Electricity Generation Alternatives for New Jersey’s Future:

What is the Right Mix for Improving Air Quality and Reducing Climate Change?

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2009 Annual Public Hearing
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NEW JERSEY CLEAN AIR COUNCIL
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Executive Summary

The New Jersey Clean Air Council’s 2009 Annual Public Hearing addressed the question of electricity generating alternatives for New Jersey’s future. The context of the hearing was three critical challenges that currently confront the State:

- improving air quality;
- reducing the threats of climate change and health impacts of air pollution; and,
- providing a reliable supply of electricity.

Possible energy alternatives for New Jersey include fossil fuels, wind, solar, nuclear, hydroelectric, waste-to-energy, energy efficiency, and other technologies like energy storage, geothermal energy and biomass-based fuels. The hearing examined the pros and cons of each of these alternatives, including timeframes for availability and costs.

Conclusions drawn from the hearing testimony include the following:

- Energy conservation and energy efficiency are clearly first choice among the options and should be integral to all strategies for future electricity generation. Conservation and efficiency are recognized as the low cost or cost savings options. Energy efficiency at the grid level (smart grid / peak demand management) will play a prominent role in the future as part of grid stabilization and modernization that will also accommodate diversified generation options (including “green” power) and deliver benefits to the economy.

- There needs to be a continued role for fossil-based generation in New Jersey and any future for new fossil-based generation in NJ must, at minimum, push the envelope in terms of efficiency, emissions, and local impacts.

- Wind and solar energy development are expected to be sustained and supported with appropriate incentives.

- Hydroelectric options, especially microhydro, need to be given attention, as do waste-to-energy (WTE) and biomass technologies. These are seen to have lower air contaminant and greenhouse gas (GHG) emissions and are suitable for decentralized, off-grid, and community-based applications which contribute to expanding the distributed generation capacity in the State. Note that careful attention must be paid to concerns such as life cycle-based sustainability, ensuring that these options do not result in using more energy than they produce, and making sure they are done in a way that is consistent with other important public policy goals (i.e. recycling).

- Geothermal heat pump (GHP) applications, especially in residential areas and as part of green/efficient buildings, are envisioned to have a significant contribution.

- The use of additional nuclear power for base load generation needs to be further examined, particularly with respect to addressing public health risks and waste disposal issues.
Given the challenge of providing a reliable electricity supply, it is evident that all electricity generation alternatives must be taken into account and considered as part of the State’s overall energy mix. However, the preferred option is toward clean energy. This includes:

- More efficient use of energy, especially at the point of end use in buildings, electric appliances, vehicles and production processes, but also including efficiency at the grid level (smart grid), including peak demand management;

- Increased utilization of renewable energy sources, including solar, wind, hydropower, and geothermal, which have the potential to provide energy services with zero or near-zero emissions of both air pollutants and GHGs and are also capable of expanding distributed generation capacity; and,

- Accelerated development and deployment of new energy technologies, particularly large scale renewable energy generation projects and next generation fossil-fuel technologies that produce near-zero emissions.

In order for New Jersey to successfully implement such a diversified energy mix, it must also modernize the State’s aging energy infrastructure with an improved transmission system and better use of the regional transmission links through the PJM grid. The goal is to ensure cleaner sources of power and incentives for greater in-state energy generation to increase energy security.

The Clean Air Council recommends that a wide array of policy solutions and actions be considered to ensure that the State moves forward on aggressively with the right mix of electric generation alternatives with appropriate environmental protection. These may include economic incentives, market-based programs such as cap and trade, and/or performance standards.

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1 PJM Interconnection (PJM) is the independent electric grid operator serving the Mid-Atlantic and parts of the Southeast and Midwest regions of the country, including New Jersey,
The Challenge

New Jersey currently faces three critical challenges: improving air quality; reducing the threats of climate change and the health impacts of air pollution; and providing a reliable supply of electricity.

Improving air quality:

Electricity generation from fossil-fuel sources, both in New Jersey and the adjacent region, results in air pollution, including emissions of particulate matter and precursors to ground-level ozone and acid rain deposition. The effects of these energy-linked emissions directly and negatively impact human health and welfare. While New Jersey has been successful in reducing emissions from these sources, they continue to contribute to a significant portion of the State’s overall emissions inventory. In addition, the region’s air quality, while greatly improved over the last two decades, continues to rank among the worst in the Nation. It is clear that more needs to be done to address air-pollution emissions from the generation of electricity. The State’s Energy Master Plan (EMP) lays out the next steps in addressing this sector through a combined strategy of reducing the overall electricity demand while increasing the amount of electricity produced from renewable, low-emitting sources.

Reducing the threats of climate change and the health impacts of air pollution:

There is broad scientific consensus that the earth’s climate is changing rapidly, and that GHG emissions from human activities, mostly the production and use of fossil fuels, contribute significantly to those changes. Recent regional changes in climate, particularly increases in temperature, have already affected hydrological systems and terrestrial and marine ecosystems in many parts of the world.

Human-induced climate change appears to be the greatest of all environmental risks, since large-scale climate modification would disrupt every ecosystem and impose catastrophic hardships on many parts of the world, including increased disease transmission and other serious public health impacts. In addition, climate change has an impact on human health, and its effects can aggravate the air pollution issues discussed above.

There is need to: (1) more fully understand how the air pollution from power generation, including GHGs, both directly (inhalation exposure, etc.) and indirectly (heat waves, vector-borne diseases, flooding) impact human health, and (2) develop a plan for addressing those health impacts. The risks will continue to grow if strong response measures are not undertaken now to curtail global climate change.
Providing a reliable supply of electricity:

Even with accelerated energy efficiency and renewable energy development, New Jersey continues to rely on a capital-intensive energy infrastructure (see Energy Infrastructure Map shown on page 52) that includes a vast natural gas and electric transmission and distribution system, fossil fuel-based power generation plants, and oil and propane manufacturing, storage and refining facilities. Given the uneven distribution of the fossil fuel resources on which the State relies, patterns of energy use also have implications in terms of security of supply. This is made worse by the following facts: 1) the State’s energy demand is outpacing its supply, 2) the price of electricity continues to rise, and 3) the State does not have complete jurisdictional control of its energy infrastructure and energy future.

The economic and environmental consequences of not addressing these challenges are tremendous. PJM forecasts that the State's electricity reliability could be jeopardized. Energy prices will continue to rise, costing New Jersey customers billions of dollars. New Jersey's economy will continue to depend on unsustainable and outdated energy systems. Furthermore, the State's contributions to regional air pollution and global climate change will increase. Near-term and long-term actions need to be established today, so that clean and reliable energy will be a certainty tomorrow.

The purpose of the Clean Air Council’s Annual Public Hearing conducted on April 1, 2009 was to develop recommendations to help address these challenges.

Recommendations:

Based on the testimony heard at the public hearing on April 1, 2009 and subsequent deliberations, the Council presents the following recommendations to the Commissioner of the New Jersey Department of Environmental Protection for consideration by the State of New Jersey. These recommendations are organized by energy alternative topics, and include background and supporting comments (both pro and con), discussion on how the alternative could be implemented, discussion on when the alternative could be implemented (ranges include near-term (within the next 5 years), medium (between 5 years and 2020) or long-term (between 2020 and 2050)) and the anticipated costs.

- Energy Efficiency

Recommendation:

The State needs to decrease the overall energy demand through energy efficiency and conservation. The Council recommends that the State focus its efforts to reduce the overall energy demand from buildings (both new and existing) through both regulations (e.g., enhanced building codes and appliance standards), and enforcement of existing regulations, as well as using incentives. As first steps, the Council recommends focusing its efforts on State-owned or leased facilities, as well as a re-evaluation of its enforcement strategies related to its existing building codes, and a determination of whether or not
improvements could result in increased compliance (and thus, cost and emission reductions).

**Background and supporting comments:**

**Pros:** Energy efficiency clearly has an important role in solving the State's energy problems by reducing electricity demand, reducing the need for more fossil-fuel power plants (thus reducing air pollution and GHG emissions), improving the grid infrastructure, and alleviating problems such as brownouts and blackouts. For the customer, this means lower energy bills, greater customer control, and greater consumer satisfaction.

**Cons:** The main disadvantage at this point is that a tremendous amount of education is needed for consumer behavior to change. People really need to understand the importance of energy efficiency and conservation.

Even with the significant conservation and efficiency successes, many predict that energy demand will still outstrip supply. New electric generating capacity will be needed.

There is also a need to make energy savings favorable to the utility sector (a policy of “decoupling”). It will be necessary to continue to provide incentives to power companies to convince them to work diligently to encourage efficiency at their customers' homes and factories – which will mean that they will need to generate less power, meaning lower income for the generators, absent the incentive payments.

**How:** Three areas are ripe for improvement in power efficiency: efficient appliances, efficient lighting, and efficient buildings. Appliances are a fertile area for power conservation. For example, kitchen and laundry appliances by themselves account for about 1/3 of all household electricity usage. Efficient lighting is a very important area for capturing power savings since 22 percent of all the electricity used in the country is for lighting. Improving building efficiency is a key solution for reducing the need for electricity and reducing air contaminant and GHG emissions due to the fact that commercial and industrial buildings account for 39 percent of total primary energy use, 70 percent of total electricity consumption, and 12 percent of total water consumption. The term "green building" is now used to refer to the whole area of reducing the environmental footprint of buildings. Thus, it refers not only to the efficient use of electricity, but also to the efficient use of heating/cooling, natural gas, and water. The term also includes measures to reduce exposure of humans in buildings to toxic materials and fumes.

There is need to modify the State's building codes to move toward “net zero” buildings. As part of this, building materials that reduce heat/insulation losses must be considered. In the context of zero energy buildings, use of other appropriate energy sources such as geothermal heat will have to be taken into account. Finally, other states have found that increased enforcement of existing building codes resulted in significant energy savings.

The Board of Public Utilities (BPU) has partnerships with every utility in the State to develop plans to communicate to households easy energy saving alternatives. Incentives,
such as rebates on energy efficient/energy saving appliances bought by households, demonstrate that part of the energy bill that consumers pay goes to such efforts to synchronize demand and supply (since electricity cannot be stored).

**When:** Immediate and Near-Term (within the next 5 years)

**Cost:** This option involves lower cost than supplying new generation from new power plants. In many sectors energy efficiency projects provide a net savings. It is modular and quick to deploy (as opposed to building new power plants), and thus economic payback tends to be favorable.

- **Fossil Fuels**

**Recommendations:**

New base load power generation is a key to ensuring New Jersey a viable electrical energy future which is affordable, reliable and supports clean air goals and standards. Clean central station power is an integral part of a multi-pronged approach that includes co-generation, renewable energy and energy conservation. Given the State’s current base load mix, it is probable that the State’s energy future will include fossil fuels (i.e., oil, natural gas and coal). This means that the State needs to be investing now in new base load capacity from these sources, including investigating and promoting advanced technologies that result in near-zero emissions from these facilities (e.g., carbon capture and storage).

The State also needs to determine the overall impact from public and private facilities (e.g., industry, schools and hospitals) installing co-generation systems to meet their own needs (thereby reducing power demand from the grid). This could be the wave of the future: smaller operations that generate just enough energy to satisfy the internal needs of such institutions.

**Background and supporting comments:**

**Pros:**

- **Oil** - Oil, along with natural gas, is a nonrenewable source of energy used primarily for generating electricity, heating and as a transportation fuel. It had been the dominant fossil fuel used in the United States, and the existing infrastructure facilitates its distribution and delivery. Net electricity generation using petroleum in the state is 2.2 percent of the national total (the same share as natural gas). The New York harbor area between New York and New Jersey (mostly in the latter) is the largest petroleum product hub in the country. Oil is still a significant source (about 19 percent) of heating fuel in New Jersey. The largest of the four Northeast Heating Oil Reserve sites is located in Woodbridge, New Jersey.

- **Natural Gas** – Natural gas-based power generation units have relatively lower GHG emissions than coal-fired power plants. These plants also have the ability to power up and power down much quicker than their coal and nuclear counterparts, and are therefore
better suited to meet the State's peak energy demand. Natural gas is also an essential fuel for the development of combined heat and power (CHP) and for peaking power.

**Coal** - Coal-fired power plants have the advantage of being relatively inexpensive and help to provide energy security if the coal comes from within the country's borders. There seems to be no practical way to eliminate coal as a significant source of electricity generation for at least the next few decades. Renewable sources like solar and wind are unlikely to grow fast enough to completely replace coal in this time period, and even if they could, power utilities need a power generation source that provides a stable base load 24 hours a day (which renewables can not). Thus, for base load power, utilities will likely be compelled to rely on a mix of sources that includes coal.

**Co-generation** - is commercially viable technology today that can produce lower-cost power with significantly lower GHG emissions than separate fossil-fueled power plants and boilers.

**Cons:** New Jersey has no fossil fuel reserves and is therefore dependent on external sources for its oil and natural gas supplies. The state is vulnerable to distillate fuel shortages and price spikes during the winter months due to high demand for home heating. The potential for shortfalls suggests a need for greater supply diversity in New Jersey’s liquid and gas fuel markets to reduce energy supply security concerns.

Plants fueled by natural gas now generate a larger share of the State's electricity supply. Natural gas is an expensive fuel for power generation. When plants fueled by more expensive fuels such as natural gas are called upon to meet the State's demand for electricity more of the time, they set a higher price for all plants running at the time. Consequently, heavier reliance on natural gas combined with increases in the price of natural gas contributes heavily to higher electricity prices.

The disadvantages of coal are substantial and include environmental damage from GHG emissions and traditional air pollutants (e.g., particulate matter, mercury) when the coal is burned. Coal accounts for 40 percent of the world's CO₂ emissions, which is the same as petroleum at 40 percent, and twice as much as natural gas at 20 percent. Due to environmental considerations, coal is likely to play a sharply reduced role in power generation going forward and may be completely phased out as an energy source within 3 to 4 decades, thus dampening future investment over the long term.

