# Powering New Jersey's Future

A CLEAN ENERGY STRATEGY FOR REPLACING THE OYSTER CREEK AND SALEM NUCLEAR PLANTS

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RESEARCH & POLICY CENTER

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The opinions expressed in this report are those of the authors and do not necessarily reflect the views of those who provided editorial review. Any factual errors are strictly the responsibility of the authors.





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Environment New Jersey Research & Policy Center

143 East State St., Suite 7
Trenton, NJ 08608

# TABLE OF CONTENTS



Environment New Jersey Research & Policy Center

AUTHORS: Tony Dutzik, Suzanne Leta Liou, and Timothy Telleen-Lawton

CONTACT: Suzanne Leta Liou

143 East State St., Suite 7
Trenton, NJ 08608

609 • 394 • 8155

sliou@environmentnewjersey.org

# EXECUTIVE SUMMARY

**The Oyster Creek and Salem nuclear power plants** are scheduled to retire between 2009 and 2020. The plants, which pose environmental, health and safety concerns, account for about 17 percent of New Jersey's electric generating capacity. New Jersey is also facing potential strains in its electricity supply given its reliance on power imported from out of state and the impending retirement of several aging fossil fuel-fired power plants. The state must plan now for replacing the power that comes from the state's nuclear facilities.

Clean energy technologies can play a major role in that effort. The analysis that follows shows that New Jersey can retire Oyster Creek and Salem at the end of their current operating licenses without sacrificing the reliability of the state's electric system or investing in significant new fossil fuel or nuclear power plant capacity.

## Oyster Creek and Salem pose environmental, health and safety concerns and should be retired at the end of their operating licenses.

Oyster Creek is the nation's oldest operating nuclear power plant. Serious concerns have been raised about age-related degradation of critical safety components at the plant. Oyster Creek's design, no longer permitted for new plants, may not be able to prevent the escape of radiation during a meltdown. And Oyster Creek's spent-fuel pool is particularly vulnerable to terrorist attack. The population of Ocean County has increased five-fold since the opening of Oyster Creek in 1969, making evacuation in the event of an accident or attack difficult if not impossible.

The Oyster Creek and Salem nuclear power plants have experienced a string of technical and managerial problems over the past decade. In 2004 for example, the Nuclear Regulatory Commission concluded that there were weaknesses in the Salem plant's leadership and management, leading some employees to believe that the owner of the plant "emphasized production over safety."[1]

Both Oyster Creek and Salem cause great damage to marine ecosystems through their use of once-through cooling systems, which take in and discharge vast amounts of water and associated aquatic life from nearby waterways. The Salem nuclear plant alone kills approximately 3 billion Delaware River fish each year.

## Even without the retirement of Oyster Creek and Salem, New Jersey's electricity system faces major challenges.

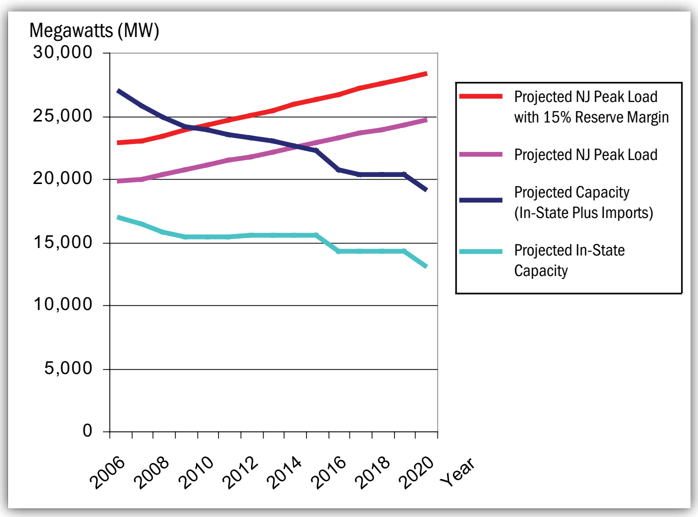
New Jersey currently imports about 28 percent of its power from other states. More importantly, New Jersey is dependent on out-of-state power to meet peak demand for electricity during the hot summer months. New Jersey has approximately 18,100 megawatts (MW) of generating capacity, yet in 2006, the state's peak demand for electricity (or "peak load") exceeded 19,800 MW.[2]

Scheduled generator retirements will place further strains on New Jersey's electric grid. New Jersey is scheduled to lose approximately 1,200 MW of generating capacity by the end of 2008 due to the anticipated shut-down of several aging fossil fuel-fired power plants. The retirement of Oyster Creek and Salem would result in another 2,900 MW of generating capacity going off line by 2020.

Not enough new generators are being built in New Jersey to close the gap. Given the historic rate at which proposed generators are completed in the PJM Interconnection region (of which New Jersey is a part), the state should expect only about 420 MW of new generation capacity to come on line in the next few years.

PJM Interconnection has already warned that closure of the retiring fossil fuel generators and Oyster Creek could result in the need for over $200 million in transmission investments to bring power from other states into New Jersey.

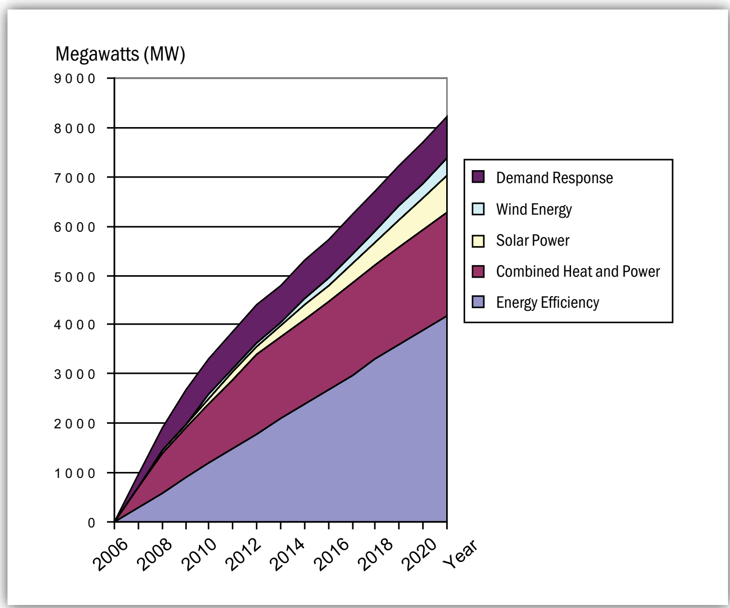
**Fig. ES-1. New Jersey Projected Peak Load and Capacity Resources, with Retirements, Including Net Imports**



## Clean energy technologies have the potential to fill the gap left by Oyster Creek and Salem.

- ✪ Energy efficiency improvements are the cheapest and fastest way to meet New Jersey's escalating power needs. Taking full advantage of New Jersey's potential for cost-effective efficiency improvements would reduce peak demand by approximately 4,186 MW by 2020.
- ✪ Combined heat and power - which maximizes energy efficiency by using the waste heat from electricity generators to provide useful heat to industrial and commercial buildings - has the potential to alleviate up to 2,100 MW of peak demand.
- ✪ Solar photovoltaic panels are the focus of a strong promotion effort in New Jersey. Achieving the solar power goals in the New Jersey renewable portfolio standard would result in 1,500 MW of solar power coming on line by 2020 - enough to reduce peak demand on the New Jersey electric grid by 750 MW.
- ✪ Wind power, particularly off the Jersey Shore, has the potential to supply more than 1,750 MW of power by 2020, enough to offset at least 350 MW of fossil fuel or nuclear power capacity.
- ✪ Demand response programs - which can use a variety of mechanisms to encourage consumers to reduce power demand during peak periods - can reduce projected peak demand by 3 percent or more, accounting for 850 MW of peak demand reductions in 2020.

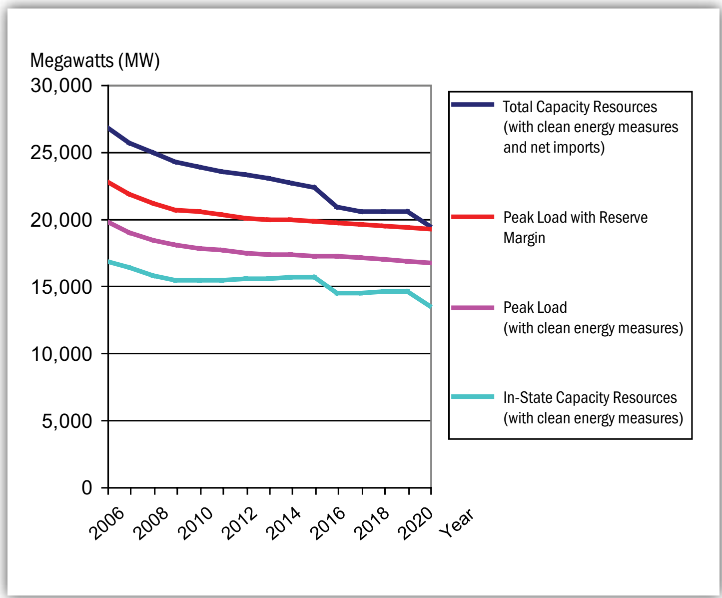
**Fig. ES-2. Potential Contribution from Clean Energy Strategies**




## Taking advantage of New Jersey's clean energy potential could allow for the retirement of Oyster Creek and Salem without threatening the reliability of the state's electric grid.

- Achieving the targets laid out above would account for approximately 8,200 MW of capacity through reduced demand and new efficient and renewable resources by 2020 - enough to replace capacity from Oyster Creek and Salem. (See Fig. ES-3.)

Fig. ES-3. Peak Demand and Capacity Resources in New Jersey, with Clean Energy Measures[3]




## Governor Corzine and the New Jersey Board of Public Utilities should anticipate and plan for the retirement of Oyster Creek and Salem at the end of their current operating licenses.

The state's Energy Master Plan should include a comprehensive set of policies that will put New Jersey on track to replace the plants with clean energy resources.

- In the short term, the state must adopt policies and practices designed to ease the transition after the closure of Oyster Creek in 2009. The state should focus on measures capable of achieving significant reductions in peak demand over the next two years. Such measures include:
  - Encouraging increased participation in PJM load management programs.
  - Encouraging voluntary conservation of energy by citizens and businesses.
  - Increasing support for deployment of combined heat and power.

- The state should also adopt policies now that will encourage clean energy technologies over the long term, including:
  - Adopting an Energy Efficiency Portfolio Standard that will require the state's utilities to achieve significant and increasing energy savings over time.
  - Renewing and doubling funding for the state's energy efficiency and renewable energy programs through the societal benefits charge.
  - Properly implementing the regional cap and trade program for power plant pollution (the Regional Greenhouse Gas Initiative) by charging generators for all pollution allowances and investing that income into programs that reduce electricity demand.
  - Rapidly expanding the penetration of combined heat and power (CHP) through the continuation and expansion of current subsidies and more aggressive marketing of the program.
  - Setting aggressive standards for energy efficiency in new homes and commercial buildings and in common appliances and equipment.
  - Requiring homes on the market to be rated for energy use so that home buyers and homeowners can evaluate the energy efficiency of their properties.
  - Requiring developers to offer solar energy systems, including solar thermal energy, as an option for all new homes and exempt renewable energy systems from property tax assessment.
  - Encouraging the development of wind power off New Jersey's coast.
  - Making New Jersey state government a leader by increasing the energy efficiency of state buildings and expanding government purchases of renewable energy.
  - Encouraging participation in demand response programs, which reward large power users for curtailing energy use during periods of peak demand.

# INTRODUCTION

New Jersey faces difficult choices about its energy future. Our electricity system is aging. Demand for electricity has been rising. The energy sources we have relied on in the past - coal, oil, natural gas and nuclear power - each have large problems, ranging from environmental damage to rising and volatile fuel costs to public safety concerns.

The debate over whether to retire the Oyster Creek and Salem nuclear power plants at the expiration of their operating licenses is typical of the choices facing New Jersey. Oyster Creek is the nation's oldest operating nuclear power plant, now nearly 40 years old. Oyster Creek and Salem have experienced significant operational problems in the past, ranging from corrosion of key components to managerial failures. And in an atmosphere of heightened concern over terrorism, the location of the plants near population centers, and the problems posed by the storage of nuclear waste, make the plants far from ideal choices for supplying New Jersey's electricity needs.

But how can New Jersey replace the power that currently comes from the Oyster Creek and Salem plants - especially given its aging fossil fuel-powered generators, its already strained transmission network, and its commitment to reducing its emissions of pollutants that cause global warming?

Clean energy solutions, including energy efficiency improvements, distributed electricity generation technologies and renewable power, have the potential to replace the power produced from Oyster Creek and Salem without jeopardizing the overall reliability of the state's electricity grid. By embracing an aggressive clean energy path for the state's future, New Jersey can reduce the need for expensive transmission upgrades, new fossil fuel plants that increase global warming emissions and costly new nuclear power plants.

The clean energy path for replacing Oyster Creek and Salem laid out in this report is not an easy path. Ideally, the state should have begun the planning process for replacing power output from Oyster Creek years ago. However, because of the short time left before Oyster Creek's 2009 retirement, the state needs to act ***immediately*** to tap its clean energy resources. New Jersey does not have the option of allowing the relicensing of Oyster Creek for a year or two while it ramps up its clean energy effort - rather, the state faces the choice of another ***20 years*** of Oyster Creek's operation or making aggressive efforts to reduce energy use and encourage clean energy resources now.

The groundwork has already been laid for New Jersey to make this historic and important transition. New Jersey's strong renewable energy standard and its cutting-edge initiatives to promote solar power and energy efficiency are already spurring the development of clean energy technologies within the state.

With New Jersey in the midst of developing an Energy Master Plan, the time has come to plan for how we can retire Oyster Creek and Salem while still ensuring the reliability of our electric grid for the future. Clean energy solutions can and should be the centerpiece of that plan.

