Energy Use and Renewable Energy Sources

Background

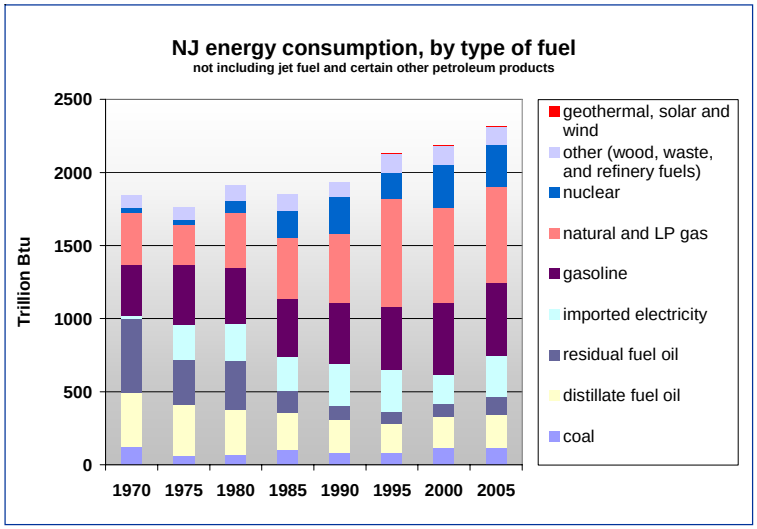
Our quality of life and economy depend on the availability of large amounts of energy, most of which comes from the combustion of fossil fuels. Fossil fuels include coal, natural gas, and a variety of liquid fuels, such as gasoline, diesel fuel, and heating oil, that are derived from petroleum. We use considerable amounts of gasoline and diesel fuel for transportation; we use heating oil and natural gas for heating our buildings, and we use electricity in a variety of ways, including manufacturing, heating and cooling, lighting, and in communications. A significant portion of electricity is generated by the combustion of fossil fuels, mostly natural gas and coal. Fossil fuels are not renewable, which means that at some point they will become depleted and increasingly costly.[1] Also, their combustion releases air pollutants, including ozone precursors such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs); acid rain precursors including NO_x and sulfur dioxide (SO_2); various toxics such as mercury; and carbon dioxide, a major greenhouse gas (GHG). Extraction, transport, refining and use of fossil fuels also cause serious environmental impacts to the earth's surface (e.g. strip mines, oil spills and storage tank leaks) and pollution of aquatic systems (e.g. acid mine drainage and thermal pollution of rivers). Large amounts of land and other resources are consumed for electricity transmission lines, oil and gas pipelines, road and rail transport of fuels, and fuels storage.

Unlike fossil fuel combustion, renewable energy sources provide energy without depleting fossil fuel reserves and with much lower overall carbon dioxide emissions. Renewable energy sources include hydropower, wave or tidal, geothermal, solar, wind and biomass. Although biomass fuel sources release carbon dioxide when burned, generally they are not considered net releasers because they also remove carbon from the atmosphere during their growth cycle.[2]

A fast-growing and promising renewable source of energy in the U.S. is wind power. New wind-power sources are generally competitive in cost with new, conventional electricity-generating plants when sited in areas with a good wind resource. A study coordinated by the NJ Commerce Commission to examine potential economic impacts of constructing up to 288 megawatts (MW) of wind power capacity off the New Jersey shore was released in September, 2008.[3] A baseline study coordinated by DEP to determine the current distribution and usage of New Jersey's offshore waters by ecological resources will be completed by 2010. This information will be used to help determine those portions of New Jersey's offshore waters that are more or less suitable for wind/alternative energy power facilities based on potential environmental impacts. Plans to build a series of towers to provide reliable meteorological data, which will help refine the assessment of locations for wind turbines, are in the process of receiving final approvals with construction anticipated during the summer of 2010. Tentative plans call for the inception of construction of three wind farms off the coast in federal waters, each with a capacity of 350 MW, by 2013 with power production to follow soon thereafter. The first commercial scale wind farm was constructed in Atlantic City and has been operational since 2005. Additional wind power projects are planned in other areas of the state. The New Jersey Energy Master Plan (EMP) calls for a total of 3000 MW of off-shore wind capacity to be built by 2020.[4]

