A Clean Electricity Strategy for the Hudson River Valley

A Report for the Hudson River Foundation
by
Synapse Energy Economics and
Pace Law School Energy Project
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Contributors to this report include:

Geoff Keith, Bruce Biewald and David E. White at Synapse Energy Economics, and Fred Zalcman at the Pace Energy Law School

Pace School of Law
78 North Broadway
E House
White Plains, NY 10603
www.law.pace.edu/energy

Synapse Energy Economics
22 Pearl Street
Cambridge, MA 02139
www.synapse-energy.com

Executive Summary

This study explores the potential costs and benefits of a Clean Electricity Plan for the Hudson River Valley, including New York City. The Clean Plan includes new energy efficiency programs, investment in renewable generation and combined heat and power (CHP) projects as well as retrofit projects designed to reduce the air and water impacts of four older fossil-fired power plants on the lower Hudson: Bowline, Lovett, Roseton and Danskammer.

We analyze the Clean Plan via simulation modeling using the PROSYM production costing model. We quantify the potential impacts of the Clean Plan by comparing it to a "business-as-usual scenario" (the Base Case). Through this modeling we project changes in air and water impacts due to the Clean Plan as well as economic costs and benefits.

The results of the study are encouraging. We find that these low-risk energy policies and projects would lead to more efficient use of electricity in the Hudson Valley, substantially reduced air pollution and greenhouse gas emissions and reduced damage to the river and the life it supports. In addition, the reliability of the state's electricity system would be improved with the addition of more distributed generation – electricity generated at the end use site.

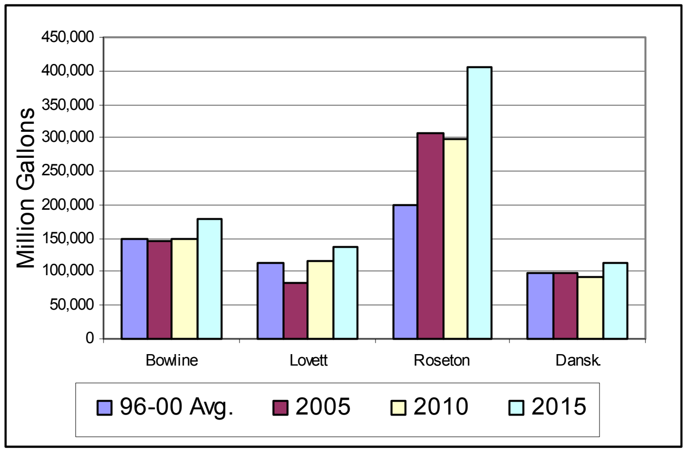
Under the Base Case, we assume that the new power plants currently under construction in New York State are completed and that, over the long term, the state's wholesale power market maintains reasonable reserve margins by adding combined-cycle and simple-cycle gas turbines. We assume that existing energy efficiency programs continue and that environmental regulations currently on the books (such as the new SO_2 and NO_x caps) are phased in on schedule. Electricity use in New York State is projected to grow in the Base Case from roughly 165,000 GWhs in 2005 to roughly 185,000 GWhs in 2015.

Base Case generation at the major fossil-fired plants in New York City is projected to grow by 30 percent in 2015 over recent levels. This increase is driven by the addition of new power plants employing efficient combined-cycle technology and state of the art emission controls. The operation of these new plants reduces the operation of the older power plants in the City considerably over the study period. Electricity generation in the Hudson Valley increases significantly as well – by 127 percent over recent levels in 2015 – also driven by generation from new, clean plants. However, the new plants in the Hudson Valley are not projected to reduce the operation of the existing fossil-fired plants there. Base Case generation at the four older plants on the Hudson River is projected to grow by 43 percent in 2015 over recent levels, and the environmental impacts of these plants grow as well.

- Water use for cooling at the four older fossil plants is projected to grow by 43 percent over recent levels by 2015.
- Projected NO_x emissions from the four plants combined are projected to rise in 2015 by roughly eight percent above recent levels.
- Projected SO_2 emissions are projected to rise in 2015 by roughly 31 percent above recent levels.
- Projected CO_2 emissions are projected to rise in 2015 by roughly 41 percent above recent levels.

Thus, none of the four fossil plants on the Hudson is likely to be rendered obsolete simply by the evolution of the regional electricity market through 2015. All of these plants are projected to continue generating substantial amounts of electricity for the foreseeable future. This means that, unless action is taken at these older fossil-fired plants, their environmental impacts are likely to increase rather than decrease over time.

Figure ES-1. Projected Base Case Trends in Water Use at the Hudson River Fossil Plants



In contrast to the Base Case, the Clean Electricity Plan reduces air emissions statewide and water use on the Hudson at very small additional costs throughout the study period.

Expanded energy efficiency programs in the Clean Plan slow the growth of peak loads and annual electricity use significantly. We model peak load reductions and energy use reductions of one percent per year relative to the Base Case, consistent with the impacts of many efficiency programs currently being implemented in the Northeast. We also model aggressive development of renewable energy in the Hudson Valley and the City. Renewable capacity is added based on its suitability to the Hudson Valley/New York City region and on its economic potential over the study period.

Table ES-1. Renewable Capacity Added in the Clean Electricity Plan (MW)

Technology	2005	2010	2015
Biomass	50	200	200
Hydro	3	25	55
LFG	4	16	16
PV	1	20	75
Wind	5	40	100
Fuel Cells	1	28	80
Total	63	329	526

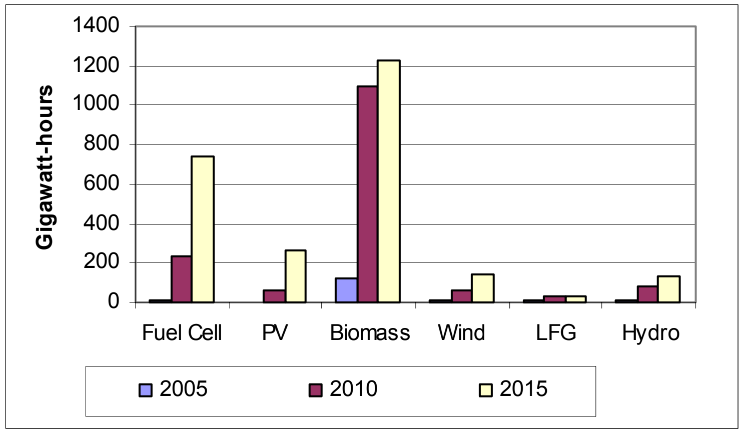
These figures are not additive across years.

In addition, the Clean Plan includes policies to support expanded use of CHP systems in both the Valley and New York City. We assume that CHP capacity added by 2005 totals 18.5 MW (electric) and total CHP capacity in 2015 is 205 MW.

Finally, we also model a number of environmental retrofit projects at the four older fossil-fired plants on the lower Hudson. These projects include wet cooling towers at Bowline, emission controls at Danskammer and the repowering of Roseton with combined-cycle turbines.

The policies and projects of the Clean Plan provide substantial benefits. Generation from new renewable sources in the Clean Plan rises from roughly 165 GWhs in 2005 to 2,540 GWhs in 2015. Most of the renewable energy in the Clean Plan comes from biomass plants, which we assume would be located in the more rural, northern part of the Valley.

Figure ES-2. Clean Plan Renewable Generation



Fuel cells provide the next largest amount of renewable energy, and we assume that the majority of the fuel cell capacity would be in the more densely populated areas of the Valley, such as New York City.

The total electricity generated by new CHP facilities in the Clean Plan increases from 88 GWhs in 2005 to 1,005 GWhs in 2015. In addition to the electricity they generate, these CHP plants reduce 347 tons of NO_x and 275 thousand tons of CO_2 in 2015 by reducing fuel combustion for heating and other services outside the electric industry.

The Clean Plan reduces generation significantly at the older fossil-fired units on the Hudson. By 2010 generation from these plants is 36 percent below the Base Case, and by 2015 it is 42 percent below the Base Case. Water use at these plants is reduced by 66 percent in 2010 and 68 percent in 2015. In addition, the Clean Plan would provide substantial CO_2 reductions by 2015, forming the foundation of a broader climate change strategy. The plan could also provide significant reductions in NO_x emissions; however emissions trading programs make it difficult to predict actual NO_x reductions.[1] The Clean Plan would also reduce the cost of meeting the SO_2 cap that will be established in 2005 and made more stringent in 2008. Cost savings from reduced SO_2 compliance costs could be as much as $30 million in 2010.

Table ES-2. Projected New York CO_2 Reductions and Maximum Potential NO_x Reductions from the Clean Plan

	2005		2010		2015	
Pollutant	Tons	Percent	Tons	Percent	Tons	Percent
NO_x	-267	-0.4%	-4,590	-9%	-10,050	-15%
CO_2	-368,000	-0.7%	-2,349,000	-4%	-6,404,000	-9%

While the Clean Plan has higher capital costs (i.e., the renewables and CHP cost more than the CCCTs and peaking turbines in the Base Case), it has lower production costs due to the energy efficiency programs, fuel cost savings from the renewable energy and savings in emission allowance costs. The net impact of the Clean Plan is a very small net increase in costs. Total electricity production costs in the Clean Plan are projected to be 0.3 percent higher than the Base Case in 2005 and 0.5 percent higher in 2015. Impacts on customers' electricity bills would be even smaller than this, as electricity production makes up only a portion of customers' electric bills. Additionally, although not specifically quantified in our modeling analysis, implementation of the Clean Plan would

[1] The owners of New York power plants that are projected to operate less under the Clean Plan could sell unneeded emission allowances to other plants in New York. Because of this, all of the NO_x reductions projected to result from the Clean Plan may not be realized. Table ES-2 shows maximum projected reductions, assuming no NO_x allowances freed by the Clean Plan are used in New York State.

provide a host of other benefits, ranging from increased reliability and fuel diversity to reduced susceptibility to natural gas supply interruptions and price volatility.

This study's policy recommendations and strategies are designed to effectuate the preferred set of resource options and capture the associated environmental, public health, reliability and job creation benefits. These recommendations cover the following major areas of opportunity:

- the ability of the distribution utility to leverage investment in clean generation and environmental retrofits at existing Hudson River plants through long-term supply contracts;
- the displacement of output from dirty plants through greater investment in energy efficiency and establishment of energy efficiency standards;
- the diversification of the Hudson River Valley's resource supply through expansion of state policies supporting renewable energy sources; and
- the development of a formal, systematic, and comprehensive planning process for the review of proposed investment in energy infrastructure (e.g., electricity generation, transmission and natural gas pipeline capacity).

Our primary policy recommendation is for the three regional distribution utilities – Consolidated Edison, Central Hudson, and Orange and Rockland Utilities - in their role as "default supplier" for a still large segment of electricity consumers, to develop a more diverse and balanced mix of energy supply and demand resource options. The distribution utilities' portfolio should be structured to minimize consumer and environmental costs while insulating consumers from unacceptable price volatility and grid failure. Specifically, the distribution utilities portfolio management responsibilities should adhere to the following principles:

- The distribution utility *qua* portfolio manager would play an integral role in a creating a well-functioning market for generation by entering into medium- and long-term contracts with project developers.
- The availability of long-term contracts could be conditioned on meeting minimal environmental performance standards for air emissions and water intake. This would provide greater assurance that the turnover of New York State's generation mix resulted in improvements to the environment and public health.
- The distribution utilities procurement of supply must include output from eligible renewable energy sources consistent with New York's Renewable Portfolio Standard requirement.
- The distribution utility should balance its supply procurement portfolio with cost-effective energy efficiency investments and fuel switching opportunities aimed at reducing peak demand. Lowering consumption, and therefore the utilities' obligation to procure supply, during the high-priced peak demand hours will lower the cost of electricity for all.

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1. Introduction

The Hudson River is one of the most varied, complex and beautiful rivers in the world. It is 315 miles long, stretching from Essex County in the North to New York City in the South. It is 3.5 miles wide at its widest point and over 200 feet deep at its deepest. It starts in the mountains as a freshwater stream and empties into upper New York Bay as a salt water estuary. For roughly 60 miles from its mouth to Poughkeepsie, the Hudson is a tidal river, with a tide change of four feet as far up as Stockport Flats.

The Hudson is usually thought of in two sections: the upper Hudson, north of Albany, and the lower Hudson, or Hudson River Valley, south of Albany. This report focuses on the Hudson River Valley, an area stretching from the Albany area south through New York City. This region is incredibly diverse, with both rural areas and one of the most densely populated and heavily industrialized areas in the world.

A number of power plants have been built on the lower Hudson to meet the electricity demands of the region. There are five fossil-fueled power plants and a nuclear power plant situated on the river between Albany and New York City: Bowline Point, Lovett, Roseton, Danskammer, Albany Station and the Indian Point nuclear plant. One of these plants, the old Albany Station, is currently being replaced with modern power generation equipment. However, the other four fossil-fueled plants utilize older power generating technology, which is less efficient and has far greater environmental impacts than new generating systems. Most of the boilers and generating units in these four plants are over 25 years old – three of them are over 45 years old – and none of them has been retrofitted with post-combustion emission controls or modern cooling systems that minimize water use from the river. This report focuses primarily on these four, fossil-fueled power plants.[2]

The environmental impacts of the fossil plants on the lower Hudson are considerable. The plants are by far the largest emitters of airborne nitrogen oxides (NO_x) and sulfur dioxide (SO_2) in the region, making them a large part of the region's smog and acid rain problems. They emit both coarse and fine particulates – major human health concerns – and a variety of heavy metals and toxic air pollutants.

The Bowline plant in West Haverstraw.

The plants also take a considerable toll on the Hudson River. None of the plants has a modern cooling system that recycles cooling water. Rather, they all rely on "once-through" systems that draw large quantities of water from the river, move it though the plant for cooling and discharge it back to the river at a higher temperature. Each year billions of fish and other aquatic organisms are

[2] The environmental impacts of the nuclear plant, Indian Point, have been examined in a number of other analyses, and we do not focus on this plant in this report.

destroyed by these systems, as they are drawn into the cooling systems or pinned against underwater screens.

The environmental impacts of these four plants stand in stark contrast to those of new power plants in the northern part of the Valley. The new generators at the Albany station, being built by PSEG Power, will dramatically reduce air emissions while increasing the plant's capacity by 350 MW. Emissions of NO_x at the new plant will be reduced by well over 90 percent, emissions of SO_2 by over 99 percent and CO_2 by roughly 50 percent. Water use will be reduced by about 95 percent. South of the Albany plant, a subsidiary of PG&E National Energy Group has just completed construction of a similar plant at Athens.[3] Employing an air-based cooling system rather than a water-based system, the Athens plant will use even less water than the new Albany plant – over 98 percent less water per MWh of output than the other plants on the Hudson.

Both of these new power plants will utilize combined-cycle combustion turbine (CCCT) generating equipment, a technology that generates electricity in two stages. In the first stage, fuel is burned to operate a gas turbine generator, and in the second stage, excess heat from the gas turbine is used to drive a steam turbine and generate additional electricity. This two-stage process can turn 50 percent or more of the fuel energy into electricity. In contrast, the steam cycle utilized by older power plants typically converts about 33 percent of the energy input, losing the majority of the fuel energy in the form of "waste" heat.

This report analyzes in detail a clean electricity strategy for the Hudson River Valley ("the Clean Plan"). The Clean Plan is composed of an aggressive package of energy efficiency programs, renewable energy, combined heat and power (CHP) projects and retrofit projects designed to reduce the environmental impacts of the four fossil-fired plants on the Hudson. Using a regional electric system model, we assess the costs and benefits of the Clean Plan relative to a "business as usual" energy future for the region.

Section 2 of this report provides background on the four older power plants situated on the lower Hudson, focusing on the environmental impacts of these plants. Section 3 describes the business-as-usual scenario to which we compare the Clean Plan. Section 4 describes the four major strategies underlying the Clean Plan, and Section 5 presents the projected results of these energy strategies, quantifying the differences between the Base Case and the Clean Plan. Finally, Section 6 presents policy recommendations to begin the transition to a clean energy future for the Hudson River Valley.

2. Providing Electricity to the Hudson River Valley

Like the rest of the nation, the Hudson River Valley gets its electricity from a network of interconnected power plants and transmission lines that spans the entire Northeast. This means that the residents and businesses of the Valley are not served exclusively by power

[3] PG&E, under significant financial strain, is currently turning this plant over to the project's lenders, who will operate the plant under the name MACH Gen LLC.

plants within the Valley. Rather, the electricity from all the power plants in New York is commingled in the state's transmission grid. In addition, power plants in New England, New Jersey and Pennsylvania also commonly provide electricity to New York consumers. Historically, the upper Hudson River Valley (north of New York City) has been a net exporter of electricity, meaning that far more electricity is generated there than is consumed by the areas residents and businesses. The majority of this exported electricity goes to serve New York City.

While the electric utilities in New York used to operate the state's electric system (including generating units and power lines), today an independent company operates the system. This company, called the New York Independent System Operator (NY ISO) dispatches power plants based on the plant owners' bids and physical operating constraints. Similarly, ISO New England operates the New England system and the Pennsylvania/New Jersey/Maryland Interconnection (PJM), operates the system serving those states.

2.1 The Four Fossil-Fueled Power Plants on the Lower Hudson

The four fossil plants on the lower Hudson all lie within a 45-mile stretch of river between New York City and Poughkeepsie. The plants include Bowline Point, Lovett, Roseton and Danskammer. Table 1 below provides summary information on each of these plants. The plants are briefly described below, and their historical water use and air emissions are discussed in more detail in Sections 2.2 and 2.3.

Traveling north from New York City, the first power plant on the Hudson is Bowline Point, on the west bank of the river at Haverstraw Bay, 37 miles above New York City. Consolidated Edison and Orange and Rockland Utilities built the Bowline plant in the early 1970's but recently sold the plant to Mirant Corporation, a subsidiary of Southern Company. Bowline station houses two 621-MW oil/gas fired boilers, each with a dedicated generating unit and cooling system. The units can switch from oil to gas in short order, and in recent years the Bowline boilers have burned considerable amounts of both fuels. During the years 1998 through 2000 (the most recent data available), the plant generated a small amount of electricity relative to its potential. Bowline's average utilization rate, or "capacity factor," during these years was 30 percent for Unit 1 and 18 percent for Unit 2.

Table 1. The Four Fossil Power Plants on the Lower Hudson

Plant	Unit	Size (MW)	Primary Fuel	Alt. Fuel	'96 – '00 Avg. Capacity Factor	On-line Year
Bowline	Unit 1	621	Oil	Gas	30%	1972
	Unit 2	621	Oil	Gas	18%	1974
Lovett	Unit 3	69	Gas	Oil	11%	1955
	Unit 4	180	Coal	Oil/Gas	63%	1966
	Unit 5	201	Coal	Oil/Gas	56%	1969
Roseton	Unit 1	621	Oil	Gas	29%	1974
	Unit 2	621	Oil	Gas	36%	1974
Danskammer	Unit 1	72	Gas	Oil	10%	1951
	Unit 2	74	Gas	Oil	13%	1954
	Unit 3	147	Coal	Gas	68%	1959
	Unit 4	239	Coal	Gas	76%	1967

The Lovett plant, located north of Bowline in Rockland County, was built by Orange and Rockland Utilities and sold to Mirant in the same transaction as the Bowline sale. Units 1 and 2 at Lovett have been retired, and today the plant consists of three older fossil-fueled boilers, numbered 3, 4 and 5. Each boiler has a dedicated generating unit and cooling system. Unit 3 is the oldest, a smaller, oil/gas-fired unit that entered service in 1955. In recent years, unit 3 has burned primarily gas and has operated at relatively low levels. Units 4 and 5 are larger, coal-fired boilers that entered service in the mid-to-late 1960s. These units have relatively low operating costs (largely due to their low-cost fuel), and they have recently operated at capacity factors in the range of 50 to 65 percent.