# NUCLEAR POWER IN NEW JERSEY: THE CASE FOR RETIRING OYSTER CREEK AND SALEM

Nuclear power has provided a significant share of New Jersey's electricity since the late 1960s. The state is home to the oldest operating nuclear power plant in the country (Oyster Creek) and three other nuclear power plants of more recent vintage (Salem units 1 and 2 and Hope Creek). But while nuclear power plants generate about half of the electricity produced in the state, they also represent a dangerous liability - posing significant threats to the environment and to public health and safety. The possibility of replacing Oyster Creek and Salem with new nuclear power plants raises similar safety concerns, as well as the specter of a repeat of the cost overruns and financial problems that have saddled ratepayers in New Jersey and other states with excessive costs for power.

## Retiring Oyster Creek and Salem Would Enhance Public Safety

Nuclear power is an inherently dangerous and technologically complex way to produce electricity. To prevent catastrophic accidents and protect the public from exposure to radiation, nuclear power plants are built with containment structures and layers of redundant safety systems. Ultimately, however, the job of protecting the safety of the public depends on effective operation of the plant by its managers and the vigorous supervision of their activities by regulators.

Unfortunately, the Oyster Creek and Salem nuclear plants have been the sites of numerous technological and management failures over the past several decades. The plants are old and, in the case of Oyster Creek, do not meet current design standards. Moreover, the Nuclear Regulatory Commission, which is charged with ensuring the safety of America's 103 operating nuclear reactors, has often shown itself to be an ineffective watchdog. As a result, New Jersey residents should have little confidence in the ability of Oyster Creek and Salem to keep operating over the long term in a safe and efficient way.

### New Jersey's Nuclear Plants Are Aging

Technological failures in complex systems like nuclear power plants tend to follow a predictable pattern. Problems tend to be most common in the early years of a plant's life, when the kinks are being worked out, become less common during the middle years of its life, and then become more common again as a plant nears the end of its useful life and critical components begin to wear out. Nuclear experts refer to this pattern as the "bathtub curve," with steeply sloping sides at either end of a plant's lifetime representing periods of higher risk.[4]

New Jersey's nuclear power plants are entering the higher-risk stage of their lifetimes. The Oyster Creek plant, for example, is the nation's oldest operating commercial nuclear power plant, having commenced operation in 1969, just four months after Richard Nixon took the oath of office as president. Should Oyster Creek's proposal for a 20-year license extension be approved, the plant will continue to operate until it is 60 years old, in 2029. The two Salem reactors, unit 1 and unit 2, began operation in 1976 and 1980 and are currently scheduled to retire in 2016 and 2020, respectively. It is likely that the owners of the Salem plant will also apply for 20-year license extensions, hoping to continue the operation of the two reactors until 2036 and 2040 when they will be 60 years old.

The continued operation of aging nuclear reactors poses several potential problems:

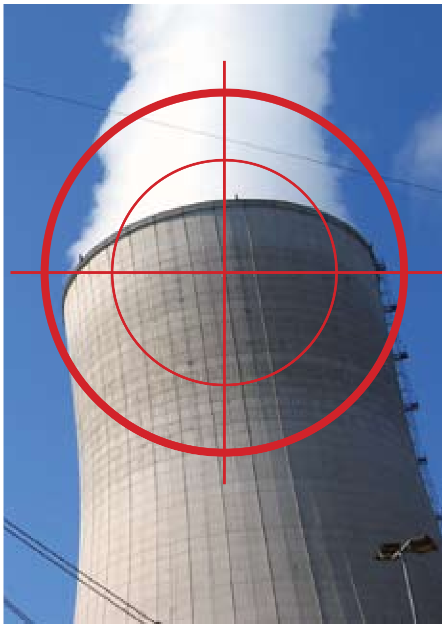
**Continued reliance on outdated technology -** Oyster Creek is one of 22 General Electric-designed "Mark I" reactors still operating in the United States.[5] Mark I reactors incorporate a flawed design that may dangerously compromise the reactor's ability to contain radiation in the event of a core meltdown. A study by Oyster Creek's owners estimated the potential for containment failure at the plant in the event of a meltdown to be 74 percent.[6] The containment structure is not the only system designed to protect the public from a nuclear accident, but it is an important one as it serves as the last line of defense against wide-scale radiation dispersal. More recent nuclear reactor designs have more robust containment structures than the Mark I.

The prospect of a core meltdown is an unlikely one, but it is not unimaginable - a 1979 malfunction at Oyster Creek led to a dangerous drop in coolant levels in the reactor core, a situation that could, under different circumstances, have led to a severe accident.[7]

**Changing conditions outside the plant -** Nuclear power plants are poorly suited to densely populated areas - in the event of an accident requiring evacuation, it would be extremely difficult to remove people from harm's way quickly. In the case of Oyster Creek, siting decisions made more than four decades ago are inappropriate today. The plant lies in the midst of New Jersey's fastest-growing county, and one that affords only a few main evacuation routes. In 1970, the year after Oyster Creek opened, the population of Ocean County was just over 108,000.[8] By 2005, the population of the county had quintupled to more than 558,000 residents.[9] Despite the potential for major demographic changes in areas around nuclear power plants, the NRC does not consider the feasibility of future evacuation in its plant relicensing decisions.

**Age-related degradation -** Perhaps the greatest concern with continuing to operate aging nuclear reactors is the prospect of age-related degradation of key equipment. Oyster Creek, for example, has experienced corrosion of its steel containment shell to within 0.07 inches of critical safety margins.[10] The Salem plant has experienced corrosion of its concrete containment liner.[11] The NRC does require reactor owners to identify and develop plans to manage age-related problems during relicensing, but the NRC's process for ensuring that age-related problems are dealt with appropriately has been criticized as ineffective by nuclear safety experts.[12]

## New Jersey's Nuclear Plants Are Potential Terrorist Targets



Nuclear reactors represent attractive potential targets to terrorists. Yet there is little reason to feel secure about the ability of the state's nuclear power plants to withstand a terrorist attack.

The U.S. Government Accountability Office (GAO), the investigative arm of the U.S. Congress, conducted a review of security improvements to nuclear power plants under the NRC's watch since the terrorist attacks on September 11, 2001. Their review, completed in 2006, found that while significant improvements had been made in plant security, the GAO was unable to conclude that all nuclear power plants were capable of defending themselves against a plausible terrorist attack, since only about one-third of the plants had conducted the necessary force-on-force inspections. The GAO also questioned changes made to the NRC's standards for protection against terrorist attacks, noting "the appearance that changes were made based on what the industry considered reasonable and feasible to defend against rather than on an assessment of the terrorist threat itself."[13]

A potentially greater threat lies in the possibility of an attack on a reactor's spent nuclear fuel. Spent-fuel pools hold nuclear fuel at densities approaching those in reactor cores. Should coolant from the spent-fuel pools be lost, the fuel could ignite, spreading highly radioactive compounds across a large area. In 2005, the National Academy of Sciences (NAS) warned that "[s]pent nuclear fuel stored in pools at some of the nation's 103 operating commercial nuclear reactors may be at risk from terrorist attacks," and recommended a series of actions to reduce the danger.[14] One study estimated that a loss of coolant accident that resulted in a spent-fuel pool catching fire could result in between 2,000 and 6,000 additional deaths from cancer.[15]

The design of the Oyster Creek spent-fuel pool raises particular concern. The pool is located on the top floor of a five-story building. Three of its walls are shared with the exterior walls of the plant. According to an NRC Spent Fuel Accident Risk report, reactors designed like Oyster Creek "do not appear to have any significant structures that might reduce the likelihood of aircraft penetration."[16]

## New Jersey's Nuclear Power Plants Have A History Of Operational And Management Problems

The Oyster Creek and Salem nuclear power plants have experienced a series of operational problems over their history.

The Salem nuclear power plant, as well as the adjacent Hope Creek plant, have come under special scrutiny in recent years due to lapses in the plants' "safety conscious work environment." A 2004 NRC investigation found that "there were numerous indications of weaknesses in corrective actions and management efforts to establish an environment where employees are consistently willing to raise safety concerns" at the two plants.[17] Indeed, a recent GAO report listed a series of specific technological and management problems at Salem and Hope Creek since 2000, including:

- Too many unplanned reactor shutdowns in 2000,
- Too many unplanned changes in power production in 2002,
- "Ineffective problem evaluations and untimely, ineffective corrective actions by plant employees, including recurring equipment failures" in 2003,
- Failure of an emergency generator in 2002,
- Inadequate maintenance procedures for a water system in 2003,
- Failure to discover degraded equipment before it broke in 2004, and
- Work culture that discourages reporting problems to senior management in 2003.[18]

In addition, in 2003, elevated levels of radioactive tritium were found in groundwater near the Salem plant.[19]

A series of independent assessments of the Salem and Hope Creek plant were conducted in 2003 and 2004. Among other things, the assessments concluded that the plants' "Physical Condition Reflects Tolerance for Mediocrity" and that performance in many areas was "less than competent."[20] While the owners of Salem and Hope Creek have taken some actions to improve safety consciousness at the plants, the persistence of operational and management problems over many years does not engender public confidence that the plant's owner can operate it effectively or that the NRC can regulate it with the necessary amount of vigor.

The NRC has also cited the Oyster Creek plant for maintenance problems. In 2004, the NRC found that Exelon, the company that owns the plant, failed to prevent the failure of a cable providing power to two back-up generators during the previous year despite the fact that the same cable failure had occurred twice before, in 1996 and again in 2001.[21] In March 2005, the NRC increased oversight at Oyster Creek after plant workers failed to adjust a threshold to classify serious emergencies.[22] The mistake could have delayed timely responses by emergency managers during a radioactive release. More recently, in ongoing litigation between citizen groups and the Atomic Safety Licensing Board, Exelon submitted dry well liner measurements with systematic errors yet made no effort to correct them.[23]

## The NRC Has Historically Been An Ineffective Watchdog

The NRC's failure to identify and force early resolution of the problems at Salem and Hope Creek is symptomatic of broader problems in the NRC's development and application of safety regulations.

Over a period of two years, the GAO issued seven reports that detailed the need for improvement in NRC practices to ensure the safety and security of nuclear power plants, the safe storage of radioactive waste, the collection of adequate funds for nuclear decommissioning, and the effective operation of nuclear reactors.[24] In a 2002 internal survey, nearly half of all NRC employees responding thought their careers would be harmed if they raised safety concerns, and nearly one-third of employees who had reported safety concerns replied that they had suffered harassment or intimidation as a result.[25] In addition, the NRC's reviews of nuclear power plant safety are fundamentally flawed. A 2003 Union of Concerned Scientists document identified numerous problems with the reviews, which, combined, lead to an overly optimistic view of the safety of individual reactors.[26]

As noted above, a 2006 GAO study indicated that the NRC's oversight of nuclear plant safety had improved, but that the agency has been "slow to act on needed improvements."[27] Unlike other areas of public health and safety, in which both state and federal officials have the opportunity to enforce regulations, state officials are barred by federal law from imposing specific safety rules for nuclear power plants in New Jersey. That power is exclusively within the domain of the NRC, and there is little in the agency's history to suggest that New Jersey residents can trust the NRC to enforce its own regulations with vigor.

## Retiring Oyster Creek and Salem Would Reduce Environmental Damage

The Oyster Creek and Salem nuclear power plants use “once-through” cooling systems that consume vast amounts of biologically rich water from nearby waterways and return similarly vast quantities of heated water to those waterways. The two plants have inflicted tremendous damage on marine ecosystems over the past few decades of operation.

The U.S. Marine Fisheries Service reports that operation of the Oyster Creek power plant - whose cooling system can pump as much as 1 million gallons of water per minute - results in the annual loss of 13,000 winter flounder, 8 million sand shrimp, as well as significant numbers of blue crab, bay anchovy and other marine species. The service expressed particular concern about winter flounder, whose numbers appeared to have declined since the late 1980s.[28] Technical problems at the plant have led to massive fish kills. In 2002, a discharge of heated water from Oyster Creek caused more than 5,000 fish to die from heat shock.[29]

Similar damage to marine life occurs at the Salem plant. According to Delaware Riverkeeper, the Salem power plant kills approximately 3 billion Delaware River fish per year.[30] A 1990 study estimated that water intakes from the Salem nuclear power plant resulted in four times more fish losses than the commercial fishing industry in the area.[31]

Environmental advocates have long urged that Oyster Creek and Salem install “closed-loop” cooling systems that dramatically reduce the amount of water that must be taken from nearby waterways, thus reducing the impact on marine ecosystems. However, such a move would be costly and the owners of the two plants have resisted it. Exelon has stated that requiring Oyster Creek to be retrofitted with a closed-loop cooling system may cause the company to reconsider its efforts to relicense the plant.[32]

# Replacing Oyster Creek or Salem with a New Nuclear Power Plant Would Not Be a Prudent Way to Solve New Jersey's Electricity Problems

Oyster Creek and Salem have a history of management and operational problems and rely on outdated technology. Replacing the two plants with new nuclear reactors - whether on the same site or elsewhere in New Jersey - may resolve some of these problems, but would not make nuclear power a wise investment for the state.

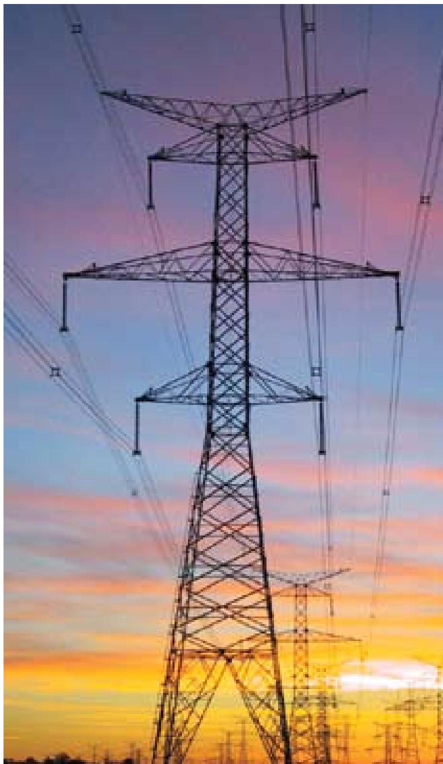
First, nuclear power plants take years to construct, meaning that the state would still need to take action to deal with the short-term energy supply concerns that arise from the retirement of Oyster Creek and several fossil fuel-fired generators.

