Energy Use and Renewable Energy Sources

Background

Our quality of life and economy depend on the availability of reliable sources 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. Specifically, we use gasoline and diesel fuel for transportation; we use heating oil and natural gas for heating and cooling of our buildings; and we use fossil fuel-generated electricity in a variety of ways, including manufacturing, heating and cooling, lighting, and communications. The combustion of fossil fuels releases carbon dioxide and other greenhouse gases (GHGs), which contribute to the warmth of the earth's climate (see "Greenhouse Gas Emissions" in the NJDEP Environmental Trends series). As of 2014, about half of the electricity consumed in New Jersey comes from greenhouse gas-free nuclear power.[1]

Renewable energy sources are described as naturally replenishing and restore themselves over relatively short periods of time. They are inexhaustible in duration on human-time scales, but limited in the amount of energy that is available per unit time. Such sources include hydro, wave, or tidal, geothermal, solar, wind, and biomass. However, due to the complexities of how biomass can be produced there is not a clear consensus as to whether it is truly renewable or carbon-neutral.[2,3,4]

Renewable energy sources do not emit greenhouse gases while producing energy. The State of New Jersey is committed to increasing the development of renewable energy sources.

Photovoltaic (PV) is a type of renewable energy technology that converts sunlight directly into electricity. Applications of PV are flexible, ranging from utility-scale solar farms to residential rooftop projects. It is a technology that has seen tremendous growth over the past decade or so in New Jersey even though a relatively lower average solar radiation falls on the State. The increase of solar energy use in New Jersey is driven by several factors, including: a strong regulatory policy known as the Renewable Portfolio Standard (RPS) that includes a solar carve out (PV requirements); updated interconnection and net metering standards set by the Board of Public Utilities (BPU) that make it easier for systems to connect to the distribution grid; federal grants and tax credits; and a Solar Renewable Energy Certificate (SREC) financing model that provides energy credits.[5]

Status and Trends

Energy Production

Fossil fuels generate about 45% of New Jersey's in-state electricity while nuclear power generates about half of our in-state electric power generation. Renewables are contributing an increasing share of the State's fuel mix for electricity generation. NJ renewable generation has increased considerably in the last 4 years and now totals about 5% of the in-state electricity production in 2016. New Jersey enjoys some of the lowest emission rates from power plants in the U.S. In 2015, the State's sulfur dioxide (SO_2) emission rate was the 5th lowest, nitrogen oxide (NOx) emission rate the 3rd lowest, and carbon dioxide (CO_2) emission rate the 9th lowest in the country.[6]

Energy Consumption

Total energy use has grown in New Jersey over the last several decades.[7] However, total energy consumption in NJ has remained relatively steady since 2010 (see Figure 1).[8] Over the past half century, there have been changes in the mix of energy sources