The Roseton plant, located in the town of Newburgh, roughly 62 miles north of New York City, is owned by Dynegy Power Corporation.[4] Roseton consists of two large dual-fueled units (oil/gas) very similar to the units at Bowline. (Consolidated Edison and its co-investors built the two plants during the same time period). Like the Bowline units, the Roseton units have been operated at relatively low levels in recent years. Both of these plants are used as "load following" resources, meaning that their production level often fluctuates, following hourly electricity demand. This is in contrast to "baseload" units, which are typically operated around the clock at very high production levels, and "peaking" units, which operate a small number of hours each year, when loads are at their highest.

The Danskammer plant is located adjacent to Roseton in Newburgh. Central Hudson Gas & Electric sold the plant to Dynegy in 2000 in the same transaction as the Roseton sale. Danskammer units 1 and 2 are the oldest units on the River, both built in the early 1950s. These units were originally designed to burn oil, but they now burn primarily natural gas. The larger units 3 and 4 were added to the station in 1959 and 1967, respectively. These were originally oil-fired units, but in 1987 they were converted to coal.

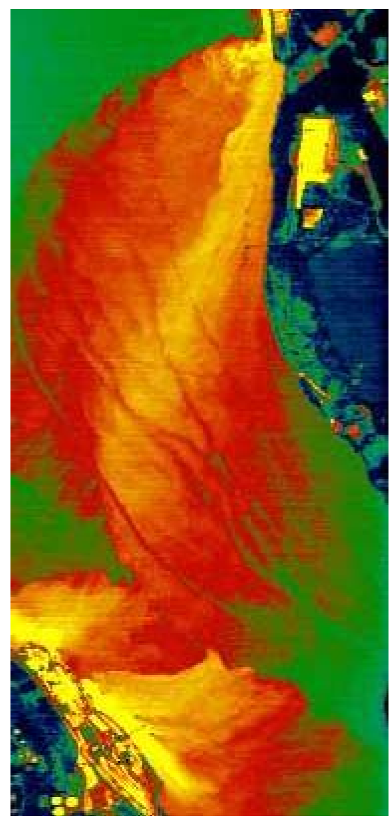
[4] The three original owners of Roseton, Consolidated Edison, Central Hudson Gas & Electric and Niagara Mohawk, sold their shares to Dynegy in 2000.

In addition to the four older plants shown in Table 1, there are two new plants in the Albany region. The Athens Generating Station, currently under construction in Athens, is scheduled to be completed in 2003. This plant will consist of three, 360-MW combined cycle combustion turbines (CCCTs), fueled by natural gas with limited oil backup capability. The Bethlehem Energy Center, scheduled to come on line in 2005, will add 750 MW of generating capacity at Niagara Mohawk's old Albany station. Both of these plants will utilize CCCT generating technology, which emits far less air pollution than traditional steam generating systems. The Bethlehem plant will be cooled with a closed cooling system including a hybrid, wet/dry cooling tower, reducing water use by roughly 98 percent relative to the Albany steam station it is replacing, even as its capacity is increased by 350 MW. The Athens plant will use a closed system with a dry cooling tower, using even less water than the Bethlehem plant.

2.2 Water Impacts

Power plants affect the rivers and lakes from which they draw water in three ways. First, they "entrain" small fish and other organisms in their cooling systems. That is, the plant's cooling water pumps draw the organisms into the cooling water piping, often injuring or killing them. Second, they "impinge" larger fish against screens in front of the intake bays, again often injuring or killing the fish. Finally, the cooling water is returned to the river as much as 34 degrees warmer, and this added heat alters the ecosystem in a large area of the river. The most important alteration is a decrease in oxygen in the heated area, as warmer water holds less oxygen than colder water. These oxygen depleted stretches are rendered less capable of supporting fish populations. Figure 2 is a thermal image showing plumes of heated water coming from the Indian Point and Lovett plants.

Figure 2: Thermal Plumes on the Hudson



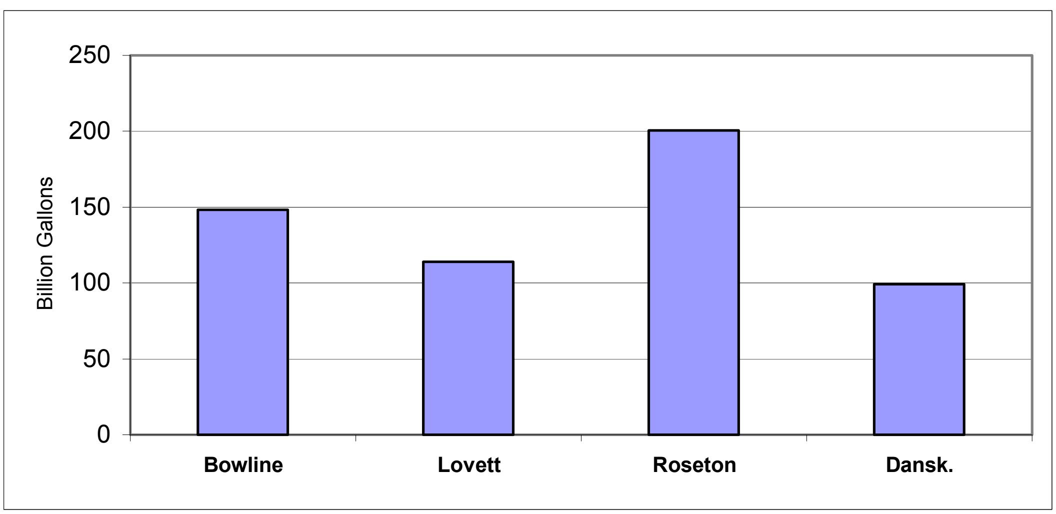
Hyperspectral image showing thermal plumes from Indian Point and Lovett (Geophysical & Environmental Research Corp, 1988). Image courtesy of Riverkeeper: www.riverkeeper.org.

All four of the older fossil-fired plants on the lower Hudson have screening systems in front of the intake bays, utilizing "traveling screens" which move across the bays, diverting impinged fish to return conduits. The only other technology that could reduce impingement and entrainment at these plants, without reducing their water intake rates, is an experimental technology called a "gunderboom," which specifically targets smaller organisms – ichthyoplankton and juvenile aquatic life. A gunderboom is a large, fine mesh barrier that is deployed in front of the water intake structure. The barrier is made of a porous fabric, which has an effective opening size of approximately 20 microns. It is held in place by cement blocks or pylons on the riverbed and flotation heads on the water surface. It usually covers an area of several thousand square feet in front of the intake structures. Advocates of gunderbooms claim that the screens will be able to reduce impingement and entrainment of ichthyoplankton and juvenile aquatic life by 80 percent, however concerns have been raised about the potential for biofouling to reduce exclusion levels dramatically. Testing underway at several power plants – including Lovett – will reveal much about the long-term viability of this technology.[5]

Reductions in cooling water use are achieved by replacing a power plant's "once-through" cooling system with a closed cooling system. As noted, all of the four fossil plants on the lower Hudson have once-through cooling systems. In these systems, water is withdrawn from the river, used to cool the plant once, and returned to the river. Because cooling water passes through the plant only once, large amounts of water are needed to cool each plant. In contrast, in a closed cooling system, cooling water cycles through the power plant and through a cooling tower where it is cooled via heat transfer to water or air. By keeping the cooling water in a closed loop, the same water is used to cool the plant many times, reducing the amount of cooling water needed. Replacing a once-through cooling system with a closed system can reduce annual water use by between 95 and 99 percent, reducing fish kills by similar percentages.

The amount of water used by a power plant with a once-through cooling system is a function of several things: the size of the plant, the utilization of the plant and the efficiency of its cooling system. All other things being equal, larger plants use more water than smaller ones, and plants that generate more electricity use more water than plants that generate less. Of the four fossil units on the Hudson, Roseton has used the most water in recent years, followed by Bowline, Lovett and Danskammer. Figure 3 shows the average annual water use at each plant during the period 1996 through 2000.

Figure 3. Average Annual Water Use, 1996 – 2000



Source: New York Department of Environmental Conservation.

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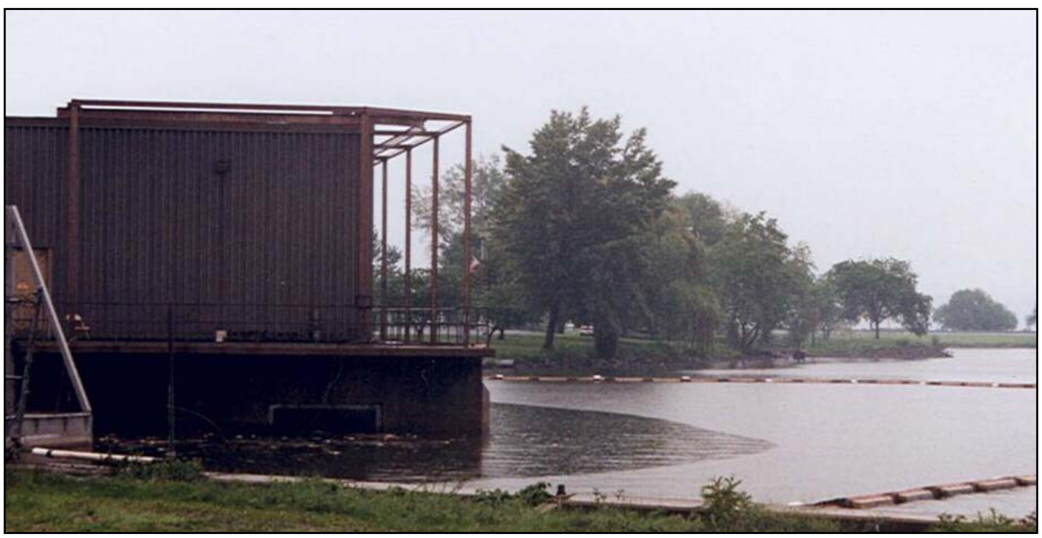
[5] In early 2003, Riverkeeper settled its longstanding dispute over the use of the gunderboom at the Lovett plant. As part of the settlement agreement, the New York DEC is requiring Mirant, the plant owner, to conduct comprehensive monitoring to demonstrate an exclusion rate of 80 percent of the organisms subject to entrainment.

The cooling system at Roseton consists of a shoreline intake structure, a submerged diffuser through which water is discharged and piping to transport cooling water some 1,500 feet from the river to the power plant.[6] The rectangular, concrete intake structure is 153 feet across its face, with 12 submerged openings, each approximately 21 feet by 10 feet. Eight traveling screens are positioned in front of the intake bays to prevent larger fish and debris from entering the pump chambers. These screens travel across the front of the intake bays and are cleared with a high-pressure water spray.[7] Water is drawn through the screens and into the intake bays by four, single-speed pumps. These pumps are operated in different configurations, based on the plant's output level. When the plant is operating at low levels, only one or two pumps are used. The use of single-speed pumps at Roseton results in highly inefficient water use at low plant utilization levels. For example, in 1996, when the plant had a capacity factor of only nine percent, Roseton used nearly 11 gallons per thousand Btu of heat input (see Figure 4). While most power plants use cooling water less efficiently at lower utilization levels, the single-speed pumps at Roseton exacerbate this problem.

Bowline is somewhat unique in that its cooling water flows from the River through an intake channel and into a manmade pond before entering the intake structure. Cooling water is drawn from the pond through a rectangular concrete cooling structure measuring 140 feet across its face. Water is drawn through six openings, 16 feet wide and 26 feet high. The fronts of the bays are covered by bar trash racks, and conventional vertical traveling screens, similar to those at Roseton.



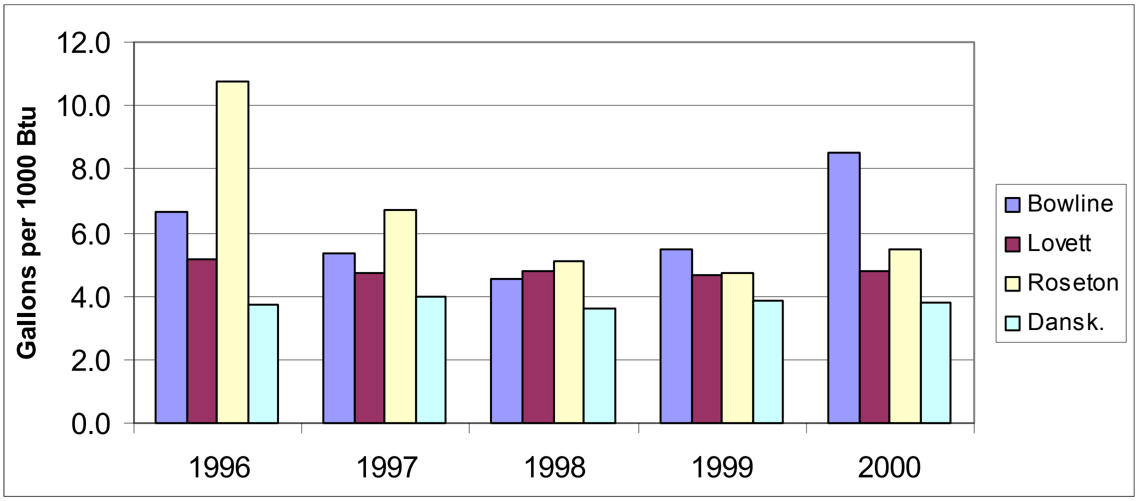
The cooling water intake structure at Bowline.

[6] The information provided in this section on the Roseton and Bowline cooling systems is taken from the Draft Environmental Impact Statement for SPDES permits at Bowline, Indian Point, and Roseton (the DEIS). The DEIS can be obtained from the New York Department of Environmental Conservation.

[7] In 1990 two new screens manufactured by Envirex were installed as R&D replacements to two older screens. These screens are fitted with troughs designed to minimize stress on fish being carried away from the intake bays.

In addition, a multi-filament nylon net has been deployed in front of the Bowline intake structure on a seasonal basis. The barrier net is deployed during the fall, winter and early spring months, the historic period of peak impingement at Bowline. Six, single-speed circulating water pumps are positioned at the rear of each bay. As at Roseton, the pumps are operated in various combinations to achieve the desired flow rate, but water use is inefficient at low plant utilization levels. Figure 4 shows an efficiency of approximately 8.5 gallons per thousand Btu in 2000, when the plant operated at a 13-percent capacity factor.

Figure 4. Efficiency of Cooling Water Use, 1996 – 2000[8]



Less detailed information is available on the cooling systems at Lovett and Danskammer, because these plants were not covered by the Draft Environmental Impact Statement for SPDES permits at Bowline, Indian Point, and Roseton (the DEIS). We do know that these plants have similar maximum water intake rates: the maximum rate for Lovett is 1,200 cubic meters per minute and the maximum rate for Danskammer is 1,117 cubic meters per minute. The three operating units at Lovett have shoreline intakes. The cooling system at Danskammer has an intake canal from the north and a surface discharge into a cove immediately to the south.[9]

There is little information available to the public on the number of fish and other aquatic organisms killed by these four power plants each year. The one source to which we had access, the DEIS, estimates mortality for several species at these three plants. Data for Roseton and Bowline are shown below. For Roseton, there are three years of complete data on entrainment mortality. These data, shown in Table 2, are for only four of the 16 fish species discussed in the DEIS. Thus, the data show only a small part of the picture at this plant, however they do provide a sense of the magnitude of the impact these plants

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[8] The water use data presented here were gathered from the New York Department of Environmental Conservation. The energy input data are from EPA's Acid Rain Database, 2000.

[9] Jay Hutchison Jr., Technical Descriptions of Hudson River Electricity Generating Stations, in Science, Law and Hudson River Power Plants (1988), at 113.

have on the Hudson. In these three years, sampling at Roseton indicates that the cooling system killed between 280 and 580 million pre-adult fish of these four species per year. Even if the plant kills much smaller numbers of the other species discussed in the DEIS, the total number is probably well over a billion pre-adult fish killed per year. Moreover, these data only estimate fish killed by entrainment. Many additional fish, usually larger fish, are killed or injured by impingement.

Table 2. Estimated number of fish killed at Roseton by Entrainment

	1982	1983	1985
Fish killed	413,230,000	580,630,000	279,340,000
Generation (MWh)	5,102,000	6,275,000	5,212,000
Fish killed per MWh	81	93	54

Life stages assessed include eggs, yolk-sac larvae, post yolk-sac larvae, and juveniles. Species accounted for: American Shad, River Herring, Striped Bass, and White Perch. Source: SPDES Draft Environmental Impact Statement, Appendix VI-1-D-1, December 1999.

Less information is available on fish kills at Bowline. The most complete data set in the DEIS, for the year 1983, indicates that the plant killed 44 million pre-adult fish of these four species that year. This suggests that substantially fewer fish are entrained at Bowline than at Roseton – perhaps as a result of the pond through which water flows between the river and the intakes. However, a more robust data set would be needed to draw such a conclusion with confidence.

2.3 Air Impacts

The three major air pollutants emitted by fossil-fueled power plants are oxides of nitrogen (NO_x), sulfur dioxide (SO_2) and carbon dioxide (CO_2). NO_x emissions are a byproduct of combustion, and different combustion conditions produce different levels of NO_x. Thus, NO_x emissions can be reduced by (a) switching fuels, (b) adding combustion controls, which change the conditions of combustion, and/or (c) adding post-combustion controls, which alter NO_x molecules in the exhaust gas. Coal combustion produces the most NO_x of any fossil fuel, residual oil produces the next most and light oils and natural gas produce the least. Thus, fuel switching to reduce NO_x emissions is either a move from coal to oil or gas or from oil to gas.

> ***Oxides of nitrogen*** *(NO_x) contribute to two environmental problems. First, in urban areas, NO_x reacts with other pollutants to create smog, a health threat to the elderly, asthmatics and people exercising. Second, NO_x molecules combine with water in the atmosphere to form nitric acid, which then falls back to the earth as acid rain. Aside from cars and trucks, fossil plants are the leading source of NO_x emissions in the U.S.*

Emissions of SO_2 result from the presence of sulfur as an impurity in coal and residual oil, and a power plant's SO_2 emissions are directly related to the amount of sulfur in the fuel. Because of this, combustion controls are not effective in reducing SO_2 emissions; plant operators must either change fuels or install post-combustion controls to capture SO_2 in the flue gases. Different types of coal contain different amounts of sulfur, and plant operators can switch from high- to low-sulfur coal to reduce SO_2 emissions. Different grades of residual oil also contain different amounts of sulfur, so plants burning oil can often reduce

Sulfur dioxide (SO_2) is the primary pollutant responsible for acid rain. Despite considerable reductions resulting from Clean Air Act Amendments of 1990, acid rain continues to damage sensitive ecosystems in New York's Adirondack and Catskill mountains. Roughly two thirds of U.S. SO_2 emissions come from power plants.

SO_2 emissions by switching to low-sulfur oil. Finally, natural gas contains virtually no sulfur, so switching from coal or oil to gas produces considerable SO_2 reductions.

Emissions of CO_2 are different from NO_x and SO_2 in an important way. Carbon is neither a byproduct of combustion nor a fuel impurity. Carbon is an integral part of the chemical energy stored in fossil fuels; thus, CO_2 emissions from fossil fuel combustion are inevitable. There are several post-combustion control technologies under development (for removing CO_2 from the flue gas of fossil-fueled plants), but it is not clear that any of these technologies will ever be cost effective or commercially available. For the foreseeable future, the only ways to reduce carbon emissions from fossil-fuel combustion will be to switch fuels or increase the efficiency of generation. Coal has the most carbon of the major fossil fuels, with oil and gas coming second and third. Thus, fuel switching to reduce CO_2 emissions is either from coal to oil or gas or from oil to gas.

