increased flexibility in public contract procurement requirements relating to contractual time-frames, bid process, etc. Utilizing private capital, for instance, to build alternative fuel refueling infrastructure, in exchange for a long-term fuel purchase agreement, would allow that infrastructure to be put in place with no capital cost to the fleet owner.

- **Utility Involvement**
  Utilities, on their own and in conjunction with the private sector, can play an important role in facilitating and promoting EV and NGV deployment, and can develop programs to promote EV charging and CNG/LNG refueling infrastructure. Like with solar, the utilities are uniquely positioned to jumpstart this nascent industry and quickly bring it to the masses.

- **Streamline the Process**
  The process for including alternative fuel vehicles and fuels to the State Procurement Contract should be re-examined and streamlined. This would ease the ability of public entities that utilize this contract to obtain these goods. Additionally, the state fuel contracting provisions should be reviewed to assure that petroleum fuels (gasoline and diesel) do not benefit from incentives, such as group purchasing discounts, that might not be available to alternative fuels. Further, consideration should be given to changing the procurement process to one that considers "total cost of ownership" instead of lowest capital cost bid.

Electric Vehicles

Deliveries of EVs to individual consumers and fleets are increasing each month. The power delivery infrastructure that enables vehicles to charge at home, at the workplace, and in public spaces simultaneously needs to be rolled out. To better utilize the benefits of EVs, EV owners will face a challenge to which owners of conventional gasoline powered vehicles are unaccustomed. EV owners will require convenient, dedicated battery charging wherever they park their vehicle for the longest duration, usually that is at home. They will desire a quick turnaround from the time they purchase their car to when they have the ability to charge at home. The time, additional cost and process of installing home electric vehicle service equipment is an added hurdle for consumers who purchase electric vehicles.

Therefore, one of the most significant opportunities/barriers in advancing the deployment and use of EVs is the development, installation and maintenance of the vehicle charging infrastructure both at home and at strategically selected public places. The consensus among the industry experts is that the majority of EV charging will occur at home, with charging at other locations referred to as "Opportunity Charging". A process must be put in place whereby stakeholders, primarily utility companies, vehicle dealers, state and municipal officials and others, can ensure a seamless experience for EV buyers in order for this market to flourish and for infrastructure development to be feasible. The installation of public, workplace and residential charging infrastructure will increase usage (miles traveled on electricity) and decrease range anxiety. Building a network of Level 2 electric recharging stations that are geographically dispersed in key locations will allow users to top up and maximize the use of electric-range rather than gasoline back-up for PHEVs (like the Chevrolet Volt).

The challenged business case for an EV charging infrastructure creates a barrier for the abovementioned issues. This can be addressed with a revolving loan program perhaps in combination with a program whereby a utility, or other entity with patient capital, funds the installation, ownership, and maintenance of EV infrastructure.

Technology for DC Fast Charging (or Level 3) is not ready for mass deployment at this point. However, the State should monitor this technology as it develops, particularly in regard to the power distribution and power storage issues associated with it.

Lastly, two additional issues involve system reliability: the potential increase to system peak demand and clustering from increased transformer load. These issues can be addressed with utility notification from vehicle dealers/OEMs and/or by the Motor Vehicle Commission, and with the promotion of a time of use rate. With a time of use rate, the consumer would have the information necessary to make informed choices. It would also be possible for the utility to be able to directly manage and stagger the additional load. These actions would reduce and help manage peak usage, and minimize the potential occurrence of overloaded transformers.

An additional option for EV owners, particularly fleet-owners, may be battery exchange stations. Such a station would be fully automated and would allow an EV with a "swappable" battery to enter a drive lane and exchange a depleted battery for a fully charged battery. While this option is currently being implemented in several locations around the world, it is unclear if this option will be widely accepted in the United States.

By 2017, a new report from Pike Research forecasts, more than 1.5 million locations to charge vehicles will be available in the United States, with a total of 7.7 million locations worldwide. The increasing demand for charge points will be driven in part by a rapid decline in electric vehicle supply equipment prices, which will require manufacturers/suppliers to adapt their business models as volumes continue to increase. In the face of this trend, manufacturers will likely integrate their equipment with such things as external storage units, home energy management systems, and smart grid equipment to add value and increase their revenue.