Status and Trends: Temperature

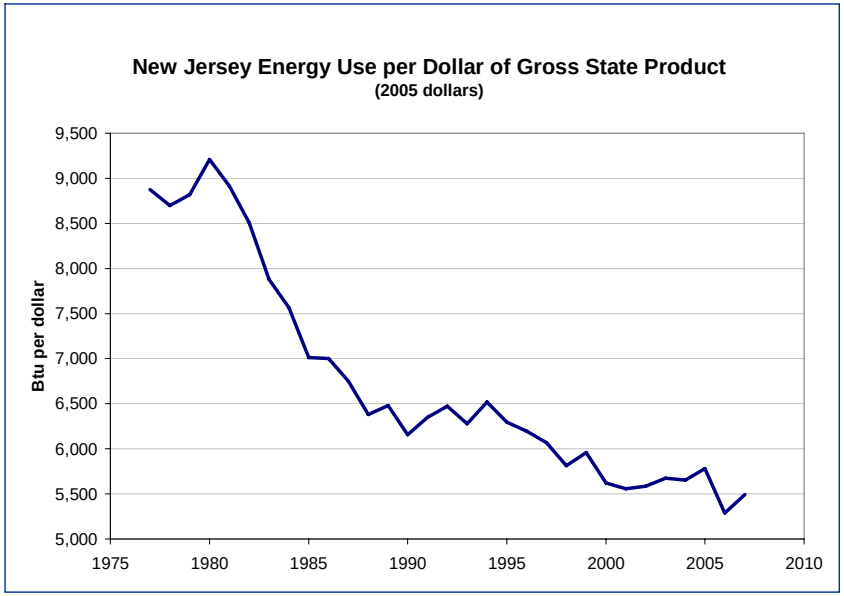
Total energy use has grown in New Jersey and the United States for the last several generations.[5] (See figure "NJ energy consumption, by type of fuel") There also has been a trend of increased energy efficiency over time. (See figure "New Jersey Energy Use per Dollar of Gross State Product.")



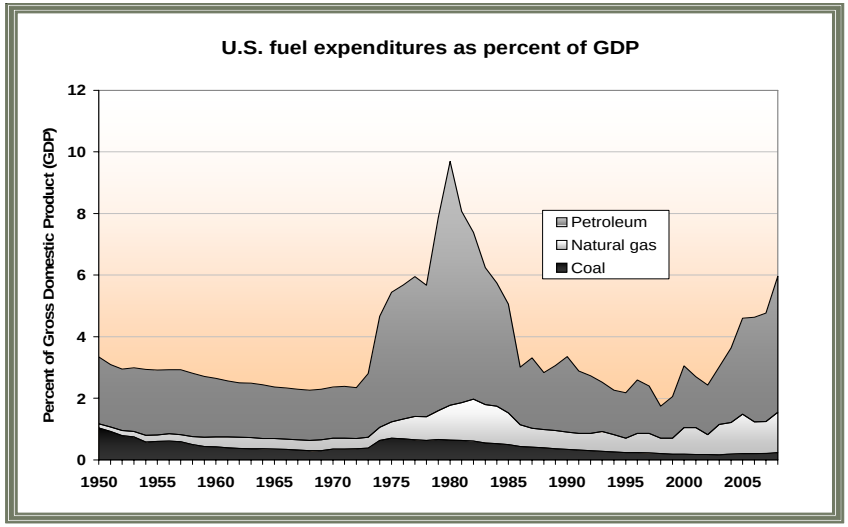
There have been changes in the mix of energy sources used, including a decline in the use of residual fuel oil and an increase in the use of nuclear power. Also, in recent years New Jersey has generated less electricity in-state, instead importing more from out-of-state sources. (See figure "NJ energy consumption, by type of fuel").