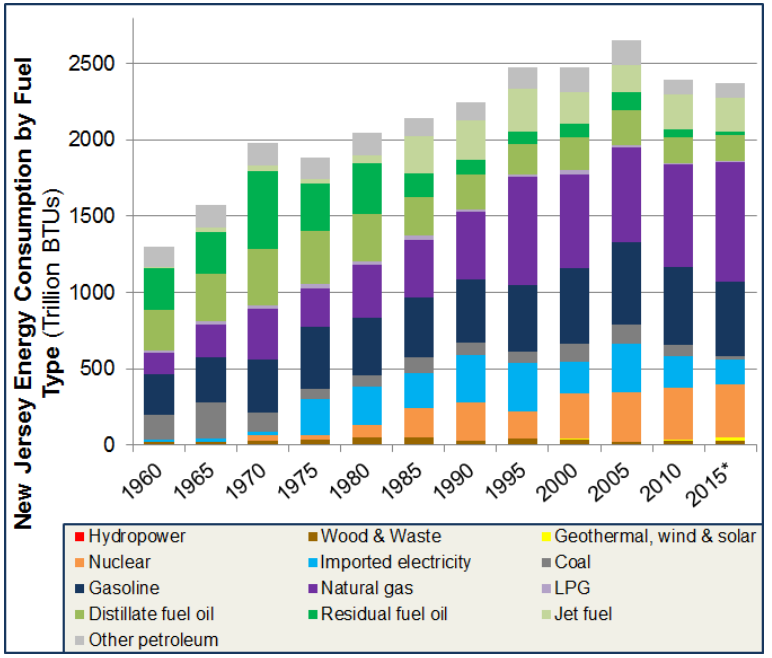

Figure 1: New Jersey's energy consumption by fuel type for 1960-2015.[15] (x-axis is displayed in five year increments; *2015 data are preliminary; LPG=Liquefied Petroleum Gas)

used, with a decline in the use of distillate fuel oil and coal, and an increase in the use of nuclear, gasoline, natural gas, and renewables (see Figure 1).[9] Imported electricity became an increasing percentage of energy consumption over the past half century; however, an important trend noted in the Energy Master Plan (EMP) update is the State's recently declining reliance on electricity imports.[10] In 2015, in-State electricity generation approximately equaled use and in 2016 exceeded, for the first time, the state's electricity consumption.

As of 2014, total energy consumption for NJ totaled approximately 2,340 trillion BTU.[6] The relative percentages of non-renewable [11] versus renewable resources[10] consumed in NJ in 2014 were 96% and 4%, respectively.

Another way of understanding how energy is utilized in NJ is to view how it is divided among various sectors. Figure 2 illustrates that total end-use energy consumption [(1)] in NJ has increased over the past half-century. One trend in total end-use energy consumption is the relative decrease in energy usage by the industrial sector in NJ over time, which may reflect the overall trend toward decreased manufacturing and industrial activities in the region.[11, 13] Also, the sector with the largest portion of energy consumed in NJ is the transportation sector, of which 21% was due to gasoline in 2014.[6] The peak year of energy use by the transportation sector was in 2008,[7] which aligns with the peak year in the price of gasoline[14] and occurred just prior to a global economic downturn. In addition, the number of vehicle miles traveled in NJ reached its peak in 2007. [15]

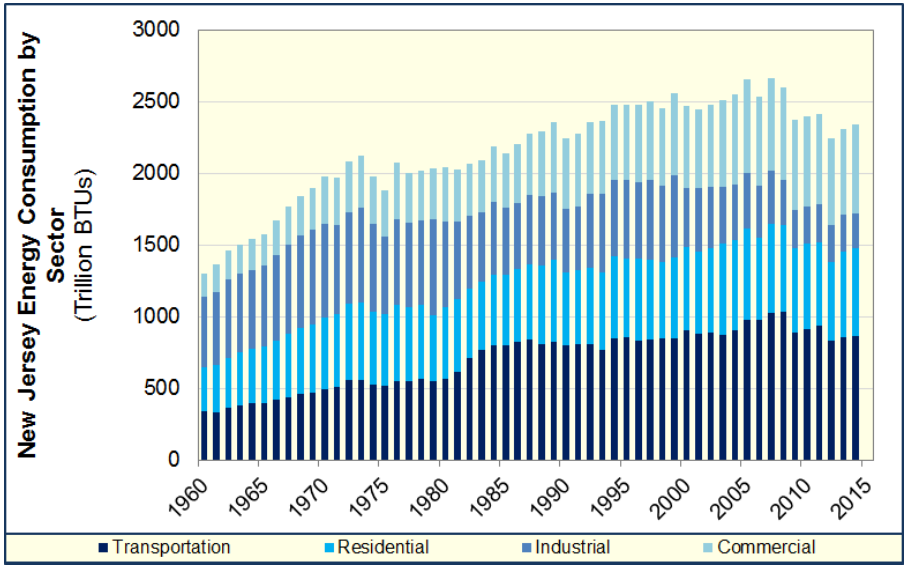

Figure 2: New Jersey's energy consumption by sector for 1960-2014[8]

[(1)] Total end-use energy consumption is defined by U.S. EIA as a sum of the four sectors displayed. It differs from total primary energy consumption in how the electric power sector is included; i.e. for total end-use energy consumption, total retail electricity sales are considered, as well as, the electricity losses due to generation, transmission, and distribution.