One specific opportunity involves 100% battery electric commercial medium and heavy duty trucks. While much of the discussion regarding electric vehicles has focused on light duty passenger vehicles, for the urban delivery/logistics/service market, all-battery electric zero-emission trucks offer one of the best options for both private and public fleets operating in an urban environment. With zero tailpipe emissions and the typical operating procedure of charging vehicles during off-peak hours (at depot-type facilities), these trucks are clearly an option that should be explored and encouraged for any urban usage that has a route or mileage of less than 150 miles per day. The infrastructure costs for electric trucks are usually relatively small ($400-$2000 avg. per vehicle depending on existing electric service and proximity to truck charging locations), based on the usually robust electric service already present at most of the depot deployment sites (typically associated with urban depot-based fleets). This low cost makes the barrier to entry into electric vehicles much less for the medium & large truck fleet users in comparison to most other AFV technology options. To go along with the low infrastructure costs, the operating costs, (fuel/electricity & maintenance) is typically 75-80% less than comparable size internal combustion engine trucks. Some EV manufacturers also offer separate acquisition strategies/leases for the truck cab & chassis (capital expense) and the batteries, so the fuel (electricity/batteries) can be allocated to the proper budget (operating expense), thereby further reducing the (higher cost) barrier to entry normally associated with EVs.

Natural Gas Vehicles (compressed natural gas and liquefied natural gas)

According to the DOE's July 2011 Alternative Fuels Price Report, the national average price for compressed natural gas (CNG) was just $2.07. The US Environmental Protection Agency (EPA) has rules concerning the manufacture, sale and installation of alternative fuel engine conversion systems. The California Air Resources Board has similar and even more stringent emission rules for conversions in that state. Only EPA and/or CARB-certified conversion systems are permitted to be installed on vehicles.

While an increasing variety of CNG vehicle models and engine families are available from OEMs, both new and used vehicles may be converted ("upfitted"). Installation of an engine conversion package and fueling system must be done by trained installers and in compliance with EPA and CARB certification requirements.

Upfitting a new vehicle provides the greatest opportunity to save fuel cost and thereby pay back the conversion cost and generate life-cycle savings. The costs range from $7,500-$25,000 or more and include the retrofit system, fuel tanks and related tubing/brackets, and the installation. Actual costs vary based on factors such as vehicle type and size, on-board fuel requirements and other considerations.

Homeowners with an existing natural gas supply line can purchase a home refueling appliance (HRA) designed to fill their vehicle over time, usually overnight. Gas from the same supply line that feeds their house is compressed and stored onboard the vehicle by the "vehicle-fueling appliance" (VRA). Commercial sized VRA's are also available.

In regard to large scale, public/private CNG refueling stations, there are some barriers to market entry (See Barriers / Opps / Result Chart). Development of CNG fueling infrastructure should initially be focused on high fuel use fleets because the economics are better suited (gas cost savings). A process must be put in place whereby stakeholders, primarily utility companies, vehicle dealers, state and municipal officials and others, can ensure a seamless experience for CNG buyers in order for this market to flourish and for infrastructure development to be feasible. A geographically dispersed CNG refueling station infrastructure will address any range anxiety.

A significant barrier to development of CNG infrastructure in large parts of northern and central New Jersey is that fact that off gases from one or more refineries is mixed with pipeline gas. This mixture is not compatible with medium/heavy duty vehicles. In order for a CNG market to flourish, the State should seek ways to resolve this situation. One solution is to eliminate the practice of inserting the refinery gas into the pipeline, thus removing the barrier for medium/heavy duty vehicles to enter the CNG market and further promotes CNG-compatible fleet vehicle development.