Production of energy by the combustion of fossil fuels releases carbon dioxide, a GHG whose presence in the atmosphere has a warming effect on the earth's climate. (Such combustion also releases gases such as NO_x that facilitate the production in the lower atmosphere of ozone, which is itself a GHG.) Globally, carbon dioxide is increasing steadily in the atmosphere, as are several other greenhouse gases. GHGs generated by human activities already have altered the earth's climate, and are likely to cause significant warming in the future. It is increasingly clear that impacts of this warming, and associated climate changes could be quite negative and irreversible over any reasonable time frame (see the separate report, Climate Change, in this Environmental Trends series).

Despite efforts to implement strategies to reduce greenhouse gas emissions in the state, these emissions have increased during the last decade. However, more aggressive control measures are required by New Jersey's new law, the Global Warming Response Act (GWRA), which was enacted in July, 2007.[6] The law limits statewide GHG emissions to 1990 levels by 2020 and to a level 80 percent below 2006 levels by 2050. (See the separate report, Greenhouse Gas Emissions, in this Environmental Trends series.)



Continued dependency on fossil fuels also means facing the risk of dramatically increasing energy costs if fossil fuel production fails to keep pace with the steadily growing demand for energy - or if production actually decreases, as some predict.[7,8,9,10,11] Prices of petroleum have in fact risen dramatically in recent years, and the price rises have not, so far, stimulated a noticeable increase in production; the year of peak global production of petroleum stands as 2005.[12] The rising cost of petroleum and to a lesser extent other fossil fuels has led to a recent increase in the percentage of the U.S. gross domestic product that is consumed by expenditures on fuel. It is likely that this increasing percentage has already had economic ramifications, and further increases in this percentage may significantly impact the economy See the figure "Fuel Expenditures as percent of U.S. GDP." NJ produces no fossil fuels; the state is totally dependent on imports.



Solutions to the twin problems of rising greenhouse gas emissions and accelerating energy costs can be found in increased energy efficiency and conservation,[13] and in the replacement of fossil fuel energy with renewable sources. Primarily because it is not blessed with abundant hydropower or geothermal energy, New Jersey receives a smaller percentage of its energy from renewable sources than the U.S. average. Nationally, three categories of renewable energy, geothermal, wind power, and solar power, supplied about 750 trillion Btu per year in 2007, which represented about 0.7 percent of the U.S. total energy consumption of about 102 quadrillion Btu/year. In the U.S. wind power capacity is expanding rapidly, adding about 200 trillion Btu of capacity between 2003 and 2007. In New Jersey, these three renewable source categories supplied in 2007 about 2.6 trillion Btu/year,[14] which represented 0.1 percent of the state's approximately 2600 trillion Btu[15] total energy consumption. Of the 2.6 trillion Btu/year in 2007, 0.5 trillion Btu is estimated to come from geothermal, 1.5 trillion Btu from solar thermal, and approximately 0.6 trillion Btu from solar photovoltaic (PV) sources. New Jersey's recent rate of growth in solar energy is higher than the U.S. as a whole. The State increased solar capacity by over 50% from 2004 to 2007; U.S. solar increased by 25%. New Jersey has the most solar PV per square mile of any state, and is second only to California in the total amount of installed solar PV capacity.[16] As of October, 2009, New Jersey had over 108 MW of solar PV capacity at over 4500 installations in the State.[17]