**How:** Fossil energy technology development is being strongly shaped by energy supply security concerns and environmental challenges. The major long-term goal for advanced fossil energy technology is near-zero net air pollution. The technological revolution underway in power generation (where advanced systems are replacing steam turbine technology) supports this long-term goal.

There is increased interest in new fuels that have a higher degree of inherent cleanliness than traditional liquid fuels derived from crude oil. Some combination of a shift to natural gas and the introduction of clean synthetic fuels derived from various feedstocks (natural gas, petroleum residuals, coal, biomass) will likely help supplement oil during the coming years.
Natural-gas-fired combined cycle power plants, offering low costs, high efficiency and low environmental impacts, are being chosen wherever natural gas is readily available. Co-generation is more cost-effective and can play a much larger role in the energy economy if based on gas turbines in combined cycle configuration. The State’s Energy Master Plan is fostering the development of 1,500 megawatts (MW) of co-generation capacity in New Jersey by 2020. By strategically placing co-generation units where both the power and heat byproduct can be used efficiently, reliability of the power supply can be improved, cost of electricity reduced, and emissions of air pollutants lowered.

Solutions to making coal a more environment friendly source of power fall into several categories: (1) upgrading the quality of coal so that it burns more cleanly; (2) retrofitting existing coal-fired plants with advanced air pollution control systems to reduce air pollution; (3) coal gasification, which removes many impurities prior to burning; (4) technologies to capture and store or convert CO₂ gas from the plants; (5) liquefying coal to be used as motor fuel, or (6) a combination of these.

Meeting the GHG mitigation goals being discussed by the new Federal Administration and U.S. Congress will require one or more of the following courses of action for existing coal power plants: (1) CO₂ capture and storage (CCS) through retrofitting existing plants with "CO₂ scrubbers", or re-powering existing plants but saving the sites; and (2) retiring the plants long before industry would like to do so.²

A major element of the overall fossil energy innovation effort is to develop the capacity to achieve deep reductions in CO₂ and other GHGs. While uncertainties regarding storage security and potentially adverse environmental impacts (especially for sequestration in deep ocean and other geologic reservoirs) must be resolved before a high degree of confidence is assigned to this option, there is growing scientific confidence that the potential for sequestering CO₂ is vast³.

Promising advanced power generation and co-generation technologies for the near to medium-term include natural-gas-fired gas-turbine-based technologies, coal integrated gasification combined cycle (IGGC) technologies, small engines suitable for co-generation applications, and various fuel cell technologies.

**When:** Near (within the next 5 years) and Medium Term (between 5 years and 2020)

**Cost:** Combined-cycle plants, which use a natural gas-fueled combustion turbine to generate electricity, and then recover heat from the turbine exhaust to generate steam that can be used to generate more electricity the next time, generate a relatively lower cost per megawatt hour (after hydroelectric, nuclear, and coal). Peaking units, such as natural gas-fueled or oil-fueled older boilers, and simple-cycle combustion turbines that do not recover waste heat, have the highest cost to generate a megawatt-hour of electricity.


Coal-fired plants are currently among the cheapest way to generate electricity. However, that does not consider the external costs of coal-fired plants. If coal-fired plants were required to capture and store the CO₂ they emit into the atmosphere, it would cost approximately 40 percent more to build and operate and the plants would produce 20 percent less electricity according to an MIT study (The Future of Coal: Options for a Carbon-Constrained World). If these costs were loaded into the effective cost of coal, then coal-generated electricity would no longer seem inexpensive and renewable electricity generated by solar and wind power becomes more economical by comparison. Conversely, if these costs can be reduced a cleaner long-term source of coal-based electricity would help stabilize the electric supply dilemma.

A study of co-generation with natural gas combined cycle technology has shown that for this system, the fuel required is a fifth less and the net cost of electricity is a quarter less per kilowatt-hour than for electricity and heat production in separate facilities. As a result, CO₂ emissions are much lower relative to the emissions from systems that generate these products singly.

- Wind

Recommendations:

The State should pursue offshore wind development carefully, taking into account the environmental studies for the offshore region now nearing completion. Support is also needed for small-scale wind energy applications. Adoption of appropriate regulations and permit approvals for small residential wind energy systems must be expedited. For renewables (including wind and solar) to be reliable energy sources, viable energy storage technology needs to be developed to compensate for periods of time with low wind or low solar energy. Therefore, the Council recommends that the state support additional research in the area of energy storage technology.

Background and supporting comments

Pros: The main advantage of wind power is that it produces renewable electricity with no emissions of CO₂ or other air contaminant emissions (not considering emissions from fabrication). Other advantages include the following: (1) Installations can be built onshore or offshore; (2) low operation and maintenance costs; (3) surrounding land is usable; (4) diversifies energy sources; and (5) creates jobs. The strongest winds are at sea, making this an ideal spot for wind power. Offshore wind farms typically mean higher efficiency and electricity production because of the higher winds and also because rotor blades can be larger since it is easier to transport large blades by ship than by land. Moreover, installing wind farms offshore beyond the sight of land tends to minimize public objections.

Cons: The disadvantages of wind power include the intermittent production of electricity, the fact that some regions do not have enough wind to make a wind turbine economical, and the fact that there are not many options to lower the costs of wind power so that it is more comparable with fossil fuels. Other disadvantages include: (1) operation at less than full capacity (only 65 to 80 percent of the time) due to wind speed dependence; (2)
location determines output; (3) potential dangers to wildlife (e.g., migrating birds, marine mammals)); (4) availability of transmission capacity; and (5) noise and visual nuisance to communities.

How: Offshore wind, along with solar, is a viable and sustainable element of New Jersey’s future energy portfolio. New Jersey is ahead of other states in the country with respect to offshore wind with its efforts to generate 300 - 400 MW from its first offshore project. The New Jersey Energy Master Plan establishes goals of 1000 MW by 2012 and 3000 MW by 2020.

The wind power industry still depends heavily on subsidies for its growth. The federal government has provided wind operators with: 1) a 10-year production tax credit (PTC) that is indexed to inflation and is currently set at 1.9 cents/kilowatt-hour; and 2) a 5-year accelerated depreciation schedule for wind turbines (normally, the useful life of a wind turbine is 20 years). These incentives were set to expire in December 2008, and the wind power industry is working for a long-term extension of the credit of more than 5 years to give the industry greater stability.

Another incentive designed to grant wind power an economic advantage is the Renewable Energy Certificates (REC) program. In New Jersey, the proposal is to have offshore wind Renewable Energy Certificates or ORECs. The ORECs can be used by utilities to meet the state Renewable Portfolio Standards (RPS), which require utilities to obtain a certain percentage of their electricity from renewable resources. The ORECs can also be sold on a voluntary basis in the open market, thus improving the project economics for the wind farm operator. Development of any OREC program should be done consistent with environmental regulations providing protection of coastal resources. In other words, ORECs should only be provided when the project is consistent with environmental regulations designed to protect coastal natural resources.

The American Recovery and Reinvestment Act of 2009 includes significant monetary pieces to support the renewable effort and green infrastructure, including creation of green jobs. Renewable energy incentives generate opportunity for increases in jobs and the construction of new kinds of infrastructure that will raise employment rates.

Local ordinances can be an obstacle to small-scale wind applications. Efforts should continue through municipal organizations such as the League of Municipalities to streamline approvals for beneficial grass-roots renewable energy projects.

New Jersey must also continue its efforts to assess the viability of large-scale wind applications, both on-shore and off-shore.

When: Near (within the next 5 years) and Medium Term (between 5 years and 2020)

Cost: Although wind power currently depends on government incentives to be competitive with fossil fuel technologies, wind power costs continue to fall. The U.S. Department of Energy (USDOE) has set a goal of lowering costs to 3.6 cents per kilowatt-hour by 2012 for large (Class 4) sites without government incentives. Such pricing would be competitive with even the cheapest coal-fired power plants, especially if
the cost of building new coal-fired power plants is considered and if fossil fuel plants see a rise in costs due to a carbon tax or cap-and-trade system. Meanwhile, strong government support is likely to continue and help the wind power industry to expand rapidly in coming years.

- **Solar**

*Recommendations:*

The Council supports Assembly Bill 3520 (The Solar Energy Advancement and Fair Competition Act). This legislation will expand the State's current *Renewable Portfolio Standard (RPS)* to include all solar energy technologies within the definition of *Solar Renewable Energy Certificates (SREC)*. It also proposes to include an investment tax credit. The solar program should now focus on larger installations. As with wind, a viable energy storage technology needs to be developed in order for solar power to be a reliable energy source. The Council recommends that the state support additional research in the area of energy storage technology.

*Background information and supporting comments:*

Similar to wind power, solar energy is a viable and sustainable part of New Jersey’s future energy portfolio. New Jersey is already second in the nation for solar power installations (upwards of 3,300 installations to date) and is moving away from its rebate program towards a more market-based SREC initiative.

There are two main ways to convert energy from the sun into electricity: (a) thermal solar power, and (b) solar photovoltaic power or solar PV. The former uses the sun's energy to heat fluids, whereas the latter uses semiconductor materials to convert the sun's energy directly into an electrical current. Solar thermal power has the advantage of being less expensive than solar PV, but otherwise the advantages and disadvantages of the two types of solar power are similar.

**Pros:** The advantages of solar power are:

1. Solar electric generation does not result in the emissions of CO₂ or other air contaminant emissions (not considering emissions from fabrication). Solar electricity satisfies government-imposed renewable energy mandates placed on power utilities and benefits from government subsidies;
2. Produces no waste by-products;
3. Equipment typically lasts 25 to 30 years with virtually no maintenance;
4. Uses free fuel (sun) and provides energy independence from foreign sources of fuel;
5. User-installed systems provide onsite electricity generation for the owner and may protect the owner from grid problems such as blackouts, brownouts, and electricity price hikes;
6. Generates electricity even on cloudy days;
7. Generates electricity during the day when electricity is the most expensive, thus avoiding highest electricity generation costs and shaving the peak for utilities; and
(8) Falling solar power costs (5 percent annually on average) have already made solar power competitive with retail electricity prices.

Cons: The disadvantages of solar power are:

(1) Provides electricity only during the day. For power at night, the system must have an ancillary power storage system, or the system owner can draw power from the grid. For renewable energy systems to be completely successful, energy storage technology is still a major challenge to solve;

(2) Contributes a fractional though significant share of total electricity demand. For example, the solar energy goal in the Energy Master Plan is 2,120 gigawatt-hours (GWh) by 2020, which is about 2 percent of electricity demand at that point (97,800 GWh under "business as usual" scenario);

(3) Remains expensive at present and is competitive with existing grid electricity in most areas only after the inclusion of government incentives and rebates;

(4) Presents a large up-front cash cost, although financing of solar equipment is becoming more available; and,

(5) Requires substantial space to capture and convert significant amounts of solar energy to fulfill energy needs since the net conversion efficiency of solar electric power systems (sunlight to electricity) is typically only 10 to 15 percent.

(6) Concerns over solar installations creating “impervious cover” are a challenge that needs careful attention.

How: Along with California, New Jersey is a national leader in solar energy. New Jersey’s Energy Master Plan indicates a continuing commitment to solar energy development in the State. The goal is to achieve 2,120 GWh of solar energy use by 2020. Depending on future efficiencies of solar panels, it is estimated that this total would require approximately 1,800 MW of solar energy generating capacity installed by 2020.

Further help for the development of solar energy will come from the availability of community-based solar programs, which would allow residential and small commercial customers to participate in the solar market through involvement in larger, lower-cost community-based systems and by grid supply projects. This will provide for increased generation distribution, placing less stress on the transmission system while providing communities with increased control over their local energy portfolio. The Energy Master Plan targets that this program will be in place by the end of 2009 after a stakeholder process determines if any statutory changes are needed or if this can be accomplished by modifying the RPS and net metering.

When: Near (within the next 5 years) and Medium Term (between 5 years and 2020)

Cost: The world average cost of solar power of 25 cents per kilowatt-hour is well above the cost of traditional U.S. power generation methods: coal (4 cents), nuclear (6 cents), or natural gas (7 cents). However, this 25 cent solar power cost is already within the retail electricity price for some residential and commercial users, which ranges widely throughout the world from about 4 to 30 cents per kilowatt-hour. It is also important to note that solar power does not have to compete against the cheapest utility generation costs to be competitive. Solar PV systems that are installed at residential and commercial
buildings have to compete only with the retail price of electricity provided by the local utility, not with the utility's generation cost.

The USDOE has provided forecasts for how the downward cost curve for solar PV will develop in the country. The USDOE data show that the current cost range of solar power (without subsidies) is above residential and commercial electricity rates in the United States. However, the USDOE expects solar costs to move progressively lower to compete with retail electricity prices over the 2008-2012 timeframe and with grid-generated power by 2012 to 2015 without subsidies.

- **Nuclear**

_Recommendation:_

New Jersey is home to four nuclear reactors (three at Salem/Hope Creek and one at Oyster Creek) which, according to the State’s Energy Master Plan, provide approximately 50% percent of the power generated in New Jersey. While these nuclear plants continue to provide New Jersey with a non-fossil fuel-based energy alternative, their infrastructure is aging and the State needs to thoroughly examine the role of nuclear energy (both existing and new plants) in the State's future energy portfolio. In particular, the State needs to determine whether or not issues associated with this power source (including health risks and waste disposal issues) can be resolved. In this context, new nuclear generation, as base load, has to be brought to the forefront of both State and Federal policy discussions. This includes continuing efforts by the Governor's Nuclear Task Force, which was established by the Energy Master Plan to address statewide base load issues.

_Background information and supporting comments:_

**Pros:** The advantages are:

1. Nuclear power generation does not generate CO₂ or other air contaminant emissions (not considering emissions from fabrication);
2. It is also a reliable power source and has always been considered base load; and
3. It could continue to add to energy independence and security, especially in situations where there are constraints on indigenous fossil fuel.