Second, nuclear power plants remain an expensive choice for providing electricity generation. A 2003 interdisciplinary study by researchers at the Massachusetts Institute of Technology estimated the cost of energy from new nuclear power plants at 6.7 cents/kWh, compared to 4.2 cents/kWh for new coal-fired power plants and 5.6 cents/kWh for natural gas combined-cycle plants under a high gas price scenario.[33] These costs are significantly higher than the cost of new wind power in much of the country and far higher than the cost of avoided energy use through improved energy efficiency.[34] The MIT study also assumed capital costs for new nuclear power plants of $2,000 per megawatt, a cost level that has been exceeded in the construction of several new plants in Japan and South Korea over the last decade.[35]

In New Jersey's deregulated electricity industry, the cost of building a new nuclear power plant would be borne by investors (and, to a certain extent, by American taxpayers, who are on the hook for the large nuclear subsidies included in the 2005 federal Energy Policy Act), not by New Jersey ratepayers. Because of nuclear power's poor track record of cost containment, there is little reason to believe that investors will risk billions of dollars of their own capital on nuclear power plants without even greater public subsidy, either at the federal or the state level.

Finally, there is no guarantee that new nuclear reactors would not be a threat to public health and safety. Like the state's existing reactors, any new reactors would be required to store their spent fuel on-site (at least until a national nuclear waste repository is completed), providing a potentially attractive target to terrorists. In addition, while the nuclear industry touts new "advanced" reactor designs, most of the proposed new reactor designs are simply modifications of earlier concepts. While "passive" safety systems and "meltdown-proof" reactor designs may provide some improvements in nuclear safety, the fact remains that nuclear power plants are complex systems containing radioactive material and can thus never be considered inherently safe.

For all of these reasons - public health and safety, security and environmental impact - the relicensing of Oyster Creek and Salem, or their replacement with new nuclear power plants, are unacceptable alternatives for serving New Jersey's energy needs.



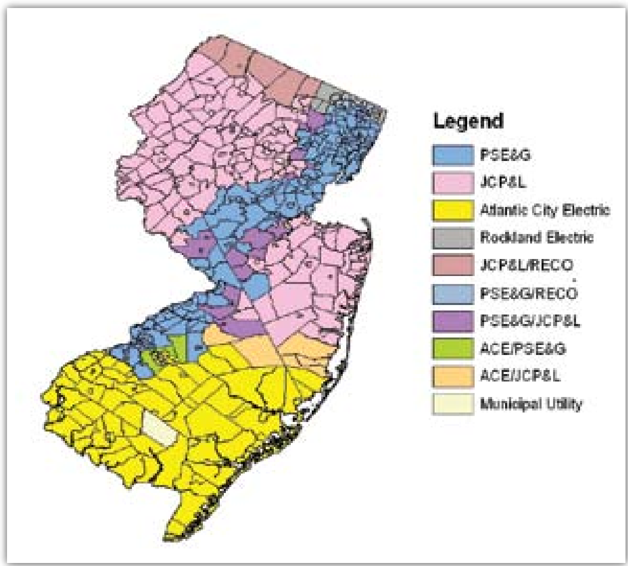
# NEW JERSEY'S ELECTRIC POWER SYSTEM: PRESENT AND FUTURE

To understand the impact of the closure of the Oyster Creek and Salem nuclear power plants, it is first necessary to understand how power is produced and distributed within New Jersey and also how New Jersey fits into the larger regional power grid.

## In-State Generation and Demand

New Jersey is divided into four primary electric service territories: those of Public Service Electric & Gas (PSE&G), FirstEnergy-owned Jersey Central Power & Light (JCP&L), PEPCO-owned Atlantic City Electric (AE), and Consolidated Edison-owned Rockland Electric (RECO).

**Fig. 1. New Jersey Utility Service Territories by Municipality**




PSE&G, which serves the highly-urbanized corridor between New York and Philadelphia, is the largest utility in the state. JCP&L, which serves a territory split between northwestern New Jersey and the northern half of the Jersey Shore, is second largest, followed by Atlantic City Electric, which serves most of South Jersey. Portions of far northern New Jersey are served by Rockland Electric, whose service territory is primarily in New York State.

Because Rockland Electric draws the bulk of its power from the New York State electric grid, we assume that it will continue to do so in the future. As a result, this analysis focuses on the three major utilities in New Jersey with significant in-state generation resources: PSE&G, JCP&L and Atlantic City Electric.

### Generation

According to the U.S. Energy Information Administration (EIA), there were 280 individual electric generating units operating in New Jersey in 2005, with a total capacity of 17,536 megawatts (MW).[36] The majority of that generation capacity is connected to the PSE&G system. In New Jersey, which restructured its electricity industry in the late 1990s, generating units are no longer owned by utilities, but rather by independent companies or separately operated affiliates of utilities.

Approximately 16,291 MW of the generation available in New Jersey at the end of 2005 was considered capacity resources by PJM Interconnection, the region's grid operator. (See Table 1 below.) Capacity resources are those that are committed to supplying power in order to meet peak summer demand.[37]

**Table 1. Electric Generating Capacity Resources in New Jersey by Major Utility Service Territory, 2005[38]**

| | Summer Capacity (MW) |
|---|---|
| Atlantic City Electric | 1,712 |
| JCP&L | 3,933 |
| PSE&G | 10,555 |

In 2006, New Jersey added approximately 600 MW of new net generating capacity, with the opening of a large new combined-cycle power plant in Linden, offset by the retirement of several smaller generators.[39]

## Demand/Load

The key factor that shapes decisions about New Jersey's electric infrastructure is not the total amount of power that is used in a year, but rather the amount of power needed to keep the lights on during periods of peak demand. The demand for electricity varies widely over the course of the year and the course of any given day - the demand for power on a hot summer day when air conditioners are running can be two to three times as great as in the middle of the night during a time of moderate temperatures.

The calculations used to determine how much generation and transmission capacity are needed in New Jersey, therefore, are based on the amount of power needed to meet demand during the few hours of heaviest demand during the year, even though those hours represent a tiny fraction of the time the electrical system must function. (See Fig. 2 and Table 2.) Millions of dollars of infrastructure are in place just to meet those peak demand periods, making the power generated and delivered to serve peak demand many times more costly than power produced during the remainder of the year.

**Fig. 2. Daily Peak Load for New Jersey Utilities, 2005[40]**

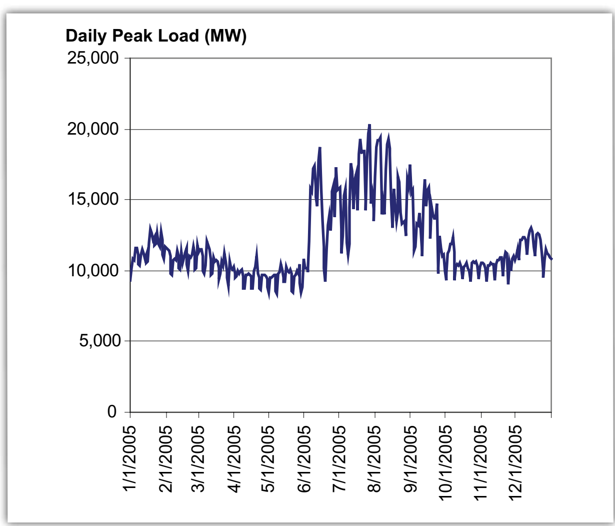


**Table 2. Percentage of Hours Exceeding Given Hourly Load, New Jersey Utilities, 2005[41]**

| Load | Hours | Percent of Hours |
|---:|---:|---:|
| Total | 8,760 | |
| >7,500 MW | 7,560 | 86.30% |
| >10,000 MW | 3,330 | 38.01% |
| >12,500 MW | 1,175 | 13.41% |
| >15,000 MW | 446 | 5.09% |
| >17,500 MW | 118 | 1.35% |
| >20,000 MW | 4 | 0.05% |

In 2006, weather-normalized demand for power at the state's four investor-owned utilities peaked at 19,418 megawatts, more than 2,000 megawatts greater than the state's total electric generation capacity. (See Table 3.)

**Table 3. Weather-Normalized Coincident Summer Peak Demand and Total Capacity Resources, 2006[42]**

| | Peak Demand (MW) | Summer Capacity (MW) | Surplus/Deficit |
|---|---:|---:|---:|
| ACE | 2,710 | 1,712 | -998 |
| JCP&L | 5,978 | 3,824 | -2,154 |
| PSE&G | 10,330 | 11,264 | 934 |
| **NJ total** | **19,018** | **16,800** | **-2,218** |

While New Jersey has more than 16,800 megawatts of capacity resources, there is no guarantee that all of that capacity will be available at any given moment - even during peak periods. Generator outages - either for expected maintenance or caused by unanticipated problems - can reduce the amount of power that can be generated within the state at any one time. As a result, planners require that electrical systems have a "reserve margin" of capacity available to handle unanticipated spikes in demand or generator or transmission line failures.

PJM Interconnection, which operates the electric transmission system in New Jersey and neighboring states, requires a reserve margin of 15 percent system-wide. In simplified terms, the amount of capacity resources must exceed projected peak demand by 15 percent in order to preserve the reliability of the system. PJM does not enforce a reserve margin in any given state, but it is generally considered good practice for any area to have a surplus of available capacity - provided either through generation within that area or transmission connections with other areas - to ensure that power demands can be met under all possible conditions.

Through this lens, New Jersey's three main utilities would need to have more than 21,870 MW of capacity available in order to ensure that its peak power demands can be met - or approximately 5,070 MW of capacity more than is provided by in-state generators connected to the networks of those utilities.

## Transmission: The Regional Electric Grid

Given that New Jersey does not have nearly enough in-state generation resources to service in-state demand, how does the state keep the lights on? The reason is that New Jersey can import large amounts of power through its transmission system connections with other states. New Jersey's most important connection is with the PJM Interconnection regional grid.

PJM provides transmission service in all or part of 14 states, stretching from Illinois to North Carolina. The PJM grid also connects to other regional power grids in the Eastern Interconnection, which covers the eastern United States. For New Jersey's purposes, the most relevant connection is with the New York Independent System Operator (NY ISO).

New Jersey's imports of power come from three main sources: imports over PJM's 500 kilovolt "backbone" transmission system of the mid-Atlantic grid; imports over lower-voltage transmission lines from neighboring utilities in eastern Pennsylvania; and imports from New York State.

### Imports From The PJM Backbone

As of June 2006, there were more than 167,000 MW of generating capacity installed in the PJM Interconnection region.[43] But not all of that capacity is available to serve demand in New Jersey, especially during peak periods. While there is ample generating capacity in the western region of PJM (much of it provided by coal-fired power plants), transmission constraints prevent much of that power from reaching "PJM East," which consists of New Jersey, the Philadelphia area, and the Delmarva peninsula.[44] Virtually all of the PJM East area has been designated a "Critical Congestion Area" by the U.S. Department of Energy.[45]

These transmission constraints limit inflows from the rest of PJM to PJM East to approximately 7,300 MW - actual limits on inflows during peak periods are closer to 6,000 MW.[46]

According to data provided by PJM, during the five hours of highest demand in New Jersey in 2006, the state drew an average of 5,970 MW of power from the mid-Atlantic 500 kV system.[47]

### Imports From Eastern Pennsylvania Utilities

In addition to New Jersey's ability to draw power from PJM's high-voltage transmission network, the state also benefits from the ability to import power over lower-voltage transmission lines from three utilities in eastern Pennsylvania - Metropolitan Edison (which, like JCP&L, is part of FirstEnergy), PECO, and PPL.

During New Jersey's five hours of peak demand in 2006, the state imported a net average of 3,290 MW of power from these Pennsylvania utilities.[48]

### Imports From New York ISO

New Jersey also has connections with the New York State electric grid, run by the New York Independent System Operator (New York ISO). Not counting imports of power from New York ISO to serve Rockland Electric customers, New Jersey imported approximately 750 MW of power from New York ISO during peak demand hours in 2006.[49]

Imports from these three sources, therefore, satisfied an average of approximately 10,000 MW of power demand in New Jersey during the peak five hours of 2006.

The importation of large amounts of power during these periods does not necessarily mean that all generators in New Jersey were operating at full capacity. PJM dispatches generators and manages the transmission system with both economic and reliability considerations in mind. For example, PJM may opt to dispatch generators elsewhere in PJM East rather than in New Jersey if those generators are less expensive to operate, provided that sufficient transmission capacity exists to carry that power to serve demand in New Jersey. (For more on how to interpret the analysis in this report, see "New Jersey and PJM: About this Analysis" below.)

## New Jersey and PJM: About this Analysis

Electric power grids are complex systems. Modeling their behavior is technically challenging, time consuming and expensive.

This report does not purport to be a detailed analysis of how the state's transmission network would behave in the event of increasing demand or generator retirements. Instead, it is a simplified analysis that nonetheless sheds light on how the state can plan for the upcoming retirement of three of the state's nuclear power plants.

Our guiding assumption is that New Jersey is a "black box" in which capacity resources must match peak demand (plus a 15 percent reserve margin), given a technically feasible amount of net electricity imports from other states. The challenge addressed in this report, therefore, is to determine how New Jersey can satisfy its electricity needs ***in the aggregate*** using resources present within the state and able to be imported from other states, given reasonable assumptions about the future availability of imported power (detailed in "Availability of Imported Power" page 21).

This analysis, however, does not shed light on at least two key questions. First, it does not address the question of whether additional transmission upgrades will be necessary within New Jersey or to serve local "load pockets" within the state. Second, it does not address the price of power, which may fluctuate based on the relative availability of low-cost generating sources both within and outside of New Jersey, as well as congestion in transmission infrastructure.

We believe that, in the aggregate, our focus on distributed resources (such as energy efficiency, demand response, combined heat and power and solar power) and centralized renewable generation close to existing transmission facilities (such as offshore wind power plants located in the vicinity of the Oyster Creek nuclear power plant) will tend to minimize the need for expensive, reliability-driven transmission investments in New Jersey as well as the need for additional transmission connections to bring in power from elsewhere in PJM. Price impacts are more difficult to anticipate. We encourage other researchers to conduct full power system modeling of the clean energy strategy detailed in this report in order to provide a more conclusive estimate of the price impacts of the changes suggested here.