Outlook and Implications

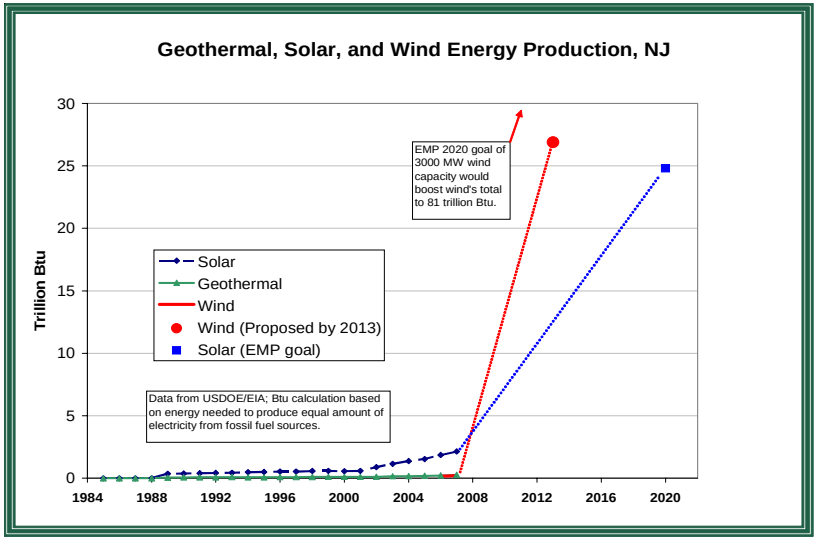
As noted above, the construction of more wind power capacity is planned. If offshore windmills totaling more than 3000 MW of capacity are built, they will join five recently installed wind generators in New Jersey that have a total a capacity of 7.5 MW, boosting the state's total wind generation capacity to over 3000 MW. This would represent a large expansion of New Jersey's renewable energy capacity.

The Energy Master Plan (EMP) calls for 2120 GWh, which represents approximately 1800 MW of capacity, to be produced by solar PV by 2020, and the supply of 30% of the State's electricity needs from renewable sources by 2020.[18] In order for solar PV to supply 2120 GWh by 2020, its capacity will have to grow at an average rate of 150 MW per year between now and then. This is a higher rate of growth than has taken place so far, which has been in the range of 25 MW per year since 2006. Programs are now in place to increase solar PV growth, including more funding at the federal and state level and increased federal income tax credits. Costs of solar PV equipment are coming down and manufacturing capacity to supply this equipment is expanding. Recent trends in average installed capacity per PV project are encouraging, with average installation size growing.

If solar PV supplies 2120 GWh by 2020, and if 3000 MW of wind capacity (which would supply about 8100 GWh)[19] is on line by then these power sources would offset approximately 102 trillion Btu[20] from fossil fuels that would be necessary to produce the same amount of electricity. This represents approximately 4 percent of the total amount of energy consumed in the State. See the chart, "Geothermal, Solar, and Wind Energy Production, NJ."

Combustion of waste, much of which is paper or other biogenic material, and wood currently provides approximately 33 trillion Btu/year in NJ. About 7 trillion Btu/y of this total is landfill gas burned in generators, which is estimated to provide about 1% of the State's total electricity.[21] Increased use of these and other biofuels has the potential to add to the renewable source percentage.

However, the current rate of growth of renewable power capacity in New Jersey is not high enough to eliminate continued dependence on fossil fuels and nuclear energy in the near future. The EMP acknowledges this in its advocacy of a balanced approach of energy efficiency, renewable energy, and conventional sources. Unless New Jersey can greatly increase the pace of introduction of renewable energy sources, or make large improvements in energy efficiency and conservation, or both, the state will remain largely dependent on nuclear energy and fossil fuels, which as noted above, may become significantly more expensive. Without increased renewable sources and energy efficiency, it will be difficult for the State to reduce its GHG emissions to the degree called for by the GWRA.



An additional option that could be considered is increased use of nuclear power. Approximately 50% of the electricity generated in New Jersey is produced by nuclear power. Expanding this source significantly soon, however is not likely as it will require federal action and steps at the national level to solve the problems that have so far hampered further development of nuclear power in the U.S. For this reason, NJ must continue its "balanced portfolio" policy as expressed in the EMP while continuing its efforts to develop emission-free technologies.

New Jersey has a number of initiatives that promote energy conservation and renewable energy. These initiatives include the following:

- A New Jersey Energy Master Plan (EMP) is required by N.J.S.A. 52:27F-14. After an intensive public participation and stakeholder process, New Jersey's Governor Corzine released the EMP in October, 2008.[22] The EMP includes a list of recommended policies and measures to reduce energy use in the State by 20% below what it otherwise would be by 2020. These measures include extensive energy efficiency improvements, such as new standards for appliances, upgraded building codes, incentives for more combined heat and power plants[23], and standards and measures to promote renewable energy sources, including:
  - Advance the use of energy efficiency, conservation, and renewable energy in our government facilities, residences, businesses, and schools;
  - Proactively pursue affordable energy prices;
  - Increase our supply of reliable, cost-effective energy that reduces our contribution to global warming; and,
  - Explore the State's infrastructure to identify ways to influence energy development