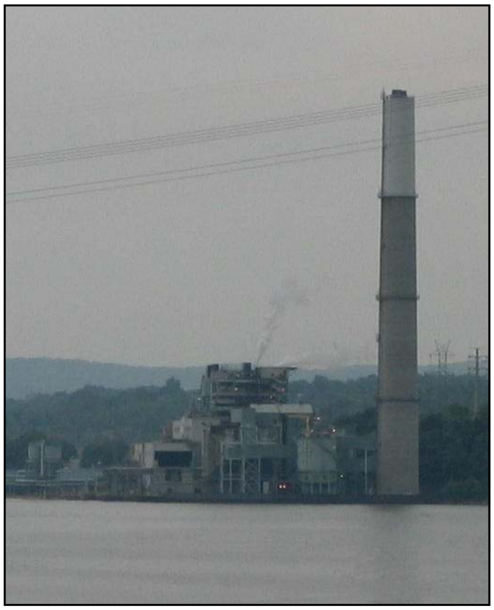
Importantly, none of the four fossil plants on the lower Hudson has post-combustion emission controls – systems that remove NO_x or SO_2 from the exhaust gases entering the plant's smokestack.[10] (As discussed below, Mirant has committed to installing post-combustion controls at Lovett units 4 and 5 by 2008.) The reason these four older plants do not have state-of-the-art emission controls is that, as lawmakers have revised the Clean Air Act over the years, they have applied more stringent regulations to new plants only. This practice of "grandfathering" existing facilities has resulted in a considerable difference in the emission rates of old versus new power plants. For example, the coal-fired units at Danskammer and Lovett emit NO_x at rates roughly 50 times that of the new power plants being built in New York (combined-cycle gas turbines). These new plants burn a cleaner fuel (natural gas), and they are required to have very effective post combustion controls.

Carbon dioxide (CO_2) is the most prevalent of the greenhouse gases – gases that are trapping heat in the earth's atmosphere and warming the earth's surface. Consequences of climate change include the spread of infectious diseases, an increase in the frequency and severity of extreme weather events, coastal zone flooding, loss of habitat, and agricultural disruption. Power generation is the largest U.S. source of CO_2, responsible for about 37 percent of total U.S. emissions.

During the past several years, the idea of updating the emission standards applied to older power plants has been hotly debated throughout the country. In New York, this debate has resulted in the promulgation of new NO_x and SO_2 standards for existing power plants. These new regulations will reduce NO_x emissions starting in 2005, by extending the current summer cap on NO_x emissions to the full year. They will reduce SO_2 emissions from New York's power plants by 25 percent in 2005 and by 50 percent in 2008 with a new state allowance program (i.e., cap-and-trade program). The new NO_x regulations are not expected to result in new emission control systems,

[10] Several of the units at these plants have *combustion* controls, which manage the conditions of combustion to reduce the formation of pollutants, but these controls cannot achieve the reduction levels of *post-combustion* controls.)

because the state's power plants currently comply with these regulations during the summer months. Thus, plant operators will simply implement their existing summer control strategy during non-summer months. The SO_2 regulations, however, are likely to result in significant additional costs at coal-fired (and many oil-fired) plants, and may well result in fuel switching or new control systems at many of these plants.



The coal-fired Lovett Plant at Tompkins Cove

In June 2003, Mirant announced a settlement with the New York Attorney General's office that will include the installation of post-combustion controls at Lovett units 4 and 5. The settlement resolved allegations that the previous plant owners violated federal and state New Source Review laws, the laws that govern the extent to which plants can be modified without triggering a review of their allowable emission levels.[11] However, the decision to commit to these controls was undoubtedly influenced by New York's new emissions regulations discussed above. As part of this settlement, Mirant will install Selective Catalytic Control (SCR) system to reduce NO_x emissions and in-duct injection and baghouses to reduce emissions of particulate matter (PM) and SO_2. Mirant estimates that these controls, to be operational by 2008, will reduce NO_x emissions by 78 percent below the plant's permitted rate and SO_2 emissions by 40 percent below the permitted level.

The current emissions characteristics of the four fossil units on the Hudson are described below. This information was collected from EPA and Department of Energy (DOE) databases. Figure 5 below shows the plants' average NO_x and SO_2 emissions over the past several years and Figure 6 shows the plant's CO_2 emissions. Table 3 shows their recent emission rates.

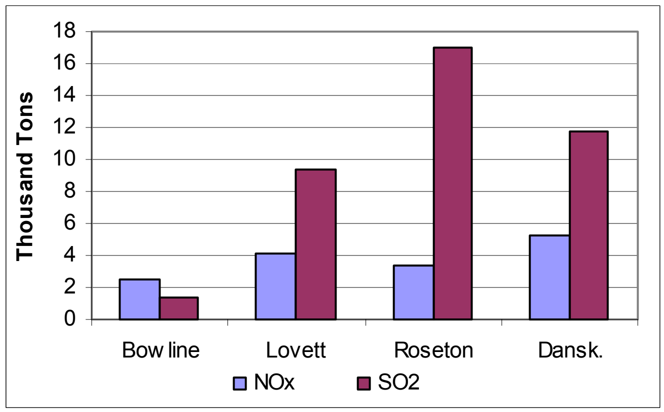
- The **Bowline** boilers burn either low-sulfur residual oil (0.32 to 0.29 percent by weight) or natural gas and have combustion controls to reduce NO_x emissions. Significant use of gas in recent years has resulted in low annual NO_x, SO_2 and CO_2 emissions relative to the other three plants.
- The coal-fired units at **Lovett** (units 4 and 5) typically burn coal with a sulfur content in the range of 0.55 to 0.65 percent by weight, placing these units among the higher sulfur emitters in the Hudson River Valley. Only unit 4 is currently fitted with NO_x combustion controls. Unit 2 burns primarily natural gas without emission controls.

[11] Mirant has admitted no violation under the settlement. See Mirant news release: *Mirant Reaches Clean Air Act Agreement with State of New York on Lovett Power Plant*, June 11, 2003.

- Both **Roseton** units have NO_x combustion controls resulting in relatively low NO_x emission rates. However, the plant burns high-sulfur oil – 0.88 to 0.95 percent sulfur by weight – and in recent years it has been by far the largest sulfur emitter in the Valley (see Figure 5).
- The coal-fired units at **Danskammer** have combustion controls to reduce their NO_x emissions, however even with these controls the units are the highest NO_x emitters on the lower Hudson. Unit 3 had the highest NO_x rate of the four fossil units in 2000 (see Table 3 below). The Danskammer coal units also have the highest SO_2 emission rates in the region. However their total annual SO_2 emissions are lower than Roseton's, because the Roseton units are much larger.

Figure 5 illustrates historic NO_x and SO_2 emissions from Bowline, Lovett, Roseton and Danskammer. The figures shown are the average of these plants' annual emissions, as reported to the U.S. EPA, for the years 1996 through 2000. The total annual emissions for each plant are a function of two things: the utilization of the plant and the emission rates of the plant. For example, Roseton has generated much more electricity than Danskammer in recent years, however typical annual NO_x emissions are lower at Roseton, because the plant emits NO_x at a lower rate.

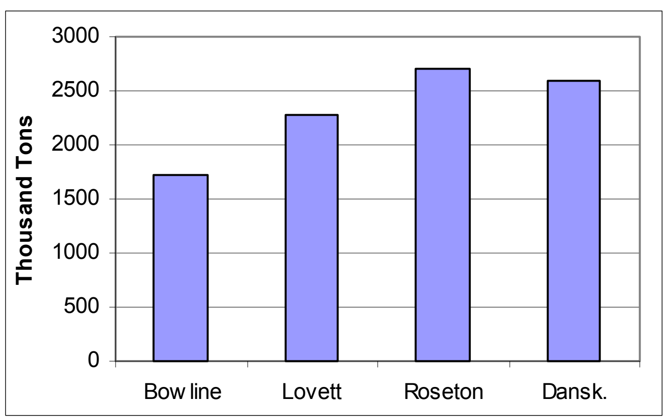
Figure 5. Average Annual NO_x and SO_2 Emissions, 1996 – 2000



ource: U.S. EPA, Acid Rain Database, 2001.

Figure 6 illustrates recent average CO_2 emissions from these four plants. Interestingly, Roseton has had the highest CO_2 emissions in recent years even though Lovett and Danskammer burn coal, the more carbon intensive fuel. This reflects the size of Roseton – unusually large for an oil-fired plant in the Northeast.

Figure 6. Average Annual CO_2 Emissions, 1996 – 2000



Source: U.S. EPA, Acid Rain Database, 2001.

While Figures 5 and 6 show which plants emit the most pollution in a typical year, Table 3 illustrates which ones emit the most air pollution per unit of electricity generated. This table shows the NO_x and SO_2 emission rates reported to the EPA for the year 2000 for each boiler.

The emission rates of a new CCCT, such as those being built at the Athens and Bethlehem plants, are also shown in Table 3. Note that NO_x emissions at new CCCTs are several orders of magnitude lower than at the older plants, SO_2 emission are virtually zero at the new plants, and CO_2 emissions are lower by a third to a half. The dramatic difference between the old and the new technology underscores the need to continue modernizing the power plants in the Hudson River Valley. Allowing the older plants to continue killing fish and polluting the air at these rates effectively provides these plants with a subsidy, as they do not have to invest in the environmental technologies that new plants must install. In today's competitive market for electricity this subsidy provides an economic advantage to these old facilities, prolonging their lives and thwarting efforts to clean the air and water in the Valley.

Table 3. Year 2000 Emission Rates at the Hudson River Fossil Plants

Plant	Unit	NOx Rate (lb/MWh)	SO_2 Rate (lb/MWh)	CO_2 Rate (lb/MWh)
Bowline	Unit 1	1.89	2.10	1,510
	Unit 2	2.68	2.17	1,780
Lovett	Unit 3	1.76	0.33	1,340
	Unit 4	3.68	8.82	2,070
	Unit 5	3.68	9.14	2,070
Roseton	Unit 1	2.00	9.77	1,670
	Unit 2	2.10	9.77	1,690
Danskammer	Unit 1	2.30	6.10	1,760
	Unit 2	2.53	8.05	1,760
	Unit 3	4.41	10.08	2,130
	Unit 4	3.89	10.29	2,130
New CCCT	---	0.05	negligible	830

Source: U.S. EPA, Acid Rain Database, 2001.

3. Business as Usual – the Base Case

We model both the Base Case and the Clean Electricity Plan using the PROSYM production costing model.[12] PROSYM is a chronological system dispatch model that allows for highly detailed modeling of multiple electricity control areas. A description of PROSYM appears in Appendix A.

The Base Case scenario is our prediction of a "business-as-usual" electricity future for the Hudson River Valley and New York City. The Base Case represents outcomes that would be expected if the current regulatory and market conditions prevail throughout the study period. In developing the assumptions underlying the Base Case we have used published predictions from credible sources wherever possible. Where such predictions do not exist, we have made conservative assumptions based on the available data. Key assumptions underlying the Base Case include the following.

- Electricity demand grows as predicted by the New York ISO.

[12] PROSYM is technically called MULTISYM when multiple control areas are being modeled as in this study, however we use the name PROSYM, because it is the model's more commonly known name.

- Fuel prices have been projected by Synapse, based on futures contracts and data reported to the Federal Energy Regulatory Commission (FERC) and the US Energy Information Administration (EIA).
- Data on the future capabilities of power plants and transmission systems are from a number of federal agencies, including EIA, EPA, FERC, the North American Electric Reliability Council (NERC) and the New York ISO.
- We assume that the only environmental controls installed at the four fossil units on the Hudson are the emission controls at Lovett 5 and 6 recently announced by Mirant.
- We have developed assumptions (listed below) about plant retirements and additions, based on extensive review of databases, trade journals and other sources.

The Base Case is the scenario against which we compare the Clean Plan to determine its costs and benefits. In Section 3.1, we describe the assumptions that underlie the Base Case; in Section 3.2 we describe the modeling results for the Base Case; and in Section 3.3 we present one sensitivity analysis we perform on the Base Case assumptions to test the robustness of study results to a key uncertainty: the future of a new generating unit proposed at the Bowline plant.

3.1 Base Case Modeling Assumptions

The projections of future electricity loads and consumption in the Base Case are from the New York ISO. The ISO releases projections each year for peak loads and total consumption in each of eleven individual transmission zones within New York State. Projections for peak loads for the Hudson River Valley (north of New York City) are 5,713 MW in 2005 and 6,010 MW in 2010. Projections for peak loads in New York City are 10,907 MW in 2005 and 11,463 MW in 2010. Table 4 shows the electricity use projections for the entire state, for New York City and for the Hudson River Valley.

Table 4. Electricity Consumption Assumed in Base Case[13]

Area	Electricity Use (GWhs)			
	2000 (actual)	2005 (projected)	2010 (projected)	2015 (projected)
New York State	156,100	165,300	174,400	184,800
Hudson River Valley	31,000	31,300	32,900	35,000
New York City	49,200	53,000	56,700	60,400

Numbers based on data from the New York ISO.

The natural gas and oil prices used in PROSYM for this study were developed by Synapse from NYMEX futures prices as of January 2003. Base prices were developed for 2005, 2010 and 2015 for each control area modeled, and delivery costs are added for each plant based on its location. Plant-specific coal prices were developed from data reported by generating companies to federal agencies. The gas and oil prices used in modeling both the Base Case and the Clean Plan are shown in Table 5. These are the base prices for the

[13] The area defined as the Hudson River Valley in this table includes the New York ISO zones F, G, H and I. New York City includes zone J.

New York control area in January, not including delivery costs. (For all fuels, PROSYM uses different prices for each month of the year.)

Table 5. January Fuel Prices Assumed for Base Case and Clean Plan Modeling ($2003 per mmBtu)

	2005	2010	2015
Natural gas	$4.60	$4.45	$5.03
Distillate Oil	$5.99	$6.00	$6.79
Residual Oil	$3.27	$3.27	$3.70

The biggest challenge in developing a Base Case for the Hudson River Valley is predicting power plant additions and retirements. Developing a new power plant entails a long period of planning, permitting and financing and a second long period of construction. Plans often change significantly during these periods, as do external conditions which gave rise to the perceived need for development, and this makes it difficult to predict the future of any power project. As discussed above, several new power plants are under construction in New York, including the Athens Generating Plant, in Athens, and the Bethlehem Energy Center, near Albany. In the Base Case we assume that these projects will be completed in 2003 and 2004 respectively, as planned.

In addition to the Athens and Bethlehem plants, we assume that four other projects under development will be completed during the study period. First, Keyspan Energy is building 250 MW of new cogeneration capacity at its Ravenswood plant in Queens. We assume that this project will be completed on schedule in 2004. Second, Consolidated Edison is developing two new cogeneration units at its East River plant in Manhattan. The steam from these units will serve the ConEd steam system and the electricity will be sold in wholesale markets. We assume that this plant too is competed on schedule in 2004. Third, the New York Power Authority (NYPA) is planning to add 500 MW of new CCCT capacity at the Charles Poletti plant in Queens in 2005 and to retire the existing steam unit there in 2008. We assume that the new Poletti unit will be operational by 2005 and that the old unit will be retired by 2010. Fourth, Consolidated Edison recently announced that it would sign a long-term contract for power from a project under development by SCS Astoria in Queens. This contract is likely to provide SCS Astoria with a substantial advantage in obtaining capital compared to the other proposed projects in the area. Thus, we include the SCS Astoria project, a 1,000 MW combined-cycle plant, in our Base Case.

Beyond these projects, it is difficult to predict when and where new plants will be added. Several other projects are well into the planning stages, including a new unit at the Bowline station and the repowering of Reliant's Astoria station in Queens. However, the climate for financing new power plants has become much less attractive since these projects were first proposed, due to the economic downturn and a substantial generating capacity surplus in the Northeast. Without long-term contracts for their output, other projects, in addition to the five described above, will have difficulty obtaining financing in the near term. Thus, we do not include any other new plants in our Base Case.

Table 6 below shows a list of all plant additions and retirements assumed in the Base Case during the study period (2005 through 2015). The key goal behind the development of these assumptions is to maintain a reasonable "reserve margin." The reserve margin is a measure of the extra generating capacity available to meet loads on a peak-load day. It is a percentage, defined as the difference between total capacity and peak load, divided by peak load. Reserve margins are important because unplanned outages of plants and transmission lines often occur, leaving the system with less than its total capacity. In order to meet peak loads in the context of unplanned outages, extra capacity must be maintained. In regulated electric industries, regulators and system planners have traditionally sought to maintain reserve margins in the range of 15 to 20 percent. Generally, competitive electricity markets have maintained lower reserve margins, however regulators are currently developing mechanisms to ensure that these markets maintain acceptable reserve margins.

With the construction of the six new plants discussed above (Athens, Bethlehem, Ravenswood, East River, Poletti and SCS Astoria), the New York State reserve margin in 2005 will be roughly 27 percent. This is an unusually large reserve margin, the product of the current power plant "construction boom" in New York. We do not expect wholesale power markets in New York to maintain reserve margins at this level over the long term. Thus, in our Base Case, we maintain reserve margins of roughly 23 percent in 2010 and 2015. We maintain this reserve margin by adding new CCCTs and simple-cycle combustion turbines (peaking units) throughout the state. The rationale for adding these types of units in the Base Case is that, without aggressive policies designed to encourage energy efficiency and renewable and CHP projects, these are the resources most likely to be added. In the Clean Electricity Plan, we maintain 23-percent reserve margins with aggressive energy efficiency and new renewable and combined heat and power capacity.

In Table 6 near-term additions are cited by name and assumed additions over the longer term are "generic" CCCTs and CTs, identified simply as "new capacity."

The Danskammer Plant in Newburgh, housing two old oil- and gas-fired units and two newer coal-fired units.

Table 6. Plant Additions and Retirements Assumed in the Base Case

Plant	Unit	Plant Additions On-line Date	Capacity (MW)
Athens	CC Unit 1	2003	360
	CC Unit 2	2003	360
	CC Unit 3	2003	360
Ravenswood	New CCCT	2004	250
East River	New CTs	2004	360
Bethlehem	CC Unit 1	2004	250
	CC Unit 2	2004	250
	CC Unit 3	2004	250
Poletti	New CCCT	2005	500
SCS Astoria	CC Unit 1	2006	500
	CC Unit 2	2006	500
New CC Capacity	---	2006-2009	250
New CC Capacity	---	2011-2014	2,200
New CT Capacity	---	2011-2014	1,100
Plant	**Unit**	**Plant Retirements Retirement Date**	**Capacity (MW)**
Waterside	Unit 6	2002	49
	Unit 8	2002	48
	Unit 9	2002	48
Albany	Unit 1	2004	94
	Unit 2	2004	94
	Unit 3	2004	95
	Unit 4	2004	97
Westover	Unit 7	2005	44
Poletti	Unit 1	2008	855

**As described in Section 3.3, we assess the base case with and without the proposed new unit at Bowline.*

3.2 Base Case Modeling Results

Our simulation of the Base Case energy future for the Hudson River Valley indicates that electricity generation in the Hudson Valley and New York City is likely to increase significantly over the study period, driven primarily by the new plant additions in this region. The Hudson Valley figures include the output of the following units: Bowline, Lovett, Roseton, Danskammer, Athens and Bethlehem. The New York City figures include: Arthur Kill, East River, Astoria Steam, Poletti, Ravenswood and SCS Astoria. Generation is projected to increase more at the fossil-fired plants in the Valley than in New York City. As shown in Table 7, generation from the fossil-fired plants in the Valley in 2005 is projected to be 67 percent above the average level for the period 1996 through 2000, driven in large part by the addition of Athens and Bethlehem. By 2015, generation at these plants is projected to rise by 127 percent over the 1996 – 2000 average. Generation at the five New York City plants decreases in 2005 from historical levels, as output from the new units at Athens and Bethlehem displaces generation from older steam units in the City. (The output of the new East River and Poletti units largely displaces the existing units at those sites.) However, generation in the City rises in 2010 and 2015, as loads grow and the new SCS Astoria units begin operating.