**Cons:** The major disadvantages of nuclear power are:

1. Disposal of radioactive waste;
2. Relatively high capital cost;
3. Some possibility of high potential risk to the general public from a malfunctioning nuclear power station; and,
4. Certain sectors believe that nuclear energy is not a solution and undermines safer, cleaner, and cheaper alternatives.

**How:** For nuclear energy to qualify as a sustainable energy option, critical concerns regarding safety and waste disposal must be addressed. Effectively addressing these concerns probably requires advanced technologies, as well as improved institutional risk...
management strategies. Advanced nuclear power technology considerations could include the "small nuclear power plant concept", which may offer some advantages like size flexibility and competitive cost.

Waste management is a challenge with various viable technical solutions, but it is unclear whether promising technical fixes can be made broadly acceptable to the public. There is the need to push the federal government for a plan on dealing with nuclear waste. Action at the state level is also needed to educate the public on what options are available and to forge a path toward a policy that makes sense.

A stable political consensus on nuclear goals and strategies is needed to bring about an energy future in which nuclear energy has a part. It would be appropriate to tap the resources of nuclear power experts at New Jersey’s academic institutions to engender a statewide dialogue on the future of nuclear power in the state’s energy mix.

**When:** Long Term (between 2020 and 2050)

**Cost:** Nuclear fuel costs are lower than fossil fuel costs. Because of the need to operate nuclear plants within current regulatory guidelines designed to ensure safety, large operating staffs are required. Accordingly, compared to fossil fuel plants, operating and maintenance costs remain high, even considering competitive pressures. Capital costs for nuclear plants are known to be relatively high.

- **Hydropower**

**Recommendation:**

Hydropower (also called hydraulic power or water power) is power that is derived from the force or energy of moving water, which is harnessed for useful purposes. Hydropower is a frequently overlooked energy alternative that needs to be considered further. New developments in hydropower technologies are areas in need of attention.

**Background and supporting comments:**

**Pros:** The advantages of hydropower are: (1) it is pollution-free energy (it produces no traditional air contaminants or solid waste); (2) it is carbon neutral, i.e., it has no direct GHG emissions; (3) water (the ‘fuel’) is essentially free; (4) system can be smaller; (5) supplies power on a steadier basis than wind or solar power; and (6) relatively inexpensive, particularly, in the case of micro-hydro.

**Cons:** The disadvantages of hydropower (particularly in the case of large hydroelectric systems) lie mainly with environmental concerns depending on size and location of the facility, such as: (1) loss of habitat; (2) buildup of sedimentation and bacteria; (3) riverbed and bank erosion downstream of the dam (in case of impoundment systems); (4) disruption of local flora and fauna, especially fish; and (5) cleanliness of the power supply for pumps, etc. that are required to run the plant. Large hydroelectric systems also tend to have high capital costs.
How: Two critical factors in a hydropower system are head and flow. Head is the water pressure created by the vertical distance that the water falls from the intake to the turbine. The amount or volume of water that is available at the site is called flow. Adequate head and flow must be present to produce hydropower.

There are three main types of hydropower facilities: (1) impoundment, which uses a dam to store water; (2) diversion, which generally uses only a part of a river’s flow; and (3) pumped storage, in which water is pumped from a lower reservoir to a higher reservoir during periods of low electrical demand and allowed to flow back down when demand is high.

Hydropower can also be classified in terms of capacity: large, small, and micro-hydro. While the parameters can vary, the USDOE defines large hydropower facilities as those that generate more than 30 MW. Small hydropower installations generate between 100 kilowatts and 30 MW. Micro-hydro plants produce up to 100 kilowatts.

The Statewide Water Supply Plan has to incorporate an assessment of the hydroelectric potential of New Jersey's water resources with special attention on micro-hydro applications and due consideration of ecological flows and other environmental sensitivities.

New technologies could be used to provide low-head hydroelectricity. These technologies can use existing assets such as municipal water treatment plants, conduits, non-electrified dams, rooftop water towers, irrigation districts, and run-of-river (or diversion) systems. There is growing interest in smaller hydro projects, especially for municipal (public power) systems in the country. Municipal water systems constitute one category of community-owned hydropower that has not been widely developed. These systems offer a lot of smaller-scale opportunities.

When: Near Term (within the next 5 years)

Cost: High capital costs are associated with large-scale hydropower plants but such large systems have fallen out of favor in the U.S. in recent years due to environmental problems. Instead, there is growing interest in smaller scale systems, particularly micro-hydro systems. Regardless of the specific design details, micro-hydro systems are almost always more cost effective than other renewable power strategies. Once a micro-hydro system has been paid for, the electricity is essentially free, except for minimal maintenance costs.

- Waste-to-Energy

Recommendation:

There is need to consider waste-to-energy (WTE) projects as a way to generate low-carbon renewable energy and fuels from non-recycled waste streams while addressing the State’s decreasing solid waste landfill capacity. WTE projects may include thermal or bio-conversion technologies, such as utilizing anaerobic digestion to generate power and producing bio-solids to serve as fertilizer, while addressing the animal manure disposal
problem associated with animal husbandry or food waste generated by the food industry such as grocery stores and restaurants. The waste oil from restaurants can also be converted into second generation, low-carbon biodiesel to be used as transportation fuel or fuel for power generation and home heating. Thermal conversion technologies may also utilize the non-recycled lower moisture biomass waste to generate power while generating bio-char to be used as soil amendments while sequestering carbon in the char.

Background and supporting comments:

Pros: With varying degrees of treatment, the methane from landfills and anaerobic digestion gas can be used as replacement fuels wherever natural gas is used to create electricity since methane is the principal component of natural gas. Methane can be burned to run an electricity generator or can even be cleaned to reach natural gas standards and placed into the natural gas distribution pipeline. The burning of methane is less harmful to the environment than just letting it be released into the atmosphere, particularly since methane is 25 times more harmful as a GHG than CO₂ and is responsible for nearly as much global warming as all other non-CO₂ GHGs combined.

About 75 percent of the State's biomass resources are produced directly by the population, most of which in solid waste. Existing municipal waste facilities convert only 17 percent of that solid waste into energy. This large proportion suggests that the State should pursue expansion of WTE technologies (other than incineration).

Agriculture and forestry management, which account for the majority of the remainder of the State's biomass resources, offers additional possibilities. Crop residues and wood wastes can be gasified to generate power or pyrolyzed to produce not only energy but also bio-char, which sequesters carbon. This creates a carbon- negative alternative for the farming community.

Furthermore, the livestock and dairy sub-sector of agriculture generates 590,000 tons of animal waste per year from 56,693 head of cattle. Energy from this source can help meet some of the energy needs within the farm sector.

Cons: The gas in any given landfill will eventually run out. Furthermore, over the long term, it is open to question whether large-scale landfills will survive in an energy-constrained future where virtually all resources will be reused or recycled out of necessity. In addition, landfill gas capture efficiency is not at its fullest potential and, even after capturing, approximately 15-25 percent landfill gas gets released to the atmosphere.

While New Jersey has considerable biomass waste resources suitable for WTE, there is still a need to carefully assess the economic and environmental impacts of their conversion into energy. Regulatory concerns across permitting agencies will have to be identified and alleviated. Facilitating the appropriate development and application of WTE technologies requires streamlined and simplified permitting processes.

How: The Energy Master Plan indicates that the State will consider incentives, including changes to the Renewable Portfolio Standard (RPS), to support WTE technologies that
are more sensitive to the environment than the current methods. However, due to their emissions and inherent inefficiencies, traditional incineration technologies will not be supported as part of this effort.

An operation that prevents methane from being released into the atmosphere may qualify for GHG credits in the Regional Greenhouse Gas Initiative (RGGI). Therefore, companies that collect or produce biogas could not only receive the revenue from the sale of the biogas or the generation of electricity but also earn revenue by receiving and selling RGGI GHG credits. This makes it more worthwhile for companies to extract methane from landfills or install anaerobic digester plants at livestock farms.

**When:** Near Term (within the next 5 years)

**Cost:** A 4 MW landfill gas power plant project in Vermont cost $ 8.4 million (2004 prices), including the construction of 7.2 miles of new transmission line to connect with the statewide transmission system. This plant provides electricity at a cost of less than 5 cents per kilowatt-hour (kWh) during the initial 20-year contract period.

- **Peak Demand**

**Recommendation:**

Reducing peak demand for electricity is key to improving air quality, especially lowering ground-level ozone. Managing peak electricity use and generation needs to be addressed not only at the consumer level but also at the utility level, where imbalances between supply and demand cause excess power generation, wasted capital, and the generation of unnecessary criteria pollutant and GHG emissions. To address this, there is need to invest in smart grid technology as part of electrical use and generation management programs. Furthermore, recognizing that there will always be peak energy demand periods, the State needs to continue its regional efforts to ensure that the electricity generated during those periods comes from clean energy sources. This is critical from an air quality perspective, since these peaks tend to coincide with hot summer days, where ground-level ozone and fine particulate matter levels can already be excessive.

**Background and supporting comments:**

**Pros:** Electricity load management programs can reduce the load on the grid, which is the entire system involved in generating and delivering electricity to customers. Demand response incentives specifically from the regional transmission organization will reduce the peak demand for electricity across the PJM territory and consequently reduce need for generation from high cost generators such as peaking plants. Overall electricity prices can be reduced by lowering demand for high priced electricity generators to operate during peak time, thereby benefiting all ratepayers. Reducing peak demand has a positive environmental impact by avoiding the need to run peaking units and consequently eliminating the emission of associated air pollutants and GHGs. Achieving the Energy Master Plan's overall goal of reducing peak demand by 5,700 MW will greatly assist the State in achieving a reliable electricity infrastructure at a more reasonable price than the business as usual scenario.
Cons: Several market barriers for energy efficiency measures at the grid level exist, including lack of capital or financing, high initial costs of more efficient technologies, lack of incentives for maintenance, and differential benefits to the user relative to the investor. Much of the aging peaker fleet will be shutdown when it is unable to meet the performance standards just adopted by NJDEP. The loss of these units threatens energy reliability in the state. The new forward capacity payment structure that PJM has established should help to get new capacity in place, but it is not clear whether it will be enough to guarantee reliable peak electric supply.

How: The Energy Master Plan includes a goal of reducing peak demand for electricity by 5,700 MW by 2020. This will be achieved through incentives and piloting of different electricity load management technologies and rate structures, including smart meters and advanced metering infrastructure. Incentives include those that will help businesses move away from using their facilities in high-demand time periods during the day (e.g., those scheduled by NJBPU for rollout in June).

New Jersey has adopted measures to address emissions from electrical generating units which operate on high demand days. These measures include interim reductions in the 2009-2015 period to meet the State's commitment to the Ozone Transport Region and performance standards in the post 2015 period. Two other states have implemented short term reductions for these units. New Jersey is continuing to work with the states in the Ozone Transport region and the U.S. Environmental Protection Agency to ensure that these performance standards are implemented regionally.

Utilities are interested in creating a flatter power demand curve and eliminating the peak electricity usage seen during the day and seasonally on particularly hot days. This can be done through variable pricing such as (a) "time-of-use pricing" where electricity consumers pay an electricity rate as much as three times higher during the few peak hours of the day and then pay a lower rate during the other non-peak hours of the day; and (b) "critical use" pricing that imposes very high electricity prices during the few days of the year when power demand is very high and utilities are bumping up against their reserves. In order to introduce variable pricing, advanced electricity meters (smart meters) are necessary that can measure when electricity is used, not just the total amount of electricity used.

When: Near Term (within the next 5 years)

Cost: The Federal Energy Regulatory Commission (FERC) advanced metering study provides some useful cost benchmark information. The FERC noted that the average cost for a meter has been in the range of $75 to $85 per unit. However, the meter typically represents only 45 percent of the total system cost, with other costs including network hardware (20 percent), installation (15 percent), project management (11 percent), and information technology (9 percent). The total capital cost per meter system has recently been in the range of $135 to $150. For the utility, there are several financial benefits that offset the capital cost of the meters. These cost savings include reduced meter reading costs, the elimination of estimated bills, the ability to better size electric generation and transmission assets, reduced outage management costs since crews can accurately
determine the scope of a problem, and reduced invoicing time (thus reducing receivables). As the buyers of smart meters, utilities must see a positive return from their capital investment through cost savings and/or by a pass-through of the costs to customers before they will decide to proceed with smart metering programs. It is noted that there is $84.5 billion allocated for smart grid technology in the American Recovery and Reinvestment Act of 2009.

New Jersey's recently adopted performance standards for high electric demand day (HEDD) electrical generating units address both boilers and combustion turbine based electric generating units. There are eight high electric demand day units that are No. 6 fuel oil-fired boilers (six of which also combust natural gas). The State expects the cost-effectiveness of installing, maintaining and operating the control equipment necessary to comply with the performance standards to be in the range of $600.00 per ton to $18,000 per ton of oxides of nitrogen (NOx) emissions reduced, with an approximate average of $5,000 per ton of NOx emissions reduced. Approximately 143 combustion turbines will either have a control apparatus installed on them or be decommissioned entirely in order to comply with the HEDD performance standards. The cost-effectiveness of the control apparatus is approximately $44,000 per ton of NOx emission reductions. The total replacement cost, including maintenance and operation, for a simple cycle combustion turbine ranges from $0.5 to 0.8 million per megawatt. While the annual tons of NOx emissions may be relatively low from these units, the pollution they emit on high ozone days is high, and these HEDD units can more than double the NOx emissions from electric generating units on high ozone days. Therefore, reducing NOx from these units on high ozone days is critical to improving public health impacts in the Region, and any pollution reduction occurring on those high ozone days is more valuable than pollution reductions occurring on other days. The public health benefits will have a cost; electricity consumers will likely suffer some negative impacts from this action through increased rates and decreased reliability on peak days.