- The GWRA, as noted above, calls for reducing GHG emissions to 1990 levels by 2020, approximately a 20 percent reduction from current levels, followed by a further reduction of emissions to 80 percent below 2006 levels by 2050). The GWRA also calls for recommendations by the DEP for how these reductions can be achieved. Draft recommendations, which rely on energy conservation and renewable energy goals of the EMP but also include proposed transportation, land use, and other actions, were released December 15, 2008.[24]

- New Jersey has taken a leadership role in the Regional Greenhouse Gas Initiative (RGGI), a ten-state[25] cooperative effort designed to implement a regional mandatory cap-and-trade program in the Northeast and Mid-Atlantic addressing CO_2 emissions from Electric Generating Units (EGUs) (i.e., power plants). Rules implementing RGGI (N.J.A.C. 7:27C) were adopted by NJDEP on October 10, 2008.[26]

RGGI is the first mandatory market-based program to reduce carbon emissions in the U.S. The program caps regional power plant CO_2 emissions at approximately current levels from 2009 through 2014 and then reduces those emissions 10 percent by 2018.

- The Global Warming Solutions Fund (GWSF) was enacted January 13, 2008.[27] This law establishes the auction by which RGGI emission allowances are sold to power producers. It also directs how the proceeds are to be distributed by the State of New Jersey. The law requires a priority system to award RGGI proceeds to projects that have the best potential to reduce energy use, greenhouse gas emissions, and impacts on ratepayers. Rules to implement this priority system were proposed February 17, 2009.[28] A public hearing concerning the proposal was held on March 23, 2009, and adoption of the rule is expected soon. The GWSF allocates 60% of proceeds from the sale of RGGI CO_2 allowances to the New Jersey Economic Development Authority, 20% to the BPU, 10% to DEP for forest and tidal marshlands preservation, and 10% to DEP to distribute to municipalities and other local government agencies to plan and carry out energy and greenhouse reduction actions.

- In 1999, the New Jersey Electric Discount and Energy Competition Act became law. This gives utility customers the opportunity to choose their electricity suppliers. As a result, energy companies that provide electricity from renewable sources have entered the New Jersey market and are offering consumers green energy choices.

- The NJ Clean Energy Program[29] has been operating since 2003. This is a ratepayer-funded program that encourages installation of energy-efficient and renewable electricity generation technologies, such as photo-voltaic units on rooftops. The Program's budget for 2008 was $419.5 million; of this, $303 million was spent or committed, with remaining funds carried over. The program provides incentives to offset the initial cost of energy efficient and renewable energy technologies for all ratepayers in New Jersey. As of December 31, 2008, it was estimated that the energy efficiency and energy capacity and generation programs, including both actual and committed actions, have produced a cumulative total of over 25 million megawatt hours of electricity savings and over 155 million dekatherms of natural gas. The program has also helped to install 108 MW of solar capacity in New Jersey through 2009. The program estimated that the annual CO2 emission reductions achieved from all its actions as of the end of 2008 were approximately 0.4 million metric tons.[30]

- The NJ Board of Public Utilities' (BPU) has adopted a Renewable Portfolio Standard (RPS) requiring that utilities meet 6.5% of customers' electricity needs from class I and II renewable energy sources by May 31, 2009.[31] The RPS requires that 22.5% of New Jersey's electricity must come from renewable sources by 2020, and that 2120 GWh of this electricity must be provided by solar energy.

- The DEP and BPU launched the Cool Cities Initiative in the Fall 2003 to plant trees in urban areas to create cooler, more comfortable environments, reduce air pollution, reduce the demand for electricity and improve urban quality of life overall. The total funding provided to this initiative by the BPU Clean Energy Program, including the current 2008 commitment, is $12,850,000. Over 26,000 trees have been planted to date. Trees have been planted in Newark, Elizabeth, Orange, Passaic, Trenton and Paterson, with the goal of expanding the program to other urban areas within New Jersey.