Another area of consideration is energy consumption specifically for electricity. In 2014, NJ consumed nearly 640 trillion BTUs of electricity.[1] The fuel mix for in-state electricity generation to meet this demand was comprised of 47% nuclear and 4% renewables; 44% natural gas, 4% coal, and 1% petroleum.

Expenditures

In terms of costs, it has been predicted that, on a longer-term scale, there will be a steadily growing demand for energy and a decrease in the production of certain fossil fuels such as coal, resulting in increased fossil fuel costs.[16,17,18,19,20,21] Expenditures (relative to NJ's Gross State Product (GSP)) on total energy consumption in NJ have been declining. This decline includes a sharp drop in 2012 (Figure 3).

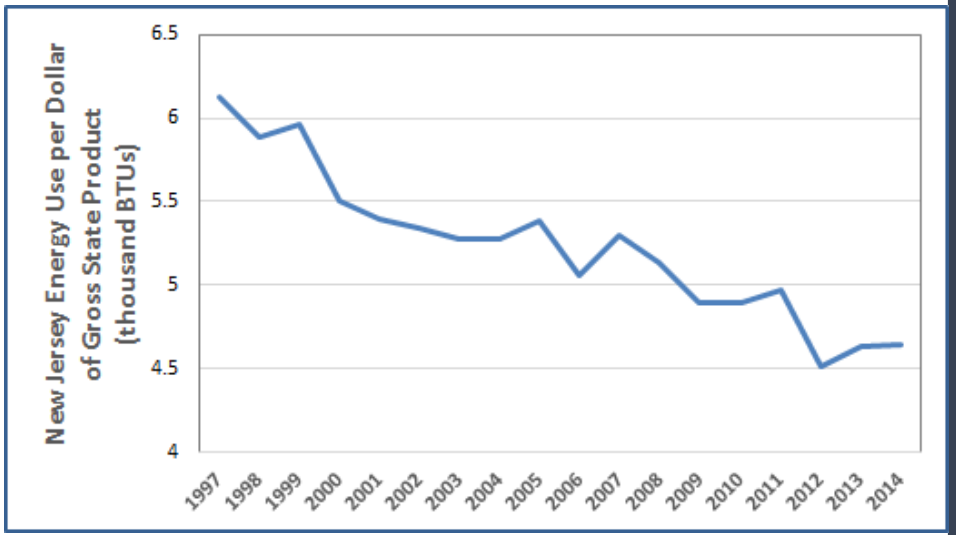

Figure 3: NJ's Energy Use per Dollar of Gross State Product
(*2011-2014 data are preliminary in that the unit costs for energy are assumed equal to 2010 unit costs***).**

Figure 4 shows the electric power generation costs by fuel over the last decade (2006 to 2015). Coal fired electric generation costs have increased due to the drastic reduction of the share of coal in the fuel mix. The cost of natural gas fired electricity generation has decreased primarily due to low gas prices and the deployment of more efficient combined cycle plants in recent years. Nuclear power generation costs have increased slightly. The cost of a mega-watt hour of energy generated through a renewable source has been dropping over time, but is still currently higher than the non-renewable energy sources.