- Other New Technologies

Recommendation:

There is need to consider other energy generation-related areas that are also of critical importance to determining New Jersey’s future energy portfolio, particularly those where new technologies play a major role. These include energy storage (power storage and backup systems), geothermal, and biomass energy generation. As discussed above, energy storage technology is still a significant challenge that needs to be resolved for renewable energy sources to be successful. There is need to include geothermal energy as part of the future energy portfolio, especially in the context of zero energy buildings. While biomass power plants have been in operation for many years, the availability of new technology in the near future will allow a wider range of waste feedstock (e.g., agricultural wastes like corn stalks, wheat straws, and even dried animal manure) to be used to produce fuels.

Background and supporting comments:

Pros: The favorable benefits of these other technologies include:
(1) Electricity storage is critical to evenly distributing the availability of solar and wind power which is needed for a complete and long-term renewable electricity solution. Advanced electricity storage solutions would also be useful in the transportation market.

(2) There is a future for the residential and commercial use of geothermal pumps as heating and cooling sources. Geothermal energy is a continuous source of power (not intermittent like wind and solar).

(3) Sustainably produced biomass is renewable and allows utilization of waste that would otherwise pose a disposal problem. Biomass can be used in existing co-fired systems (e.g., combination with coal), eliminating the need for new facility construction.

Cons: The main disadvantages for each of the above are:

(1) A cheap form of large-scale electricity storage (other than virtual storage offered by conventional plants) is not yet available.

(2) Drawbacks of geothermal heat pumps include high up-front costs, the need for space to install the pipelines in the ground, and the fact that the system only works well when temperature differences between the ground and the air are large.

(3) Biomass still involves burning waste products, which releases CO₂ and other pollutants into the air. Also, biomass sources are diverse. When viewed from a lifecycle perspective, one biomass stream may provide a net environmental benefit while another causes a net environmental detriment. These choices must be made carefully.

(4) The increased use of electric motor vehicles in coming years makes it necessary for projections of demand for electricity to include a factor for increased use of electricity for transportation (given projected availability of new technologies, such as electric vehicles, in this area). Such projections are beyond the scope of the 2009 Public Hearing.

How: There are basically three ways to store electricity directly: batteries, super capacitors, and superconducting magnetic energy storage. However, electricity does not need to be stored as electricity in order to be retrieved later. It can be stored in the form of water, compressed air, hydrogen, or mechanical energy. Technologies to do this are: pumped hydro, compressed air, hydrogen for a fuel cell, or mechanical energy in a flywheel.

Geothermal heat pumps (GHPs) are simple pumps that take advantage of the relatively constant temperature of the earth's interior and use it as a source of both heat and cooling. A simple water pump and underground pipe system operate to circulate the fluids from the surface to the ground in a continuous cycle. Geothermal pumps can be used anywhere, most often in residential settings. This renewable heat source offsets electricity and fuel consumption associated with heating.

There are three major technologies for using biomass as a power generation fuel: (a) direct fired, (b) co-fired, and (c) gasification. Most biomass power plants currently use a direct fired system. Biomass also has small-scale applications and is amenable to a combined heat and power (CHP) or co-generation configuration. Biomass CHP projects are particularly effective when they are part of a district heating system.

When: Near (within the next 5 years) and Medium Term (between 5 years and 2020)
Costs: Compressed air storage systems (for energy storage) appear to be fairly attractive in terms of capital costs both for 2-hour and 20-hour storage options. An early study has shown that wind-generated electricity can be transformed from an intermittent resource to a base load power supply if combined with compressed air energy storage (CAES), adding probably $0.01/kWh to wind electricity production costs.

The USDOE found that geothermal heat pumps could save a typical homeowner hundreds of dollars per year in energy costs, with the system paying for itself in 2 to 10 years depending on a variety of factors.

Biomass is a profitable alternative mainly when cheap or even negative cost biomass residues or wastes are available. With state of the art combustion technology at a scale of 40 to 60 MW and biomass prices of about $2 per gigajoule, electricity production costs would be in the order of $0.05 to $0.06 per kWh. Co-combustion, particularly at efficient coal-fired power plants, can obtain similar costs.

- Transmission Infrastructure - Stability and Accommodating Renewables

Recommendation:

In order to address the air and climate concerns of today, new electricity transmission lines and upgrades (e.g., the development of additional high-voltage transmission) are critical. This is particularly important with respect to renewable sources of electricity, which are often not located near the areas where the energy is needed. At the same time, New Jersey needs to consider the impact of its aging energy infrastructure. Purchasing out of state power puts pressure on PJM to deliver, placing the State at the mercy of others in terms of the "cleanliness" of its power and exports jobs as well.

There is also need to consider issues of grid stabilization when dealing with some renewable energy systems like wind and solar. A key problem is the modernization of the entire electricity delivery system to make it more reliable, and a critical element of such modernization, is the accommodation of a wide variety of generation options (e.g., a grid that allows a wide variety of local and regional generation technologies (including green power)). There is value in having a diverse fleet of assets, that is, different types of power plants with different fuel sources. This provides flexibility in operations that could take advantage of favorable fuel prices and availability.

- The Right Mix

Recommendation:

Given the challenges facing New Jersey, it is evident that all energy/electricity generation alternatives must be taken into account. Clearly priority is given to clean energy options, with particular focus on energy conservation/efficiency, renewable energy systems, and advanced technology for conventional fossil-fuel systems. For the latter, a near-zero
emission capability will be required to ensure environmental sustainability. Due attention must also be given to maximizing the potentials of energy technologies, such as hydroelectric, geothermal and biomass, with readily available resources in the State and small-scale applicability. Such systems would help expand off-grid, distributed generation capacity in the State and facilitate the development of community-based energy systems.

This recommendation implies that New Jersey needs to ensure the successful implementation of the 5 major actions of the Energy Master Plan: 1) maximize energy conservation and energy efficiency, 2) reduce peak electricity demand, 3) strive to exceed the current renewable portfolio standard and meet 30% of demand with renewables by 2020, 4) develop a 21st century infrastructure, and 5) invest in innovative clean energy technologies and businesses that will lead to major reductions in demand and increases in supply of clean and renewable electric power.

PJM must continue to offer a structure that assures consistent opportunity for development across fuel types. PJM operates “capacity markets” that are intended to create incentives for locating new generation in areas facing electric supply shortages. Properly functioning capacity markets will create incentives for new generation in the State (including large-scale renewable energy projects).

- Policy Solutions

Recommendation:

A whole array of policy solutions/options must be considered in order to move forward effectively. In developing the appropriate policies, the following should be considered:

- It is critical to balance four areas when dealing with energy issues: air quality, climate change, energy security, and economic impact.
- The net impact on GHG emissions should be a critical consideration for all State decisions. To support this, the GHG inventory methodologies should be continuously refined and improved as a decision support tool.
- It is important to understand the critical link between NJBPU and NJDEP’s work efforts toward ensuring clean air, clean water and clean energy, and that the working relationship between these two agencies needs to continue to be fostered.
- Policies to induce new power technologies (e.g. biomass, wind, etc.) have to be considered both individually and collectively. In considering alternatives, lifecycle impacts and economic efficiency have to be factored in. Lifecycle environmental, social and economic impacts need to be considered up front so that one problem is not replaced with another. Economic efficiency in this context should be understood as more than just engineering efficiency, more than just creating value added jobs. It also involves acknowledging tradeoffs and recognizing that incentives matter. Alternatives include specific technologies (e.g., biomass, solar, wind, etc.) and the types of policy instruments required to induce these technologies (e.g., cap and trade, taxes, subsidies).
- Development and installation of new technologies costs money and it is important to establish incentives to help offset these costs. These technologies will
ultimately result in New Jersey jobs and can be receiving financing help from the cap and trade mechanisms discussed elsewhere in this report.

- The State must support national climate change legislation to set targets and timetables based on science (IPCC) and establish a national cap and trade system. A national cap and trade system will establish a market-based price for carbon that will drive innovation and investment to meet environmental goals at the lowest cost.
- There is a need for the State to encourage more competition in terms of developing alternative energy systems designed to avoid dependency on foreign energy sources. Maintaining a fair and vigorous competitive energy supply market should also help in keeping energy prices more affordable.
- Job creation as part of the State’s overall effort to “green” its energy supply is also critical.
Summary of Testimony

Mark Mauriello
Acting Commissioner
New Jersey Department of Environmental Protection

The topics that Commissioner Mauriello discussed in his presentation to the Council are summarized into three critical areas; air quality, climate change and energy supply. These areas are closely interrelated where energy supply is linked to emission issues.

Traditional energy sources are all important contributors to providing for energy demand in New Jersey. Mauriello considers that the work that is going on within the Council is going to determine how contributions of the various sectors may increase or decrease in the future. This is also dependent on the advice and the recommendations that the public put forth to the Department.

In terms of climate change Mauriello believes we are in a very exciting time. The Global Warming Response Act has very ambitious targets for greenhouse gas reductions in the 2020 and 2050 period. The challenge is how to arrive at these targets.

The reduction will be realized through three different means;

1. The Energy Master Plan implementation (this is a comprehensive plan that looks at all issues from demand reduction to increase in supply), and moving toward renewable energy sources.

This includes:

- Encouraging the public to install solar arrays in various locations;
- Inspecting problem areas like municipal landfills and determining if there are productive uses there;
- Examining hydropower, both ocean and inlet, as well as some innovative ideas of reusing old quarries up in the northwestern part of the State to generate hydropower and;
- Researching wind power which is an important renewable energy source. New Jersey is currently close to having a number of environmental studies for the off-shore region completed. There is a large public support from communities who want to install turbines in their communities.

Along with these public efforts the Council is working to determine a way to accommodate these initiatives in a manner that doesn't compromise or impact the environment.

2. The second component is a move towards low-emission vehicles.

BPU and DOT are collaborating on how to ensure that the infrastructure is in place when the market does shift to low-emission vehicles. They are working to ensure convenient operating opportunities and places to re-charge. Mauriello acknowledges that there is a lot of opportunity and a lot of need for continued collaboration.
3. The third component to meeting those goals is the Regional Greenhouse Gas Initiative (RGGI).

New Jersey has participated in two of the cap and trade auctions, most recently within the past two weeks. The revenue total for the two auctions is on the order of $35 million. These funds are particularly important in helping to meet targets and reduce greenhouse gas, which is costly. The revenue is split between three agencies. The EPA gets 60 percent, BPU gets 20 percent, DEP gets 20 percent for a wide range of actions from energy efficiency, renewable development, ratepayer relief, in some cases forest and tidal marsh stewardship and a large part of the DEP fund is to help maintain and improve forest health for the purpose of carbon sequestration.

The issues that these three programs collectively address also include health issues and employment. Renewable energy initiatives are a tremendous opportunity for increase in employment and the construction of new kinds of infrastructure that will raise employment rates as well as find solutions to potential health related issues.

The federal stimulus bill has some significant monetary pieces to support the renewable effort and green infrastructure. The goal of the Council is to examine these issues and advise how to get people back to work and to discuss health issues and environmental impacts that result from the quality of the air.

The State does not traditionally do a good job of linking its land use and its transportation planning to a point where it makes smart decisions as a State to try to ensure growth in the right places and not creating more needs for people to travel by car. This is an area of which the Council can find improvements for the future.

The Council relies on the help of the public to make this State a better place. Mauriello concludes that we are going to need help figuring out what the future energy picture looks like with particular emphasis on protecting the quality of the air for the people in the State.

**Leonard Bielory**  
**M.D. Chairman**  
**Clean Air Council**

Dr. Bielory is a physician on the Clean Air Council and tries to steer the direction of discussion of the impacts of climate change on public health.

He states, “If we're not part of the solution, we're part of the problem. This is a human issue. We have the ability to change the future and that's what we're here for, to understand the perspective of what impact we can have.”

Climate change is going to have an impact on the quality and quantity of life. There has and will continue to be an increase in mortality. As such, clean energy, the focus of today's Clean Air Council meeting is of major importance to reflect upon. Combustion of fuel results in the emission of carbon dioxide (CO₂), methane and nitrous oxide. These greenhouse gases accumulate resulting in what some call “Global Warming”. As CO₂ emissions are increasing so is temperature and, consequently, health issues.
There is historical proof that prior to the Industrial Revolution allergies rarely existed. Discovered letters written by the Royal Society of Medicine in Britain to the French during their Industrial Revolution that state the beginning of ragweed allergy with symptoms like summertime runny nose and watery eyes. The French responded that they were not familiar with such symptoms. This is potentially a result of the fact that the French industrial revolution didn’t occur until about 20 to 30 years later. As such, there is reasonable proof that ragweed allergy and allergy symptoms that started to occur in England at the time were a result of the Industrial revolution and have only increased over the years.

Researchers have concluded that if we stop all greenhouse gas emissions at this point in time the earth will continue to warm for the next 100 years. What are the consequences of this to public health?

- Mortality: The southern hemisphere is going to have or is already having increased mortality. It will migrate north. There is recent information proven regarding kidney stones in the southern belt of the United States. As temperature rises, dehydration increases. As dehydration increases, one out of ten people will have a kidney stone in their life;

- Morbidity: while we talk about increased mortality, increased morbidity will actually occur over time. There will be increased severity and frequency of asthma and allergies. In addition, cases of cardio vascular disease, heart failure, cerebral vascular disease will rise. Consequently more and more people will require emergency and hospital attention. A percentage published in 2006 states that a change in 5 parts per billion of ozone will lead to an increase of respiratory hospital admission. This is morbidity and it is directly correlated to the particulate matter that we breathe and;

- Temperature Increase: Climate change has an effect on health, but in a variety of domains, such as heat stress, heart and respiratory failure, air pollution, increased asthma, COPD and allergies. Vector-borne diseases will increase as a result of growth of certain parasites in locations with more water. These include Malaria, encephalitis and other water-borne diseases. Cholera problems may increase. Issues regarding water resources and food supply may rise. With a climate change, a variety of domains will be affected.

Bielory concludes that we can make a change. While studies are underway these are not enough. Our footprints are a bioprint of health for the future. However, we can actually change that. There are a variety of variables with a certain mitigation structure and certain modeling has occurred and certain data is now supporting that. We must act now for the future.
Nicholas Asselta
Commissioner
Board of Public Utilities
The DEP and BPU are working together to solve the issues of clean air, clean water and our existence for energy in the future. Commissioner Nicholas Asselta represents the BPU in discussions of the issues they have identified and are working to address.