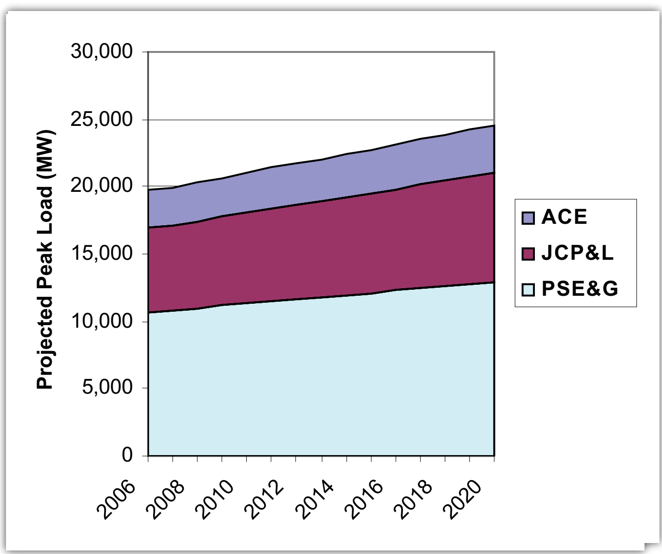
# The Future:
# Forecast Load Growth, Generation Retirements and Additions, and Imported Power Availability

Electricity demand in New Jersey has increased steadily in recent years and is projected to increase still further in the years to come. At the same time, a number of major electric generating units - including Oyster Creek and Salem, but not limited to them - are scheduled to retire in the years to come. While some new power plants have recently been proposed in the state, they will likely be insufficient to compensate for increased demand and the loss of several major sources of electricity.

## Forecast Load Growth

In its 2007 Load Management Report, PJM Interconnection estimated annual rates of load growth for the state's major utilities through 2022. PJM projects that summer peak load will increase by an average of 1.9 percent annually in the JCP&L service territory, 1.9 percent annually in the Atlantic City Electric territory, and 1.4 percent in the PSE&G territory.[50] (See Fig. 3.)

**Fig. 3. Projected Peak Load Growth, 2006 through 2020**[51]



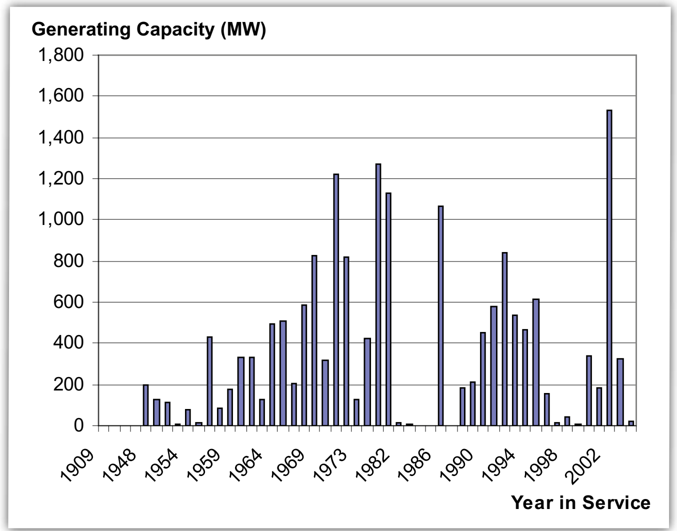

Should PJM's projections hold true, peak demand in the territories of the state's three largest utilities would increase by approximately 4,780 MW, or 24 percent, between 2006 and 2020.

**Note:** The data reported above, which form the basis of our analysis, represent "non-coincident" summer peak loads - i.e. the maximum load experienced in each utility service territory. Because each utility's peak load does not occur at the same moment as the peak load of the system as a whole, "coincident" peak load - the load in a particular service territory at the time of maximum load on the entire system - is generally used for system planning purposes. PJM does not estimate coincident peak load for individual utility service territories beyond 2010. In 2007, for example, PJM projects that the coincident peak load in the three major New Jersey utility service territories will be approximately 3 percent lower than the sum of the non-coincident peak loads. Our use of non-coincident peak loads, therefore, adds an additional layer of conservatism to our analysis of New Jersey's future electricity needs.

## Generation Retirements And Additions

At the same time that load is projected to increase, several major generating units are scheduled to retire. New Jersey has its share of older power plants - more than 45 percent of the state's electric generating capacity is more than 30 years old. (See Fig. 4.) As time goes on, more of these aging plants will retire, leaving the state with the need to replace the capacity they bring to the grid.

**Fig. 4. NJ Electric Generating Capacity by Year Placed in Service**[52]




The owners of power plants accounting for more than 1,200 MW of generating capacity have already notified PJM of their intention to retire the plants.[53] Factoring in the scheduled retirements of Oyster Creek (in 2009), Salem unit 1 (in 2016) and unit 2 (in 2020), New Jersey could lose as much as 4,126 MW of generating capacity to retirement between now and 2020 - or about 23 percent of its current generating capacity. This does not include any other generating units that might retire over the next decade and a half.

There have been a number of proposals for new electric power plants in New Jersey, particularly over the past year. As of January 2007, PJM had active requests for interconnection to the grid from 15 proposed power plants in the state, which could eventually account for 3,300 MW of generating capacity - or 82 percent of the capacity New Jersey could lose by 2020.[54]

Not all of that capacity, however, is likely to be built. Proposals for new power plants are often withdrawn for economic or other reasons. In addition, some proposed generators - such as a new coal-fired power plant proposed for West Deptford - will likely face fierce and legitimate opposition for their environmental and public health impacts. [55]

Since the commencement of operations of PJM as an independent system operator, more than 22,700 MW of capacity have been built or are in the process of being built in the region. By contrast, more than 122,000 MW of capacity have been proposed but subsequently withdrawn.[56] Should those trends continue to hold true, one could anticipate that no more than 12.5 percent of the currently proposed capacity in New Jersey will end up being built - or approximately 420 MW of new capacity.

## Availability Of Imported Power

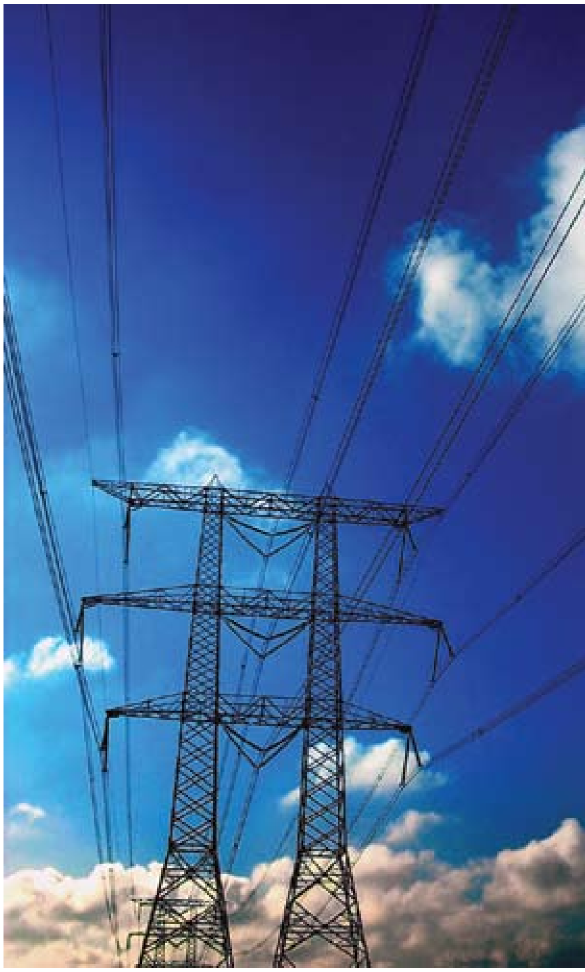
Determining the exact amount of imported power available to New Jersey at any given time is difficult, since the state is part of a larger, integrated power market with the rest of PJM East and, to some extent, New York State. For the purposes of this analysis, we made the following assumptions about the availability of imported power to New Jersey.

### PJM Backbone Transmission System

We assume that New Jersey will continue to be able to draw upon 6,000 MW of net capacity imports during peak periods from the PJM backbone 500 kV transmission network. New Jersey's draw upon the 500 kV PJM network roughly approximates the amount of power capable of being transferred over PJM's eastern interface. To the extent that other customers elsewhere in PJM East compete for this power, New Jersey's ability to rely on these imports may be in question. In addition, constraints in the network could prevent power from being delivered to the locations within New Jersey where it is in demand.

### Imports from Eastern Pennsylvania Utilities

In addition to New Jersey's imports over the region's 500 kilovolt transmission system, the state also imports electricity from neighboring utilities in southeastern Pennsylvania along lower-voltage transmission lines. To arrive at a conservative estimate of the amount of power New Jersey can expect to import from neighboring utilities in eastern Pennsylvania over low-voltage lines, we calculated non-coincident summer peak loads for three Pennsylvania utilities (Metropolitan Edison, PECO and PPL) and compared those figures with the amount of generation capacity within those utilities' service territories, minus projected generator retirements obtained from PJM.[57] We did not assume any additions of new capacity within these three utility territories (likely a very conservative assumption). Further, we assumed that these three utilities would need to maintain a 15 percent reserve margin overall, and that any additional capacity would be available to export power for use in New Jersey.



As a result, the amount of import capacity we assume to be available from the three Pennsylvania utilities declines throughout the study period, reaching zero in 2018.

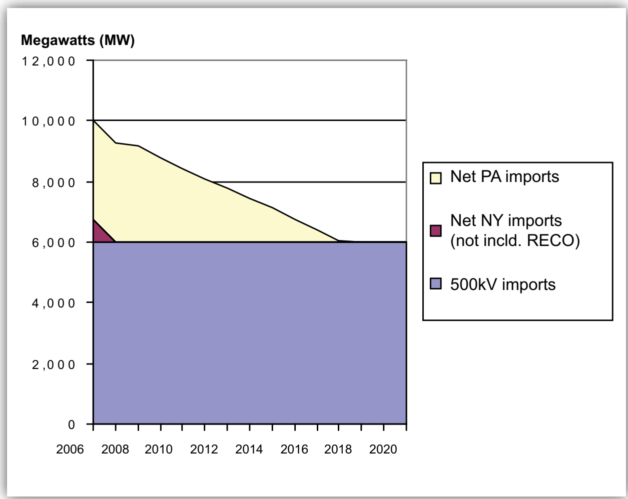
### Imports from New York ISO

The addition of new transmission lines linking New Jersey with Long Island - scheduled to begin in 2007 - could erode or end New Jersey's position as a net importer of power at peak periods from New York ISO. The new transmission line would enable the transfer of 600 MW of power from PJM through New Jersey to Long Island.[58] As noted above, excluding imports of power from New York to serve Rockland Electric customers, New Jersey imported about 750 MW of power from New York ISO during peak demand periods in 2006. For the sake of this analysis, we assume that net imports of power from New York ISO (other than to serve Rockland Electric customers) will fall to zero in 2007 and remain at that level until 2020.

### Imports Summary

Combining these assumptions, we assume that New Jersey's peak import capacity will decline from approximately 10,000 MW in 2006 to 8,400 MW in 2010, 6,800 MW in 2015 and 6,000 MW in 2020. (See Fig. 5.) We believe these to be conservative assumptions of the degree to which New Jersey can rely on other states for power.

**Fig. 5. Power Import Capacity Assumptions**

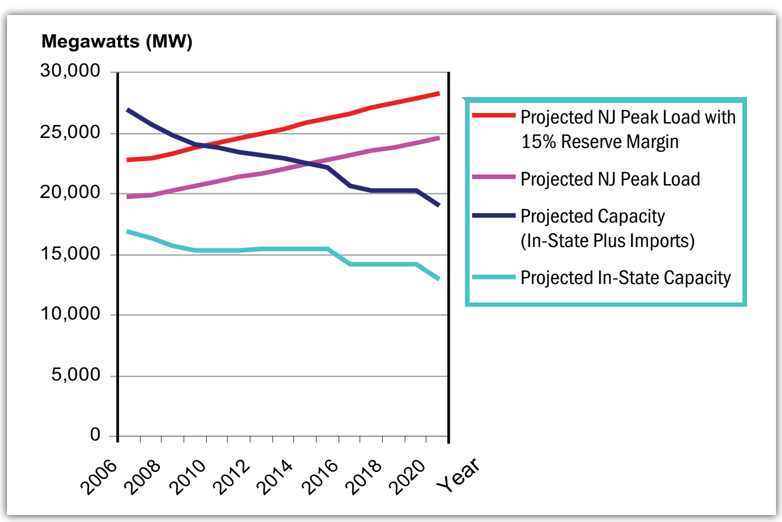



## Summary

Given current projections of load growth, anticipated generation retirements, a conservative assessment of how much proposed new capacity will come on line and a conservative assessment of future import capacity, New Jersey could very quickly find itself in need of new power resources, with the gap between peak demand and available capacity increasing over time.

Assuming that the state maintains a 15 percent reserve margin (including net imports from outside the state), New Jersey should be able to maintain system reliability through 2009 (including the retirement of Oyster Creek in that year). The state begins to experience a capacity shortage in 2010. That shortage grows to more than 9,000 MW by 2020. (See Fig. 6.)

**Fig. 6. Projected NJ Peak Demand versus Capacity Resources**



There are two ways that New Jersey could fill that gap. The first is by expanding transmission capacity in order to allow the importation of more power from other states. In theory, there is plenty of power in the PJM system to fulfill demand in New Jersey, at least in the near term. PJM projects that it will exceed its 15 percent reserve margin system-wide through at least 2010-2011.[59]

There are two problems with increased reliance on imports, however. The first problem lies in getting excess power from elsewhere in PJM to New Jersey, particularly over the long term. In 2004, PJM conducted a detailed analysis of the impact of several proposed generator retirements in the PSE&G system and the 2009 scheduled retirement of Oyster Creek. PJM projected that the retirements would overload several transmission lines, particularly in northwest New Jersey, and that the Oyster Creek retirement would result in an overload of one of the 500kV transmission lines that brings power to northern New Jersey from Pennsylvania.[60] PJM estimated the price tag of transmission upgrades to address those problems at more than $200 million.