Table 7. Trends in Electricity Generation at the Major Downstate Plants (GWhs)

	1996-2000 Average	2005	2000-2005 Change	2010	2000-2010 Change	2015	2000-2015 Change
Hudson Valley	9,273	15,495	67%	18,054	95%	21,050	127%
New York City	12,070	10,389	-14%	14,893	23%	15,646	30%
Total	21,343	25,884	21%	32,947	54%	36,696	72%

Over the entire study period, generation is projected to grow more in the Valley than in the City, as the new units displace the existing units in the City more than they displace the existing units in the Valley. This is because the existing units in the City tend to be older, less efficient and have higher fuel costs than the existing capacity in the Valley. With the exception of Bowline, the major existing fossil units in the Hudson Valley burn coal or high-sulfur oil, much less expensive fuels than the gas and low-sulfur oil burned by the fossil plants in the City. The lower fuel costs put these plants lower in the dispatch order, making them less susceptible to displacement by the new gas-fired plants.

Table 8 shows projected generation throughout the study period at each of the four older fossil-fired plants on the Hudson. Note that these figures should not be construed as precise predictions, but rather as indications of probable trends. Operation at Bowline is relatively stable over the 2000 – 2010 period, with the plant showing a significant increase in operation by 2015. Operation at Roseton increases significantly over the period, doubling in 2015 relative to historical levels. (Much of the increase in generation at Roseton by 2005 is the result of increased gas prices in 2005 relative to the 1996 – 2000 period, coupled with Roseton's ability to burn the lower cost, high-sulfur oil. In contrast, Bowline is required to burn low-sulfur oil.) Generation at the coal-fired units either falls or remains steady through 2010 and then increases over historical levels in 2015.

Table 8. Projected Base Case Generation at Hudson River Fossil Plants (GWhs)

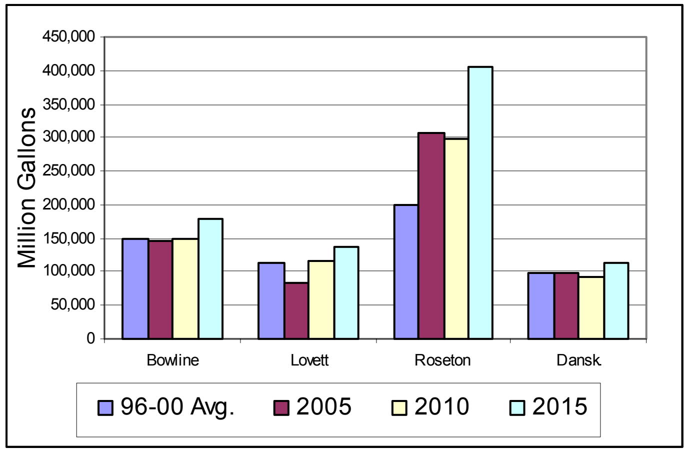
Plant	1996-2000 Average	2005	2000-2005 Change	2010	2000-2010 Change	2015	2000-2015 Change
Bowline	2,058	2,033	-1%	2,075	1%	2,503	22%
Lovett	2,040	1,507	-26%	2,067	1%	2,475	21%
Roseton	2,711	4,134	52%	4,023	48%	5,497	103%
Danskammer	2,464	2,407	-2%	2,324	-6%	2,772	13%
Total	9,273	10,082	9%	10,489	13%	13,248	43%

For the purposes of this analysis, the most important result of the Base Case modeling is that none of the four fossil plants on the Hudson is likely to be rendered obsolete simply by the evolution of the regional electricity market through 2015. In other words, all of these plants are projected to continue generating substantial amounts of electricity for the foreseeable future, with all of them increasing their output in 2015 over baseline levels. *This means that, unless action is taken at these older fossil-fired plants, their environmental impacts are likely to increase rather than decrease over time.*

We can make a rough estimate of future water use consistent with these projections of plant utilization by extrapolating water use in proportion to the changes in generation.[14] This is not a precise method of predicting impacts, because power plants' emission rates and water use rates are slightly different at different operating levels.[15] However, this approach is sufficient to provide a general picture of water use at these plants, given the changes in utilization projected here.

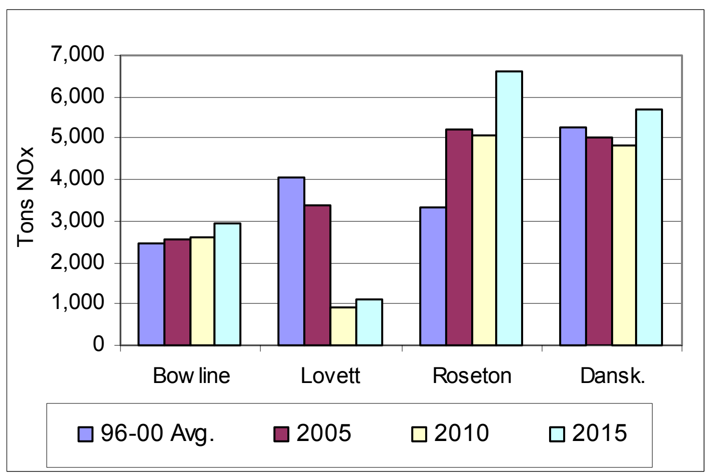
As seen in Figure 7, water use is projected to rise most in the Base Case at Roseton, due to the increased utilization of that plant. *Total water use at the four fossil plants in 2015 is projected to rise by 43 percent from baseline levels.*

Figure 7. Projected Base Case Trends in Water Use at the Hudson River Fossil Plants



Changes in NO_x, SO_2 and CO_2 emissions consistent with the Base Case projection of plant utilization are shown in Figures 8, 9 and 10. These changes in air emissions were calculated within the PROSYM model. The largest NO_x increases are likely to come at Roseton, due to the increased utilization projected at that plant. In fact, Roseton will surpass Danskammer in 2005 as the largest NO_x emitter in the Valley if its output rises as projected here.

Figure 8. Projected NO_x Emissions at the Old Hudson River Fossil Plants



In addition, the effects of the SCR controls we assume will be added at Lovett are clearly visible in Figure 8, as NO_x emissions from that plant fall dramatically in 2010. The NO_x controls at Lovett represent the only significant change in NO_x emission rates that we envision at these plants in the Base Case. The changes in annual emissions at the other plants are entirely due to changes in utilization. *Projected NO_x emissions from the four plants combined rise in 2015 by roughly eight percent above baseline levels*, as increases at Roseton more than offset decreases at Lovett.

[14] While PROSYM calculates changes in air emissions internally, it does not calculate changes in water use.

[15] In particular, this method of estimating future water use is likely to overstate water use at Roseton, because the plant uses cooling water more efficiently at higher operating levels. Thus, with output predicted to rise substantially, this linear extrapolation of water use is likely to overstate water use by a small amount.

Turning to SO_2 emissions, we find that Roseton is projected to remain the largest SO_2 emitter in the area, potentially emitting over 25,000 tons of SO_2 in 2015. Again, we assume that Roseton continues to burn high-sulfur oil in the Base Case and that it purchases the necessary SO_2 allowances to comply with New York's new SO_2 regulations. At Lovett, the SO_2 reduction in 2005 is due to a reduction in plant utilization, however, the plant's SO_2 rate is reduced by roughly 40 percent in 2010 and 2015 by the PM controls that we assume are installed in 2008. Finally, note that SO_2 emissions increase at Bowline in 2005 over historical levels. This reflects our assumption that gas prices will remain higher on average in 2005 period than they were in the 1996 – 2000 period. In response, Bowline is projected to burn more oil in 2005 than it did during the baseline period. Recall, however, that Bowline is required to burn low-sulfur oil, so the SO_2 increases from this shift are mitigated somewhat. *Projected SO_2 emissions from the four plants combined rise in 2015 by roughly 31 percent over baseline levels.*

Figure 9. Projected SO_2 Emissions at Hudson River Fossil Plants

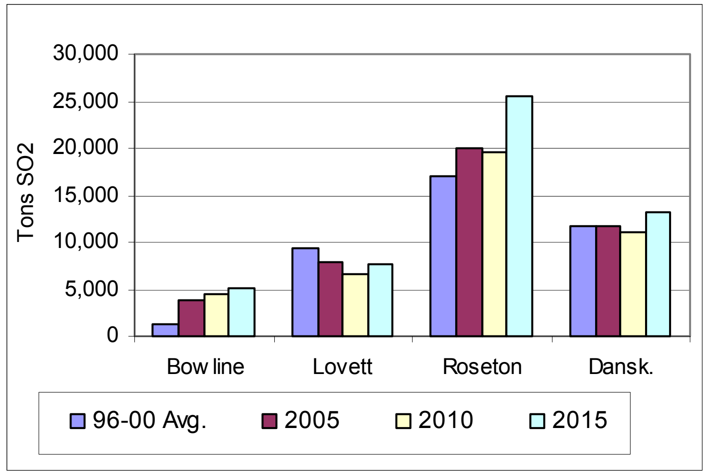


Figure 10. Projected Trends in CO_2 Emissions at Older Plants on the Hudson

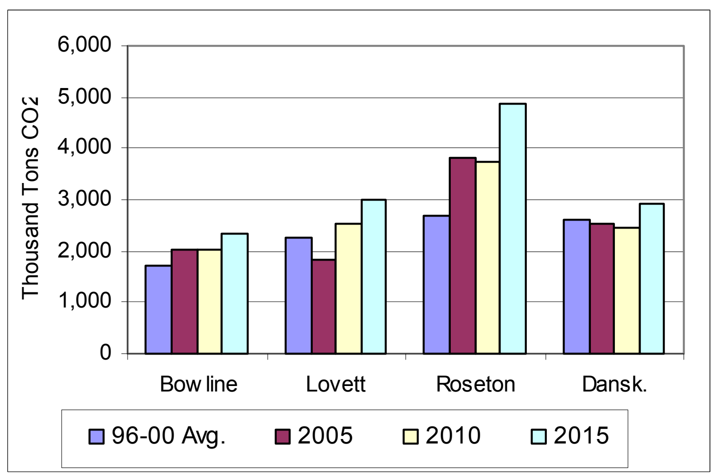


Figure 10 shows projected Base Case CO_2 emissions at these four plants. As discussed in Section 1, CO_2 emissions are relatively constant for each fuel type, thus for a given plant burning the same fuel, they change in direct proportion to plant utilization. (Note for example, that the NO_x and PM controls installed at Lovett in 2008 do not reduce CO_2 emissions.) Because of this, the CO_2 emissions projected in the Base Case follow patterns very similar to the predicted water use trends (shown in Figure 7 above), which follow plant utilization fairly closely. The one significant difference between the water use and CO_2 trends at these plants is the increasing CO_2 emissions from Bowline. This trend reflects the same shift away from gas at Bowline that we see in the plant's SO_2 emission trend. Residual fuel oil emits about 174 pounds of CO_2 per mmBtu burned, while natural gas emits about 117 pounds per mmBtu, so the shift from gas to oil increases the CO_2 rate at Bowline. This leads higher total annual emissions in 2005 and 2010 even though the plant's output remains roughly constant. *Projected CO_2 emissions* *from the four plants combined in 2015 are projected rise by roughly 41 percent over baseline levels, driven by increases in the utilization of all four plants.*[16]

In sum, our Base Case modeling indicates that all of these plants will continue generating substantial amounts of electricity during the coming decade. Electrical output and water use in 2015 at the four plants combined is projected to be 43 percent above historical levels. Emissions of NO_x are projected to be eight percent above historical levels; emissions of SO_2, 31 percent above historical levels, and emissions of CO_2, 41 percent above historical levels.

3.3 Sensitivity Analysis – Adding Bowline Unit 3

Because the proposed Bowline 3 project is in the advanced stages of planning and is only being delayed by financial problems, we have also assessed a Base Case scenario in which that project is completed as scheduled in 2008. We assess this scenario as a sensitivity analysis, to determine whether the addition of that project would significantly affect the trends predicted above at the four fossil-fired plants on the lower Hudson. This analysis indicates that the addition of Bowline 3 would not significantly affect projected utilization levels at the older fossil-fired units on the River. As shown in Table 9, the projected capacity factors at the Hudson River fossil units with Bowline 3 are only slightly different from those in our Base Case (without Bowline 3).

Table 9. Projected Generation, Hudson River Fossil Plants with Bowline 3 (MWhs)

	2010		2015	
Plant	Base Case	With Bowline 3	Base Case	With Bowline 3
Bowline 1	21%	20%	26%	26%
Bowline 2	19%	18%	21%	21%
Lovett 3	0%	0%	0%	0%
Lovett 4	68%	68%	81%	80%
Lovett 5	66%	66%	79%	79%
Roseton 1	38%	37%	52%	50%
Roseton 2	39%	38%	53%	51%
Danskammer 1	7%	5%	9%	8%
Danskammer 2	8%	7%	16%	13%
Danskammer 3	77%	77%	83%	83%
Danskammer 4	65%	65%	81%	80%

There are two reasons for the small impact of Bowline 3 on the other plants in the Valley. First, if the Bowline 3 unit were completed in 2008, in addition to the other units we

[16] Note that we do not assume that CO_2 emissions are regulated in New York in either the Base Case or Clean Plan, although Governor Pataki has sought support from the governors of 10 Northeast states to work towards development of a regional cap on power sector emissions of CO_2. This initiative has been positively received, and state leaders will be convening in September 2003 to begin detailed discussions on the operational and design elements of a cap-and-trade program for regional emissions of CO_2 from the power sector. However, given the very preliminary nature of these discussions, we do not include CO_2 regulations as part of our Base Case assumptions.

assume are added in the Base Case, we project that Bowline 3 would operate at a relatively low capacity factor (in the range of 30 percent) in 2010. This is not surprising, given that generating capacity in the Valley would grow by 34 percent without Bowline 3 between 2002 and 2010, and capacity in the City would grow substantially as well.[17] Second, many of the generating units in the Valley burn lower cost fuels (e.g., coal and oil) than would Bowline 3 (gas). Lower fuel costs help to place these plants lower in the dispatch order than would be the new Bowline unit, especially in the context of higher projected gas prices. The result is that other gas-fired plants in the Hudson Valley and New York City are affected by the addition of Bowline 3 more than these four plants.

4. Clean Energy Policies and Technologies

The Clean Electricity Plan we model is composed of energy policies that could be implemented in the Hudson Valley and New York State and specific environmental retrofit projects at the four fossil plants on the Hudson. The policies we model include: (a) more aggressive energy efficiency programs, (b) the use of renewable energy resources, and (c) incentives for combined heat and power (CHP) production. We model these policies as being implemented in the Hudson Valley and New York City only. The specific strategies we assess at the four fossil plants include retrofit technologies, such as cooling towers and emission controls, and repowering. Note that the clean electricity strategy we model has not been optimized to maximize a particular environmental benefit or to minimize costs. Rather, we have simply brought together common energy policies and retrofit options that we felt would provide substantial benefits at reasonable costs. Specifically, we did not have access to the data necessary to determine which of the four older fossil-fired plants has the greatest impact on the River. Thus, we have judged benefits in terms of reduced water usage, not reduced aquatic impacts. Additional work is currently underway to determine the relative impacts of these four power plants, and this work may tell us, for example, where the construction of closed-loop cooling systems would have the greatest benefits.

The subsections below describe these policies and plant-specific projects. The results of modeling the clean strategies are presented in Section 5, below.

We did not have access to the data necessary to determine which of the four older fossil-fired plants is having the greatest impact on the River. Thus, we have judged benefits in terms of reduced water usage, not reduced aquatic impacts. Additional work is currently underway to determine the relative impacts of these four power plants, and this work may tell us, for example, where the construction of closed-loop cooling systems would have the greatest benefits.

4.1 Energy Efficiency

In New York, as in other parts of the United States, there is a vast potential to increase the efficiency of electricity use. All types of electricity customers – residential, commercial,

[17] Plants coming on line in New York City between 2002 and 2010 include: the new units at Ravenswood Poletti and East River and the new SCS Astoria plant.

industrial, institutional, governmental – have numerous opportunities to replace aging electric equipment with newer, more efficient models, or to buy a high-efficiency product when purchasing new appliances or lighting fixtures. There is a long and ever-growing list of new technologies to reduce electricity consumption, including compact florescent lighting; efficient refrigerators; efficient heating, ventilation and air conditioning equipment; efficient motors; water heater improvements and insulation; weather-stripping of houses and businesses; and more. There are also many design and behavioral modifications that allow citizens and businesses to manage their energy use more efficiently.[18]

Many efficiency measures cost significantly less than the generating, transmitting and distributing electricity – i.e., they are highly cost effective. In many cases, efficiency measures have a payback period of two years or less. Thus, energy efficiency is an effective and low-cost resource for lowering system-wide electricity costs and reducing customers' electricity bills.

Energy efficiency also has significant environmental benefits. Every kWh that is saved through efficiency results in less electricity generation, and thus less pollution. Unlike other pollution control measures – such as scrubbers, selective catalytic reduction, and allowance trading schemes – energy efficiency measures can reduce air emissions with a *net reduction* in costs. Thus, it should be considered as one of the top priorities when investigating options for reducing air emissions.

Energy efficiency also offers other benefits to electricity customers and society in general. It can help reduce the demand on local transmission and distribution systems, potentially deferring expensive T&D upgrades or mitigating local transmission congestion problems. Efficiency can help reduce reliance upon fossil fuels, with their inherently unstable price and supply characteristics. It can also help promote local economic development and job promotion by increasing the disposable income of citizens and reducing costs to businesses and industries.

New York State has a history of implementing successful energy efficiency programs, and the New York State Energy Research and Development Authority (NYSERDA) is currently sponsoring several energy efficiency programs throughout the state. Nonetheless, there remains a considerable efficiency potential to be developed in the state. For the clean electricity plan, we have developed modeling assumptions representative of additional efficiency programs in New York State. These inputs are based on a review of the energy efficiency programs currently being implemented in the northeastern US, and the efficiency potential in New York City and the Hudson Valley region. As shown in Table 10, we model additional efficiency programs in the Hudson Valley region by reducing peak load and energy use by roughly one percent per year, starting in 2004. This assumption is summarized in Table 10.

[18] For the purpose of this report, we define energy efficiency to include those technologies and measures that reduce the amount of energy needed to provide a given electricity service (e.g., lighting, heating motor power). There are also *additional* efficiency savings that can be obtained through lifestyle changes and other ways to reduce the level of electricity services required.

Table 10. Assumed Efficiency Impacts under the Clean Plan (Percent Reduction from Base Case)

	2005		2010		2015	
	Energy	Peak	Energy	Peak	Energy	Peak
Hudson Valley	1.0%	1.0%	6.0%	6.0%	11%	11%

We assume that the new efficiency programs implemented in the Clean Plan cost, on average, $25 per MWh of electricity saved. This figure is based on a review of data published by the utilities and energy efficiency agencies currently operating programs in the Northeastern US. In NYSERDA's most recent evaluation of its major efficiency programs, the agency placed the cost of energy saved at $11 per MWh for programs that are not co-funded and $44 per MWh for co-funded programs.[19] Co-funded programs are those in which the customer pays some portion of the cost of the efficiency upgrade.

4.2 Renewable Energy

Studies of the renewable energy potential in New York State suggest that the state has adequate resource potential to support significant development of a variety of new renewable generation technologies. The most comprehensive study to date, recently released in draft form, was performed for NYSERDA.[20] This study found an economic potential of over 15 million MWhs of new renewable energy in New York by 2012 assuming high avoided costs. It found an economic potential of over 11 million MWhs assuming low avoided costs. In both cases, the study identified the greatest economic potential in wind and biomass energy.