The BPU has used its resources to create programs, like the Solar Program, to help solve these issues. Currently there are 3,300 solar panel installations in New Jersey and as a result the program is No. 2 in the nation. The BPU is now moving toward encouraging larger installations that can make an even greater impact on the total consumption and usage for the future.

Another important issue the BPU is working on is trying to fit and retrofit some of the State facilities with solar and wind applications. The taxpayers in New Jersey make programs like this possible.

The BPU also feels it is important to assess the involvement of businesses and to understand the challenges that most businesses will face in the future. They will create a demand/response program to incentivize businesses to look at their productive production levels and encourage them to move away from using their facilities in high density (peak demand) time periods of the day. This will produce incentives for businesses to reschedule their energy usage during the parts of the day that are marked by high energy without losing productivity.

Energy efficiency, EE, has become a very critical issue for BPU and as such they have partnered with every electric utility in the State to develop plans on how to communicate to consumers some of the very easy alternatives a household can switch to in order to save energy. BPU is encouraging the public to conserve energy by giving rebates to those who purchase new, energy-efficient appliances. Consumers will receive a rebate in return to help offset the cost of that energy-efficient appliance.

Asselta asserts that our future is renewable energy. The goal of the BPU is to have 30 percent of New Jersey's energy needs generated by renewable sources by 2030. It is foreseeable that renewables, natural gas and LNGs off the coast are a reality down the road. The ability to store electricity that is produced and not used is going to be key technology in the future. New Jersey is always going to rely on energy sources such as coal plants in Ohio and Pennsylvania because the PJM grid purchases that power and distributes it to New Jersey however, 51 percent of the electricity produced for New Jersey is produced by three nuclear plants within New Jersey. Though Asselta does not formally promote nuclear power, he states that it is a possible alternative that could offset some of the other energy needs in the future.

Mr. Asselta concludes that the BPU is hoping that all these technological advances continue so that these particular alternatives are as efficient and as environmentally sensitive to our state as possible. That is the charge to BPU.
Upendra J. Chivukula  
Assemblyman and Chair  
Telecommunications and Utilities Committee  
As a Chairman for the Telecommunication and Utilities Committee Assemblyman Chivukula has focused on the various energy issues, challenges, and opportunities presented in the State of New Jersey of which the Energy Master Plan, released in October 2008, has proposed to solve.

The Master Plan stresses the need to reduce demand which is growing very rapidly, however can be reduced by using energy efficient technology and by conservation. To do so, energy demand supply goals must be met with the intent to produce about 640 megawatts of electric demand. However, this does not come without more challenges, mainly the issue of funding.

There are many ways the State of New Jersey can spend money to promote progress in this area.

1. They can promote combined heat power plants that are more efficient than conventional power plants by up to 70 percent.
2. They can help the Global Warming Response Act reach its target reductions of greenhouse gas emissions to 21 percent by 2020 and to 80 percent reductions by 2050.
3. They can support energy alternatives such as wind, solar, and hydro to establish distribution generation. Wind power only accounts for about 13 percent of our energy demands. The best location for efficient wind power is off shore. Currently the Board of Public Utilities has contracted a $17.5 million project to try and see if offshore wind power on the Atlantic coast is a viable energy alternative, and even more work can be done.
4. They can face the challenges of building infrastructure that facilitates and enables distribution generation. This can be realized on a micro scale, by encouraging hospitals, university campuses and homes to generate their own energy.
5. They can advance research regarding the capacity of landfills of solid waste. Studies show that there is only an available landfill capacity of 21 years. Solid waste in landfills produces methane gas which is 21 times more potent than carbon dioxide. A possible solution to this problem is to separate and remove any toxic materials and burn the solid waste at temperatures of 3,000 degrees.
6. They can further examine geothermal as another potential opportunity.

These are viable opportunities we need to look at.

Chivukula discussed that his part of legislation, the Assembly Bill 3520, contains a very aggressive venue report for standards. They are trying to figure out how to promote solar energy along with rebate programs to reach these goals. They believe that utilizing distributor generation will allow solar energy alternatives to be a more cost effective and viable as an alternative resource.

Since these new technologies are costly. Chivukula recommends to the Council in his conclusion that in order to create a balance of spending the state needs to create “green”
jobs. It is also essential to place a tremendous amount of pressure to educate consumers to change their behavior.

Mike Aucott  
Office of Science  
NJDEP

Mr. Michael Aucott discussed greenhouse gas (GHG) inventory and electric demand predictions. Essentially, he translates energy data into greenhouse gas emissions which is simply a function of distinguishing how much carbon a fuel contains. These inventory predictions were developed with linear methods using historical data.

The inventory predictions have concluded that the programs such as the Energy Master Plan, Low – Emissions Vehicle Program, and RGGI, together, if all three are successful, should result in the state meeting the 2020 limit.

The data he has compiled shows that emissions reductions were lower by about 8 million metric tons in 2006 from 2005. He speaks of this as encouraging data but that it is important to look at all the factors that may have resulted in these findings. He argues that while some reductions in 2006 were due to progress and energy efficiency, it is also likely that weather fluctuations may have been a factor. He accounted for weather changes into his predictions by looking at heating degree days and cooling degree days. A heating degree day is the efficiency between 65 degrees Fahrenheit and the average temperature for that day. Using data from the New Jersey State Climatologist he was able to see that 2006 had very few heating degree days compared to 2005. This data would conclude that less energy was demanded in 2006 and consequently less fuel was used for heating and cooling. Thus there was a reduction in greenhouse gas emissions.

He states that while it is still important to track progress in meeting the state’s goals that it is also important to normalize for weather conditions. And, while predictions have some uncertainty it is still important to get a sense of what the problems are, where to go and what has been successful.

Unfortunately, peak use is predicted to increase at an even faster rate in the years to come. The Energy Master Plan identifies four big challenges. The following are essentially the chief issues that we face:

- Growth and supply has not kept pace with growth and demand;
- The price of energy has increased substantially. It has become more and more volatile.

Aucott predicts that without action, the contribution to global warming will continue. The state has much less authority than it once had to plan, predict and enforce. He believes that the Energy Master Plan is a bold concept, but that it may be the idea that will help plan our future.

The Energy Master Plan identifies five major actions to meet the challenges

- Maximize energy conservation,
- Reduce peak demand,
- Strive to exceed the current RPS,
- Develop 21st Century infrastructure and
- Invest in innovative clean technologies and businesses.

If successful, Aucott says, these actions will lead to major reductions in demand and increases in supply. He follows that these degrees of reduction are needed globally if we're going to avert a potentially catastrophic climate change.

Aucott concludes with recommendations based on this data that it is important to take the long-term view, expect there will be variations from our predictions and strive to take a broad-based, multi-faceted approach and focus on the needs for resiliency, redundancy and flexibility.

**Tonalee Carlson Key**
**Air Quality Management**
**NJDEP**

A number of states have come together to increase awareness of the issues associated with high energy demand days. Ms. Carlson-Key's aim was to provide an overview of the process of this project, explain how it was carried from a regional effort to a New Jersey State effort and to discuss the actions taken to address emissions on high demand days.

The findings of this project were as follows: On electric demand days NOx emissions from EGUs increase dramatically. The average NOx production on non-ozone days was found to be approximately 212 tons. However on ozone days there was a recorded total of 370 tons. This is a substantial increase of roughly 70 to 80 percent.

In order to investigate this in greater depth, the project started exploring what was happening with the mix of generating units that were operating on various days. To do this, the project team examined 2005 to 2007 ozone season day that records the percentage of time electrical generating units operated during the ozone season. The team needed to specifically understand what fuels were being used to generate energy on high demand days and distinguish what part NOx was playing in this production. What was found was that a significant amount of NOx was generated by units that used natural gas and diesel fuels (those associated with conduction turbines).

With the knowledge that there were more NOx emissions on high electric demand days, it was decided it was important to realize what this meant in terms of air quality. The result of the sensitivity modeling that was done shows that broad regions were seeing 1 to 20 ppb reductions while others were seeing very significant 6 ppb reductions.

There was a need to move forward to figure out how to do something with the information compiled. They established a regional effort that included active member states as well as regional transmissions organizations like PJM, public utility commissions like BPU, generating companies and the EPA to work collectively on this project.

The result of this was an MOU by some of the OTC states to get reductions in the 2009 time frame. Specifically, New Jersey prepared a rule which is referred to as the High Electric Demand Day Rule that was part of a large wish-list package. As an aside, the
Commissioner has just signed this rule. It will be in the Register on April 20\textsuperscript{th} and will be effective May 19, 2009.

New Jersey decided to take a two-phase approach. The first phase was designed for short-term reductions of 19.8 tons per high electric demand day. The second phase, the long-term, was designed to assess performance standards for electric generating units.

[For more details on the rule visit the full transcript on the website.]

Lastly, Carlson-Key discussed the learning processes that contributed to the planning of this project. The project team interacted with organizations like The Regional Transmission Organization (RTO), ISO-New England, and ISO-New York that control the wholesale movement and pricing of electricity. They helped contribute an abundance of information to figure out which days are high electric demand days. They also gave information regarding alerts, electric distribution and demand/response. This information helped decide how to address the issue and provide solutions for generators to meet performance standards.

Overall, Carlson-Key concluded that the project was a delicate issue because it needed to be designed in a way that would not disrupt electricity generation enough for the lights to go off. Ultimately the project has been successful.

\textbf{Frank Felder, Ph.D.}  
\textbf{Director, Center for Energy, Economic \& Environmental Policy}  
\textbf{Edward J. Bloustein School of Planning and Public Policy}  
\textbf{Rutgers, the State University of New Jersey}

Dr. Frank Felder presented information regarding electric wholesale market and the notion of energy efficiency. He notes that the wholesale electricity market is a relatively new phenomenon. The Energy Master Plan promotes this market structure which ultimately reduces the state’s ability to control its future with respect to the electricity grid.

Currently, the state faces further obstacles due to the complicated mixture of planning and regulation. In addition there are cap-and-trade markets of SO\textsubscript{2}, NO\textsubscript{x}, and CO\textsubscript{2} greenhouse gases that come into conflict with certain standards regarding air emissions. Ultimately Felder recommends the importance of economic efficiency to solve this problem. By this he means doing more with less, achieving the same outcome using less or achieving a better outcome using the same amount. Felder proposes that there is no way out of the long-term climate change problems without improving efficiency. What efficiency does is grow society’s resources, temper conflict between various interest groups, and allow us to have hope that our children will live better lives. As such, policies and proposals must consider how to increase economic efficiency in order to have a chance at meeting the 2050 goals. If efficiency isn’t established into policy over the next couple years, Felder predicts that there will be significant fights within interest groups.

Energy efficiency is more than a simple input/output analysis. It is also important to consider costs. The equation becomes more than a factor of how much fuel is used to get
energy out. It is also a factor of how much does it cost in terms of labor, materials, infrastructure and so on. Felder proposes that what is needed is to create long-term, sustainable jobs that add value to the economy. That would make us, as a state and nation, more efficient.

The other difficulty is the notion of trade-offs. For example, if we do more for one thing, what will it cost elsewhere? If we reduce this emission what are the implications on the economy? There is no way to get around the notion of trade-offs, however, Felder recommends the urgency of optimizing trade-offs in the various sectors. He chose to recommend to the Council key questions they should consider when listening to the many recommendations they hear.

1. What is a given project trying to achieve and by how much?
2. Given the objectives of the proposal, and is there a more efficient way of doing it?
3. Does the proposal acknowledge its limitations?
   For example, under what conditions should a nuclear power plant not be built.
   This will force analytical discipline and a better understanding of where this makes sense and where it doesn’t.

Finally, Felder proposes the importance of considering alternative energy sources like biomass, wind, solar, nuclear, transmission lines, energy efficiency, demand/response, etc, along with policy alternatives. While he acknowledges that there is no single correct answer, Felder recommends that policy needs to establish a structure so the state has the right mix of answers, for example cap-and-trade or rebates. In addition, it is not only important to consider these individual policies but also their interaction with one another and how they connect to the state, regional and national level. He believes answering these questions is the most important step to be addresses first and foremost.

Sean McNamara  
Manager – Regulatory Legislative Affairs  
State Government Policy, PJM  

Mr. Sean McNamara presented PJM’s position that air quality and climate change are significant issues that need to be addressed. He acknowledges the work the Clean Air Council does in helping New Jersey address those problems and states that PJM promises to work with the Council and the State of New Jersey to help improve both these issues.

PJM is the regional transmission organization that serves all or part of 13 states and the District of Columbia. Their job is to ensure the reliability of the bulk power grid and to operate a competitive wholesale market for electricity serving more than 50 million Americans. They do this by operating the electrical grid to meet the highest level of reliability standards, administering a day-head and real-time market and planning for the long-term adequacy of the bulk transmission system.

PJM's No. 1 priority and the priority that drives all of the decisions that it makes is reliability. In order to ensure that the transmission system remains reliable, PJM uses an open process called the Regional
Transmission Expansion Plan (RTEP) to study the transmission system to identify what changes or additions to the grid are needed to ensure reliability and the successful operation of the wholesale markets.

PJM's RTEP process includes both a five year and fifteen year dimension. The results of the studies performed by PJM staff along with the recommended upgrades required to address for reliability, criteria violations are submitted to PJM's independent board of managers for the PJM board for approval. Once approved, the upgrades become part of PJM's overall RTEP.

McNamara addresses the independent nature of PJM's board which ensures that decisions made by PJM about the transmission system are made without undue influence from any PJM member or stakeholder.

PJM's RTEP process is holistic. The studies consider multiple inputs including load forecasts, market efficiency analysis, generation projects requesting interconnection to the grid, which include renewable generation, generation deactivation and retirements and demand response and energy efficiency.