The second problem with increasing imports is that much of the power available from Pennsylvania and the Midwest is generated with coal, which causes severe environmental damage. Increasing power imports from the region would undermine New Jersey's commitment to reducing global warming emissions and potentially result in increased air pollution emissions which, given prevailing winds, could have public health impacts in New Jersey.

The other option is for New Jersey to find in-state resources that can compensate for the loss of fossil fuel and nuclear units scheduled to retire. Here too, however, New Jersey faces a fork in the road. It can choose to encourage new fossil fuel or nuclear generating plants, with all their attendant problems, or it can seek to maximize its use of clean energy resources to address the shortfall.

The next section describes one scenario by which New Jersey could maintain the reliability of its electric system without major new investments in fossil fuel or nuclear power generation - investing in clean energy solutions.

# A CLEAN ENERGY STRATEGY FOR REPLACING OYSTER CREEK AND SALEM

New Jersey has the potential to absorb the retirement of Oyster Creek and Salem while preserving the reliability of its electric grid and avoiding major investments in new nuclear or fossil fuel generation. Doing so will not be easy, but it is possible. In this section, we map out a scenario by which clean energy solutions can make a significant contribution to the continued reliability of the state's electric grid.

## Energy Efficiency

### Potential Peak Demand Reduction: 4,186 MW by 2020

New Jersey has great potential to improve the efficiency with which it uses energy in its homes, businesses and industry. Improving energy efficiency reduces demand for electricity, including during peak periods, thus reducing strain on the electric grid.

In 2004, the Rutgers University Center for Energy, Economic and Environmental Policy commissioned a study by KEMA, Inc. that examined the potential for improving the energy efficiency of New Jersey's economy. The study found that New Jersey has the technical potential to reduce electricity demand by 6,725 MW by 2020 - or about 27 percent compared to projected load in the state's three largest utility territories in that year.[61] Of those savings, about two-thirds, or 4,186 MW, appear to be cost-effective to consumers. Compared with PJM's forecast of projected electricity load growth, this would represent a reduction of 17 percent in peak load compared with projected peak load at the state's three largest utilities in 2020.

The KEMA study identified many opportunities for improved energy efficiency, including:

- Installation of high efficiency heating and cooling equipment in homes and businesses.
- Purchase of EnergyStar new homes, appliances, windows and other products.
- Stronger energy efficiency standards for appliances.
- Improvements in the energy efficiency of commercial lighting.
- Better management of heating, cooling and ventilation systems in commercial buildings.[62]

However, for several reasons, New Jersey may be able to attain cost-effective peak load reductions beyond those identified in the KEMA study:

- Energy prices, both for electricity and natural gas, have proven to be much higher than anticipated in the KEMA study. For example, the KEMA study assumed that electricity prices for residential consumers would remain under 14 cents/kWh until approximately 2016. As of August 2006, the average New Jersey residential consumer was already paying 14.78 cents/kWh.[63] To the extent that energy prices remain higher than predicted in the KEMA study, greater amounts of energy efficiency improvements will be cost effective and all energy efficiency improvements will provide greater economic benefits to consumers.

- KEMA's estimates of cost-effectiveness included savings from all aspects of the electricity system but not so-called "externalities" - such as the economic benefits of avoided air pollution or global warming emissions. Including these societal benefits would improve the economic profile of energy efficiency measures.

- The KEMA study reflects the status of energy efficiency technology at the time the study was issued. Continued reductions in price or improvements in the performance of energy efficient equipment could allow for greater reductions in energy consumption in future years.

- Finally, the KEMA study did not include voluntary conservation efforts, which can play an important role in achieving energy savings.

New Jersey has already taken significant steps to reap savings from energy efficiency. The state plans to invest $118 million per year in energy efficiency programs between 2005 and 2008.[64] And New Jersey's Clean Energy Program has already delivered impressive energy efficiency savings - the program's 2005 energy efficiency efforts alone will result in 141 MW of load reductions.[65]

But to achieve the energy efficiency savings detailed in the KEMA study, New Jersey will have to redouble its efforts to promote energy efficiency. To date, New Jersey has funded energy efficiency programs through a "systems benefit charge" on customers' utility bills. Consumers pay a small per-kilowatt-hour fee to support energy efficiency programs. The investment makes sense: consumers have the opportunity to benefit directly through rebates and other incentives for energy efficient products and all consumers benefit through avoided investments in transmission and distribution infrastructure.

Direct, ratepayer-funded spending on energy efficiency, however, is not the only way to encourage improvements in energy efficiency. Advanced building energy codes and appliance efficiency standards can set a high "floor" for the energy efficiency performance of new buildings and equipment. And there are several new opportunities arising in New Jersey to provide a major boost to energy efficiency.

**Regional Greenhouse Gas Initiative -** New Jersey is part of a nine-state initiative to reduce global warming pollution from power plants. Called the Regional Greenhouse Gas Initiative, or RGGI, the program sets limits on the amount of global warming pollution allowed from power plants in the region and enforces those limits through a "cap and trade" system. Under cap and trade, permits (called "allowances") are required for every unit of pollution a power plant releases to the atmosphere. Power plants that produce fewer emissions need fewer allowances, enabling owners to sell the extra allowances to other power plants that find it more difficult or costly to reduce their emissions.

A critical question in the design of programs like RGGI is how emission allowances will be distributed. A program in which 100 percent of the emission allowances are auctioned to electricity generators (instead of given away for free) has the potential to raise a large amount of money for public purposes - including investments in clean energy programs - while not resulting in a significant increase in electricity costs.[66]

It is difficult to predict the amount of funding that would be available to New Jersey should it choose to auction allowances under RGGI. Modeling conducted for the RGGI state working group estimated the cost of carbon dioxide allowances under the program at $1 to $3 per ton.[67] But a more aggressive approach to enforcing the emissions cap that prevents compliance with RGGI through "leakage" of emission reductions via power purchases from other states (for example, importation of more coal-fired power from

Pennsylvania), could yield much higher auction prices in the range of $5 to $11 per ton.[68] With an initial allocation of nearly 23 million tons of carbon dioxide, New Jersey could therefore receive between $23 million and $253 million in annual revenue from allowance auctions.[69] Dedicating a significant portion of this revenue to energy efficiency would address New Jersey's electric capacity problems while, at the same time, reducing the cost of complying with RGGI by curbing demand for power.[70]

**PJM capacity market -** Recognizing that current market policies are not providing the right incentives for investments that would resolve the region's electric capacity problems, PJM has proposed a new system, called the Reliability Pricing Model (RPM), which would reward generation investments designed to improve reliability in the region. The New Jersey Board of Public Utilities (BPU) and the New Jersey Ratepayer Advocate have vigorously opposed the proposed design for RPM, which the BPU claims will increase rates for New Jersey customers with no guarantee that needed capacity improvements will actually occur. Further, the BPU claims that the proposed market design does not provide sufficient incentives for energy efficiency, which is generally the least-cost way to address capacity problems.[71]

A well-designed capacity market could provide a needed boost to energy efficiency by allowing demand-side resources to compete on a par with supply-side resources and ensure that money paid by electricity customers is directed toward solving real, local reliability problems in a least-cost way. PJM's RPM proposal does not meet that standard, but a better designed capacity market could play a role in forwarding the goal of improving energy efficiency in the state.

**Other prospective state policies -** New Jersey has many other opportunities to take full advantage of the benefits of energy efficiency. One option is to set an energy efficiency portfolio standard, similar to the state's existing renewable portfolio standard, that requires a growing share of the state's electricity load to be met through energy efficiency improvements. Such a program has the benefit of delivering assured, minimum improvements in energy efficiency that increase over time and several other states have similar programs in place.[72]

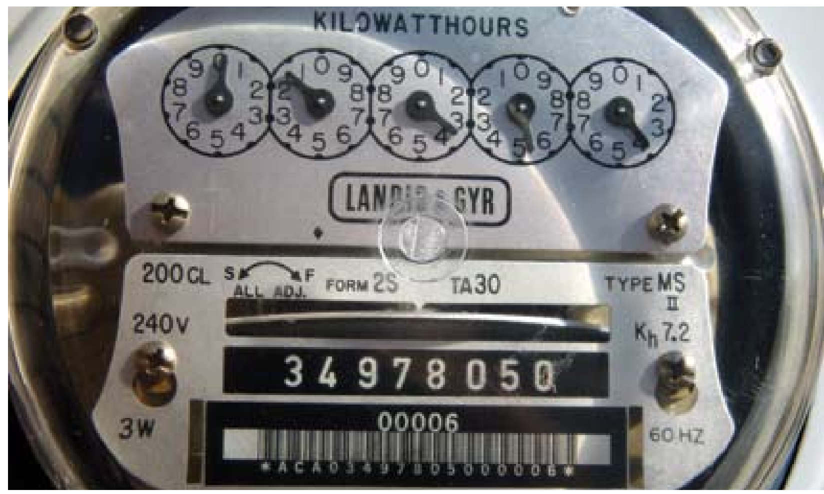
A second option is to modify the state's current system of securing electricity for basic generation service customers (those who have not switched to a competitive electricity supplier). Currently, power for those customers is purchased through an annual auction. However, other states, such as Maine, are now experimenting with allowing demand-side resources to compete with power purchases in similar auctions. In addition, states such as Rhode Island and California now require utilities to develop long-term plans for power purchases that maximize cost-effective energy efficiency improvements when they are less expensive than purchasing power.

Finally, New Jersey can act to "decouple" utility revenues from power sales. Currently, distribution utilities charge for power on a per-kilowatt-hour basis, with the per-kilowatt-hour rate based on an expectation of the revenue needed to serve its customers. However, if the utility sells more power than expected, and does not need to spend a proportional amount of money to maintain its system to serve that added demand, it can claim the additional revenue as profit. Such an arrangement makes it disadvantageous for utilities to support improved energy efficiency. Changing rate structures so that utilities do not face an incentive to sell more power would eliminate a major obstacle to energy efficiency improvements in New Jersey.

# Distributed Generation/Combined Heat and Power

## Potential Peak Demand Reduction: 2,100 MW by 2020

The core of New Jersey's electric reliability problem is that the state as a whole, and areas within the state, do not have enough local generation resources to service demand. As a result, the state must import power from elsewhere and make costly transmission investments to transport that power where it is needed. Distributed generation - generation located at or near the location where power is consumed - is a potentially powerful solution to this problem. In contrast to the traditional model of the electric grid, in which vast amounts of power are produced at giant, central-station power plants and then carried across long distances on transmission wires, distributed generation technologies are small, located nearby (in most cases on a customer's property), and designed mainly to serve that customer's load.




Distributed generation (DG) has several advantages as a source of power supply, perhaps the largest of which being that DG does not require long-distance transmission. Long-distance transmission not only requires expensive investments paid for by ratepayers, but it also results in power "losses" that reduce the energy efficiency of the system as a whole.

There are many types of distributed generation, ranging from stand-by diesel generators to small wind turbines. In this report, we examine the potential impact of two types of distributed generation technologies - combined heat and power and solar photovoltaic power. We will discuss solar photovoltaics in the next section.

Combined heat and power (CHP) technology pairs the production of electricity with the production of heat, which can then be used to power industrial processes or to provide space heating or cooling for homes and businesses. CHP has value both as a source of distributed generation and as an energy efficiency improvement. Central station power plants waste vast amounts of energy by failing to capture the energy value of the steam leaving turbines. While the average American power plant operates at a thermal efficiency of about 35 percent, CHP plants can achieve efficiencies of 80 percent or greater, meaning that more of the energy that goes into the plant is available for useful work.[73]

CHP also has value as a reserve of distributed generation capacity that can be used to reduce peak demand on the grid. New Jersey already has significant CHP capacity, with nearly 3,500 MW installed, representing about 20 percent of the state's electric generating capacity.[74] Indeed, New Jersey is second only to New York among northeastern states in total CHP capacity.

Despite the large amount of CHP already installed in the state, there remains great potential for expansion. The 2004 KEMA, Inc. study cited earlier identified a market potential of approximately 2,100 MW of additional CHP, which could be realized with a reduction of "stand-by" power charges (fees charged to CHP owners to pay for the ability to draw power from the grid when their CHP units are not operational) and an incentive for new CHP of $1/Watt.[75] The total program cost of achieving that penetration of CHP was estimated at $662 million, which, if divided equally over a 13-year period from 2007 through 2020, amounts to approximately $51 million of today's dollars per year.

While the public cost of CHP development might appear to be high, CHP pays back some or all of those costs in reduced spending for new generation and transmission infrastructure. Nor is avoided infrastructure investment the only avoided cost - deployment of CHP would likely reduce the need for incentive payments to generators to provide additional capacity under PJM's proposed capacity market as well as other power system costs.

New Jersey has already adopted significant incentives for new CHP applications, but the current state program does not have enough funding to provide support to all the businesses that wish to install CHP. Because of the lack of funding, the state has done little to promote its CHP incentives, meaning that the current state effort barely scratches the surface of the potential for CHP installations in New Jersey. By combining additional incentives, more aggressive promotion of CHP as a clean energy strategy, and utility and regulatory policies that encourage CHP, New Jersey can ensure that the state achieves its full potential for CHP development. The state should also continue to ensure that CHP development does not harm local air quality by requiring state-of-the-art emission controls on distributed generation equipment and ensure that it enhances the state's energy objectives by enforcing minimum energy-efficiency standards.

Beyond commercial and industrial CHP applications, which are already common, new forms of distributed generation hold promise for reducing demand for power from large power plants in the future. Small-scale CHP and distributed generation technologies, such as would be suitable for residential or small commercial use, could play an important role in improving the energy efficiency of home and small business energy use in New Jersey in the decades to come. Similarly, fuel cells, which use an electrochemical process to convert hydrogen fuel into electricity, could also provide efficiently produced local electricity to customers of all sizes. New Jersey should encourage the development of these newer distributed generation technologies.

## Solar Photovoltaics

### Potential Peak Demand Reduction: 750 MW by 2020

Solar photovoltaic panels provide an ideal solution to many of New Jersey's energy problems. They are generally sited on rooftops or elsewhere in close proximity to where power is used, thus reducing demand for centrally generated power. They provide the most electricity during the exact times when electricity demand tends to be highest - on hot, sunny summer afternoons. And they produce no global warming pollution.