The most recent study of renewable energy potential in New York State found an economic potential of over 15 million MWhs of new renewable energy by 2012 assuming high avoided costs, and 11 million MWhs assuming low avoided costs.

New York's 2002 State Energy Plan required NYSERDA to investigate the feasibility of establishing a Renewable Portfolio Standard (RPS) in the state. NYSERDA's preliminary investigation found that an RPS could be implemented in the state's existing competitive electricity market. In February 2003, the New York State Public Service Commission (PSC) initiated proceedings to develop and implement a RPS for retail electric sales in the state. In April and May, the Commission held a series of collaborative meetings to determine the specifics of the RPS.

The RPS under consideration at the PSC would require that 25 percent of retail electric sales in the state originate from renewable resources by 2013. Because the standard will include existing resources, which already comprise a significant portion of the New York mix (in the range of 18 percent), the new renewable generation required by the RPS would be less than 25 percent.

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19 NYSERDA, *New York Energy Smart Program Evaluation and Status Report*, May 2003, p. S-6.

20 Optimal Energy, et. al., *Energy Efficiency and Renewable Supply Potential in New York State and Five Load Zones*, available in draft form from NYSERDA.

The renewables development scenario in the Clean Plan is based on the assumption that an aggressive policy to support renewables, such as an RPS, is implemented in New York State. However, in order to isolate the effects of renewables development in the Hudson Valley, we do not model additional renewables in other areas of New York; we assess the costs and benefits of aggressive renewables development in the Hudson Valley only. Further, we assume that renewable technologies are developed in the Hudson Valley in quantities proportional to their potential in this region. Photovoltaics (PV) and fuel cells are perhaps best suited to the Hudson Valley, because it is a relatively small, densely populated region and these technologies are compact and operate on energy sources available in the Valley (sunlight and natural gas). Thus, we model substantial development of these technologies in the Valley relative to their statewide potential. Technologies like wind energy and biomass have potential in the Hudson Valley, but they are better suited to other regions of the state, thus we assume more limited penetration of these technologies in the Valley relative to their statewide potential. (We add wind and biomass capacity only in the zones north of New York City, and the vast majority of it is added in the more rural areas of the northern Hudson Valley.) The potential for additional hydro and landfill gas capacity in the Valley is even more limited, and our assumptions reflect this.

We assume that the average capital cost of the new renewables modeled in the Clean Plan is $70 per MWh. (This is roughly $30 to $35 per MWh more expensive than the new capacity added in the Base Case.) Most studies of the cost of renewable energy (including the Optimal Study cited above) project that new wind, landfill gas and hydro energy will cost much less than $70 per MWh; that the biomass energy will cost slightly less than this and that the fuel cell and PV energy will cost more than this. In the context of a statewide RPS, this is likely to be a conservative assumption regarding the cost of renewables. Assuming market prices in the range of $40 per MWh, this is a premium of roughly $30 per MWh for renewable energy. Data from other states indicate that actual RPS premiums are not this high. Cantor Fitzgerald, a brokerage firm specializing in emissions trading, has been tracking bid prices for Massachusetts renewable credits and has posted data indicating bid prices in the range of $24 per MWh.[21] In addition, a recent study by the New York Department of Public Service found that the premium required to meet the RPS under consideration in New York would be considerably less than $30 per MWh.[22]

A brief discussion of each of the renewable resources included in the clean electricity strategies follows. The amounts of each renewable technology that we add in the Clean Plan are shown in Table 11 below.

4.2.1 Solar PV

Solar photovoltaic (PV) panels generate electricity directly from sunlight using the photoelectric effect. Solar PV systems offer considerable benefits relative to fossil-and nuclear-fueled generation. PV systems are modular, silent, create no pollution in

[21] This information is available to subscribers to Cantor Fitzgenerald's research at: www.emissionstrading.com.

[22] New York Department of Public Service et. al., *New York Renewable Portfolio Standard Cost Study Report*, July 28 2003.

operation, can be operated unattended and require little maintenance. They are usually deployed on a small scale close to the location of electricity consumption, avoiding the need for investments in transmission infrastructure and reducing system line losses. Finally, while PV systems are dependent on the sun—and are therefore not dispatchable—their peak output generally coincides with afternoon peaks in electricity demand, when electricity is most valuable.

The primary hurdle that PV systems face is high up-front cost. While PV units have virtually no operating costs, they are expensive to manufacture. In a sense, users of PV trade operating costs for up-front (capital) costs. When the time value of money is factored in, this can be an expensive tradeoff. However, technological improvements have caused a steady decline in the capital costs of PV systems over the past 20 years. Experience with rebate programs demonstrates that appropriate incentives can create strong markets for PV technology.

There are many small-scale PV systems currently in operation in New York, from large rooftop systems hundreds of kW in size to units a few hundred watts in size used to power highway signs and mobile equipment. While average levels of sunlight are not as high in the New York region as in regions like the Southeast and Southwest, there is ample sunlight in the New York for PV generation, especially during the summer. The amount of PV capacity added over the next decade will be highly dependent on energy policy decisions made at the state and local levels.

4.2.2 Hydroelectric Power

Hydroelectric power is currently the dominant source of the existing renewable supply in New York, accounting for 97 percent of the state's renewable electricity.[23] Two large hydropower installations account for 75 percent of the hydro energy in New York, with over 340 small hydro facilities constituting the balance.

The benefits of hydropower include zero fuel costs and low operating costs, no emissions, and energy storage capabilities at store-and-release facilities. However, hydro also has a number of environmental impacts, concerns over which have caused several states to exclude hydropower from their RPSs. These impacts include riparian habitat degradation, fish mortality, hindering of fish migration, and reduced water quality. The Low Impact Hydropower Institute (LIHI) has established a certification process for hydropower facilities. LIHI certification is awarded to a hydropower facility that is found to meet or exceed criteria which address eight key areas, including river flows, water quality, fish passage and protection, and endangered species protection. LIHI certification is required for participation in some programs, such as state RPSs and green power sales programs.

Due to regulatory and siting challenges, any additional hydro capacity sited in New York will probably take the form of repowerings of existing dams (i.e., replacement of old turbines with new ones that produce more power) or expansions of capacity at existing dams (i.e., adding additional turbines to existing dams).

[23] 2002 New York State Energy Plan.

Due to the considerable regulatory and siting challenges to building a large new hydropower facility, any additional hydro capacity sited in New York will probably take the form of repowerings of existing dams (i.e., replacement of old turbines with new ones that produce more power) or expansions of capacity at existing dams (i.e., adding additional turbines to existing dams). We expect that these types of projects would qualify for the RPS currently under consideration in New York. Because most of New York's existing hydro capacity is outside of the Hudson Valley, most of the potential for new hydro capacity is also outside this area. Thus, we assume that the clean electricity plan results in only modest additions in hydro capacity in the Hudson Valley – three MW in 2005 rising to 55 MW in 2015.

4.2.3 Wind

Wind technology is the fastest growing power generation source in the world. Currently, installed wind capacity in New York is extremely limited, but studies indicate that the state has significant potential for wind power, particularly offshore applications. The NYSERDA study cited above projects an economic potential for wind in New York of over 3.5 million MWhs by 2012 assuming high avoided costs and 1.2 million MWhs assuming low avoided costs. These figures correspond to approximately 1,200 and 400 nominal MWs.

Wind energy does not produce air emissions and relies on a free, non-depletable fuel source. The relatively high capital cost of wind turbines can be partially offset by low operating costs and a federal production tax credit of about 1.8 cents per kWh. In some areas, wind power is already cost competitive with electricity from fossil fuel-based sources.

One limitation of wind energy however is its intermittent nature – it can only provide power when the wind is blowing at sufficiently high speeds, and those times may not always coincide with periods of high electricity demand. Fortunately, the ability to predict wind generation into the short-run future has improved, and the wind generation adds to the reliability of the system even though its output is intermittent.

As discussed above, the vast majority of the wind potential in New York is in areas outside the Hudson Valley, such as Long Island and on the shores of lakes Erie and Ontario. We model the development of small-scale wind projects in the northern Hudson Valley, totaling one MW in 2005 and 75 MW in 2015.

4.2.4 Biomass and Landfill Gas

Biomass power generation generally refers to the combustion of wood and other biofuels to generate electricity. These fuels can be either dedicated feedstocks – plants grown specifically for this use – or wood wastes. To date most biomass power generation has occurred in boilers, however several new combustion technologies are emerging. The four combustion technologies most likely to be used during the study period are: direct firing of biomass in boilers, co-firing of biomass in coal-fired power plants, use of biomass in combined heat and power plants and biomass gasification plants.

The NYSERDA study identifies a considerable biomass resource in New York State. Under a scenario in which the federal production tax credit for biomass is extended through 2012 and a modest state-level policy is enacted to encourage co-firing, the study projects roughly 425 MW of new biomass co-firing, gasification and CHP projects.

The combustion of biomass does result in air emissions – most importantly NO_x and CO_2. We assume that in order to qualify for an RPS or other subsidy in New York, the new biomass generation in the Hudson Valley would be required to rely on fuel that is part of a carbon neutral fuel cycle. Thus, we do not model net CO_2 emissions from biomass generation. We also assume that new biomass plants will have to minimize NO_x emissions in order to qualify for an RPS or other subsidy. Thus, we model new biomass generation as having, on average, a NO_x rate of 0.1 lb per MWh.

Electricity generators relying on landfill gas utilize the methane given off by decomposing debris in landfills. Larger landfills in the US are required by EPA to capture their off-gas emissions with a landfill cap, and once a cap is in place, collection of the methane and use for electricity generation is a relatively simple matter (assuming there is sufficient gas production). Electricity generated from landfill gas is eligible for many of the state RPSs across the country, and where it is eligible it often provides some of the lowest cost renewable electricity. We assume that landfill gas projects are eligible to meet a New York RPS. However, because the addition of landfill gas generating capacity is dependent on a suitable landfill, the potential for adding this type of capacity in New York is very limited. Therefore we model a very small amount of new landfill gas capacity in the Clean Plan (only 16 MW by 2015).

While there are emissions associated with landfill gas combustion, the alternative to combustion for electricity is simple flaring of landfill gas. Thus, with our baseline emission assumption being that of an open flare, we model no net emissions from the combustion of landfill gas.

4.2.5 Fuel Cells

Fuel cells generate power by means of an electrochemical reaction that is fueled by hydrogen. The majority of currently operating fuel cells rely on hydrocarbon fuels such as natural gas for their hydrogen supply, but it is possible that a hydrogen delivery infrastructure will supply a significant number of fuel cell applications in the future.

Fuel cells that operate on hydrogen have no air emissions, however we assume that all fuel cells added in the Clean Plan will operate on methane using a fuel reformed to produce hydrogen onsite. Emissions from fuel cells operating on methane are typically much lower than emissions from combustion-based generation. Emissions of NO_x are in the range of 0.03 pounds per MWh and emissions of CO_2 are in the range of 1,000. However many fuel cell installations will utilize waste heat from the unit, a practice which can lower net emissions considerably. We assume that heat is recovered from many of the new fuel cell installations in New York and that net NO_x emissions are 0.02 lb/MWh and net CO_2 emissions are 800 lb/MWh.

Like PV, fuel cell development is principally constrained by its high capital cost. Fuel cells are not yet a mature technology, and many engineering and technical challenges remain to their widespread dissemination. However, fuel cell development is proceeding at a very fast pace, and the electricity produced from fuel cells is expected to comprise a substantial portion of New York's renewable generation over the next several decades. Currently, there are several fuel cells operating in New York City at hospitals, wastewater treatment plants and commercial buildings. We model aggressive development of fuel cell technology in the Hudson Valley, especially in New York City, with capacity rising from one MW in 2005 to 80 MW in 2015.

Table 11. Renewable Capacity Added in the Clean Electricity Plan (MW)

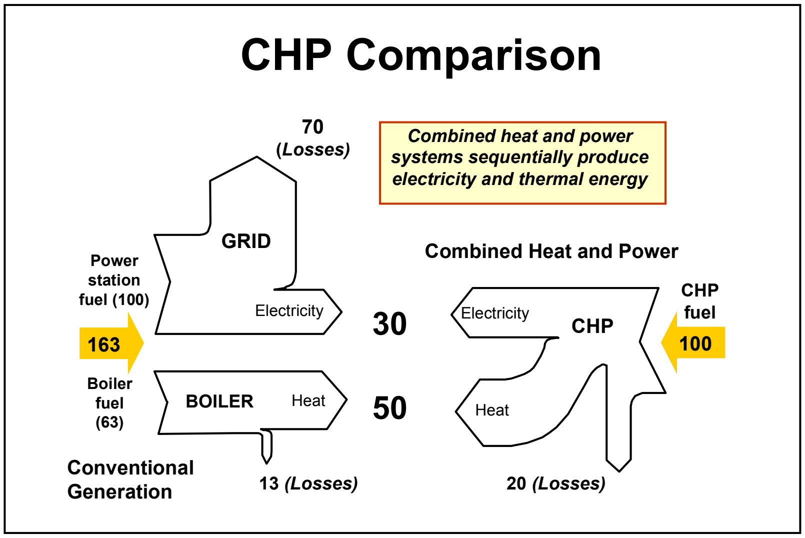
Technology	2005	2010	2015
Biomass	50	200	200
Hydro	3	25	55
LFG	4	16	16
PV	1	20	75
Wind	5	40	100
Fuel Cells	1	28	80
Total	63	329	526

4.3 Combined Heat and Power

Businesses and industry in New York State that utilize both electricity and fuel for thermal processes can dramatically increase the efficiency of their energy use and reduce environmental impacts by employing on-site power generation with waste heat recovery to replace the need for boiler fuel. This approach, called combined heat and power, or "CHP," is already an important generating resource in New York with approximately 5,000 MW of capacity installed at 210 sites.

Figure 11 illustrates the efficiency advantage of CHP compared with purchased electricity and fuel-fired boilers. By combining the electrical and thermal energy generation in one process, the example CHP system shown has an overall efficiency of 80 percent compared with 30 to 33 percent for simple electric generation. Considering both thermal and electrical processes together, CHP requires 40 percent less primary energy than purchased fuel and power.

Figure 11. CHP versus Separate Power Generation and Heat Production



A recent report prepared by Energy Nexus (now Energy and Environmental Analysis) and the Pace Energy Project identified nearly 26,000 sites throughout New York with the technical potential to deploy, in the aggregate, 8,500 MW of additional CHP capacity.[24] Nearly three-quarters of the CHP technical potential is in the small size range (less than five MW) and is concentrated at commercial and institutional facilities.

Market penetration of CHP will depend on the degree of economic advantage for CHP compared to separately purchased fuel and power, the prevailing size of the CHP market, the speed with which the current market can ramp-up in the development of new projects, and the sites remaining with economic potential. The Energy Nexus/Pace study concluded that anywhere from 764 to 2,200 MW of CHP could be added by 2012 depending upon prevailing market and regulatory conditions over the study period.

In our Clean Electricity Plan, we model the addition of a range of different types of CHP plants, from small microturbines to large boiler-based CHP projects. Based on the findings of the Nexus/Pace study, we assume that the majority of the new CHP capacity in New York is less than five MW in size and has the characteristics of a microturbine (generally under one MW) or a small gas turbine. The costs and operating characteristics of our CHP technologies are based on information in the Nexus/Pace report. We assume that small CHP operates in during daytime hours only and that large CHP operates around the clock (with periodic maintenance outages).

The amount of CHP capacity added in the Hudson Valley in each study year, and the assumed cost of that capacity, is shown in Table 12. In developing assumptions for CHP additions, we began with the economic potential identified in the Nexus/Pace report. However, we have chosen more conservative numbers than this economic potential,

[24] See: Energy Nexus Group and Pave Energy Project, *Combined Heat and Power Market Potential for New York State*, prepared for NYSERDA and ORNL, October 2001.

because we are developing a clean strategy consisting of relatively aggressive investment in efficiency, renewables, CHP and retrofit technologies at the Hudson plants. In a scenario in which all of these policies are pursued together, we assume that none of them is pursued to its full economic potential.

Table 12. Addition of CHP Capacity in the Clean Plan[25]

	2005		2010		2015	
Size	kW	$/kW	kW	$/kW	kW	$/kW
<5,000 kW	15,000	$1,150	55,000	$1,050	160,000	$950
>5,000 kW	3,500	$950	18,000	$900	45,000	$850

4.4 Retrofit Technologies at the Four Fossil Plants

The Clean Electricity Plan incorporates environmental retrofit projects at one or more of the four fossil-fueled plants along the Hudson. We have selected retrofit technologies that represent cost-effective ways to reduce water use, minimize fish impingement, and reduce air emissions at the affected plants. The projects we model at each Hudson River plant are as follows.

- Bowline – construction of wet cooling towers between 2005 and 2010.
- Lovett – installation of SCR NO_x reduction systems and baghouses and carbon injection systems to reduce PM, SO_2 and mercury between 2005 and 2010. (As discussed in Section 2, we assume that these systems are installed in both the Base Case and the Clean Plan. This is the only environmental retrofit that we assume occurs in the Base Case.)
- Roseton – plant repowering. This entails removal of the existing steam generating units and construction of new CCCT systems with wet cooling towers.
- Danskammer – installation of SCR NO_x reduction systems and baghouses and carbon injection systems to reduce PM, SO_2 and mercury between 2005 and 2010.

These retrofit technologies are described below, along with the costs and performance characteristics we assume for each project. All costs shown are in constant 2003 dollars.

4.4.1 Cooling Towers

Cooling towers function either by using natural draft circulation or mechanically impelled airflow to cool water. Heat is transferred from the cooling water to the atmosphere through evaporation. A typical mechanical draft cooling tower is approximately 45 feet high and relies on fans to draw air in either a counterflow or crossflow pattern to the direction of water flow. Natural draft towers are very tall (400 to 600 feet) cylindrical structures that rely on a chimney effect to promote airflow.

[25] The figures in this table are not additive. That is, the 15,000 kW of small CHP added in 2005 is included in the 55,000 kW figure in 2010.

Because of their large size, natural draft towers typically have higher capital costs than mechanical draft towers. These high capital costs can be offset by lower operating cost (due to the absence of energy-consuming fans). For the aging fossil plants along the Hudson River, which have historically operated with relatively low capacity factors, we determined that it would be more sensible to retrofit the plants with mechanical draft towers because of their lower capital cost.

Cooling towers using different cooling processes are available, and in general, tower costs are higher for the technologies that use less water. In a "wet tower," cooling water flows though the plant and then through the cooling tower, where it is cooled through contact with ambient air. Wet cooling systems use the most water of any cooling tower technology, due to evaporative losses resulting from the cooling water/air contact. "Dry cooling" is a technology in which steam/air heat exchangers cool and condense steam from the plant directly. Dry towers use the least water, but they cost considerably more than wet towers. Hybrid towers, or "wet/dry" towers fall in between wet and dry towers in both water use and costs.

Converting from a once-through cooling system (the system currently used at all four of the fossil fuel-based plants on the Hudson) to a wet tower can reduce annual water use by over 95 percent. Converting to a dry tower from a once-through system reduces water use by upwards of 99 percent. In the Clean Electricity Plan, we model the construction of wet cooling towers at Bowline and Roseton. The construction of the towers at Roseton in the Clean Plan is part of the larger repowering project. We modeled cooling tower retrofits at Bowline because, at the time of our research, Bowline was the only plant for which we had access to a detailed engineering study of cooling tower retrofits. Performing similar studies to estimate the feasibility and cost of retrofitting the other plants with cooling towers was beyond the scope of our work. However, future studies of cooling tower retrofits at Danskammer, Roseton and Lovett may indicate that retrofits at one or more of these plants (in place of, or in addition to a retrofit at Bowline) would provide greater benefits.