- New Jersey State Government spends an estimated $171 million a year on energy, consuming 7 trillion Btus, which results in the emission of approximately 739,000 metric tons of carbon dioxide.[32] In recognition of the state's sizeable infrastructure of buildings and motor vehicles, efforts to increase efficiency and obtain energy from renewable sources are underway.

- The NJ Department of Community Affairs Green Homes Office works to increase the use of innovative green design and building technologies, raise building standards and create a consumer demand for energy efficient homes.

- Emissions reductions by several NJ industrial facilities are required according to corporate covenants and the EPA Energy Star Program.[33]

- In January, 2006, New Jersey adopted a Low Emission Vehicle (LEV) program modeled after California's LEV Program.[34] The program contains three components: vehicle emission standards, fleet-wide emission requirements, and a Zero Emission Vehicle (ZEV) sales requirement. The adoption of the LEV program ensures that vehicles designed to incrementally produce fewer and fewer GHG emissions over time will be available for purchase in New Jersey. On May 19, 2009, President Obama announced a national policy initiative directing the U.S. Environmental Protection Agency and the U.S. Department of Transportation to propose federal motor vehicle GHG emission standards and related fuel economy standards. When implemented, the National Program could impact the GHG emission reductions projected for the New Jersey LEV program.

The initiatives above that are currently in place have reduced the use of fossil fuel energy from what it otherwise would have been. Much more remains to be done.

More Information

The Department, through its Office of Climate and Energy, Office of Planning and Sustainable Communities, and Office of Science, as well as other programs, continues to work to implement New Jersey's new GHG reduction law, the RGGI program, and other energy-related initiatives, and continues to work with the BPU to expand energy efficiency and renewable energy in the State. More information on the Energy Master Plan and other BPU initiatives is available at http://www.nj.gov/emp . More information on GHG reduction and related efforts is available at http://www.state.nj.us/globalwarming/index.shtml

References

[1] Smil, Vaclav, 2003, Energy at the Crossroads: Global Perspectives and Uncertainties, MIT Press, Cambridge, MA

[2] However, the degree to which biomass fuels release no net carbon dioxide depends on the percentage of the carbon they contain that is from plants, and on the amount of fossil fuels used in the production, harvesting, and transport of these plant-derived materials. Ethanol, for example, is produced from corn or sugar cane, but these crops as currently grown require large inputs of fossil fuels such as diesel fuel for tractors and chemicals such as pesticides derived from petroleum.

[3] Global Insight, 2008, *An Assessment of the Potential Costs and Benefits of Offshore Wind Turbines*, prepared for State of New Jersey by Global Insight, Eddystone, PA and Lexington, MA, September, 2008, http://www.state.nj.us/bpu/pdf/announcements/njoswt.pdf

[4] NJ Board of Public Utilities (BPU), 2008, State of New Jersey Energy Master Plan (EMP), http://www.nj.gov/emp/docs/pdf/081022_emp.pdf

[5] U.S. Department of Energy, Energy Information Administration, State Energy Data, 2005, http://tonto.eia.doe.gov/state/

[6] P.L. 2007, c.112,

[7] Goodstein, David, 2004, Out of Gas: The End of the Age of Oil, W.W. Norton, NY

[8] Deffeyes, Kenneth, 2003, Hubbert's Peak: The Impending World Oil Shortage, Princeton University Press, Princeton, NJ.

[9] Heinberg, Richard, 2003, The Party's Over: Oil, War and the Fate of Industrial Societies, New Society Publishers.

[10] Deffeyes, Kenneth, 2005, Beyond Oil: The View from Hubbert's Peak, Hill and Wang

[11] Simmons, Matthew, 2005, Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy, Wiley

[12] U.S. Department of Energy, Energy Information Administration, 2008, http://www.eia.doe.gov/emeu/ipsr/t11d.xls

[13] In this context, "energy efficiency" means the accomplishment of more work with the same amount of energy, and "energy conservation" means the use of less energy, which is not necessarily be the result of increased efficiency. For example, a person could use less gasoline by driving a new car that got better mileage, or a person could use gasoline by driving the existing car fewer miles.