The major drawback of solar panels is that they are expensive. But that is changing. Prices have declined at an average rate of about 4 percent per year over the last 15 years.[76] And while a worldwide shortage of silicon has kept prices relatively high over the last two years (a result of silicon supplies being unable to keep up with skyrocketing global demand for solar power), the addition of new silicon supply capacity will likely relieve the shortage within the next two years and manufacturers are working on improved designs that reduce the need for silicon.[77] As a result, solar panel prices should soon continue their long-term downward trend.

But solar power provides much more value than a reduction in homeowners' electricity costs. Because it is distributed and provides power at peak times, solar photovoltaics provide benefits in reduced system costs of $3,500 to $6,000 per kW.[78] The scale of these benefits means that aggressive public policies to promote solar power - such as New Jersey's market and rebate-based system to compensate homeowners and businesses who install solar panels - are worthwhile.

New Jersey's revised renewable portfolio standard (RPS) calls for solar power to provide 2.12 percent of New Jersey's electricity by 2020-21.[79] The BPU estimates that this will translate into approximately 1,500 MW of solar power by 2020.[80]

The key question with regard to electric power system reliability is how much fossil fuel-fired generation solar power can reliably supplant. As with other renewable resources, like wind, solar power is an "intermittent" resource, meaning that solar panels generate power only when the sun is shining. The good news for New Jersey is that the availability of power generated by solar panels matches up very well with times of peak demand. Solar power in the northern half of New Jersey generally has an effective load carrying capacity - or capacity value - of 50 to 70 percent, assuming relatively low penetration of solar panels (less than 10 percent of utility peak electricity production).[81] Assuming that solar panels installed under New Jersey's RPS are able to reliably replace 50 percent of the capacity of a fossil-fuel power plant, the state could avoid 750 MW of peak demand on the electricity system by meeting the state's RPS goals.

New Jersey can help ease the path toward compliance with the RPS by enacting a series of policies that encourage solar power development. New Jersey should require builders to offer solar power (including both photovoltaics and solar hot water heating) as an option to new homebuyers and exempt renewable energy technologies from property tax assessment. In addition, the state can encourage - through financial incentives or other means - the construction of "zero-energy" homes, which combine advanced energy efficiency technologies with small-scale renewable power production to achieve dramatically reduced consumption of fossil fuels.

## Wind Power

### Potential Peak Capacity Increase: 350 MW by 2020

In addition to solar power, New Jersey also has the ability to replace some of its retiring electric generation with wind power. Like solar energy, wind power is renewable and pollution-free. Unlike solar, however, wind power is not a distributed resource (with the exception of small-scale wind turbines) and power supply is generally not as well-matched to utility peak loads.

Still, wind power has great potential to reduce New Jersey's dependence on fossil fuel and nuclear power generation. New Jersey has modest potential for wind power development on land - particularly in the Highlands and along the Jersey Shore. But there is greater potential by far for offshore wind development.

New Jersey's offshore wind potential is immense. A recent assessment of offshore wind energy potential in New Jersey identified 1,233 square nautical miles of offshore area that is "conditionally viable" for wind power development. With power densities of 20 MW per square mile, the total amount of nameplate generating capacity that could be developed off New Jersey's shore could theoretically exceed that of all the current fossil and nuclear power generators in the state.[82] Even greater potential exists in deeper waters and far offshore areas that have consistent, strong winds, but are not technologically feasible for wind power development at present.[83]

As noted above, utility-scale wind is not a distributed resource, and therefore relies on the transmission network to carry electricity from the place where it is generated to the locations where it is used. Fortunately, New Jersey's offshore wind resource is located in close proximity to existing transmission infrastructure. The Jersey Shore area already features a transmission network built to carry power from the Oyster Creek nuclear power plant and the B.L. England fossil fuel plant - both of which are expected to retire over the next few years. The 2005 wind resource study referred to above found that the region's transmission network already has sufficient capacity to bring a significant amount of offshore wind power onto the grid.[84]

Wind, like solar power, is an intermittent resource. Unlike solar power, which makes its greatest contribution to the grid on hot, sunny days, wind power generation is not well-correlated to periods of peak demand. However, properly sited wind power can make a contribution to meeting New Jersey's peak capacity needs. PJM currently assigns new wind projects an initial "capacity credit" of 20 percent, meaning that 10 MW of wind power capacity offsets 2 MW of fossil fuel capacity.[85] For any wind project, detailed studies are needed to determine the effective contribution of the wind farm to the reliability of the grid.

The prospect of large-scale offshore wind power development has raised some concerns about its potential impact on Jersey Shore recreation and on wildlife. A blue-ribbon panel review of New Jersey offshore wind issues completed in 2006 concluded that there is insufficient data to fully assess the impact of offshore wind in New Jersey and recommended the construction of one test wind farm, with a capacity of no more than 350 MW, which could be used to study the impacts of offshore wind power development. Given the timeline set out by the blue-ribbon panel for approving an initial test project and studying its impacts, it is unlikely that the test wind farm could commence operation earlier than 2009 and that any additional wind farms could be built sooner than 2013-2014.[86]

In this analysis, we assume that a 350 MW wind farm is built off the New Jersey shore in 2009 and - provided that concerns about tourism and wildlife impact are addressed - that subsequent wind farms of similar size are built every two years beginning in 2014, for a total of 1,750 MW of wind capacity by 2020. Assuming that each megawatt of wind power alleviates the need for 0.2 MW of additional fossil fuel generation or transmission capacity, wind power development at this level would add 350 MW to New Jersey's peak generation capacity in 2020.

It is important to note that, beyond its contribution to meeting peak demand, wind power reduces the need for fossil fuel generation throughout the year, helping to contribute to New Jersey's compliance with the Regional Greenhouse Gas Initiative goals for carbon dioxide emission reductions and New Jersey's renewable portfolio standard. Land-based wind resources can also contribute to achieving these goals.

New Jersey should solidify its commitment to wind power - including offshore wind power - by adopting a "carve-out" for in-state wind resources in the state's RPS, similar to the carve-out for solar power. Such a provision would require that New Jersey begin to tap its own wind resource, rather than relying on imports of renewable energy from elsewhere.

## Demand Response

### Potential Peak Demand Reduction: 850 MW by 2020

Utilities have long recognized that encouraging industries to shift their electricity demand away from peak periods can reduce the need for expensive peak power production. Utilities have devised a variety of programs to achieve these peak load reductions, including "interruptible power" contracts and programs to allow facilities to receive financial rewards if they curtail their demand during periods of strain on the electric grid.

PJM currently operates two demand-response programs: an emergency load response program, in which electricity users can opt to have their electricity service curtailed (with compensation) during times of extreme stress on the grid, and an economic load response program in which consumers can offer to curtail their load on a day-ahead or real-time basis.[87] As of 2005, 32 MW of load in New Jersey took part in PJM's emergency program, while another 174 MW took part in the economic load reduction program.[88]

The participation of New Jersey companies in demand response programs barely scratches the surface of the potential. Currently, participation in PJM's load management programs amounts to just over 1 percent of New Jersey's peak summer load. However, load management programs in other states have succeeded in reducing peak load by as much as 3 percent. [89] And PJM Interconnection believes that as much as 7.5 percent of peak load could be reduced through load management strategies.[90] New Jersey should take a more aggressive role in promoting participation in PJM's demand response programs - both through outreach to businesses and by helping businesses purchase and install the advanced meters needed to participate in the demand response program.

A newer tool for encouraging demand reduction at peak times is real-time pricing. Unlike traditional utility rates, which charge a given price for power regardless of when it is consumed, real-time rates pass on the marginal cost of producing power directly to consumers. That is, at peak periods, when the price of power on wholesale markets can increase dramatically, consumers face very high prices and therefore have a financial incentive to reduce their electricity consumption. Real-time pricing can also be a boon to those who install solar panels, which tend to provide more power at times when electricity prices are at their highest. Real-time pricing is currently the default option for large industrial and commercial consumers in New Jersey who have not contracted with alternative suppliers.[91]

Real-time pricing, however, is not a panacea for a number of reasons. First, the large industrial and commercial consumers who are currently exposed to real-time prices in New Jersey are among those most likely to switch to alternative electricity providers. One of the main motivations to switch to alternative providers is to achieve stable, long-term prices for electricity. Many commercial and industrial establishments may opt for certainty in electricity prices over the prospect of saving money through judicious management of their electricity use that would be required under real-time pricing.

Second, the degree to which real-time pricing works to achieve significant reductions in demand - even for those large industrial and commercial customers who would be most likely to have the sophistication necessary to manage their electricity loads - is questionable. A 2005 study of eight real-time pricing programs found that many commercial and industrial customers do not respond vigorously to higher prices for electricity at peak periods. This is particularly likely to be the case when consumers find out electricity prices only after the fact rather than being quoted a "day-ahead" price for the power they will consume.[92]

Third, there are concerns about whether real-time pricing can and should be extended to residential consumers. Pilot real-time pricing programs in California and Illinois have shown that residential consumers do respond to higher prices at peak periods, leading to significant reductions in peak demand and also to lower electricity bills.[93] Low-income residents were among those that were able to shave their electricity bills, but more study is needed to ensure that real-time price signals won't encourage behavior among low-income and fixed-income residents (such as turning off air conditioners on extremely hot summer days) that could jeopardize their health. Also, the cost of real-time meters and the infrastructure for adjusting electricity prices needs to be factored into any evaluation of the costs and benefits of real-time pricing.

Based on the previous experience of successful load management programs, we can expect that an aggressive demand response effort could shave projected peak load at least by 3 percent.[94] Because such programs require few investments in physical infrastructure (with the exception, perhaps, of advanced meters), we assume that the 3 percent load reduction can take place relatively quickly. Even greater reductions may be possible in the future.

## Other Issues in System Reliability

### Non-peak Demand

To this point, this discussion has revolved around what New Jersey needs to do to ensure that it has adequate generating and transmission capacity to serve periods of peak electricity demand. However, the loss of the Oyster Creek and Salem nuclear plants, along with several fossil fuel fired generators, also reduces the amount of relatively inexpensive "baseload" power available to New Jersey at all periods.

Several of the measures put forth in this analysis - particularly energy efficiency improvements and combined heat and power - have the potential to reduce demand for electricity at all periods, not just those of peak demand. While solar power will have less of a role to play in meeting winter electricity demands (or demand at night), wind power tends to provide more electricity in the late fall and winter when wind speeds are higher.[95]

In sum, while the primary economic justification for implementing many of the clean energy solutions in this report is to address peak demand, many of these solutions can also reduce the need for power at other times of the year.

### Voluntary Actions

One important energy-saving tool that has not yet been addressed is the potential impact of voluntary actions to reduce energy consumption and take advantage of clean energy sources. Voluntary efforts - particularly those encouraged through public education efforts - have the potential to make a big impact on energy consumption patterns during times of crisis. For example, the energy crises of the 1970s prompted massive changes in individual behavior. The U.S. Department of Energy estimated that changes in behavior by residential energy consumers (e.g. lowering thermostats) saved 1 quadrillion BTUs, or about 6 percent of what residential energy consumption would have been in 1986 without conservation measures.[96]

Effective action by government and the private sector can encourage voluntary actions in response to power supply challenges. In 2000 and 2001, for example, California experienced an energy crisis driven, in large part, by manipulation of the state's power markets. The state experienced rolling blackouts and the price of power, particularly on the wholesale market, skyrocketed.

Heading into the summer of 2001, analysts predicted widespread rolling blackouts in California. The state responded by launching an aggressive drive to encourage improved energy efficiency and voluntary conservation of energy. The effort included a massive public education effort, reductions in peak demand at government facilities, a program that provided consumers who cut back their energy use by 20 percent or more with a 20 percent rebate on their summer 2001 electricity bills, and a host of other measures. The effort reduced peak demand during the summer of 2001 by 10 percent compared to the summer before, and the state achieved its goal of avoiding further rolling blackouts.[97] Moreover, many of those energy savings persisted into 2002 after the immediate crisis ended.[98] California's success in curbing energy use can be attributed, to some degree, to the extraordinary conditions California consumers faced during the energy crisis - conditions New Jersey should not hope to replicate. Still, the California example demonstrates that it is possible, with strong leadership from government, to achieve significant reductions in power consumption through voluntary efforts within a very short period of time.

New tools, such as New Jersey's Green Power Choice program, also give individuals and businesses the ability to purchase renewable energy products. More than 6,000 New Jersey residents and businesses now take part in the program, through which customers can choose to purchase power generated from renewable resources in the mid-Atlantic region.[99]

In addition, individuals can help support clean energy solutions through work in their communities. Ensuring that new municipal buildings and schools are built to high energy efficiency standards, supporting community-scale wind projects and other activities can make a contribution to reducing dependence on fossil and nuclear power in New Jersey.

## Natural Gas Efficiency

New Jersey's electricity and natural gas markets are closely related. Dual-fuel (generally oil and natural gas) and natural gas power plants account for 50 percent of New Jersey's electric generating capacity and natural gas-fired generation accounted for 28 percent of the electricity produced in New Jersey in 2004, second only to nuclear power.[100] Natural gas-fired generation often sets the wholesale price of electricity in the PJM region and rising natural gas prices have been a key driver of higher electricity prices in New Jersey and beyond.[101]

The closure of three of New Jersey's four nuclear power plants, along with the scheduled closure of 475 MW of coal and oil-fired generation at the B.L. England power plant, could leave New Jersey even more dependent on natural gas for electricity. For instance, while combined heat and power is energy efficient, most CHP applications use natural gas as a fuel. Using CHP as a replacement for coal, oil and nuclear-fired power plants, therefore, would lead to a net increase in the state's dependence on natural gas for electricity generation.

For these reasons, it is critically important that New Jersey adopt strong energy efficiency strategies to reduce natural gas use in other sectors of the state's economy. As is the case with electricity, there is vast potential within New Jersey to use natural gas more efficiently. In its 2004 study, KEMA estimated that New Jersey has the economic potential to save nearly 1.4 billion therms of natural gas by 2020 through improved energy efficiency, primarily in homes.[102] These savings represent about 22 percent of the natural gas used for all purposes in New Jersey during 2004, a level of savings consistent with Gov. Corzine's commitment to reduce natural gas consumption by 20 percent by 2020.[103]

By taking advantage of New Jersey's cost-effective potential for natural gas savings, the state can ensure that it has adequate supplies of natural gas for heating, industrial use and electricity generation and insulate itself to a certain degree from price volatility in natural gas markets.