We used a methodology developed by EPA to estimate the cost of building wet towers at each of these plants. This methodology is found in the *Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule*, published by EPA.[26] Total project costs at Bowline are assumed to be $76.7 million, or $63 per kW. Cooling tower operation and maintenance costs are based on the plant-specific cost estimates provided in a report prepared by Power Tech Associates that examines the environmental and economic impacts of installing closed cooling water systems at four plants on the lower Hudson River.[27]

The reduced water use achieved by a cooling tower comes at a cost in terms of plant performance. This cost consists of two components: a turbine efficiency energy penalty and increased auxiliary energy loads to operate fans and other systems in the tower. The

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[26] US EPA, *Technical Development Document for the Proposed Section 316(b) Phase II Existing Facilities Rule*, April 2002, EPA 821-R-02-003.

[27] Power Tech Associates, *Economic and Environmental Review of Closed Cooling Water Systems for the Hudson River Power Plants*, November 1999.

extent of this efficiency loss depends on ambient factors and characteristics of the plant and tower. To calculate the total energy penalty from these two factors, we have used the methodology laid out in EPA's *316(b) Technical Development Document*. Applying this methodology to retrofit project at Bowline results in a total energy penalty of approximately 1.6 percent. We have factored this energy penalty into the heat rates (efficiency) of the Bowline units under the Clean Plan.

4.4.2 Selective Catalytic Reduction NOx Controls

One of the most common post-combustion control systems for NO_x at electric power plants is Selective Catalytic Reduction (SCR). SCR systems inject ammonia or another catalyst into the flue gas stream where the mixture of gases passes through a noble metal catalyst. In the presence of the ammonia and metal catalyst, much of the NO_x in the gas stream is reduced to molecular nitrogen and water. SCR is capable of NO_x reductions in the range of 70 to 90 percent. Higher reduction efficiencies are possible but generally not cost effective. Retrofitting an SCR system on an existing boiler typically reduces the efficiency of electricity generation from the boiler/generator by a small amount

In the U.S. SCR is commonly installed on power plant boilers ranging from 25 to 800 MW in size. It is also widely used to reduce NO_x emissions from gas turbines. SCR controls are required for new power plants in most areas of the Northeast. As discussed in Section 2, Mirant recently announced the installation of SCR on units 4 and 5 at the Lovett plant.

We assume a reduction efficiency of 75 percent for the SCR systems we model at Lovett and Danskammer. This assumption is based on statements made by Mirant regarding the projected reductions at Lovett. We assume a capital cost of $85 per MW for SCR retrofits, based on EPA data.[28] We also assume small additions to fixed and variable O&M costs and a small (0.5 percent) loss in efficiency at boiler/generators at which SCR is installed.

4.4.3 SO_2 and PM Controls

In addition to SCR, Mirant has announced the installation of a baghouse and in-duct injection systems to reduce SO_2 and particulate matter (PM) at Lovett units 4 and 5. A baghouse is a system of fabric filters through which boiler exhaust gases pass, which physically captures particulate matter. Because much SO_2 is emitted in particulate form, baghouses can reduce SO_2 emissions significantly. A baghouse can also become an effective mercury control technology when coupled with an activated carbon injection system. With this system, activated carbon introduced in the flue gas stream reacts with mercury there and allows the mercury to be captured in the baghouse. Reductions of mercury from baghouses with in-duct injection vary widely, depending on the type of baghouse installed and the amount of carbon injected. Mirant has not indicated whether they will use the system installed at Lovett to reduce mercury emissions from the plant.

[28] U.S. Environmental Protection Agency (USEPA) 1998. *Analyzing Electric Power Generation Under the CAAA*, Appendix No.5: Pollution Control Performance and Costs. March 1998.

For the control systems we model at Lovett and Danskammer, we assume a 40 percent reduction in SO_2 emissions, based on statements from Mirant about the systems. The system would also reduce PM and mercury emissions substantially, but these pollutants are beyond the scope of this analysis. We assume capital costs of $40 per kW for this emission control system, based on studies of system costs at similar plants. Total project costs are $15.2 million at Lovett and $15.4 million at Danskammer.

4.4.4 Repowering

Repowering a generation facility means replacing the plant's old, inefficient and polluting equipment with newer, more efficient equipment. Today, virtually all repowering projects replace old equipment with combined-cycle combustion turbines (CCCTs). As discussed in Section 1, CCCTs generate electricity in two stages. In the first stage, fuel is burned to operate a gas turbine generator, and in the second stage, excess heat from the gas turbine is used to drive a steam turbine and generate additional electricity. This two-stage process can turn 50 percent or more of the fuel energy into electricity. Repowering has become commonplace in the electric industry since the early 1990s. One project, discussed in Section 1 above, is currently under construction in New York: the PSEG Bethlehem Energy Center outside Albany. When completed in 2005, this project will consist of 750 MW of combined-cycle generating capacity, including a net increase in 350 MW relative to the old Albany Steam Plant being replaced.

In practice, repowering can be done in at least two ways, either by rebuilding and replacing part or all of an existing plant or by closing down an existing power plant, building a new unit next to it and reusing the existing transmission and fuel facilities.

Repowering older power plants provides a number of important environmental and electric system reliability benefits: improved plant availability, lower plant operating and maintenance costs; increased plant capacity and generation; reduced facility heat rates which lead to significantly more efficient fuel use; reuse of industrial sites; up to 99 percent reductions in water intake and related fish impacts; and large reductions in air emissions, both overall and in terms of emissions per MWh of electricity. The Governor and New York State Legislature have recognized the general benefits of repowering existing power plants by amending the state's Article X law to expedite the siting process for plant repowering applications.[29]

A recent study on repowering KeySpan's generating facilities on Long Island by the Center for Management Analysis at Long Island University noted the benefits of repowering, including what it termed "compelling" environmental benefits:

> Improvements in efficiency from about 35 percent to close to 60 percent in the conversion of fuel to electricity can be achieved. The resulting reduction in fuel burned for a given amount of generation will be significantly less nitrogen oxides and carbon monoxide emitted. Modern combined cycle units have state of the art emission control systems in contrast to the older steam electric units with no such controls. The re-powered units achieve emission reductions

[29] See: N.Y. Pub. Service Law § 165(4)(b).

immediately since they replace higher emitting, older units that would likely continue to operate in an expansion program of new greenfield projects.[30]

Detailed engineering and economic analyses must be performed to determine the optimum size of the repowered unit and the extent to which existing facilities can be refurbished and reused. The types of existing facilities that can be refurbished and reused include boilers, turbine generators, condensers, transmission switchyards, and other auxiliary plant equipment. The reuse of this equipment can lower the cost of building the repowered facility as compared to the cost of constructing a new unit at a new site.

Our Clean Electricity Plan includes repowering of Roseton. We model retirement of both boilers and steam generators between 2005 and 2010 and completion of a 500-MW CCCT between 2010 and 2015. We assume the total capital costs of this project are $275 million ($550 per kW). Because a site-specific analysis of a repowering project at Roseton is beyond the scope of this study, this figure is based on a review of available cost information on recent CCCT projects. The figure is conservative (many recent CCCT projects have posted lower costs), and would probably correspond to a scenario in which little of the existing Roseton plant could be incorporated into the new plant.

Importantly, the repowering of Roseton could result in a significant revenue stream for Dynegy in the form of unneeded emissions allowances. Under both the Acid Rain Program and the NOx SIP Call allowance programs, companies that retire plants before the end of their useful lives will continue to receive emission allowances for some period. Recently, the Roseton plant has been receiving roughly 28,000 SO_2 allowances per year. Repowering the plant with gas-fired equipment would virtually eliminate SO_2 emissions, freeing these allowances for sale. Finally, it is important to note that any one of the four fossil plants on the River could be repowered. We have chosen Roseton because it has very substantial air *and* water impacts. However, further work could determine that repowering at another on or more of these plants could be part of a more attractive overall clean electricity strategy for the Hudson Valley.

5. The Clean Electricity Plan

The clean electricity plan we model is composed of strategies selected from the following four categories.

1. Slowing the growth of electricity use with energy conservation and efficiency measures;
2. Adding more renewable and low-impact generating technologies to the region's capacity mix;
3. Increasing the efficiency of electricity generation with combined-heat and power (CHP) technology; and

[30] *The Feasibility of Re-Powering KeySpan's Long Island Electric Generating Plants to Meet Future Energy Needs*, Long Island University, Center for Management Analysis, August 6, 2002, at page 8.

4. Modernizing the older power plants on the lower Hudson by (a) adding pollution control technologies to them or (b) replacing them with entirely new generating units.

Before exploring the projected results of implementing the Clean Plan, it is worth noting two things about the Plan. First, our goal in selecting policies and projects for the clean plan was to achieve aggressive reductions in air emissions and water use at reasonable costs. However, an optimizing approach, designed to either minimize costs or maximize environmental benefits, was beyond the scope of this study. Thus, the strategy laid out here is intended to serve simply as an example of how these kinds of policies and projects can provide highly cost effective environmental benefits. Other mixes of policies and projects may provide equally attractive results, and an optimization analysis might well identify a more attractive strategy for reducing the environmental impacts of electricity generation in the Hudson Valley.

Second, the strategy laid out here focuses exclusively on the Hudson River Valley. That is, we simulate policy implementation and retrofit projects only in this region. However, the benefits of the clean plan would be enjoyed by citizens throughout New York State and, in some cases, beyond the state. Similarly, where the Clean Plan is projected to result in incremental costs relative to the Base Case, these costs would be borne by all electric ratepayers in New York.

5.1 Electricity Loads and Generation under the Clean Plan

The energy efficiency programs implemented in the Clean Electricity Plan reduce peak loads and energy use in the Hudson River Valley substantially. Both peak loads and total annual electricity use are reduced by approximately one percent per year, starting in 2005. Thus, loads and consumption in the Clean Plan are one percent below Base Case levels in 2005, six percent below the Base Case in 2010 and 11 percent below the Base Case in 2015. Table 13 shows the electricity use reductions achieved by the Clean Plan.

Table 13. Reductions in Electricity Use Achieved by the Clean Plan (GWh)

	2005	2010	2015
Hudson Valley	-298	-1,923	-3,797
New York City	-529	-3,403	-6,649
Total	-827	-5,326	-10,446

Six different renewable energy types were included in the Clean Plan: PV, fuel cells, wind, biomass, landfill gas and hydro power. Section 4 above describes these technologies and the amount of each capacity type added in the Clean Plan (see Table 11). Total generation from renewable sources in the Clean Plan rises from roughly 165 GWhs in 2005 to 1,560 GWhs in 2010 to 2,540 GWhs in 2015. Figure 12 shows new renewable generation projected by fuel type for each of the study years. As noted above, this mix of renewable fuels reflects the renewable resources available in the Hudson Valley and the projected costs of the different technologies over the study period. Most of the renewable energy in the clean plan comes from biomass plants, which we assume would be located in the more rural, northern part of the Valley. Fuel cells provide the next largest amount of energy, and we assume that the majority of the fuel cell capacity will be in the more densely populated areas of the Valley, such as New York City.

The only air emissions from this renewable generation would come from the biomass and fuel cell generation. Projected NO_x emissions from biomass are roughly six tons in 2005 rising to 62 tons in 2015, and NO_x emissions from fuel cells are 0.08 ton rising to roughly seven tons. Emissions of CO_2 from fuel cells are projected to be roughly 3,400 tons in 2005 rising to roughly 295,000 tons in 2015. These emissions are included in the emissions analysis of the Clean Plan below.

Figure 12. Renewable Generation in the Clean Plan

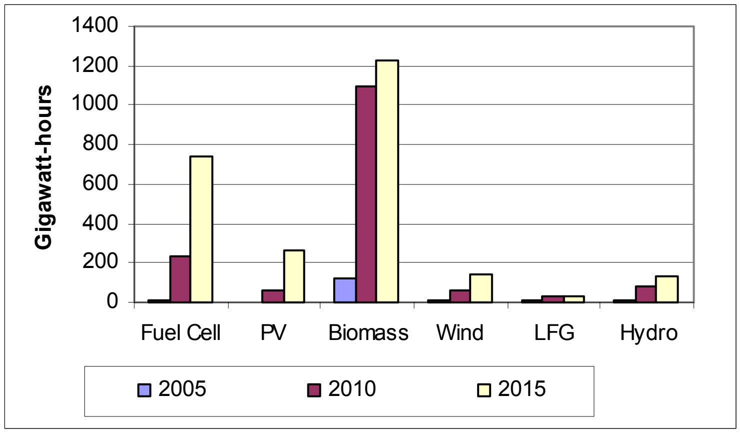
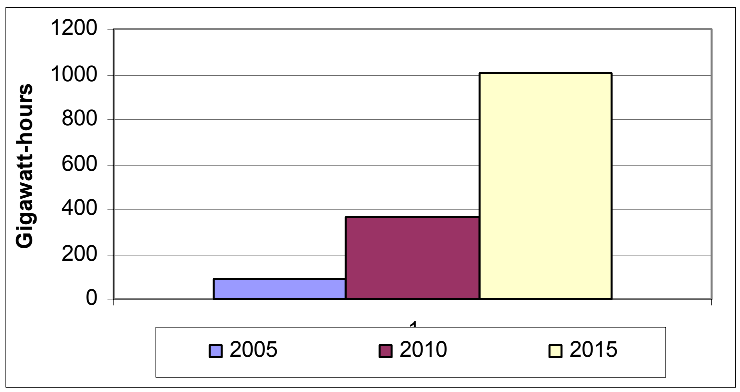


Figure 13 shows the projected generation from the CHP projects added under the Clean Plan. As discussed in Section 4, we assume that the larger CHP plants operate in a baseload mode, at very high capacity factors. We assume that the smaller CHP plants operate at commercial and small industrial facilities and that they operate during daytime hours. The total electricity generated by new CHP facilities in the Clean Plan rises from 88 GWhs in 2005 to 366 GWhs in 2010 to 1,005 GWhs in 2015.

Figure 13. CHP Generation in the Clean Plan



In addition to the electricity they generate, these CHP plants are projected to provide roughly 413,000 mmBtu of useful heat in 2005, 1,715,000 mmBtu in 2010 and 4,704,000 mmBtu in 2015. In reducing the operation of boilers, furnaces and other equipment that would have provided this heat, we estimate that these CHP plants would reduce 30 tons of NO_x and 24 thousand tons of CO_2 in 2005. By 2015 these figures rise to 347 tons of NO_x and 275 thousand tons of CO_2. The new CHP facilities do not reduce SO_2 emissions appreciably, because we assume that the boilers and furnaces they displace are gas-fired and thus emit negligible levels of SO_2.

Table 14 compares Base Case and Clean Plan generation at the four older fossil-fired plants in the Hudson Valley, the five older fossil plants in New York City and the two sets of plants combined. (The Hudson Valley plants include Danskammer, Roseton, Lovett and Bowline. The output of the new CCCTs we model at Roseton is not included. The New

York City plants include: Arthur Kill, East River, Astoria, Poletti and Ravenswood. Projected output from the new units at Poletti and East River is not included.)

The policies modeled in the Clean Plan have a significant effect on these older, fossil-fired plants. The Clean Plan reduces generation from these nine plants combined by roughly 18 percent relative to the Base Case in 2005, by 40 percent in 2010 and by 36 percent in 2015. By 2015 the Clean Plan has a larger effect on generation in the Valley than generation in the City, due to the retirement of the Roseton steam units. (Note in Table 13 that the Roseton steam units were projected to generate a considerable amount of electricity in the Base Case in 2015.)

Table 14. Projected Generation at the Older Fossil-Fired Plants in the Clean Plan Compared to Base Case (GWhs)[31]

Plant/Case	2005	2005 % Change	2010	2010 % Change	2015	2015 % Change
HV Plants-Base Case	10,082		10,489		13,248	
HV Plants-Clean Plan	10,057	-0.2%	6,710	-36%	7,706	-42%
HV Plants-Difference	-25		-3,779		-5,542	
NYC Plants-Base Case	6,791		7,352		5,149	
NYC Plants-Clean Plan	3,864	-43%	3,967	-46%	4,034	-22%
NYC Plants-Difference	-2,926		-3,385		-1,115	
Total-Base Case	16,872		17,840		18,397	
Total-Clean Plan	13,921	-18%	10,677	-40%	11,740	-36%
Total-Difference	-2,951		-7,164		-6,656	

Table 15 compares projected generation in the Base Case and the Clean Plan at all the large power plants – old and new – in the study area. The Clean Plan reduces the operation of Roseton most, followed by Ravenswood and Arthur Kill in New York City. The largest increase in generation caused by the Clean Plan occurs at the new Roseton facility (which we assume comes on line between 2010 and 2015), however the Clean Plan also results in small increases in generation at several old fossil units (Danskammer and, in 2015, the Astoria Steam plant). These increases are due primarily to the retirement of the old Roseton units.

[31] Note that in Table 14 the Base Case and Clean Plan figures for 2010 and 2015 reflect the retirement of the steam unit at Poletti between 2005 and 2010. The Clean Plan figures for 2010 and 2015 also reflect the retirement of the two steam units at Roseton between 2005 and 2010.

Table 15. Projected Generation at Hudson River Fossil Plants in Base Case and Clean Electricity Plan

Plant/Case	2005 Change GWh	2005 Change %	2010 Change GWh	2010 Change %	2015 Change GWh	2015 Change %
Hudson Valley						
Bowline	0	0%	31	1%	-25	-1%
Lovett	-31	-2%	7	0%	-43	-2%
Roseton Steam	-15	0%	-4,023	-100%	-5,497	-100%
Roseton CCCT	---	---	---	---	2,846	100%
Danskammer	20	1%	206	9%	23	1%
Athens	-137	-6%	-106	-4%	102	4%
Bethlehem	-43	-1%	-143	-3%	-80	-2%
New York City						
Arthur Kill	-65	-6%	-94	-8%	-156	-9%
Astoria Steam	-103	-18%	4	1%	10	8%
East River Steam	-1	0%	-4	-1%	-1	0%
New East River Cogen.	-3	0%	-12	0%	-21	-1%
Poletti Steam	-21	-7%	---	---	---	---
New Poletti CCCT	-2	0%	12	1%	19	1%
Ravenswood	-2,737	-62%	-3,290	-66%	-968	-34%
SCS Astoria	---	---	-69	-2%	12	0%
Total	-3,137	-12%	-7,482	-23%	-3,778	-10%

The new (repowered) plant at Roseton does not produce as much electricity as the older steam units there for two reasons. First, the new CCCTs burn gas (with limited distillate oil backup capability when gas is not available), while the old steam units could burn either gas or oil. When burning oil, the old steam units have substantially lower fuel costs than would the new CCCTs. Second, the old steam units are larger (621 MW) than the repowered plant modeled (500 MW).

Looking at electricity generation more broadly, we find that the distribution of electricity generation between the Hudson Valley and the rest of New York State in the Clean Plan is fairly similar to that projected in the Base Case. In the Base Case in 2005, 40 percent of total state generation comes from the Hudson Valley; in 2010 that number is 44 percent and in 2015 it is 43 percent. In the Clean Plan in 2005, 40 percent of total state generation occurs in the Valley; in 2010 that number is 42 percent and in 2015 it is 43 percent.

In addition to reductions in generation in New York, the Clean Plan is projected to reduce generation by small amounts in many of the contiguous control areas. By 2015, reductions on the order of 0.3 percent are achieved in both New England and PJM. And smaller reductions are achieved in several Canadian control areas.