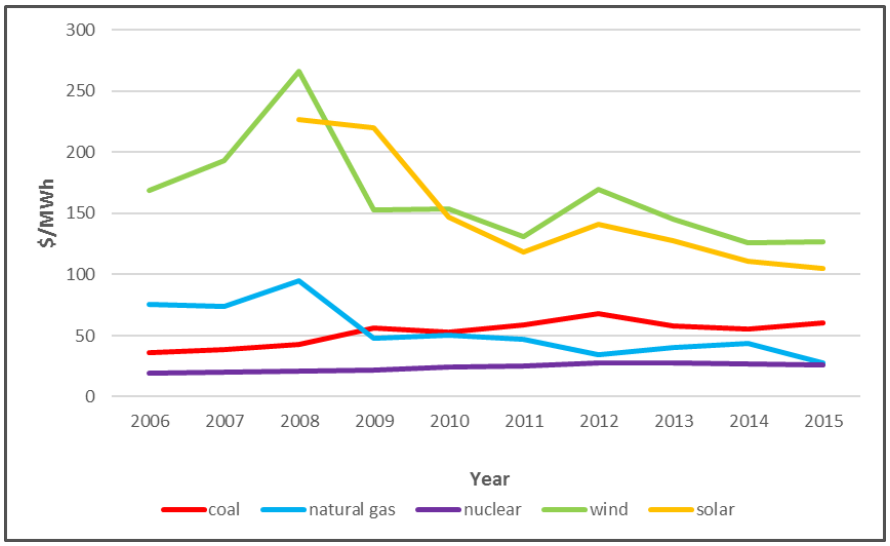

Figure 4: Estimated NJ Electricity Generation Cost by Fuel Source

Solar homeowners and commercial businesses can earn money using Solar Renewable Energy Certificates (SRECs) for the energy generated by their solar PV installation. SRECs are proof that the utility is meeting the states' RPS requirement which entails including a minimum amount of solar power each year. The SREC price can have a large range and it will depend on supply and demand. If the utility cannot easily obtain SRECs, the prices may rise. In New Jersey, the price of the SREC has declined, with increasing solar PV installation, reaching levels between $40 and $60 per million BTU between 2013 and 2016 (Figure 5).

[(2)] To comply with RPS, a percentage of renewables (other than solar) come from out of state but within the PJM grid through the mechanism of renewable energy certificates (REC).

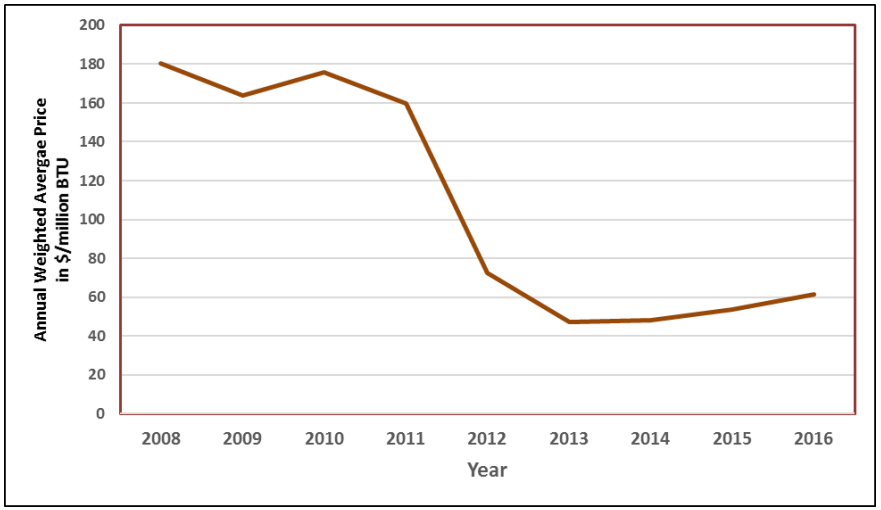

Figure 5: Solar Renewable Energy Certificate (SREC) Price

Impacts of U.S. Domestic Shale Gas on New Jersey

It is important to note that New Jersey does not possess shale gas resources due to its geology. Yet, with the recent advent and continuing improvement of advanced crude oil and natural gas production technologies, EIA projects U.S. domestic supply, largely from growing shale gas production, will outpace domestic consumption and spur net exports by 2018.[22]

Production of Renewable Energy Resources and Goals

New Jersey's electric power sector's percentage of energy from renewable sources (approximately 5% as of 2016[2]) is below the U.S. average (approximately 17% as of May 2016).[1,23] This is largely due to the fact that New Jersey does not have significant hydropower[1] and has limited on-shore wind resources. Nuclear power remains as an important energy source whose generation produces no greenhouse gases, reducing the state's overall contributions to GHG emissions.