[14] USDOE/EIA (EIA), 2009, State Energy Data System, http://www.eia.doe.gov/emeu/states/state.html?q_state_a=nj&q_state=NEW%20JERSEY . These data are derived from responses by manufacturers to EIA surveys that indicate destinations of renewable energy equipment and from KWh produced from wind as reported to EIA. In the case of solar PV and wind, power produced is converted by EIA to Btu based on the U.S. average rate of Btu consumed in electricity production; it thus represents the energy that would have been consumed had this amount of electricity been produced through fossil fuel combustion.

[15] This value does not include jet fuel sold in NJ, and certain petroleum fractions that are not combusted but are instead used as feedstocks for plastics, road paving, etc.

[16] Solar Energy Industries Association, 2009, US Solar Industry Year in Review, 2008, http://www.seia.org/galleries/pdf/2008_Year_in_Review-small.pdf

[17] BPU, 2009, www.njcleanenergy.com

[18] BPU, 2008, State of New Jersey Energy Master Plan (EMP), http://www.nj.gov/emp/docs/pdf/081022_emp.pdf

[19] The five wind generators near Atlantic City have a combined total capacity of 7.5 MW. In 2007, based on EIA data (http://www.eia.doe.gov/cneaf/alternate/page/renew_energy_consump/table5.html), they supplied 20,412 KWh, which represents approximately 31% of total capacity.

[20] 3000 MW of capacity operating at 31% utilization would produce about 8.2 million MWh/year, which, using EIA's conversion factor of 9884 Btu/Kwh, would represent the consumption of approximately 81 trillion Btu had this electricity been produced by the combustion of fossil fuels.

[21] Estimated by M. Aucott, NJDEP, based on NJDEP landfill data.

[22] BPU, 2008, State of New Jersey Energy Master Plan (EMP), http://www.nj.gov/emp/docs/pdf/081022_emp.pdf

[23] CHP incentives include funds available through the retail margin fund. "Retail margin" means an amount, reflecting differences in prices that electric power suppliers and electric public utilities may charge in providing electric generation service and basic generation service, respectively, to retail customers, excluding residential customers, which the board may authorize to be charged to categories of basic generation service customers of electric public utilities in this State, other than residential customers, under the board's continuing regulation of basic generation service pursuant to sections 3 and 9 of P.L.1999, c.23 (C.48:3-51 and 48:3-57), for the purpose of promoting a competitive retail market for the supply of electricity.

[24] http://www.state.nj.us/globalwarming/home/documents/pdf/final_report20081215.pdf

[25] In December 2005, the governors of seven of the states signed a Memorandum of Understanding agreeing to adopt the program. Maryland joined RGGI in mid-2007, and Massachusetts and Rhode Island joined in January 2007.

[26] This adoption was published in the November 17, 2008 New Jersey Register at 40 N.J.R. 6541(b).

[27] N.J.S.A. 26:2C-50 et seq.

[28] http://www.nj.gov/dep/rules/proposals/021709a.pdf

[29] http://www.njcleanenergy.com/

[30] New Jersey Board of Public Utilities (NJBPU), 2008, New Jersey's Clean Energy Program Report, submitted to the NJBPU, Reporting Period: January 1, 2008 through December 31, 2008, www.njcleanenergy.com

[31] Class I renewables are solar, wind, fuel cells powered by renewable fuels, geothermal, wave or tidal, and sustainable biomass

[32] BPU, 2008, EMP, p. 87

[33] Over the period 1990 to 2001, several energy efficiency, fuel switching, recycling, and pollution prevention projects by DuPont Chambers Works, Johnson & Johnson, L'Oreal USA Clark Manufacturing, Lucent Technologies, Shering-Plough, and the Naval Air Station at Lakehurst have reduced CO_2 emissions by a total of 1.1 million short tons over the lifetimes of the projects.

[34] 38 N.J.R. 497(b), (January 17, 2006)