5.2 Water Use and Air Emissions under the Clean Plan

Table 16 shows the impact of the Clean Plan on cooling water use in each study year. We project water use at Lovett and Danskammer under the Clean Plan in the same way we projected it for the Base Case: we change water use at each plant by the same percentage as the projected change in generation. There is little difference between Base Case and

Clean Plan water use at Lovett or Danskammer, as no retrofits targeting water impacts are modeled there.

Table 16. Projected Changes in Water Use: Base Case versus Clean Electricity Plan

	2005		2010		2015	
Plant	Million Gals	% Change	Million Gals	% Change	Million Gals	% Change
Bowline	40	0.0%	-141,800	-95%	-171,240	-95%
Lovett	-1,710	-2.0%	360	0%	-2,390	-2%
Roseton*	-1,080	-0.4%	-297,320	-100%	-396,000	-97%
Danskammer	800	0.8%	8,310	9%	940	1%
Total	-1,950	-0.3%	-430,450	-66%	-568,480	-68%

**Data for the Roseton site are for the steam units in 2005 and the new CCCTs in 2015.*

At Roseton and Bowline, however, the Clean Plan reduces water use dramatically. At Roseton we model the retirement of the two steam units between 2005 and 2010; thus water use is reduced by 100 percent at this site in 2010. We model the addition of 500 MW of new CCCT capacity at Roseton by 2015 with wet cooling towers, and this facility is projected to use roughly 10,520 million gallons in 2015. Thus, the 2015 reduction in water use at Roseton, relative to the Base Case, is over 97 percent. At Bowline, the wet cooling towers modeled reduce water use by 95 percent from the existing once-through system there. Because the operation of that plant is very similar in the Base Case and Clean Cases (see Table 15), water use reductions in the Clean Case are 95 percent. Overall, the Clean Plan reduces water use at the four plants by less than one percent in 2005 and by roughly two thirds in 2010 and 2015. Total reductions in water use resulting from the Clean Plan rise from roughly 1,950 million gallons in 2005 to over 568,480 million gallons in 2010.

Overall, the Clean Plan reduces water use at the four plants by roughly two thirds in 2010 and 2015. Total reductions in water use resulting from the Clean Plan rise from roughly 1,950 million gallons in 2005 to over 568,480 million gallons in 2010.

Turning to air emissions, we start with a view of statewide emissions, because the allowance programs to which many New York power plants are subject (discussed in Section 2) are an important factor at the state level. First, while the Clean Plan reduces SO_2 emissions in the Hudson Valley, we do not project reductions statewide due to the state SO_2 allowance program. That is, because New York will have a single-state SO_2 cap during the study years, we assume that statewide emissions in the Base Case and Clean Plan are the same in each year (i.e., are at the capped level). However, the efficiency programs and new renewable energy and CHP projects modeled in the Clean Plan would reduce the cost of meeting the state SO_2 cap. How much the Clean Plan would reduce the cost of compliance would depend on how much generators would have to spend to comply with the rule. Given that this is a very aggressive SO_2 cap, it is likely to raise the cost of allowances for New York generators significantly above historical levels. The Clean Plan would mitigate these increases in cost.

We do project reductions in NO_x and CO_2 from the Clean Plan. Emissions of CO_2 are not assumed to be capped during the study period, so we project that the modeled CO_2 reductions would be achieved by the Clean Plan. Projecting the NO_x impacts of the Clean Plan is more difficult. During the study period, NO_x emissions for many New York generators will be capped under the federal NO_x SIP Call trading program during the summer and capped at the same level during the balance of the year by a New York regulation (discussed in Section 2). Under the SIP Call trading program, NO_x allowances will be tradable across the 32 easternmost states in the US. Because this trading program is so large, it is impossible to predict the fate of NO_x emission reductions achieved by the Clean Plan. There are a number of possibilities, some of which are listed below.

- The reductions might come at a New York generator not subject to the NO_x cap. In this case the reductions would be fully preserved as NO_x reductions in New York.
- The reductions might result in a sale of allowances from one New York generator to another. In this case the reductions would presumably be lost as the buyer used the allowances to emit more NO_x.
- The reductions might result in a sale of allowances from a New York generator to a generator in a nearby, upwind state. In this case the NO_x reductions could be partially lost, as the state could be affected by the use of the allowances in the upwind state.
- The reductions might result in a sale of allowances from a New York generator to a generator in a distant or downwind state. In this case the NO_x reductions would be fully preserved in New York.

Reviewing these possibilities, it seems likely that the actual NO_x reductions in New York resulting from the Clean Plan would fall somewhere between zero and the figure projected by the Clean Plan modeling. Hence, we treat the NO_x reductions projected by the model as "maximum potential" reductions. Actual reductions would probably be lower than this figure. However, to the extent that NO_x allowances freed up by the Clean Plan are sold to other New York generators, the Plan would lower the cost to New York generators of complying with the NO_x caps.

Table 17 shows the projected statewide CO_2 reductions and the maximum potential NO_x reductions from the Clean Plan. The reductions shown here are net of the emissions from the new biomass and fuel cell plants we model in the Clean Plan. However, these figures are electric sector emissions only, thus they do not include the emission reductions provided by the CHP plants' displacement of fuel combustion for non-electric purposes.

Table 17. Projected New York NO_x and CO_2 Reductions from the Clean Plan

	2005		2010		2015	
Pollutant	Tons	Percent	Tons	Percent	Tons	Percent
NO_x	-267	-0.4%	-4,590	-9%	-10,050	-15%
CO_2	-368,000	-0.7%	-2,349,000	-4%	-6,404,000	-9%

Turning to the four fossil-fired plants on the lower Hudson, we find substantial emission reductions from the Clean Plan. Table 18 shows the total changes in NO_x, SO_2 and CO_2 emissions projected for these four plants due to the Clean Plan. Again, note that, because of emissions trading, these SO_2 reductions would likely be offset by increases in other areas of the state and these NO_x reductions represent maximum potential reductions from the Clean Plan. The vast majority of the emission reductions achieved in the Clean Plan occur at Roseton and Danskammer. The plan changes NO_x emissions at Bowline and Lovett very little relative to the Base Case. (No controls or retrofits are modeled at Bowline, and the SCR controls modeled at Lovett are assumed to be added in both the Base Case and the Clean Plan.) The bulk of the emission reductions come at Roseton and Danskammer between 2005 and 2010, when we model the retirement of Roseton for repowering and the installation of SCR and SO_2/PM controls at Danskammer. We model the completion of the new CCCT units at Roseton (totaling 500 MW) by 2015, and the emission reductions shown in Table 18 are net of the emissions from these units.

Table 18. Projected Emission Reductions at the Four Hudson River Plants Due to the Clean Plan

	2005		2010		2015	
Pollutant	Tons	Percent	Tons	Percent	Tons	Percent
NO_x	-39	<1%	-8,718	-65%	-10,902	-67%
SO_2	-97	<1%	-23,313	-56%	-30,803	-60%
CO_2	-23,942	<1%	-3,464,324	-32%	-4,212,162	-32%

Comparing Tables 17 and 18, we find that, in 2010 and 2015, the Clean Plan is projected to reduce NO_x emissions by greater amounts at the four Hudson fossil plants than in the state. This indicates that the Clean Plan would likely shift emissions from the Hudson Valley to other areas of the state in these years. The same phenomenon occurs with CO_2 emissions in 2010.

5.3 Costs and Savings Under the Clean Plan

The costs we assume for the major energy programs in the Clean Plan (described in Section 4) are $25 per MWh for energy efficiency and $70 per MWh for renewable energy. Costs assumed for CHP projects are shown in Table 12 above.

Table 19. Cost Assumptions for Hudson River Retrofit Projects

Unit	Size (MW)	Technology	Total Cost ($2003)	$/kW	Dep. Per.	Annual Cost ($2003)
Bowline 1&2	1,225	Wet Tower	76,700,000	$63	20	$9,482,464
Roseton 1&2	500	Repowering	275,000,000	$550	20	$33,998,404
Danskammer 3	147	SCR	12,495,000	$85	20	$1,508,416
Danskammer 4	239	SCR	20,315,000	$85	20	$2,452,459
Danskammer 3-4	386	PM Controls	15,440,000	$40	20	$1,908,856
Lovett 4	180	SCR	15,300,000	$83	20	$1,847,041
Lovett 5	201	SCR	17,085,000	$83	20	$2,062,529
Lovett 4-5	381	SO_2/PM Controls	15,240,000	$40	20	$1,884,130

Table 19 summarizes the costs we assume for each of the retrofit projects at the four fossil plants on the Hudson. Annualized costs are calculated based on the total capital cost and depreciation periods shown in Table 19 and a cost of capital of 10.76 percent. This cost of capital is based on an assumed debt/equity ratio of 85/15, a cost of debt of 8.25 percent and a cost of equity of 25 percent. These figures were chosen to reflect the companies that would likely be involved in these projects. In the near, term the cost of equity to Mirant and Dynegy will be extremely high, as both companies are in tenuous financial positions.

The cost of debt is based on the assumption that these projects are financed in the context of long term contracts with local utilities (see discussion in Section 6).

The costs of the Clean Plan, including efficiency programs, renewable energy, CHP projects and the retrofit projects, are projected to be very small throughout the study period. Table 20 shows the projected costs of the Clean Plan in each study year.

For each year, the first row of Table 20 shows statewide electricity production costs projected by the model under the Base Case and the Clean Plan. Production costs include: start-up costs, fixed and variable O&M and fuel costs. The next row shows the annualized capital costs of the new CCCTs and peaking turbines added in the Base Case in 2010 and 2015. The next three rows show the annualized capital costs of the renewable energy, energy efficiency, CHP projects and retrofit projects of the Clean Plan.[32]

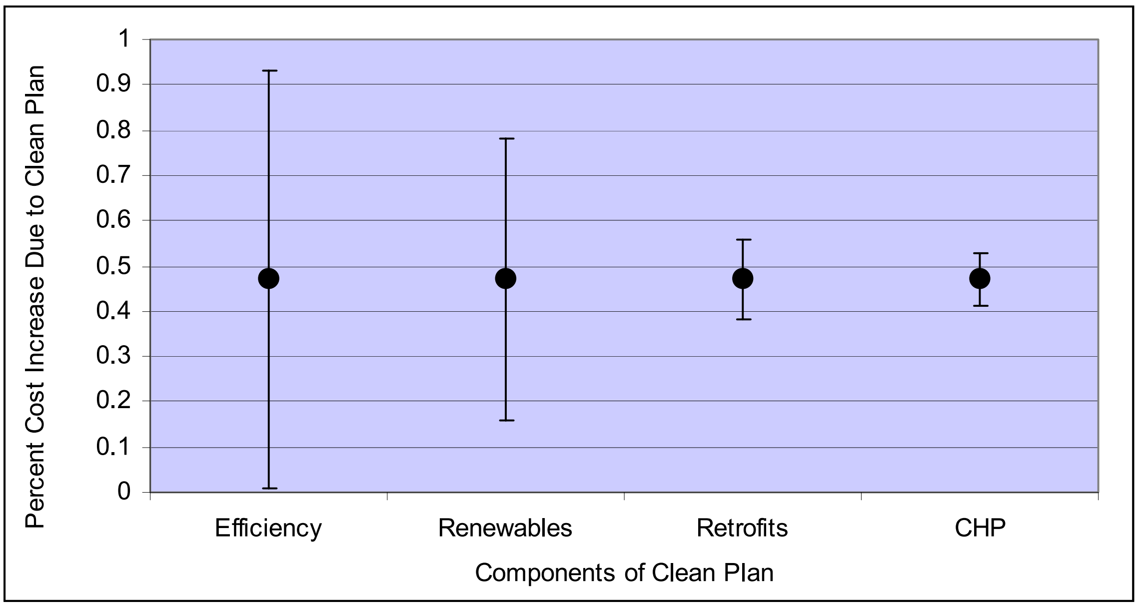
Table 20. Projected Electricity Production Costs in the Base Case and Clean Plan

Cost Component	Base Case	Clean Plan
2005		
Production Costs	$4,026,933,707	$4,005,836,533
New CC/CT Capital Costs	$0	$0
Renewables Capital Costs	$0	$11,571,000
Efficiency Capital Costs	$0	$20,575,000
CHP Capital Costs	$0	$1,604,800
Retrofit Costs	$0	$0
Total	$4,026,933,707	$4,039,587,333
Change		$12,653,626
Percent Change		0.3%
2010		
Production Costs	$4,504,502,823	$4,293,202,521
New CC/CT Capital Costs	$17,000,000	$0
Renewables Capital Costs	$0	$109,351,200
Efficiency Capital Costs	$0	$132,950,000
CHP Capital Costs	$0	$4,814,400
Retrofit Costs	$0	$21,145,894
Total	$4,521,502,823	$4,561,464,016
Change		$39,961,192
Percent Change		0.9%
2015		
Production Costs	$5,541,692,659	$5,122,894,621
New CC/CT Capital Costs	$85,612,000	$0
Renewables Capital Costs	$0	$177,688,000
Efficiency Capital Costs	$0	$263,275,000
CHP Capital Costs	$0	$34,476,000
Retrofit Costs	$0	$55,144,298
Total	$5,627,304,659	$5,653,477,919
Change		$26,173,260
Percent Change		0.5%

[32] The annualized cost of the retrofit projects in 2010 does not include the cost of repowering the Roseton plant, as we assume that project begins after 2010. Also note that we have not included in these calculations savings associated with allowances freed up due to the retrofit at Roseton.

As seen in Table 20, the model predicts very small increases in costs with the Clean Plan ranging from an increase of 0.3 percent in 2005 to 0.9 percent in 2010. However, these cost increases are very small relative to the likely range of error around the assumptions regarding the costs of the different components of the Clean Plan. While there is no way to identify this range of error precisely, we have performed sensitivity analyses on each component of the Clean Plan using an assumed range of error of ±10 percent. Figure 21 shows the results of this analysis for the year 2015. The points show the 2015 cost impact of the full plan (an increase of 0.47 percent), as shown in Table 20 above. Vertical bars around the points represent the change in the overall cost impact of the Clean Plan that would result from a 10-percent increase or decrease in the cost of that component.

Table 21. Sensitivity of Overall Clean Plan Cost Impact in 2015 to the Costs of Each Component of the Clean Plan



Not surprisingly, the cost of the energy saved via efficiency programs has the largest impact on overall costs. Efficiency costs are 50 percent of the total annual cost of the Clean Plan in 2015. However, even with costs 10-percent higher than assumed ($27.5 per MWh versus $25 per MWh), efficiency provides the lowest cost energy of any new energy provided either in the Base Case or the Clean Plan. Renewables, at 33 percent of Clean Plan costs in 2015, have the second largest impact on overall costs. The retrofit projects (10 percent of annual costs) and the CHP projects (six percent of annual costs) have much smaller impacts on overall costs.

The bill impacts electricity customers in the Hudson Valley would see would be even smaller than the cost impacts discussed above. Since electricity production costs are generally about a third of customers' total electricity bills, bill impacts would be roughly a third of these impacts, ranging from an increase of about 0.1 percent in 2005 to about 0.03 percent in 2010.

6. Conclusions and Policy Recommendations

The Clean Electricity Plan we analyze here would provide significant benefits for virtually negligible incremental costs.

- The energy efficiency programs adopted in the Clean Plan reduce annual electricity use by six percent in 2010 and 11 percent in 2015.
- The statewide RPS envisioned increases renewable generation in the Hudson Valley by 1,560 GWh in 2010 and 2,540 in 2015.
- Generation at the four older fossil-fired plants on the Hudson is 40 percent lower than in the Base Case in 2010 and 36 percent lower in 2015.
- Emissions of NO_x, SO_2, and CO_2 from these plants would fall by 67, 60 and 32 percent respectively in 2015.
- Water use at these four plants would fall by 66 percent in 2010 and 68 percent in 2015.
- Statewide CO_2 emissions are reduced by 6.4 million tons (nine percent) in 2015 and NO_x emissions could fall by as much as 10,000 tons (15 percent). Further, the cost of meeting the state's impending SO_2 cap would be significantly lower under the Clean Plan.
- The incremental costs of the Clean Plan would be under one percent of total system costs throughout the life of the plan. Customers' bill impacts would be even lower than this.

A major objective of this research report is to identify the policy measures that will effectively remove or reduce barriers to implementation of the economically and environmentally preferred resource mix comprising the Clean Energy Plan for the Hudson River Valley. Outlined below are a set of policy recommendations and strategies that are designed to effectuate the preferred set of resource options and capture the associated environmental, public health, reliability and job creation benefits. These recommendations cover the following major areas of opportunity:

- the ability of the distribution utility to leverage investment in clean generation and environmental retrofits at existing Hudson River plants through long-term supply contracts;
- the displacement of output from dirty plants through greater investment in energy efficiency and establishment of energy efficiency standards;
- the diversification of the Hudson River Valley's resource supply through expansion of state policies supporting renewable energy sources; and
- the development of a formal, systematic, and comprehensive planning process for the review of proposed investment in energy infrastructure (e.g., electricity generation, transmission and natural gas pipeline capacity).

6.1 Distribution Utility Portfolio Management to Protect Consumers and Foster a Balanced and Environmentally Sound Resource Mix

More than six years into New York's experiment in electricity restructuring, the two most significant and seemingly intractable problems include:

- **The lack of a wide array of service choices available to residential and small commercial customers.** Following the restructuring of New York's electricity industry, it was assumed that consumers would be lured by the lower prices and greater service choices offered by an array of competitive energy service companies (ESCOs), and that retail competition would flourish. However, vigorous competition for residential and small commercial customers has been slow to materialize. As a result, residential customers remain de facto captive customers of the distribution utility under "default service." This default service is typically limited to providing the consumer with the basic commodity (energy). New York utilities have thus far met their default service obligations primarily through purchases in the wholesale spot market and passing the associated costs directly through to consumers. This has exposed customers to considerable price volatility and has resulted in a narrowing of services (e.g., resource diversity, long-term price management) formerly enjoyed by customers in a regulated environment.

- **The lack of financial market conditions and arrangements conducive to the construction of new and cleaner generation**. For a variety of reasons ranging from the Enron financial debacle to a general slow-down in the New York economy post-9/11, developers of new generation projects are facing severe capital constraints. Several state-approved generating plants have been scuttled or delayed, with developers unable to attract necessary financing and subject to credit rating downgrades.[33] These capital constraints also hinder the repowering of older, inefficient and environmentally significant power plants, notwithstanding the clear economic and environmental advantages of plant refurbishment. Project success often hinges on the developer's demonstrated assurance of a long-term revenue stream with a financially sound buyer such as the utility default service provider.

The distribution utility is uniquely situated to address these problems through more active *portfolio management.* The aim of the portfolio manager would be to develop a diverse and balanced mix of supply and demand resource options that would meet well-established goals of utility service under a range of scenarios: minimizing consumer and environmental costs while insulating consumers from unacceptable price volatility and grid failure.

[33] "Credit Crunch Endangers Some Upstate New York Power Plants", Albany Times-Union, October 28, 2002.