In 2014, 47.2% of New Jersey's 58.9 trillion BTU of renewable energy was supplied mostly by solar PV production.[24] NJ has been a leader in advancing solar capacity compared with the U.S. At present, the State has more than 2,000 MW (2.0 gigawatts) of solar capacity.

Compared with the U.S., the State's cumulative solar capacity began growing sooner and reached its peak in annual added solar capacity earlier.[25,26] The current peak in annual added solar PV capacity in New Jersey was reached in 2012 with 417 megawatts (MW) of capacity added alone in that year.[26] More recently (in 2016), 20,101 PV projects were completed in NJ, representing 369.9 MW of annual added solar capacity[25] and bringing the cumulative total of PV projects to 67,045. In contrast, the peak in annual added PV capacity for the U.S. has not yet been reached, with the greatest contribution thus far of 7,260 MW of capacity added in 2015.[24] In 2015, New Jersey ranked 10th among U.S. states in the amount of installed PV capacity per year.[27] In terms of total installed solar capacity, as of 2016, NJ is ranked 4th highest State in the U.S., only surpassed by California, North Carolina, and Arizona which are more favorably located in terms of solar radiation.[28] The State is ranked number 1 for megawatt (MW) of solar per square mile.[29]

In the U.S., onshore wind power capacity is expanding rapidly, adding about 62,542 MW of capacity between 2006 and 2015.[30] As of 2015, NJ had a total of 9 MW of installed, onshore wind capacity.[31] According to the American Wind Energy Association (AWEA), New Jersey ranked 37th among U.S. states in total installed onshore wind capacity (as measured by total MW; ranking does not adjust for land area).[32] This can be attributed to the fact that New Jersey has little onshore wind resources.

The Solar Advancement Act (SAA) and Offshore Wind Economic Development Act (OWEDA) are two acts that encourage the development of solar and wind energy, respectively, in New Jersey. If PV and wind capacity goals are met by 2028 (Figure 4), these renewable energy sources would offset approximately 68.5 trillion BTU from combustion of fossil fuels that would be necessary to produce the same amount of electricity. This 68.5 trillion BTU from fossil fuels combustion represents approximately 2.9% of the total amount of energy consumed in the State as of 2014. [(3),7]

[(3)] U.S. EIA MSN Code TETCBNJ represents total primary energy consumption in New Jersey. In 2014, the value equaled 2,340,188 billion BTU at time of data export.