## Continued Technological Advances

Current assessments of the potential for New Jersey to save energy and make use of efficient and renewable resources do not take into account the potential for technological advances and for new ways to combine the benefits of various clean energy solutions. Each of the clean energy solutions described above represents a measure for which technology exists today. New Jersey should also ensure that the state is able to take advantage of continued technological advances in a variety of areas.

### Updated Energy Efficiency Codes and Standards

New technologies continue to come onto the market that can improve the energy efficiency of equipment and buildings. To ensure that these technologies find their way into New Jersey's markets quickly, the state should continually upgrade its energy codes for residential and commercial buildings and adopt new standards for appliance and equipment efficiency as those technologies improve. While New Jersey is in the process of updating its building codes to the most recent international model building energy codes, the state should develop codes that achieve energy savings of at least 15 percent compared with the current international model code. The state should also adopt energy efficiency standards for 14 household and business appliances, a move that would reduce peak electricity demand by 222 MW in 2020.[104]

### Low-Energy and Zero-Energy Buildings

Energy efficiency and renewable energy technologies can work together powerfully when combined in new construction. Smart building design can reduce energy needs by incorporating energy efficient technology with "passive solar" heating and lighting and small-scale renewable energy production through solar panels or geothermal heat pumps. New homes billed as "zero-energy" homes are being built in California and the trend toward "green building" has shown that commercial buildings can use many of the same approaches to achieve dramatic reductions in energy use. The U.S. Conference of Mayors and the American Institute of Architects have set a target of reducing fossil fuel use in the construction and operation of new buildings by 50 percent by 2010, with additional 10 percent reductions in fossil fuel use every five years beyond then.[105] While New Jersey should continue to set a high "floor" for new construction through strong building energy codes, it should also provide support - particularly through new government construction projects like schools - to raise the ceiling for the level of energy efficiency that can be achieved in new construction.

### New Sources of Renewable Energy

Wind, solar and biomass energy are the mainstays of New Jersey's renewable energy economy and will likely remain so for the foreseeable future. However, New Jersey should continue to evaluate and, if appropriate, promote new types of renewable energy development. For example, tidal and wave energy have tremendous theoretical potential as a renewable energy source. A 10 MW tidal energy facility is in the process of being installed in New York City's East River. Provided that tidal or wave energy can be demonstrated to be compatible with marine preservation efforts, the forces of ocean waters could become an important source of energy for New Jersey in the future.

# NEW JERSEY CAN USE CLEAN ENERGY TO REPLACE OYSTER CREEK AND SALEM

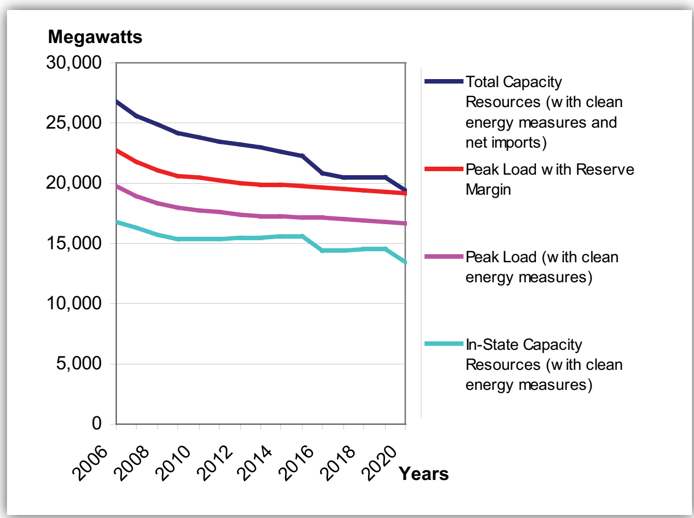
By focusing on clean energy solutions, New Jersey can ensure the reliability of its electricity system even with the closure of the Oyster Creek and Salem nuclear power plants and fossil fuel-fired power plants.

The first step is to reduce the demand for electricity provided through the region's electricity grid. Taking full advantage of the state's cost-effective energy efficiency potential, making a strong effort to take advantage of New Jersey's potential for distributed generation, and aggressively promoting demand response measures can ease the strain on the power grid and reduce New Jersey's reliance on power imported from other states.

The second step is to replace retiring generation, to the extent possible, with clean, renewable resources like wind power.

By 2020, using this collection of measures, New Jersey could cut its peak demand for electricity from the transmission grid by approximately one-third compared with projected levels. And by moving forward with offshore wind power at a judicious pace, the state could add an additional 350 MW of peak capacity resources to the state's electricity mix. (See Fig. 7.)

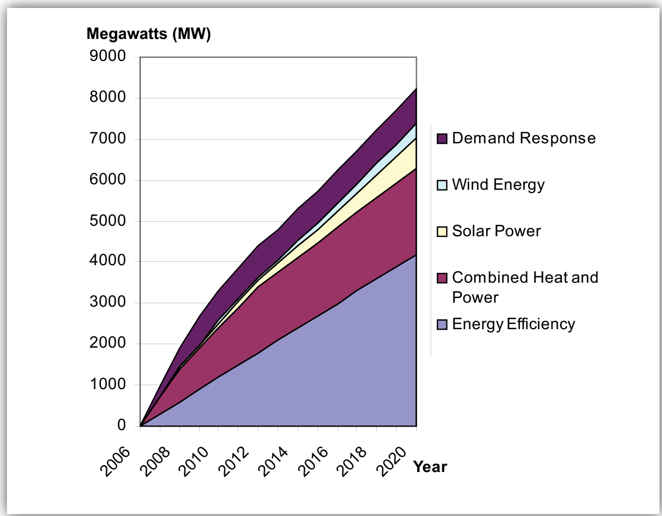
**Fig. 7. Peak Demand and Capacity Resources in New Jersey, with Clean Energy Measures**[106]




The result is that, by 2020, New Jersey will still have access to enough power in the aggregate to support system reliability. Moreover, the state would do so despite declining reliance on imports of power from out of state.

Energy efficiency improvements make the largest contribution to addressing New Jersey's electric reliability challenges, with combined heat and power also making a large contribution. Solar and wind energy, while they play relatively small roles in addressing New Jersey's short-term capacity issues, are technologies with a great deal of potential for providing for the state's long-term electricity needs.

Fig. 8. Contributions to Peak Demand Reduction/Additional In-State Capacity




## Conclusions and Recommendations

Based on the analysis above, we can conclude that clean energy solutions have the potential to replace generation from the Oyster Creek and Salem nuclear power plants, as well as other fossil fuel-fired power plants that are scheduled for retirement.

This is not to say that replacing power from Oyster Creek and Salem will be easy. In particular, the state faces an urgent upcoming deadline with the scheduled closure of Oyster Creek in 2009. As a result, the state must take several urgent short-term actions:

- New Jersey should encourage increased participation in PJM load management programs. As noted above, just over 1 percent of New Jersey's peak summer load is currently subscribed in PJM's existing load management programs. The state should seek to boost this figure significantly over the next two years by educating businesses about the benefits of participation, identifying barriers to participation, and implementing strategies to overcome those barriers (for example, by assisting businesses in the purchase of the advanced meters necessary for participation in the program).

- New Jersey should increase support for deployment of combined heat and power. New Jersey businesses have expressed strong interest in combined heat and power and distributed generation technology. Demand for state assistance far exceeds availability. The prospect of using revenues from the sale of carbon emission allowances under RGGI (beginning in 2009) could provide a good long-term source of support for CHP and DG initiatives, but the state should immediately increase its efforts to address the pent-up demand for CHP and DG.

- New Jersey should educate the public about the need for voluntary energy conservation by citizens and businesses. The state should begin to prepare the public for the retirement of Oyster Creek in 2009, and encourage peak load reductions by citizens and businesses.

- The state should work in concert with PJM and the state's utilities to identify any local reliability problems that would result from the closure of Oyster Creek and to develop least-cost strategies to mitigate those problems. The closure of Oyster

Creek need not cause long-term problems for New Jersey if the state adopts a clean energy strategy. But it may cause short-term challenges. Investing hundreds of millions of ratepayer dollars in major, permanent transmission upgrades may not be a sensible response to those short-term challenges. Instead, state officials should work creatively with PJM and utilities to identify least-cost approaches to reducing power supply challenges after the retirement of Oyster Creek.

Some may suggest that it would be easier to allow Oyster Creek to run for a couple of additional years beyond its 2009 license expiration in order to smooth New Jersey's transition to a clean energy system. However, this is not a realistic option. Should the Nuclear Regulatory Commission approve Oyster Creek's license extension, the plant will be licensed to operate for another ***20 years***, until 2029. Once that license extension is approved, there is little to nothing that New Jersey can do to force the plant's early closure. By making the necessary short-term effort to reduce power demand and address any reliability issues that would result from the closure of Oyster Creek, New Jersey can avoid continued long-term dependence on an outdated nuclear power plant that poses major environmental and public safety concerns.

In addition to planning for the retirement of Oyster Creek, New Jersey should also use its ongoing Energy Master Plan process to design a clean energy strategy that would allow for the orderly retirement of both Oyster Creek and Salem without impacts on the reliability of the state's electric system. New Jersey should pursue efforts in four areas:

## Energy Efficiency

- ✪ Adopt an Energy Efficiency Portfolio Standard that will require the state's utilities to achieve significant and increasing energy savings over time.
- ✪ Renew and double funding for the state's energy efficiency and renewable energy programs through the societal benefits charge.
- ✪ Set aggressive standards for energy efficiency in new homes and commercial buildings and in common appliances and equipment.
- ✪ Require homes on the market to be rated for energy use so that homebuyers and homeowners can evaluate the energy efficiency of their properties.
- ✪ Properly implement the regional cap and trade program for power plant pollution (the Regional Greenhouse Gas Initiative) by charging generators for all pollution credits and investing that income into programs that reduce electricity consumption, including energy efficiency and combined heat and power.

## Combined Heat and Power

- ✪ Rapidly expand deployment of combined heat and power through the continuation and expansion of current subsidies and more aggressive marketing of the program. Also, remove any remaining hurdles to utility interconnection of combined heat and power systems.

## Renewable Energy

- ✪ Encourage the development of wind power off New Jersey's coast, including through the creation of a wind "carve-out" in the state's RPS.
- ✪ Require developers to offer solar energy systems, including solar thermal energy,

as an option for all new homes and exempt renewable energy systems from property tax assessment.

- ✪ Make New Jersey state government a leader by increasing the energy efficiency of state buildings and expanding government purchases of renewable energy.

## Demand Response

- ✪ Encourage participation in demand response programs, which reward large power users for curtailing energy use during periods of peak demand.

Because of the limited scope of this analysis, we cannot conclude that no transmission or generation investments will need to be made in New Jersey over the next decade and a half with the retirement of Oyster Creek and Salem. We did not attempt to undertake load flow modeling of the New Jersey electricity system in this analysis. As a result, the closure of specific generating units could lead to the need for improvements of specific transmission lines. Moreover, the closure of specific units could increase transmission congestion or reduce the availability of low-cost generating resources - both of which could have an impact on the price of electricity in New Jersey. Finally, unexpected events - such as the retirement of additional fossil fuel generators or greater-than-projected load growth - could put additional strain on the state's electricity grid in the years to come.

However, the types of measures proposed here will tend to minimize the need for new investments in the transmission system. Combined heat and power, solar power, energy efficiency and demand response are all distributed resources - that is, they tend to lessen demand on the power grid by reducing power consumption and generating more electricity locally. Even offshore wind - which does require some additional transmission capacity - is well situated to take advantage of the existing transmission network within New Jersey.


A transition away from nuclear power and toward cleaner and safer sources of energy is possible. New Jersey's ability to use clean energy to preserve the reliability of its electricity system depends critically on the decisions and investments made by state officials over the next several years and a long-term commitment to clean energy in the state. New Jersey has already made tremendous progress, committing to a landmark initiative to promote solar power in the state and making great progress on issues like energy efficiency and combined heat and power.

Now, with state officials developing an energy master plan, the state has the opportunity to ensure that New Jersey can safely retire its existing nuclear plants, while avoiding increases in pollution and putting the state on a path toward a clean energy future.

# METHODOLOGY AND SOURCES

## Boundaries Of The Analysis

The data and analysis presented in this report relate to New Jersey's three largest utilities: Atlantic City Electric, Jersey Central Power and Light (JCP&L), and Public Service Electric and Gas (PSE&G). Rockland Electric, which is connected to the New York State electric grid and is not interconnected with the rest of the New Jersey electric system, was excluded from this analysis.

## Load Projections

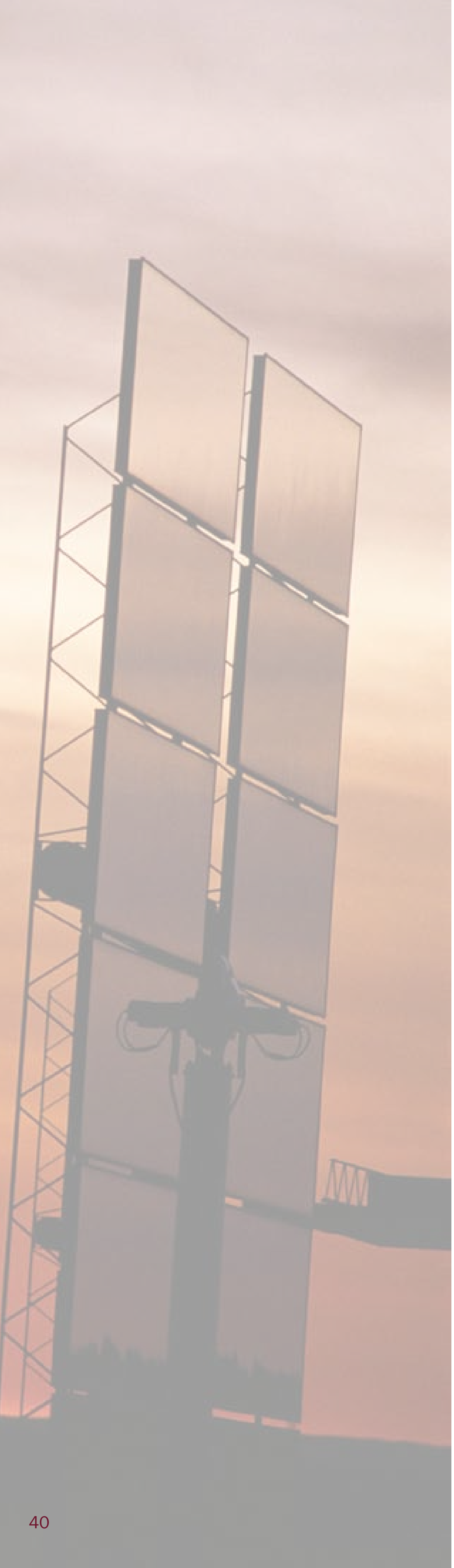
Projections of peak load in three of New Jersey's four major utility service territories are based on non-coincident peak load projections from PJM Interconnection, ***PJM Load Forecast Report,*** January 2007.