PJM does not control which types of generation resources are proposed to be built or retired, nor do they have a preference for or advocate for any certain type of generation. McNamara situates that PJM can be considered a generation agnostic or neutral organization so will not be making any recommendations or suggestions on which types of generations should or could be built.

However, PJM provides the process through which resources are added to the grid and the markets where they can participate. In addition, PJM is an enabler of diverse generation resources. The RTEP process offers a structure that assures consistent opportunity for development across fuel types. More than 59,000 megawatts of renewable technologies are active in their interconnection request process. Interconnection request totals through January 31, 2009 include 55,000 megawatts of wind generation, 600 megawatts of methane, 500 megawatts of biomass and 2,700 megawatts of hydro.

The potential impacts of these renewable sources of generation cannot be underestimated. As an example, an increased penetration of wind power shows the potential for mitigating wholesale prices while providing significant CO₂ emissions reductions. With 15,000 megawatts of wind capacity installed, wholesale market price reductions of $4.50 to $6.00 a megawatt hour, which translates to reductions in annual market-wide expenditures of between $3.5 to $4.7 billion.

Displacement of about 43,000 gigawatt hours of fossil-fueled generation with about 60 percent of the displaced generation being coal and the remainder being natural gas and oil-fired units. The 15,000 megawatts of wind capacity, if installed, will generate CO₂ emission reductions of almost 35 million short tons in the absence of any CO₂ price.

While PJM maintains a neutral stance on generation sources they encourage the development of more renewable sources of electricity. This will not only assist New
Jersey in achieving its air quality and emissions goals, but will improve the reliability of the grid, as well.

The fact still remains that PJM is a Regional Transmission Organization and is responsible for the bulk transmission system. New Jersey's native load growth over the next ten years is projected to be around 1.6 percent per year, which is down slightly given the downturn in the economy. Even with the recession, the trend for load growth is still moving upward.

To address the growing demand in New Jersey, PJM has identified numerous upgrades and is working closely with the transmission owners that are responsible for building the facilities. Among the more significant upgrades is a new 500 kV transmission line from Susquehanna, Pennsylvania through PSE&G's Roseland station in New Jersey. This line will address 23 overload conditions on 230 kV and 500 kV transmission lines in the New Jersey and Pennsylvania area, making the system more reliable and keeping the lights on in New Jersey.

New and or upgraded transmission lines also enable renewable sources of energy to reach loads. The fact of the matter is that most of the areas in the United States where renewable sources of energy are located are not located in the areas where the energy is needed. This implies that additional transmission lines will be required in order for the energy to flow to the load; therefore, the Clean Air Council will be advocating for an increase in the use of renewable resources. To achieve its goals around air quality and climate issues, new transmission lines and upgrades will be needed.

Reiterating the fact that PJM is neutral in the type of generation that is proposed, McNamara suggests that building a base-load plant in New Jersey will help close a supply and demand gap in the State, decrease the State's need to import energy, and obviously, improve the reliability of the grid and reduce electricity prices. While improving the energy situation in New Jersey new base-load power could also assist the State in meeting its highly aggressive reductions in greenhouse gas emissions and assist in improving air quality.

McNamara encourages the Clean Air Council to support the Energy Master Plan's consideration that adding additional base-load generation is needed in the State. He believes that non-carbon emitting solutions, such as nuclear is one possible solution.

PJM believes that demand response and energy efficiency will also play a very prominent role in the generation mix going forward and suggests that the Clean Air Council give great consideration to demand response resources and energy efficiency when making their recommendation.

The best and most cost effective means to reduce emissions and improve air quality is to reduce the amount of load on the system. The cheapest and cleanest megawatt of energy is the one that is not needed.
Demand response is the ability of electric consumers to control their costs and reduce their electric loads, often during times of high congestion and high prices, thus reducing the amount of electricity that must be supplied.

PJM has a significant amount of demand response already participating within its footprint. There are 4,620 megawatts of demand response committed as capacity resources for the 2008/2009 delivery year that began June 1st of 2008. McNamara states that PJM is working hard with its members and stakeholders to increase the use of demand response.

PJM is looking to develop a price responsive demand product and to put into place the infrastructure to support it and enable it. PJM is also looking to develop a CO₂ displacement certification for implementation in our Generator Attributes Tracking System or GATS to increase the participation of demand response resources in our market.

Energy efficiency is once again surfacing as a viable alternative to building new generation sources. By definition, energy efficiency is the installation of more efficient devices or equipment or the implementation of more energy efficient processes or systems. These devices or systems meet the requirements to exceed building code, appliance standards or other relevant standards during the time of installation.

PJM is also working to increase energy efficiency usage across the RTO. Starting with the 2012/2013 base residual auction later this spring, energy efficiency can bid into its capacity auction and if selected receive a capacity payment or revenue stream over a four-year period of time.

PJM has submitted a report completed in January of this year entitled, Potential Effects of Proposed Climate Change Policies on PJM's Energy Market. PJM recognizes that legislation to reduce carbon emissions is coming and will have a significant impact, not only on PJM, but also the members and their customers. This study was undertaken to help inform decision makers in Washington and elsewhere on how climate control proposals will affect the wholesale market and wholesale market prices.

The study has many conclusions on what the varying price levels for carbon will do to the market, consumer's bills and for carbon reduction; however, the study also shows that a significant mitigation of price impact occurs through increased demand response and energy efficiency so a 2 to 10 percent increase in energy efficiency measures can reduce wholesale prices of up to $18 billion per year across PJM. A 2 to 10 percent increase in energy efficiency measures also results in 14 billion to 60 million tons of emission reductions.

The desired outcome of our effort is that PJM will see a significant increase in the amount of demand response and energy efficiency that has been offered and selected in our Reliability Pricing Model (RPM) capacity market. These resources will not only increase the reliability of the grid, but will also contribute heavily in the process to reduce greenhouse gas emissions. PJM encourages the Clean Air Council to consider greater...
levels of demand response and energy efficiency when developing their recommendations.
So, once again, PJM appreciates the opportunity to share its thoughts to assist the Clean Air Council in making their recommendations.

From the testimony provided, PJM believes that reliability needs to be the first consideration giving the need of and the ever increasing demand for electricity. Aside from that, a holistic approach is required and should include transmission, new baseload generation and ever increasing amounts of demand response and energy efficiency.

William Levis
President & Chief Operating Officer
PSE&G Power
Mr. William Levis discussed PSE&G’s approaches to climate change. He specifically opted to discuss clean central power, the ever increasing need for it and how to make it feasible.

From a baseload generation standpoint, New Jersey has three options: coal (which accounts for 49% of the nations power), natural gas (which accounts for 20 %), and nuclear (which accounts for just under 20% nationally and greater than 50% state-wide). In order to distinguish what is available to New Jersey from a baseload capacity standpoint Levis suggests it is helpful to refer back to 1990. Over the years, natural gas has become a greater contributor to the energy capacity in the State. Nuclear has remained relatively constant since no new plants have been developed. Additionally, coal remains relatively flat while there has been a drop in oil capacity along the way. This information reflects the fuel diversity standpoint.

PSE&G looked at the Energy Master Plan to make sure they were meeting its restrictions and goals. They projected various levels of generation of the different types of fuels and predict that they are well positioned to meet the 2020 limits. Their strategy, according to Levis, is to utilize the most of their existing assets. They have made significant investments to existing units and Levis proposes that they have excelled with not only reliability but with cost efficiency, safety efficiency, and have done so in an environmentally responsible fashion.

An example of one of the aforementioned investments includes a $440 million extended power upgrade steam generator replacement which is said to have increased the output of two of their units by 200 megawatts. Furthermore, they predict that the major components should not need to be replaced for 60 years.

Regarding coal, PSE&G has made significant investments for environmental retrofits at the Hudson and Mercer stations. Those include things like scrubbers, SCRs, smoke stack gas filters which deal with SOx, NOx, Mercury and particulates; and, also, another several hundred million dollars in reliability improvements so that the unit will operate reliably when those environmental retrofits are accomplished.

What is next for PSE&G? They are faced with more questions than answers, such as:
What will the price of carbon be? Will this effect generation sources and make others more economic?

Interconnect costs; a plant can be built but it still needs to be connected to the grid. What will the costs be and will it be subject to the same rules of all other generation types?

Will transportation become electric? If so when is power required? How will it be supplied overnight if that's in fact when we are going to do it? How successful will the demand side management be?

What fuels will be available; natural gas? Coal-bed methane gas? How viable are these alternatives? What will the costs be?

What will be that next technological break?

These questions cannot be answered with much certainty. This poses a challenge as they attempt to make 40, 60, and 80 year decisions using information that could change with the next election.

Ultimately, Levis believes that diverse-unit plants that have diverse fuel capabilities are a viable future investment. Using this system, during the coldest days of the year the plant will be able to switch its fuel to oil in order to meet the heating demand. Natural gas will be used for the rest of the year as it has a lower CO₂ footprint than coal or oil. Diverse-unit type plants ensure the greatest amount of energy efficiency without reducing supply.

Nuclear power, though a potentially low greenhouse gas emitter, is a costly alternative - around $10 billion. Levis points out the significance of that number as the cost of one nuclear plant would be slightly greater than the entire net worth of PSE&G Company. The company needs to establish great regulatory certainty and financial certainty before it can deliver a nuclear project.

To conclude, Levis states that PSE&G understands the significance of climate change. The need to solve it is why the company approaches this issue on what he calls “every known front”.

Christopher Archer
Deputy Base Civil Engineer
McGuire Air Force Base

Mr. Christopher Archer appeared before the Clean Air Council to discuss the environmental accomplishments within the Air Force as well as to focus on other plans for the future. He begins by reading a quote from the Fourth Chief of Staff of the Air Force, General Thomas D. White, in 1959. The quote reads, “The mission of the Department of Defense is more than aircraft, guns and missiles. Part of the defense job is protecting the land, waters, timber, and wildlife – the priceless natural resources that make this great nation of ours worth defending.”

In the early 90’s the Air Force set ambitious goals to reduce such things as solid waste, hazardous waste, hazardous waste disposal, and hazardous material purchases by 50 percent. Since then both McGuire and the entire Air Force have exceeded their goals to reduction levels of 75 percent. In addition, they established an aggressive recycling system that was matched by equal success.
More recently, the McGuire Air Force has started to focus its efforts on reducing energy consumption and plans to become energy sustainable by 2015. So far, Secretary Wynne has partnered with industries and universities to help bring the Air Force to meet its ambitious goals. They are following the motto of the Air Force Smart Ops for the 21st Century that promotes the idea that “if it makes sense and it has a good return on investment, than absolutely do it”.

As an example, facilities on bases were able to be updated with better insulation. The investment cost roughly $100,000 however the project paid for itself in only one year. As part of Secretary Wynne’s program, he is establishing this concept not only in infrastructure but across the board to include vehicles, fuels, aircraft ops and cargo ops.

Another major initiative was established using this principle to create a C17 air landing zone in Lakehurst, New Jersey. The original issue was that C17 cargo aircraft needed to fly all the way to Charleston, South Carolina to complete practice missions. Since the creation of the additional landing zone they have reduced a two hour flight to roughly 25 minutes. The $12 million invested paid for itself within a year.

In terms of reaching its goals of achieving energy sustainability, Archer discussed the plans to reduce energy consumption by 50 percent in 2011 and an additional 10 percent by 2013. All new facilities being built are shooting for LEED certification. Specifically, the McGuire base has been working for the last three years with an Energy Saving Performance Contractor to further develop its plans to reduce consumption.

[To view a complete list of the initiatives developed in McGuire Base visit the website]

Archer noted the fact that there will be much help needed from local universities and industries to help provide expertise, innovative thought and cutting-edge technology. He concluded that energy sustainable progress is going to be a challenge, but they are going to continue to aim toward their 5 year goals. Energy sustainability has the added benefit for the Air Force to provide security. Energy self-reliance will be able to keep a mission going despite issues that may arise on the energy grid. As such, McGuire is leading the way to set an example for the rest of the community.

**Dennis Canavan**  
**Senior Director**  
**Global Energy, Johnson & Johnson**

Mr. Dennis Canavan began his discussion with background information regarding J&J. It was founded in New Brunswick, New Jersey in 1886 and remains the location of its headquarters. Today it is a much more decentralized company. They have about 250 operating separate companies around the world. They have about 120,000 employees, almost 15,000 employees and retirees in the State of New Jersey and operate in 57 countries.

There are three parts to the business; a consumer business with products like baby shampoo and Tylenol and Neutrogena, a pharmaceutical business and a medical devices business.
As a healthcare company they understand that climate change will have a devastating effect on human health. As a result, they began reducing greenhouse gas emissions as early as 1999. By 2003, it became an official policy of the company, mandatory for all of sites around the world.

J&J set a goal to reduce absolute emissions for all of their facilities by 7 percent compared to their 1990 emissions by 2010. Though this number may not seem large, it is important to remember that between 1990 and 2008 their company, in terms of sales, had grown more than six fold. While they grew, they had to continue to reduce absolute emissions to meet these standards.

Canavan referenced a couple of recent projects begun by the company in the last few years. One key initiative was the construction of a geothermal system which has had great success in Europe, particularly in their French plant. Second, they have included biomass projects. They built a wood-chip burning boiler using wood-chips from a sustainable forest rather than building a gas-fired boiler. Third, they began massive solar installations across their global sites as well as state-wide. Finally, they used geographical location as an advantage and have used methane gas from near by municipal waste dumps to run their facilities.

[For a complete list of all J&Js projects both global and state-wide visit the full transcript on the website…]

In conclusion, Canavan wanted to focus on promoting the success J&J has had as a model for others to follow. He states that while they were doing something good for the environment they also experienced a 17 percent internal rate of return on these projects. He recommends to companies that are looking at climate change legislation and fear the cost of starting these projects should look at their experiences and successes. There are many economic opportunities to reduce emissions and continue to make a profit.

**Joseph Dominguez**

**Senior Vice President for Governmental Affairs and General Counsel**

**Exelon Generation**

Mr. Joseph Dominquez presented the different technologies Exelon Generation is applying and the discussions they are making to move forward.