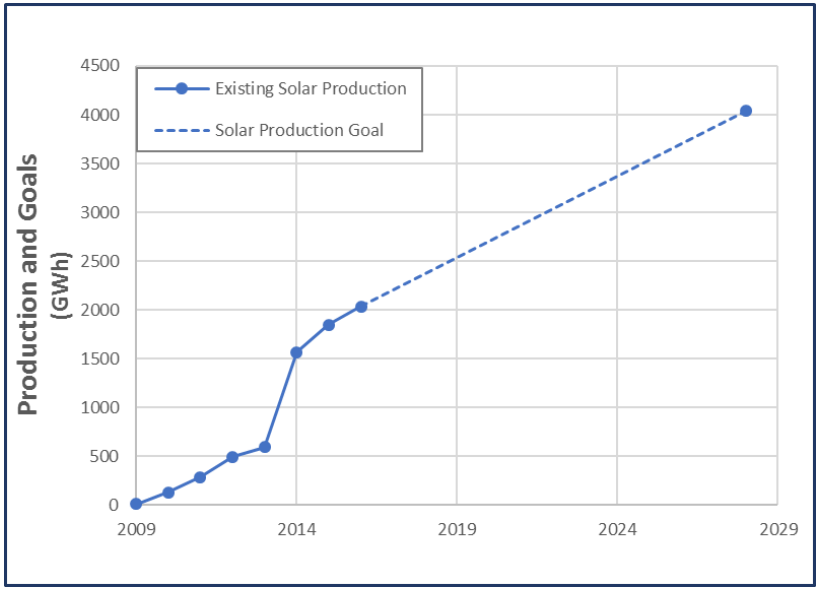

Figure 6: New Jersey solar energy production over time and goals (Solar goal is based on SAA with 4,038 GWh targeted by year 2028)

Outlook and Implications

The current rate of growth of renewable power capacity in New Jersey is not enough to replace fossil fuels in the near future. If renewable energy penetrates to levels as seen by fossil fuels today, there will be an added need for flexible, load -balancing generation to smooth out the variability and intermittency associated with most renewable technologies. The New Jersey Energy Master Plan (EMP) acknowledges this in its advocacy of a balanced approach of energy efficiency, renewable energy, and cleaner, flexible conventional sources.[10]

Nuclear power is currently vital in meeting New Jersey's electricity needs. However, the future role of nuclear power in the State is unclear. The Oyster Creek nuclear power plant will retire in 2019.[33] If other nuclear power plants are closed down in New Jersey, notwithstanding significant development of in-State renewables, additional fossil fuel generation will be needed to compensate for the loss of the base load generation. Recent developments suggest that this could be satisfied by additional natural gas over the short term or new nuclear power plants over the long term. As discussed, the State is already shifting toward

increased use of cleaner burning natural gas. It is also possible that nuclear power will be maintained or increased over the long-term.[34,35] The Federal Nuclear Regulatory Commission (NRC) issued an Early Site Permit to PSEG (PSEG Power, LLC and PSEG Nuclear, LLC) recently,[36] which, in addition to numerous other measures and required approvals, may provide the opportunity for a new reactor to be built in the next 20 years. New Jersey is expected to continue its "balanced portfolio" policy, as expressed in the New Jersey Energy Master Plan (EMP) (see below), while continuing its efforts to develop emission-free technologies.

New Jersey is affected by several initiatives that are intended to reduce reliance on fossil fuels and promote cleaner energy, energy conservation, and renewable energy. These State and Federal initiatives include the following:

Global Warming and the Energy Master Plan

- In 2007, New Jersey adopted the Global Warming Response Act (GWRA), which calls for reducing GHG emissions to 1990 levels by 2020, followed by a further reduction of emissions to 80% below 2006 levels by 2050. The State is currently on track to meet the 2020 target. The GWRA also calls for recommendations from DEP as to how reductions can be achieved. The recommendations released in December 2009 rely on energy conservation and renewable energy goals in the EMP, and also include proposed transportation, land use, and other actions. While the EMP was not intended as a plan to meet the GWRA goals exclusively, much of the reduction necessary to meet the 2020 limit is expected to be accomplished through the implementation of the EMP. The EMP is required by N.J.S.A. 52:27F-14. After an intensive public participation and stakeholder process, the 2008 plan was updated in December 2011[38] and again in 2015.[39] The EMP update includes a list of recommended policies and measures to increase in-state electric energy generation, improve grid reliability, encourage energy resiliency, and recognize the significant economic and environmental benefits of energy efficiency, conservation, renewable and nuclear energy sources. It also accelerates the Renewable Portfolio Standard (RPS) solar requirement.