- The distribution utility *qua* portfolio manager would play an integral role in a creating a well-functioning market for generation by entering into medium- and long-term contracts with project developers.
- The availability of long-term contracts could be conditioned on meeting minimal environmental performance standards for air emissions and water intake. This would provide greater assurance that the turnover of New York State's generation mix resulted in improvements to the environment and public health.
- Satisfaction by the distribution utility of its portfolio management responsibilities should be consistent with New York's RPS requirements. In other words, the distribution utilities' obligation to enter into long-term purchase agreements with renewable energy developers for energy and/or renewable energy credits (RECs) should be "hard-wired" into their overall supply acquisition processes.
- The distribution utility should balance its supply procurement portfolio with cost-effective energy efficiency investments and fuel switching opportunities aimed at reducing peak demand. Lowering consumption, and therefore the utilities' obligation to procure supply, during the high-priced peak demand hours will lower the cost of electricity for all.[34]

The distribution utility also plays an integral role in distributing electricity to area homes, businesses and industry through its monopoly control of the local "wires" network. In order to maintain reliability and power quality distribution utilities such as Consolidated Edison have committed to making major capital improvements to the distribution network. In this connection, the distribution utility should also investigate energy efficiency, load management and clean on-site generation as potential means of deferring or avoiding more costly distribution system upgrades, replacement or expansion while achieving the same level of reliability. Some New York utilities are taking steps towards reinstituting portfolio management, albeit in a limited and somewhat *ad hoc* manner. Recently, Consolidated Edison entered into a 10-year contract with Astoria Energy for 500 Mw of capacity and associated energy from a new, natural gas-fired plant being constructed in Queens. In addition to helping insulate Con Edison's customers from future price fluctuations, this long-term financial commitment should help bring this modern plant to fruition. Similarly, in June of 2003, Con Edison issued an RFP for delivery of 125 Mw of load reductions in constrained parts of its service territory.[35]

While the recent Con Edison RFP's marks clear progress, we recommend that portfolio management be pursued by all New York utilities in a more formal, regular and systematic manner. The Commission should initiate a generic proceeding to establish the policies and procedures governing distributed utility portfolio management.

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[34] Mid Atlantic Cost Curve Analysis, JBS and Associates (on behalf of the National Association of Energy Service Companies and the Pace Energy Project), December 2000, available at http://www.law.pace.edu/energy/pdffiles/cost-curve-analysis.pdf.

[35] "Con Edison Issues Request for Proposals to Encourage Energy Conservation", press release dated June 6, 2003, viewed at http://www.coned.com/about/about.asp?pr=20030606.

More specifically, we recommend that the two Hudson River Valley distribution utilities – Central Hudson and Orange and Rockland Utilities – issue Requests for Proposals for long-term power supply contracts. Eligibility to participate in the bidding process should be restricted to the four existing lower Hudson power plants (e.g., Bowline, Roseton, Danskammer and Lovett) and conditioned on the plant operator agreeing to meet specific environmental performance benchmarks. Effective benchmarks could be a maximum annual NO_x emission rate of 1.5 lb/MWh, an SO_2 rate of 2.0 lb/MWh and a water use rate of no more than one gallon per 1,000 mmBtu of heat input. These emission rates could be achieved by either installing controls, repowering or burning exclusively natural gas. This water use rate could be achieved by installing a closed-cycle cooling system.

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6.2 Expand Statewide Energy Efficiency and Conservation Programs

New York is one of several states to have established a clean energy fund as an integral part of its restructuring of the state's electric industry. The New York Energy Smart Program, created in 1996 and administered by the New York State Energy Research and Development Authority, is designed to support investment in energy efficiency, renewable energy and energy affordability measures for low-income consumers – initiatives that provide important economic and environmental benefits, but which would be not be realized through reliance on competitive markets alone. The Energy Smart Program is funded through the System Benefits Charge (SBC); a small surcharge paid by customers of the states' electric distribution companies. The Energy Smart Program funding mechanism[36] generates about $160 million annually, of which $115 million is earmarked for energy efficiency improvements. Based on the initial success of the program, has been extended through June 2006.

The Energy Smart Program has made impressive strides in just 4 years. Anticipated energy, environmental and economic benefits derived from funds committed through December 2002 include:

- 1,500 GWh of annual electric savings (over 1% of total statewide consumption);
- 1,000 MW of peak demand reductions, or the equivalent of 1-2 large central station power plants;
- annual emission reductions of 1,800,000 tons of CO_2, or the equivalent of removing 360,000 cars from New York's roadways for one year. Additionally, 2,200 tons NOx (1.1% of annual power plant emissions); and 3,800 tons SO_2 are avoided; and
- the creation or retention of 7,900 jobs statewide.

[36] The Long Island Power Authority (LIPA) and the New York Power Authority (NYPA) administer separate clean energy funds, with annual spending levels of $ 22 million (2003), and $100 million, respectively.

Moreover, every dollar spent through the Energy Smart Program leverages three dollars of private investment, augmenting the benefits noted above.[37]

Impressive as these results are, additional cost-effective energy savings opportunities abound. A detailed study of the remaining technical and economic potential for energy efficiency improvements in New York State, commissioned by NYSERDA, finds large amounts of technical potential for efficiency and renewable energy. It also found that much of this theoretical potential would be economical compared to conventional electricity generation.[38] Accounting for the persistence of market barriers inhibiting the full realization of statewide economic potential, the report nevertheless concludes that:

> currently planned initiatives are expected to provide 13,675 GWh and 3,456 summer-peak MW annually by 2022. This represents 7.5% and 9.4% of the expected statewide energy and demand requirements, respectively.[39]

These studies suggest that New York can garner significant additional benefits by increasing the level of funding and extending the term of the SBC beyond June 2006. These programs should continue to emphasize "market transformation" programs aimed at achieving long term and permanent improvements in the efficient use of energy, foster the development of a competitive energy services industry and address the energy burden on low-income households.

6.2.1 Establish Energy Efficiency Standards for Products Not Covered by Federal Law

Ratepayer-funded energy efficiency programs work in tandem with energy efficiency standards. While the former increase consumer demand and market share for energy efficient products, the latter lock in these gains by proscribing the sales of inefficient units.

A prime example of this synergy between incentive programs and standards is in the refrigerator market, where utility incentive programs increased the availability of efficient products, ultimately paving the way minimum efficiency standards. This cycle is repeated as technological progress creates new opportunities for energy saving equipment.

A recent study[40] conducted by the Northeast Energy Efficiency Partnerships and the Appliance Standards Awareness Project suggests that New Yorkers could realize as much as $4.5 billion in direct economic benefits by adopting readily-achievable standards for 9

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[37] *New York Energy $mart Program Evaluation and Status Report, New York State Energy Research and Development Authority, May 2003.*

[38] *Energy Efficiency and Renewable Energy Resource Development in New York State - Final Report, Volume I: Summary Report (prepared for the New York State Energy Research and Development Authority) August 2003, p.1-1.*

[39] Ibid., p. 1-2.

[40] *Energy Efficiency Standards: A Low-Cost, High Leverage Policy for Northeast States.*

products, many of which are not covered by the existing federal standards program.[41] The study further found that these same standards could reduce New York's peak electricity demand by nearly 1,080 MW by 2020, nearly 3% of New York State's current generating capacity; and reduce carbon emissions by over 550,000 metric tons by 2020, an amount equivalent to the greenhouse gases produced by 450,000 cars.

6.2.2 Expanding the Role Played by Energy Efficiency in Wholesale Markets

Both as "market maker" and steward of the transmission grid, the New York Independent System Operator (NYISO) has come to play a critical role in the delivery of safe, efficient, reliable, affordable and environmentally sound electric energy to the Hudson River Valley and throughout New York State. While there has been a general recognition of the role played by energy efficiency in fulfilling these objectives, there are a number of untapped opportunities to leverage energy efficiency investment through NYISO policy and program reforms. As a general proposition, regulators need to structure the market and market rules so customers, retail sellers, distribution utilities, and current and potential vendors of demand response have an opportunity to realize the value of the services they can offer.

Increasing reliability and relieving persistent congestion are two excellent opportunities for energy efficiency and load management to play a significant new role in NYISO operations.

- A "reliability" problem exists when there is an unacceptably high possibility of the lights going out, as occurred on August 14, 2003, plunging much of the Northeast into darkness.
- An "economic congestion" problem exists when more expensive generation has to be operated in an area because there is not enough transmission capability to move less expensive, but otherwise available, electricity to that area. "Persistent" economic congestion occurs when natural market forces do not result in sufficient investments in profitable solutions to the congestion such as: building new transmission lines to the congested area, building new, less expensive generators in the congested area, or creating price responsive demand reductions in the congested area.

Reliability and persistent economic congestion problems exist in several areas of the state. Reliability is primarily a concern during the summer for downstate New York, since: the combination of high usage, resulting from high heat and humidity, combined with a major generator plant or a major transmission line going out-of-service could cause blackouts. Since barriers to investment in new generation and new transmission have persisted since the restructuring of New York's electricity industry, concerns about system reliability have grown.

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[41] The products include: 1) cable boxes; 2) ceiling fans; 3) torchiere lamps; 4) large-packaged HVAC; 5) exit signs; 6) traffic signals; 7) unit and duct heaters; 8) commercial clothes washers; and 9) commercial refrigerators and freezers.

Economic congestion is prevalent during middle to high usage periods when it is difficult to move sufficient less expensive energy from the Western part of the state to the Eastern part, and in moving less expensive electricity down the Hudson River Valley and into New York and Long Island. The NYISO estimates that congestion costs for the NYISO in 2002 were approximately $900 million out of total sales of about $5.7 billion. Persistent economic congestion is likely to continue due to such enduring problems as the difficulty of siting new generating plants or transmission lines in highly populated areas, financing difficulties and the disappearance of high congestion prices once significant investments are made.

Energy efficiency and load management may obviate the need for, or enable the postponement or reduction in scale of transmission investments otherwise needed to meet to maintain reliable electric service. Energy efficiency should be examined, along with new generation and transmission expansion, as a least cost means of relieving long-term congestion situations. Current practices at the NYISO is to use transmission as the "default solution" if there are reliability or persistent congestion problems that the market does not solve. In many cases it is likely that demand response, energy efficiency and distributed generation would be the more cost-effective solution. Demand response programs have already demonstrated their cost-effectiveness as emergency reliability solutions, in fact the NYISO already offers several programs to encourage consumers to respond to NYISO declared emergencies by shifting or reducing demand. These programs have been highly successful, credited by the NYISO with playing major roles in averting blackouts during the summers of 2001 and 2002. We recommend that the NYISO take further steps to encourage consumer demand responsiveness by including energy efficiency and demand response programs in the plans it is now developing for dealing with persistent reliability and economic congestion problems.

6.1.3 Conservation and Energy Efficiency Contingency Planning

New York State must take steps to ensure that its energy infrastructure is sufficiently robust to respond to foreseeable and unforeseeable contingencies, including the threat of terrorist attack, and to ensure the continued and uninterrupted delivery of energy. Energy efficiency can play a critical role here. We recommend that New York State develop a well-designed energy efficiency and peak response contingency plan that can be immediately implemented if needed. The tragic events of September 11, and news reports that terrorists are targeting nuclear plants and other parts of our integrated energy system, highlight just how important it is that New York be prepared for an energy emergency. New York must be prepared for the sudden loss of significant energy assets including power plants, transmission lines, and gas pipelines.

California's successful reduction of peak demand by over 12 percent from June 2000 to June 2001 demonstrates that it is possible to move quickly to conserve energy. With adequate preparation time and the opportunity to build upon the state's premiere energy efficiency programs, New York should be able to do far better than California. Of course, the best and most cost-effective preparation would be to maximize cost-effective investment in energy efficiency as soon as possible. Investing in energy efficiency now will ensure that demand is already reduced if and when New York needs to act quickly to ensure reliable and affordable energy supplies.

6.3 Expand State Policies Supporting Renewable Energy

As noted, New York State is embarked on a process for developing one of the Nation's most aggressive Renewable Portfolio Standards (RPS) in the Nation, with 25% of the State's electricity requirements coming from qualified renewable energy sources by 2013. The Public Service Commission has initiated a proceeding for the development of the design and operational elements of the New York RPS, with a Commission decision expected in the late Fall of 2003.

In addition to - and in furtherance of - the RPS targets, there are a number of actions that can be taken to diversify New York State's electricity mix through renewable energy resources.

6.3.1 Expanded Net Metering

New York already has a statutory requirement for solar residential electric systems. Residential customers whose solar systems, up to ten kilowatts, generate more electricity than they need at any time obtain a credit for any electricity they supply to the grid. Their meters "run backwards" when they generate more electricity than they are consuming, with the result that they only pay for the net electricity that is supplied to them by their local energy supplier. Customers are effectively paid the same amount for a kilowatt-hour of electricity that they produce as they are charged when they buy a kilowatt-hour, which substantially improves the economics of installing renewable energy on their premises.

Legislation considered in the last session by the New York Legislature would amend the Public Service Law to expand the existing net metering law to include wind and solar generating systems for residences, farms and businesses. The proposed legislation would also eliminate the ability of electric corporations to penalize customers with wind or solar generators through higher rates, backup charges or other additional fees. The proposed expansion of net metering would encourage residential, farm and commercial customers to interconnect wind and solar generators located on their premises to the electric distribution system and would result in decreased reliance on dirty fossil-fueled power and dangerous nuclear power.

6.3.2 Addressing Utility Interface Barriers

Much work needs to be done to move fuel cells, solar and other customer-sited renewable energy resources into the mainstream. The vision of widely available, reliable and low cost "plug and play" renewable energy systems is yet unrealized. At present, consumers must run a gauntlet of utility, state and local approval processes before their system can become operational. What should be a matter of routine for the homeowner is often a trap for the unsuspecting. In many instances, it will make the most sense for the renewable project to be configured to connect to the grid rather than operate in an islanded mode. The interconnection of distributed generation to the utility grid continues to raise complex legal, technical and regulatory issues that must be addressed:

- **Interconnection.** State agencies will require timely interconnection at reasonable cost. While great strides have been made by the NYPSC to standardize and streamline the interconnection process for small DG systems, developers believe the application process is still too slow, and forces them to incur study and cost and capital expenditures that are unnecessary for assuring grid reliability and worker safety. Moreover, utilities may present complicated and one-sided interconnection contracts.

- **Standby rates.** The utility's charges for back-up power can be excessive, undermining the economics of DG projects. Additionally, rate structure is critical – recovery through fixed (and therefore unavoidable) charges lengthens the payback period and directly affects the attractiveness of the DG installation.
- **Uncompensated system benefits.** Regulators in California and New York are just beginning to grapple with the problem of recognizing and compensating DG owners for the benefits they provide to the system. In New York for example, it appears that utilities will soon be required to issue RFP's eliciting bids from the DG community to provide distributed generation in lieu of major upgrades to the T&D system. And several ISO's have recently instituted programs to pay the DG owner the market clearing price to reduce load through operation of on-site generation. There are a host of other benefits, however, (e.g., VAR support, emissions reduction, fuel diversity) for which the developer may receive no compensation.
- **Address financial disincentives for utility support:** Distribution utilities will play an important role in the market development of DG. There are myriad ways the incumbent utility can and will block transformative technologies. If DG is to flourish, it will be absolutely essential for regulators to address the financial disincentives to the utility of on-site generation. In a nutshell, DG located on the customer side of the meter translates into lost sales, lost revenues and lost profits. Regulation needs to better align the utilities' financial interests with those of the DG owners, the utilities' other customers and society at large.

6.2.3 Addressing State Government Institutional Barriers

On June 11, 2001, New York Governor George Pataki signed an executive order directing all state agencies to purchase 10 percent of their electricity from renewable sources by 2005, and 20 percent of their electricity requirements by 2010. The executive order represents the largest procurement commitment of any state in the country and, given the state's considerable buying power, should give a boost to the development of vibrant markets for wind, photovoltaics, biomass, fuel cells and other renewable energy sources.

In order to achieve these ambitious goals, much work needs to be done to confront the myriad operational barriers that stymie renewable use in state facilities. For example, there is little financial (or non-pecuniary) incentive for facilities managers to deploy cost effective renewable or energy efficiency measures, since any resulting bill savings that accrue cannot be retained at the facility level. Similarly, consideration of integrating renewable energy technologies only occurs, if at all, at a very late stage of project development -- well after architectural plans have been development and construction bids have been let.

We recommend that NYSERDA as head of the Interagency Advisory Council recently created to assist state agencies implement the Governor's renewable procurement directive, conduct a comprehensive identification of state procurement laws, regulations and operational guidelines that may inhibit utilization of renewable and efficient sources of energy in state facilities.

6.4 Reforming New York's Process for Siting New Generating Facilities

6.4.1 Reauthorize and Reform the State's Power Plant Siting Law

New York's Article X review and approval process for the siting and permitting of proposed new generating facilities was allowed to sunset on January 1, 2003. The Senate and Assembly could not reconcile their significant substantive differences over the pace, scope and conduct of siting review.[42]

As things currently stand, New York State's existing power plant siting process essentially depends upon market forces to determine how best to meet it's the state's future energy needs. Market forces alone will never fairly balance society's interests in a diverse energy supply, clean environment and a strong economy. Obvious problems that have emerged include New York's increasing reliance on natural gas to generate electricity, under-investment in energy efficiency and renewable resources and divergence between private sector interests and public ones in decisions about where and when to build new power plants.

Article X must be reauthorized and reformed in several important respects to better serve New York State's interests in safe, clean, affordable and reliable electric service. Moreover, the current process must be overhauled if there is to be meaningful and effective public participation. Essential changes include the following:

- **Re-establish "needs" determination as a fundamental element in demonstrating that a proposed project is in the public interest.** The prevailing notion that a developer's willingness to put its own capital at risk is a sufficient indication of "need" is fundamentally flawed. The social and environmental externalities of electric power production are enormous, and the interests of the developer and the community often diverge. The Article X process should be structured to allow decision makers to take a hard look at how a proposed generation facility fits into the existing and planned gas and electric transmission infrastructure, rather than simply defer to the judgment of market participants.
- **Require an analysis of the relationship between proposed power plants, alternatives, and their relative merits and demerits.** The New York power plant siting process is applicant-driven, and does not lend itself to a relative consideration

[42] As a consequence, and until such time as Article X is reauthorized, power plant siting will be governed by the State Environmental Quality Review Act (SEQRA), the general environmental review process applicable to actions having a potentially significant impact on the environment.

of plants and sites, or to other resource alternatives (such as energy efficiency or renewable energy technologies). Applications for building power plants are addressed as they are received but proceed through the process independently. There is an urgent need for an analytic overlay that considers cumulative and interactive impacts of multiple power plant sitings on: 1) the environment; 2) fuel mix and diversity; 3) the nature of the gas contract of the generator, whether it is firm or interruptible; 4) natural gas pipeline capacity; and 5) transmission capacity and constraints.

6.4.2 Reauthorization and Reform of the State Energy Planning Process

While the Article X renewal debate has received considerable attention, the simultaneous expiration of the state energy planning process pursuant to Article VI of the Energy Law has gone relatively unnoticed. The State Energy Plan is intended to provide policy guidance for energy-related decisions by government and market participants within the state. Actions and decisions undertaken by all State agencies, Boards, Commissions, and Authorities must be "reasonably consistent" with the forecasts, policies and long-range planning objectives and strategies contained in the Energy Plan.

As set forth in the previous section, New York requires an energy planning process that recognizes and responds to the need for comprehensive resource planning in restructured markets. It is increasingly evident that "the market" will not automatically meet our energy needs reliably, safely, at reasonable cost, and with due concern about the environment. The State Energy Planning Board should work together with the Legislature to support reauthorization of Article 6, but in a strengthened form that will adequately protect the State's interest in a clean environment, economic justice and a strong economy. There is an urgent need to reconstitute a systematic, unbiased and ultimately credible review of the costs and benefits of a wide range of alternatives for meeting growth in the region's demand for electric services. That credible review can and should be part of the state energy planning process.

In addition to the important linkages between power markets and natural gas markets, the relationships between and among existing and proposed power plants from an environmental and reliability standpoint other critical energy network impacts and synergies exist. More broadly, there is at present no clear process for optimizing the siting of new central station power plants, distributed generation, electric transmission and distribution upgrades and expansions, and gas transmission expansions. This is all one integrated, interactive and critically consequential energy infrastructure.

As our analysis demonstrates, there is a pressing need for comprehensive resource planning that truly provides a "blueprint for action." To that end, we recommend that future state energy plans and updates include clear goals with meaningful performance metrics and periodic evaluation.