In total, Exelon is the largest generation company in the country. They are predominantly a nuclear company and own 17 nuclear reactors. In addition, they operate wind farms, manage the largest solar array and landfill gas application east of Mississippi.

Exelon has taken the preliminary steps to file for permits to construct a new nuclear project in Victoria Texas. They aspire to do many things to reinvent the energy grid and reach climate change restrictions by 2030. However, the Brattle Group estimates that the cost of doing all these plans would total over $1.7 trillion. These investment costs are enormous. The cost of materials to build nuclear plants, whether they are copper or costs of cement, have increased dramatically along with labor and financing costs. Regardless, Exelon has established goals to eliminate their carbon footprint by 2020. Dominquez clarified this to mean that while the company plans to retain their coal and
natural gas assets, they will build cleaner technology to offset and displace the carbon that is already accounted for in their dispatch plan.

The foreseeable future initiatives to achieve these ambitious goals is to upgrade and increase output of existing nuclear power plants and construct natural gas plants that emit very little carbon.

Interestingly, Dominguez chose to share research coming out of Europe that may negate the general view that natural gas is cleaner than coal. From a pure emissions standpoint at the power plant it remains true that coal is the less clean fuel. However, in Europe researchers have begun tracking emissions from natural gas not only at the power plant but from the well in which it is extracted. Conclusions have found that a number of natural gas wells have embedded CO₂ in them and they bleed-off CO₂ into the atmosphere. In this regard, some natural gas wells produce an overall carbon impact that is even greater than coal. Dominguez points out the difficulty this will have in determining taxes of emissions and how the cap-and-trade policy will work properly.

Dominguez reflects that there has been somewhat of a renaissance in terms of public reception to nuclear power. Though, he believes it hasn’t been significant enough. Dominguez understands the immediate need to figure out a way to deal with the existing carbon dioxide being emitted from power plants. He predicts one solution is to deploy roughly 300 nuclear power plants nationally. Dominguez concludes his recommendations to the Council by stating a need for a carbon policy without picking winners or losers and to create an appropriate and consistent price signal for the market.

Jeff A. Halfinger
Babcock & Wilcox Company

Mr. Halfinger began by recapping information about nuclear power that had been mentioned throughout the hearing as a lead in to his proposal. He recaps that nuclear is baseload power that runs all the time and is always available. It is a non-emissions technology as the only emission it generates is heat. Halfinger also reiterated the common sentiment expressed throughout the hearing that companies struggle to find funds and time to build nuclear plants or significantly enhance their pre-existing nuclear capabilities.

Nuclear power plants, as we know them today, are very large vessels within a facility. The parts include a large steel vessel which is the reactor, either three or 4 steam generators, a pressurizer, a steam turbine, and a spin generator. These parts work together to put electricity out on the grid. These large facilities also have the added inconvenience of needing to be located near a large reservoir or source of water for cooling, such as a river.

Babcock and Wilcox Company has found a new way to distribute nuclear power in a much smaller, convenient form, module reactors. These reactors contain within one small vessel, called the Nuclear Steam Supply System, all the parts of a traditional nuclear power plant. These convenient reactors can be installed in any location to generate power for nearby buildings.
There are many benefits of using these module reactors over building enormous and costly nuclear power plants. Traditional nuclear plants need to be built to produce as many megawatts of energy as possible in order to amortize high development and construction costs. On the other hand, the construction schedule for the module systems is much shorter and project financing is much lower. Because they predict to make large numbers of reactors, production costs get cheaper. Halfinger continues that with the modules there are simplified operations and maintenance.

The reactor sits within a concrete containment building. All the fuel needed for the lifespan of a reactor is stored inside the reactor building. The majority of the structure is constructed underground. This has numerous advantages for shielding against missile penetration and seismic effects. Halfinger mentions that discussions have been made with McGuire Air Force base and Kirkland Air Force base about how this technology could be used in facilities like that which are trying to get off the grid and be more sustainable. For locations that have large energy demands, high energy prices and lots of usable land, module reactors are an economically wise and environmentally friendly decision.

In conclusion, Halfinger broke down the competitive advantages of investing in module reactors. They are: the short construction cycle and the shop fabrication of the components, the reduced risk at the site and the supply chain, shorter construction schedule (roughly three-years), it will involve PWR technology, so the regulator is very familiar and comfortable with the technology, it has a five-year refueling cycle so the O&M costs are optimized, and, finally, because there are a lot of benefits, safeguards and security with the facility being underground and the spent fuel being entirely contained.

Rick Mroz
NJ Energy Coalition

The New Jersey Energy Coalition is made up of 60 organizations that are active in the State including state-wide organizations like New Jersey SEED, New Jersey Alliance For Action, New Jersey BIA and state-wide labor organizations like the IBEW. The mission of the Coalition to talk about air quality issues, energy issues, environmental issues, all of which come together in the work that has come to fruition in the Energy Master Plan.

The Coalition has been supportive of The Master Plan and has worked collaboratively with the administration to support its goals whether they are for energy efficiency, introduction of renewables, conservation, or for other measures. A lot of the Coalition’s work has been to continue to focus the discussion publicly and with policy makers that there is still a need to meet the baseload generation issues.

Although New Jersey has made enormous progress by generating 10,000 gigawatts of electricity through combined heat power and using renewable resources to produce as much as 30 percent of the remaining demand for electricity, at the end of the day approximately 47,800 gigawatts of the 2020 demand remains to be met by other generation sources.

While some companies have taken the initiative to upgrade facilities or invest in changing fuels, nevertheless, there is still a serious baseload need. As existing plants age and need to be retired, New Jersey’s baseload capacity and economy will suffer.
Mroz recommends that policy makers, stakeholders like the New Jersey Energy Coalition, environmental groups and industry need to be pressing the importance of these issues. It is not just a New Jersey policy issue. It's one that really goes beyond the federal energy policy. In fact, the new administration in Washington has a great opportunity to forge what will be the future of that energy policy for baseload generation and for the nuclear fleet issues.

Also the administration faces issues as to the challenges to possibly restart and to encourage the federal tax credits discussed earlier in the hearing that will assist companies on how to plan. Any company trying to plan for the future needs to see what the setting of the regulated utility market will be in 20, 30, 40 and 50 years. If the energy future is stable and the policies are clear, companies will see benefits in making investments and see the value in staying and committing to work here in New Jersey.

Mroz states that regardless of the challenges of the re-licensing existing nuclear generation facilities, or the challenges for the construction of possible new clean central station plants, there needs to be a clear policy with clear regulatory settings so that companies that want to build can build, that the capital markets see a clear path and are willing to invest and support the investment construction for new generation facilities whether they be nuclear or otherwise.

Discussion and the debate need to begin with the intent of finding a clear path that will give comfort to investors and businesses and secure the future for New Jersey.

Robert Williams
Senior Research Scientist
Princeton Environmental Institute
Mr. Robert Williams discussed before the Council options on what should be done with coal power to meet greenhouse gas mitigation goals.

For existing coal-fired power plants, there will be two options. One option is to pursue CO₂ capture and storage by means of retrofitting existing plants with CO₂ scrubbers or other technologies. The other option is to retire these plants long before industry would like. Williams’s focus of study is how to re-power existing coal plants to avoid the latter fate. His presentation focuses on what the available options are for retrofitting existing coal fired power plants specifically using his calculations on the Hudson Plant in New Jersey.

The first option is to retrofit the plant with amine scrubbers. This means scrubbing the CO₂ out of the stack gases. However this is quite costly, it involves a huge energy penalty and it requires very high greenhouse gas emissions in order to make the technology cost effective. The alternative option is the use of various re-powering options, that is, replacing the equipment entirely, but saving the site, including the coal-handling facilities. Among these, the least costly stand-alone power option is the coal integrated gasification combined cycle power plant with carbon capture and storage.

The commercially ready technology that Williams has factored into his calculations involves the co-production of liquid fuels and electricity with carbon capturing storage.
These offer the prospect of very low CO₂ capture costs because cost of CO₂ capture is simply the cost of CO₂ drying and compression. So, with this model it is easy to put the carbon into a pipeline and send it somewhere underground.

These combined facilities offer higher energy efficiency and lower capital costs than for any separate production facilities and they offer attractive economics for power generation at high oil prices. They also offer extremely low conventional pollutant emissions, such as SOₓ, NOₓ and ROₓ (particulate matter) and mercury at the plant and from the ultimate burning of the synthetic fuels.

There is an additional option to add biomass to the coal and co-process coal and biomass to make liquid fuels and electricity with CCS. When doing this biomass’ status, which is usually considered as a carbon-neutral feedstock, becomes one that is carbon negative because they are sequestering photosynthetic CO₂, underground along with the CO₂ that was stored underground associated with the coal.

Williams reiterates that this is not an advanced technology. Commercial coal to gasoline and coal to liquids technologies with CCS are going to be commercially ready in essentially the 2012 time frame compared to post 2020 for these other technologies. And in fact, there is already a CCS project underway in New Jersey. New Jersey is unique in thinking about CCS opportunities early on, even though less than 20 percent of its generation comes from coal, compared to about 50 percent U.S. average.

[To view the full analysis of Mr. Williams’s report on various alternatives on the Hudson Plant visit the website]

Williams concludes with the system that he has given focused attention to throughout his presentation is one that would gasify coal and biomass to make synthetic liquid fuels and co-product electricity. Co-production, as he indicated, offers very large energy efficiency and capital cost advantages compared to separate production of liquid fuels and electricity in separate units. Biomass coal co-processing enables facilities to exploit simultaneously negative greenhouse gas emission benefits of photosynthetic CO₂ storage and also coal conversion scale economies. Finally, he proposes initiatives/actions to be pursued by the Department of Energy and the Department of Defense regarding these viable technology options.

**Hal Bozarth**  
**Executive Director**  
**Chemistry Council of NJ**

The goal of Mr. Hal Bozarth’s presentation is to provide some facts about New Jersey and about the views of the manufacturing sector of which he represents. His goal is to provide a different perspective on energy issues.

Bozarth begins by outlining the recent situation for many companies during this economic environment. AGC Chemicals closed their Bayonne site last year and as a result 160 people were fired. Sunoco plans to lay off 20 percent of its salaried employees. Rohm Haas will cut 900 jobs, given their merger with Dow and after the merger is done, another 3,500 jobs will be gone. GlaxoSmithKline expects to cut 6,000 jobs. Dow
Chemical will cut 5,000 jobs worldwide, close 20 plants and sell several businesses. Ashland bought Hercules and slashed at least 200 jobs, if not more. Bristol-Myers Squibb had 3,700 cuts while Praxair had 1,600. If Merck buys Schering Plough, there will be significant cuts, all within New Jersey. Finally, Chemtura’s bankruptcy resulted in the closure of four plants in New Jersey.

Bozarth elaborates to provide facts about the energy situation in the state. New Jersey’s industrial energy price rates are 60 percent above the national average. Of all sectors, industry rank ninth in the nation for the highest energy rates in the country. Bozarth then provides a few questions he hopes the Council will consider before making their recommendations.

1. Should there be a cap and tax system that potentially adds another $100 for a kilowatt of energy?
2. Should there be a tax on existing carbon-based fuels?
3. Should policy-makers worry about the economic repercussions of what they do?

He suggests to the people in leadership positions to instead, consider looking for new options within The United States for new energy supplies. Options include off-shore and inland oil drilling and searching for domestic sources of natural gas.

All chemistry businesses, including those that make pharmaceuticals, flavors and fragrances, rely heavily on energy. Considering the current economic recession, if energy is predicted to increase to cost $150 a barrel there will be massive implications. Bozarth communicates his fear that if the industrial sector, which is a high-energy intensive user, has to cut its greenhouse gas emissions and increase costs then policy-makers are going to have widespread disapproval like nothing they’ve seen in the last year.

In conclusion, Bozarth’s recommendation to the Council is to drill here and drill now. He believes that unless China and India begin renewable energy initiatives, the United States will only be stunting its own economy. He supports this claim by stating that U.S. industrial capabilities will never be able to compete on a worldwide level if energy rates increase, because other nations are never going to follow our lead.

**Kenny Esser**
Chief Energy Advisor
Office of Governor Jon S. Corzine

Mr. Kenny Esser came to the hearing to represent the Office of Governor Jon Corzine and to provide an overview of the current actions of the State government.

The Energy Master Plan, released by the governor in October 2008, is a combination of aggressive goals and targets as well as an acceptance of the reality of the energy situation in the State. There are three challenges addressed in the Energy Master Plan: reliability, affordability and greenhouse gas emissions. In other words, how can the State improve the reliability of its systems, the affordability of energy supply and reduce greenhouse gas emissions? In the Master Plan there are outlined five different goals accompanied with about 25 different action items to get there.
The first issue is encouraging energy efficiency which is projected to reduce demand for electricity by 20 percent by 2020. The Master Plan has established three action items to reach that target. The first, to establish building code legislation to encourage more energy efficient buildings; second, create more efficient appliance standards so that consumers are buying the latest appliances; and, third, consider how in New Jersey to reach 3.7 million buildings between now and 2020 to get the energy savings that are needed.

The second issue the governor’s office is working to address is peak demand. According to Esser, the issue with demand response has created a situation where energy prices skyrocket. He states that the governor needs to find a way to reach the market, either through metering technology or rebate programs, and encourage the public to change their behavior.

The third issue concerns renewable energy. The Global Warming Response Act, signed by the governor, mandates 20 percent reductions of greenhouse gases by 2020. After the governor signed the Act, Esser’s office calculated that through the planned use of renewable energy, New Jersey would actually be able to exceed that number and reach reductions of 30 percent by 2020. Esser believes that with the help of the initiatives taken to advance solar and wind technologies, coupled with energy storage technology (which he is confident will mature) energy prices will fall.

Additionally, Esser states that the governor is going to assemble a task force to further research baseload demand in New Jersey and conclude what the future holds for nuclear energy. Currently the knowledge of these areas is underdeveloped. There needs to be an examination of baseload demand, baseload supply and the relation of these in the PJM marketplace.