## Projected Capacity Resources

Estimates of current generating capacity in New Jersey were based on data from U.S. Department of Energy, Energy Information Administration, ***EIA-Form 860 Database*** for year 2005, downloaded from www.eia.doe.gov, 13 December 2006. To arrive at our baseline estimate for generating capacity in 2006, we excluded all units indicated in the EIA database as having already been retired from service. We excluded units indicated as having retired during 2006, per PJM Interconnection, ***Generator Deactivations (as of October 23, 2006)***, undated. We also excluded approximately 1,200 MW of small cogeneration and combined heat and power resources that are listed in the Form 860 database, but which did not appear in PJM's list of capacity resources for the region per PJM Interconnection, ***2006 PJM Load, Capacity and Transmission Report,*** 24 October 2006. Finally, we added capacity from units scheduled to initiate operations during 2006, per PJM Interconnection, ***Generator Interconnection Request Queues***, downloaded from www.pjm.com/planning/project-queues/queue-gen-active.jsp, 29 January 2007.

Anticipated generation retirements were based on PJM Interconnection, ***Future Deactivations (as of January 3, 2007),*** undated. Four generating units identified by PJM as scheduled for retirement, totaling 182 MW in capacity, were not able to be identified in the EIA Form 860 database. As a result, estimates of current and future generation capacity may be overstated by that amount. To estimate the impact of future retirements, we assumed that units listed by PJM as scheduled to retire would retire on the date listed in the Future Deactivations document. For the three nuclear units, we assumed that each would retire at the expiration of its operating license: Oyster Creek in 2009, Salem unit 1 in 2016 and Salem unit 2 in 2020.

Our assumptions for New Jersey's capacity to import power from other states at times of peak demand were based on average net power flows between New Jersey utilities and neighboring states during the five hours of peak demand in 2006. The data were provided by PJM via an Excel file, which is available at oasis.pjm.com/indexmain.html, under Special Notice, 1/26/07. We assumed that New Jersey would retain access to the approximately 6,000 MW of net power import capacity over PJM's 500kV transmission network that it received during peak periods in 2006. We assumed that New Jersey would experience declining imports from neighboring utilities in Pennsylvania (assumptions are described in the text of the report) and that net imports from New York ISO at periods of peak demand would cease in 2007.



New proposed generation additions in New Jersey were estimated to be 12.4 percent of the amount of new generation currently in PJM's generator interconnection queue for New Jersey. The 12.4 percent figure was based on the ratio of generation capacity completed or under construction versus total amount of generation capacity proposed from 1997 to present from PJM Interconnection, ***PJM RTO as of October 30, 2006, Megawatt Summary by Queue Letter***, 30 October 2006. Total proposed generation was derived by summing the capacity of generators listed for New Jersey in PJM Interconnection, ***Generation Interconnection Request Queues***, downloaded from www.pjm.com/planning/project-queues/queue-gen-active.jsp, 29 January 2007. Proposed generators were assigned to utility service areas based on the location of the PJM substation intended to serve them. Projected in-service dates were based on projections from PJM.

## Estimated Impact Of Clean Energy Measures

The estimated peak capacity impact of the clean energy measures was estimated in the following ways.

### Energy Efficiency

We assumed that New Jersey could achieve the economic energy efficiency potential described in KEMA, Inc., ***New Jersey Energy Efficiency and Distributed Generation Market Assessment***, final report to Rutgers University Center for Energy, Economic and Environmental Policy, August 2004. We assumed that peak electricity demand would be reduced by 4,186 MW in 2020, with the reductions achieved linearly between 2007 and 2020.

### Combined Heat and Power

We assumed that New Jersey could achieve the market potential for CHP laid out in the accelerated case of KEMA, Inc., ***New Jersey Energy Efficiency and Distributed Generation Market Assessment***, final report to Rutgers University Center for Energy, Economic and Environmental Policy, August 2004. Phase-in of combined heat and power was assumed to be roughly that developed by KEMA in its accelerated case.

### Solar Power

Assumed solar power installations were based on the assumption that New Jersey would need to install approximately 1,500 MW of solar photovoltaic capacity by 2020 to comply with the solar provision of New Jersey's renewable portfolio standard, with solar capacity phased in at the rate described in the state's renewable portfolio standard, N.J.A.C.14:8-2.1 et seq. (2006). For capacity purposes, we assumed that solar photovoltaics would have a peak capacity value equal to one-half their rated capacity, which is lower than the effective load carrying capacity of most solar applications in New Jersey, based on Richard Perez, ***Determination of Photovoltaic Effective Capacity for New Jersey,*** undated.

## Wind Power

Estimates of offshore wind power deployment are based on installation of a 350 MW pilot wind farm off the New Jersey coast in 2009, followed by installations of additional 350 MW wind farms every two years beginning in 2014, for total offshore wind deployment of 1,750 MW in 2020. This amount of wind power is well within the market potential for offshore wind under a high incentive scenario as determined by Navigant Consulting, Inc., et al., ***New Jersey Renewable Energy Market Assessment***, final report to Rutgers University Center for Energy, Economic and Environmental Policy, 2 August 2004.

## Demand Response

We assumed that demand response efforts would be capable of diverting 3 percent of peak load to non-peak periods, well within the range of achievable peak load reduction identified in G. Barbose, C. Goldman, et al., Lawrence Berkeley National Laboratory, ***Real Time Pricing as a Default or Optional Service for C&I Customers: A Comparative Analysis of Eight Case Studies,*** August 2005.

## Combined Impact of Clean Energy Strategies

In assessing the combined impact of clean energy strategies, we assumed that the peak load reductions achieved by each of the strategies were additive. We also treated distributed generation (combined heat and power and solar) as reductions in system load, not as capacity resources.

## Oyster Creek Nuclear Power Plant Fact Sheet

Oyster Creek Nuclear Generating Station is the nation's oldest operating nuclear power plant. The plant's obsolete design, aging components, environmental impacts, and location in the state's fastest-growing county make it a poor choice for serving New Jersey's energy needs. Yet the plant's owner, Exelon Corporation, has filed an application to extend the plant's license for another 20 years, to 2029.

For many reasons, Oyster Creek should be retired at the end of its current 40-year license in 2009.

### Oyster Creek Generates Hazardous Radioactive Waste

- As of 2002, the last year for which data is available, Oyster Creek had created 403.5 metric tons of radioactive waste since it began operations in 1969.[107] If its license is renewed, it will produce another 330 metric tons of nuclear waste before it retires, assuming waste continues to be generated at the same rate.[108]

- This nuclear waste will remain in New Jersey, at the Oyster Creek plant, indefinitely, where it will pose a continuing attractive target to terrorists and threat to public health. (See below.)

- In the long run, the United States plans to move radioactive waste from nuclear power plants to a central location, currently designated as Yucca Mountain in Nevada. But transporting the waste out of New Jersey poses its own threats to public safety.
  - According to current plans, nuclear waste would be transported through New Jersey's most densely populated areas, with trucks carrying waste along roadways like I-287 and I-80, trains passing through Newark, and barges traveling along the Jersey Shore.[109]
  - Accidents in the transportation of nuclear waste are inevitable. The U.S. Nuclear Regulatory Commission estimates that about 19 trucks and 21 trains carrying radioactive waste nationwide would be expected to have accidents en route to Yucca Mountain.[110] Groups opposed to the plan have estimated numbers as high as 130 truck accidents and 440 accidents on rails.[111]
  - Waste shipments would continue through New Jersey for 38 years or more.[112] And Yucca Mountain is unlikely to have enough capacity to store all the waste likely to be generated by nuclear power plants over the next couple of decades, meaning that some waste could remain in New Jersey for a long period of time.[113]

### A Terrorist Attack On Oyster Creek's Fuel Pond Could Kill Thousands

- Oyster Creek stores most of its radioactive waste in a pond on the top floor of the reactor building, with only a tall metal structure above it, which is not designed to withstand a plane crash.[114]

- Should coolant be lost from the spent fuel pool - as a result of human error, natural disaster or terrorist attack - the spent fuel could catch fire, dispersing radioactivity over a large area. A recent study estimated that number of cancer deaths that would result from such an incident at 1,900 to 5,700, with economic costs of $100 billion to $370 billion.[115]

- A 2006 National Academy of Sciences found that spent fuel ponds pose a risk to public health and national security in the event of a terrorist attack. According to the report, if an attack leads to a fire, "it could result in the release of large amounts of radioactive material." It concluded that "successful terrorist attacks on spent fuel pools, though difficult, are possible."[116]

## Operation Of Oyster Creek Poses A Risk To Public Health

Oyster Creek is the nation's oldest operating nuclear power plant. Serious concerns have been raised about age-related degradation of critical safety components at the plant.

- The plant's design, now prohibited from construction, may not be able to prevent the escape of radiation during a meltdown. A study by Oyster Creek's owners estimated the potential for containment failure at the plant in the event of a meltdown to be 74 percent.[117]

- The reactor has experienced corrosion of its steel containment shell to within 0.07 inches of critical safety margins.[118]

- In 2004, the Nuclear Regulatory Commission found that Exelon, the company that owns the plant, did not prevent the failure of a cable providing power to two back-up generators during the previous year despite the fact that the same cable failure had occurred twice before.[119] Back-up generators are crucial to plant safety because they take over emergency operations at the plant when a blackout occurs.

- In 1979, Oyster Creek came close to suffering a severe accident when the plant once responded to a sudden change in the reactor's cooling system, known as a "transient," in a way that violated protocol and only made the problem worse. The result was a dangerous loss of coolant from around the reactor core, which, under different circumstances, could have led to a severe accident.[120] Only three other occurrences of this serious problem are known to have occurred, during the Three Mile Island accident in 1979, at the Davis-Besse plant in Ohio, and the Pilgrim plant in Massachusetts.[121]

## Evacuation Would Be Virtually Impossible

In the event of an accident at Oyster Creek, evacuation of the surrounding area would be slow and difficult, due in part to rapid population growth in the area around the plant over the last four decades. Yet, the NRC does not consider the feasibility of future evacuation in its plant relicensing decisions.

- Evacuation of the area around Oyster Creek could take more than nine hours, not nearly fast enough to protect the public in the event of a fast-moving nuclear accident.[122] And that assumes that the evacuation goes as planned.

- The evacuation plan for Oyster Creek is based on inaccurate assumptions:
  - The plan assumes that only a few of the 20 zones within 10 miles of the plant would be evacuated according to the plan; if other people within or beyond the 10 mile radius decide to leave when the nuclear accident is announced, it will further clog the roadways, slowing the evacuation. [123]
  - The plan assumes emergency personnel would remain on duty and not help their own family escape first or flee the area entirely. Some studies suggest many would.[124]

- The evacuation only deals with people within 10 miles of the plant, even though harmful radioactivity would be expected to extend farther. [125]

- Ocean County's population continues to grow, raising further questions about the adequacy of evacuation plans. In 1970, the year after Oyster Creek opened, the population of Ocean County was just over 108,000.[126] By 2005, the population of the county had quintupled to more than 558,000 residents.[127]

## The Nuclear Regulatory Commission Has Historically Been An Ineffective Watchdog

New Jersey residents can have little confidence that the U.S. Nuclear Regulatory Commission (NRC) will regulate Oyster Creek in a way that protects public safety. As former NRC commissioner Peter Bradford said, "The NRC never errs on the side of safety, of environmental protection, or of public involvement."[128]

- Over a period of two years, the Government Accountability Office - the investigative arm of Congress - issued seven reports that detailed the need for improvement in NRC practices to ensure the safety and security of nuclear power plants, the safe storage of radioactive waste, the collection of adequate funds for nuclear decommissioning, and the effective operation of nuclear reactors.[129]

- In a 2002 internal survey, nearly half of all NRC employees responding thought their careers would be harmed if they raised safety concerns, and nearly one-third of employees who had reported safety concerns replied that they had suffered harassment or intimidation as a result.[130]

- A 2003 Union of Concerned Scientists document identified numerous problems with the NRC's risk studies for nuclear plants, which, combined, lead to an overly optimistic view of the safety of individual reactors.[131]

## Oyster Creek Disrupts Local Marine Ecosystems

The plant's "once-through" cooling system pumps as much as 1 million gallons of biologically rich water per minute from the south branch of the Forked River, then pumps the heated water to Oyster Creek, damaging marine life in the area. Exelon has resisted installing a closed-loop cooling system that would reduce the environmental impact of the plant.

- The U.S. Marine Fisheries Service reports that operation of the Oyster Creek power plant results in the annual loss of 13,000 winter flounder, 8 million sand shrimp, as well as significant numbers of blue crab, bay anchovy and other marine species. [132]

- Winter flounder seem to be the most threatened; their numbers appear to have declined since the late 1980s.[133]

- Technical problems at the plant have led to massive fish kills. In 2002, a discharge of heated water from Oyster Creek caused more than 5,000 fish to die from heat shock.[134]

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# FOR MORE INFORMATION, CONTACT


Environment New Jersey
Research & Policy Center

**Suzanne Leta Liou**

143 East State St., Suite 7
Trenton, NJ 08608

609 • 394 • 8155

sliou@environmentnewjersey.org


ENVIRONMENT NEW JERSEY
RESEARCH & POLICY CENTER