Biodiesel

The opportunities to use biodiesel in New Jersey have never been greater. With U.S. EPA's implementation of the RFS2, biodiesel production, availability and demand skyrocketed in 2011. The RFS2 establishes assurance for investors that the industry will continue to grow, but it does not determine where the growth will occur. State programs that include low carbon fuel standard requirements and incentive programs are a better

indicator of where the industry will continue to expand. For example, the state of Illinois has had a sales tax incentive for biodiesel blends since 2003. Since then, more than 150 million gallons of production capacity have been built in the state, impacting and supporting nearly 7,800 jobs in all sectors of the state economy.

Barriers to the use of biodiesel are largely due to limited availability of the product in the market place. However, with the implementation of the federal RFS2, more petroleum marketers are purchasing biodiesel and offering it to their customers. In 2011, New Jersey has seen at least two major marketers invest in the necessary infrastructure to offer the product, at various blend levels, throughout the state.

Another perceived barrier is the question of support by the engine manufacturing sector. All major U.S. automakers and engine manufacturers accept the use of up to at least B5, and many major engine companies have stated formally that the use of high quality biodiesel blends up to B20 will not void their parts and workmanship warranties. While the choices of diesel-powered passenger vehicles is limited in the U.S., most of the companies who offer diesel options have research underway that will lead to ultimate approval of the use of biodiesel up to B20.

One additional opportunity presented by increased demand for biodiesel is the potential for in-state production. However, there is a lack of capital investment available to build new production facilities or retrofit existing structures to manufacture biodiesel. One of the advantages of the production chemistry of biodiesel is that it can be made from multiple sources of feedstock. The biodiesel industry has been active in setting quality standards for biodiesel for more than 15 years. ASTM specifications exist for diesel fuel and biodiesel fuel blends from 6 to 20 percent (B6 – B20 (D7467-09)), biodiesel blends up to B5 to be used for on- and off-road diesel applications (D975-08a), and home heating and boiler applications (D396-08b). ASTM approved the original specification for pure B100 (D6751) in December 2001. These performance-based ASTM specifications apply regardless of the feedstock materials used to make the fuel. It may make economic sense to use virgin vegetable oil and animal tallow in the Midwest, but recycled greases and oils are more cost-effective in areas with high population densities such as NJ. Regardless of the feedstock, a lack of ability for private investors to acquire enough capital to build or retrofit has been a barrier. Some states offer grants or incentives to bring new biodiesel business to their state, while others offer low-interest guaranteed loan programs. Such incentives could vary in NJ, with the largest reserved to those biodiesel production pathways with the lowest GHG emission impact, for example.

Propane Vehicles

Historically, propane autogas is 30-40% less expensive than gasoline and fleets are currently saving in excess of $1.50 per gallon. There are over 10,000 propane retailers in the nation and over 320 facilities in New Jersey capable of providing autogas delivery service with a minimum of additional capital outlay. Also, inasmuch as New Jersey already requires gasoline station attendants to refuel vehicles at the pump, there would be no additional operating expenses associated with propane delivery personnel providing these services at retail sale. A state of the art fueling station would cost $50,000 max, but,

under current market conditions, many propane retailers would install a fueling station for little to no capital cost to the user, in exchange for fuel supply agreement. Permitting is a relatively simple process because propane stations only require 1 or 3 phase electric and crash barriers. Propane has a narrower flammability range than gasoline or diesel, the fueling sites operate under very low pressure (<200psi), pumps are zero emission and must have a sealed connection before fueling can take place.

In addition to light and medium duty vehicles, a market opportunity sometimes overlooked involves the advantages that propane offers lawn maintenance companies. Currently, a number of firms have estimated 30% savings on propane fueled mowers that emit about half of the greenhouse gas emissions of their gasoline fueled counterparts while also producing ease of maintenance and fuel delivery. Clearly, this is an opportunity that can be applied to government entities and authorities that have significant workloads in this area. The New Jersey Turnpike and Garden State Parkway along with municipal and state government facilities would represent a significant market to both help reduce costs and improve our environment.

Flexible Fuel Vehicles (using up to 85% ethanol)

Though there is currently a limited number of stations in NJ that offer ethanol with a high percentage, such as E85, the demand for this fuel is on the rise and it is expected that more stations will begin to offer E85. However, E85's reduced energy content compared to gasoline can increase fuel costs.