Esser concludes that the ultimate goal is to provide a reliable, affordable energy supply that is completely environmentally neutral. Through he realizes this cannot be fully achieved by 2020 he presses that the issue is unavoidable. The initiatives already taken by the state are buying time before the ultimate solution presents itself. Esser believes the solution is on its way and in the meantime the government has found a way to create jobs, lower energy bills and reduce greenhouse gas emissions.

**Public Speakers**

**Mike Kennedy**
The first public speaker, Mr. Mike Kennedy came to the hearing from Normandy Beach, which is in Ocean County, New Jersey. He came to the meeting to present the roadblocks he has faced that have discouraged him from installing a small wind turbine in his backyard. Kennedy says that the turbines he wishes to install meet local regulations in terms of height and diameter. He researched that all buildings within Brick Township have a 35 foot height restriction and that the 30 foot energy structure would be well within building code requirements.

The turbine will generate 3 kilowatts of energy which Kennedy says will ultimately pay for his electric bills. Furthermore, many other people in his township expressed a desire
to install similar turbines. He saw the economic benefits of creating a small business to help his neighbors install their turbines, save money, and reduce greenhouse gas emissions.

Kennedy proceeded with the next step only to reach another obstacle. DEP representatives informed Mr. Kennedy that he needed to apply for a permit in order to install the turbine. He was later told that an individual permit would cost $3,600 plus a percentage of the installation. This cost would almost equal the cost of the turbine which is marked at $4,500.

Kennedy notes that many presenters at the hearing discussed solving the issue of affordability. Certainly, under the current regulations, affordability is far from solved for individuals seeking a chance to save money and reduce their carbon footprint. There was also an expressed need to create green jobs. Kennedy sought to create a green job by installing household wind turbines. After regulations, there was no economic benefit to begin this local business.

Kennedy feels that the Department of Environmental Protection is supposed to protect New Jersey’s environment and instead they are preventing him from doing just that. He asks the Council to assist him in getting the DEP to reduce their fees. He also asks that the State mandate that the municipalities adopt some type of ordinance for a small wind energy system that is consistent throughout the State. He wishes to make this a viable energy solution.

**Bob Van Camper**

Mr. Van Camper came to say something about the Governor supporting Liquefied Natural Gas (LNG).

The proposal for an (LNG) program constitute building one permanent island one, floating island and another pipe pickup system off the coast of New Jersey. This has not been previously done in the open ocean. Van Camper wonders how can there be environmental regulations that cover these circumstances?

And, in the end, he believes that this will only create more dependence on foreign fossil fuel. He believes this is a situation we have to get away from. He strongly thinks that the only thing that is ever going to lower costs is competition. By competition he means not only more companies and utilities but more alternative types of energy. That is what the Governor should be looking to develop. Alternative energy sources are going to get us away from these problems.
**Glossary of Acronyms**

**Acid rain deposition** - rain or any other form of precipitation that is unusually acidic. It has harmful effects on plants, aquatic animals, and infrastructure. Acid rain is mostly caused by human emissions of sulfur and nitrogen compounds which react in the atmosphere to produce acids.

**Anaerobic Digestion** - a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. Anaerobic digestion is a renewable energy source because the process produces a methane and CO₂ rich biogas suitable for energy production helping replace fossil fuels. Also, the nutrient-rich solids left after digestion can be used as fertilizer.

**Base load generation** - the minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Base load values typically vary from hour to hour in most commercial and industrial areas.

**Bio-char** - charcoal created by pyrolysis of biomass. The resulting charcoal-like material is a form of carbon capture and storage. Charcoal is a stable solid and rich in carbon content, and thus, can be used to lock carbon in the soil. Biochar is of increasing interest because of concerns about climate change caused by emissions of CO₂ and other GHGs.

**Biomass-based fuel** - a renewable energy source using living and recently dead biological material as fuel or for industrial production. In this context, biomass is commonly plant matter grown to generate electricity or produce heat. For example, forest residues (such as dead trees, branches and tree stumps), yard clippings and wood chips may be used as biofuel. However, biomass also includes plant or animal matter used for production of fibers or chemicals. Biomass may also include biodegradable wastes that can be burnt as fuel.

**Carbon Capture** - a theoretical approach to mitigating the contribution of fossil fuel emissions to global warming, based on capturing CO₂ from large point sources such as fossil fuel power plants. It can also be used to describe the scrubbing of CO₂ from ambient air as a geoengineering technique. The carbon dioxide might then be permanently stored away from the atmosphere in a process termed carbon capture and storage, or CCS.

**Coal-fired Power Plant** - a power plant that burns coal to produce electricity.

**Co-generation** – Also known as combined heat and power or CHP, it is the use of a heat engine or a power station to simultaneously generate both electricity and useful heat.

**Combined cycle power plants** - electricity generating plants comprising a gas-turbine generator unit, whose exhaust gases are fed to a waste-heat boiler, which may or may not
have a supplementary burner. The steam raised by the boiler is used to drive a steam-turbine generator.

**Compressed air energy storage systems (CAES)** – systems which use off-peak electrical power to compress and pump air into airtight chambers underground. Then when electricity is needed during peak hours, the air is released from the underground chambers. The air is heated and expanded through a combustion turbine to generate the needed electricity. The underground chambers are generally caverns cut out of impervious rock formations, salt caverns, or depleted gas or oil fields.

**Distributed Generation** – the generation of electricity from many small, local energy sources, rather than one large centralized source.

**Electric Transmission** - the bulk transfer of electrical power (or more correctly energy), a process in the delivery of electricity to consumers. A power transmission network typically connects power plants to multiple substations near a populated area. The wiring from substations to customers is referred to as electricity distribution.

**EMP** - means Energy Master Plan. It is the State's road map toward a responsible energy future.

**Fuel Cell Technologies** - an electrochemical conversion device. It produces electricity from fuel (on the anode side) and an oxidant (on the cathode side), which react in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate virtually continuously as long as the necessary flows are maintained.

**Geothermal** - power extracted from heat stored in the earth. This geothermal energy originates from the original formation of the planet, from radioactive decay of minerals, and from solar energy absorbed at the surface.

**Geothermal heat pumps (GHPs)** - simple pumps that take advantage of the relatively constant temperature of the earth's interior and use it as a source of both heat and cooling. In the summer, the ground is cooler than the air and the GHP can be used for cooling. In the winter, the ground is warmer than the air and the GHP can be used for heating. A simple water pump and underground pipe system operate to circulate the fluids from the surface to the ground in a continuous cycle.

**Gigawatt-hours** - One gigawatt-hour (GWh) equals one million kilowatt-hours.

**Ground-level ozone** - the primary constituent of smog, VOCs and NOx emitted from a variety of sources, including vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents, combine in the presence of sunlight and hot weather to cause ground-level ozone to form in harmful concentrations in the air.

**Hydroelectric** - electricity generated by hydropower, i.e., the production of power through use of the gravitational force of falling or flowing water. **Microhydro** is a term used for hydroelectric power installations that typically produce up to 100 kW of power.
**Integrated gasification combined cycle (IGCC)** - a technology used by power plants that first gasifies coal and then burns the gas to produce electricity.

**Kilowatt** - One thousand watts; ten 100-watt lightbulbs consume a kilowatt of electricity. One kilowatt equals 3,415 BTU (British Thermal Unit).

**Megawatt** – a unit of power equal to one million watts (see “watts” defined below).

**Net metering** – a system which allows home-based renewable energy systems to send excess power not immediately needed in the home directly back into the electrical grid while crediting the homeowner for the excess power. Also known as net billing.

**Particulate matter** - Also known as particle pollution or PM, it is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Sources of particulate matter can be man made or natural. Human activities that generate significant amounts of particulate matter include the burning of fossil fuels in vehicles and power plants, and various industrial processes.

**Peak demand** - term used in energy demand management to describe a period in which electrical power is expected to be provided for a sustained period at a significantly higher than average supply level. Peak demand fluctuations may occur on daily, monthly, seasonal and/or yearly cycles. For a utility, the actual point of peak demand is a single half hour or hourly period which represents the highest point of customer consumption of electricity. Related terms are: peak load and on-peak.

**PJM** - The regional transmission organization which plans and operates the electric transmission grid in a region that covers thirteen states and the District of Columbia, stretching from New Jersey as far west as Illinois and as far south as North Carolina. PJM also designs and administers wholesale electricity markets in that region.

**Pyrolysis** - the chemical decomposition or alteration of a condensed or compacted substance (e.g., wood, coal, or other combustible materials) by heating.

**Plasma Gasification** - a waste treatment technology that uses electrical energy and the high temperatures created by an electrical arc gasifier. This arc breaks down waste primarily into elemental gas and solid waste (slag), in a device called a plasma converter. The process has been intended to be a net generator of electricity, depending upon the composition of input wastes, and to reduce the volumes of waste being sent to landfill sites.

**Regional Greenhouse Gas Initiative (RGGI)** - a ten-state cooperative effort designed to implement a regional mandatory cap-and-trade program in the Northeast and Mid-Atlantic addressing CO₂ emissions from Electric Generating Units (EGUs) (i.e., power plants). Hosting its first allowance auction on September 25, 2008, RGGI became the first mandatory market-based CO₂ emissions reduction program in the U.S. Specifically, the program caps regional power plant CO₂ emissions at approximately current levels from 2009 through 2014 and then reduces those emissions 10 percent by 2018.
**Renewable portfolio standards (RPS)** - standards imposed by a country or state requiring a utility to generate or buy a certain amount of renewable electricity based on a percentage of its total electricity output.

**Smart grid** - term used to define the modernized system of generating and delivering electricity to customers characterized by the following performance features: a) self-healing from power disturbance events (able to rapidly detect, analyze, respond and restore itself from perturbations); b) enabling active participation by consumers in demand response; c) operating resiliently against physical or cyber attack; d) providing a quality of power consistent with consumer and industry needs; e) accommodating all generation and storage options; f) fully enabling maturing electricity markets; and g) optimizing assets (a grid that uses information technology and monitoring to continually optimize its capital assets while minimizing operations and maintenance costs).

**Solar renewable energy certificates (SRECs)** - a market-based incentive feature of an RPS program. Each generating plant is awarded one SREC for each unit of solar energy produced, usually one megawatt, once that amount of solar energy has been generated and delivered. The environmental value of the SREC is equal to the contribution that one megawatt of clean power makes to improve the environment. The monetary value of the certificate, however, is determined by the marketplace, i.e., how much a buyer of an SREC is willing to pay and how much a seller is willing to accept. Once the buyer purchases the SREC, it cannot be resold and is effectively retired. The money the seller received for the SREC helps offset the cost of constructing or operating the solar renewable energy facility, or buying more solar renewable energy.

**Super Capacitors** - electrochemical capacitors that have an unusually high energy density when compared to common capacitors, typically on the order of thousands of times greater than a high capacity electrolytic capacitor. They have a variety of commercial applications, notably in "energy smoothing" and momentary-load devices.

**Superconducting Magnetic Energy Storage** - systems that store energy in the magnetic field created by the flow of direct current in a superconducting coil which has been cryogenically cooled to a temperature below its superconducting critical temperature.

**Waste-to-energy** - is a form of energy recovery through the process of creating energy in the form of electricity or heat from the incineration of waste source. Most WTE processes produce electricity directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

**Watt** - A unit of power measuring of the rate of energy conversion. It is equal to one joule per second (a joule is the energy exerted by a force of one newton acting to move an object through a distance of one meter). A human climbing a flight of stairs is doing work at a rate of 200 watts. **Watt-hour** is a unit of energy equivalent to one watt of power expended for one hour of time. Electric "energy" is measured in watt-hours, kilowatt-hours, megawatt-hours, or gigawatt-hours.
CAC PUBLIC HEARING HISTORY

2008  Improving Air Quality at Our Ports & Airports—Setting an Agenda for a Cleaner Future


2006  Indoor Air Quality

2005  Air Pollution—Effects on Public Health, Health Care Costs, and Health Insurance Costs

2004  Fine Particulate Matter in the Atmosphere
   •  Health Impacts in NJ
   •  Need for Control Measures

2003  Moving Transportation in the Right Direction

2002  Innovative Solutions for Clean Air

2001  Air Quality Needs Beyond 2000

2000  Air Toxics in New Jersey

1999  The Impact of Electric Utility Deregulation on New Jersey’s Environment

1998  CLEAN AIR Complying with the Clean Air Act: Status, Problems, Impacts, and Strategies

1997  Particulate Matter: The proposed Standard and How it May Affect NJ

1996  Clearing the Air Communicating with the Public

1995  Strategies for Meeting Clean Air Goals

1994  Air Pollution in NJ: State Appropriations vs. Fees & Fines

1993  Enhanced Automobile Inspection and Maintenance Procedures

1992  Impact on the Public of the New Clean Air Act Requirements

1991  Air Pollution Emergencies

1990  Trucks, Buses, and Cars: Emissions and Inspections

1989  Risk Assessment - The Future of Environmental Quality

1988  The Waste Crisis, Disposal Without Air Pollution
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<td>1986</td>
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<td>1981</td>
<td>How Can NJ Stimulate Car and Van Pooling to Improve Air Quality</td>
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<td>1980</td>
<td>(October) Ride Sharing, Car – and Van-Pooling</td>
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<td>What Are the Roles of Municipal, County, and Regional Agencies in the New Jersey Air Pollution Program?</td>
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<td>Clean Air and Transportation Alternatives to the Automobile and Will the Environmental Impact Statement Serve to Improve Air Quality in NJ?</td>
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<td>1971</td>
<td>How Citizens of NJ Can Fight Air Pollution Most Effectively with Recommendations for Action</td>
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<td>Status of Air Pollution Control in NJ, with Recommendations for Further Actions</td>
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New Jersey Energy Master Plan. 2008 (http://nj.gov/nj/trans/)

New Jersey State Energy Infrastructure Profile – Map

Map provided by NJ State Museum/Energy Information Administration