Energy Efficiency and Renewables

- Governor Christie signed the Energy Savings Improvement Program Act (ESIP) on September 21, 2012. This allows government agencies to make energy-related improvements to their facilities and pay for the costs using the value of energy savings that result from the improvements. The ESIP provides all government agencies in New Jersey with a flexible tool to improve and reduce energy usage with minimal expenditure of new financial resources.
- 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 has been operating since 2003.[40] This is a ratepayer-funded program that encourages installation of energy efficiency measures and renewable electricity generation technologies. It was estimated that the 2015 energy efficiency programs, including both actual and committed actions, were to produce a total of over 11.3 million MWh of electricity lifetime savings and over 34.3 million therms of natural gas lifetime savings.[41] The program has also helped to install or commit 14.3 million MWh of renewable energy lifetime savings in New Jersey.[40]
- The NJ Board of Public Utilities (BPU) has adopted a Renewable Portfolio Standard (RPS) requiring that utilities meet 8.4% of customers' electricity needs from Class I and II renewable energy sources by May 31, 2012.[(4)] The RPS requires that 20.38% of New Jersey's electricity must come from renewable sources by 2020, and an additional 3.47% must be provided by in-State solar energy.[42] At the time of publication of the EMP update in 2015, the State was noted as being on track to meet these targets.[10]
- On June 23, 2012, Governor Christie signed the Solar Advancement Act (SAA), which among other things, accelerates the solar RPS and gives the State more oversight over solar development. As noted previously, the RPS calls for 4.1% of the State's electricity to be generated from in-state solar electric power by 2028. This goal translates to an equivalent 3.24 gigawatts (GW) solar capacity by 2028. Recent solar trends and the oversupply of SRECs in the market indicates that obtaining the goals of the solar RPS is realistic and may be achieved sooner than 2028.
- Governor Christie signed the Offshore Wind Economic Development Act (OWEDA) on August 19, 2010, which established an offshore wind renewable energy certificate program (OREC). It also made financial assistance available and provided tax credits to businesses that develop water-access facilities to

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

support qualified offshore wind projects. OWEDA calls for at least 1,100 MW of offshore wind development (with no specific target date) and has provided a financial mechanism that balances the costs with benefits.

Motor Vehicles

- In January 2006, New Jersey adopted a Low Emission Vehicle (LEV) program.[43] 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 GHG emissions over time will be available for purchase in New Jersey.
- On April 1, 2010, the U.S. EPA and the U.S. Department of Transportation jointly adopted federal motor vehicle GHG emission standards and related fuel economy standards for passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016.[44] These rules required these vehicles to meet an estimated combined average emissions level of 250 grams of carbon dioxide per mile, equivalent to 35.5 miles per gallon (MPG) if the automobile industry elected to meet this carbon dioxide level solely through fuel economy improvements.
- On August 28, 2012, the U.S. Environmental Protection Agency and the U.S. Department of Transportation issued a joint Final Rulemaking to extend the National Program of harmonized greenhouse gas and fuel economy standards to model years 2017 through 2025 passenger vehicles.[45] The EPA released (on July 18, 2016) a draft Technical Assessment Report (TAR) finding that vehicle manufacturers are on track to meet current fuel economy and GHG reduction targets for 2025.[406] The final standards are projected to result in an average industry fleetwide level of 163 grams/mile of carbon dioxide (CO2) in model year 2025, which is equivalent to 54.5 miles per gallon (mpg) if achieved exclusively through fuel economy improvements.
- The State has initiatives to encourage electric vehicle (EV) use. These include the Drive Green New Jersey initiative, a sales tax exemption on EV sales, and grants, and an employer recognition element to encourage employers to purchase and install electric vehicle charging stations.[47] In addition, "It Pays to Plug In" is a New Jersey initiative that provides grants to employers to offset the cost of purchasing and installing electric vehicle charging stations. This program is intended to encourage individuals to purchase and drive electric cars to work, which will reduce vehicle emissions.[48]

More Information

The Department of Environmental Protection, through its Office of Air Quality, Energy & Sustainability (AQES), as well as other programs, continues to implement New Jersey's initiatives and continues to work with the BPU to expand clean energy, 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 energy efficiency and renewable energy, along with related efforts is available at http://www.state.nj.us/dep/aqes/oeere.html.

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