APPENDIX

Ralph Izzo
Chairman, President & CEO, PSEG
Testimony to the Joint Session of the
Senate Environment and Energy Committee and
Assembly Telecommunications and Utilities Committee
Statehouse, Trenton, N.J.
Dec. 4, 2017

Good morning.

My name is Ralph Izzo. I am Chairman, President and CEO of Public Service Enterprise Group, a diversified energy company headquartered in Newark, New Jersey. I expect that you are very familiar with PSE&G, the state's largest electric and gas utility, which serves 2.2 million electric customers and 1.8 million gas customers in New Jersey. Another one of PSEG's companies is PSEG Power, which operates a diverse fleet of power plants with over 10,000 megawatts of generating capacity in New Jersey and several northeastern states.

PSEG Power owns and operates the Hope Creek and Salem nuclear power plants in Salem County. PSEG shares ownership of the two Salem plants, as well as the Peach Bottom nuclear plant in Pennsylvania, with Exelon. Together, Salem and Hope Creek comprise the second-largest commercial nuclear generating facility in the United States, on pace to produce nearly 30 terawatt-hours of electricity in 2017. All told, New Jersey's nuclear fleet provides nearly half of the electricity generated in New Jersey, and approximately 40 percent of the energy consumed by millions of New Jersey homes and businesses.

The U.S. nuclear industry is in crisis.

Around the country, several nuclear plants have closed and still more are at risk of closing – not because of operational or safety issues, but rather under economic pressure, resulting from flaws in deregulated energy markets. Identical units are under no such pressure in state-regulated jurisdictions. Specifically, nuclear generating units are struggling to remain economically viable in a sustained period of depressed wholesale electric prices, the result of a lack of recognition in the U.S. energy markets of important externalities, such as fuel diversity or environmental attributes.

These flaws aren't new. They were implicit even as the New Jersey energy industry was deregulated in the 1990s. However, these flaws were masked by comparatively high prices for natural gas and have been revealed only as the price of gas has fallen to historic lows and remained there.

Innovations in drilling technologies and the discovery of vast, untapped resources in the region known as the Marcellus Shale have led to tremendous supplies of natural gas. And as we all learned in our first economics class, the law of supply and demand instructs us that, when supply goes up, prices come down.

Similar pressures that have forced other nuclear plants around the country to close – in states such as Vermont and Wisconsin, that threatened others in New York, Illinois and Connecticut, and are continuing to put plants in Pennsylvania and Ohio at risk – are now on New Jersey's doorstep.

New Jersey's nuclear fleet is facing a crisis, as well. That is the crisis that brings me here today.

At this moment – today – our nuclear plants are in the black. That's due in part to the operational excellence of our workforce, who work tirelessly to improve the efficiency with which our units are able to produce electricity. But it is due primarily to the fact that our company was able to pre-sell electricity the past three years under contracts that are above current market prices.

Those contracts are finite, and some of those contracts are set to expire before the end of this year - most by the end of next year. Unless market prices change, we will no longer be covering our costs, within the next two years.

Without intervention – without a thoughtful, economic safety net – PSEG will be forced to close its New Jersey nuclear plants.

If that happens, New Jersey will still be able to purchase the electricity it needs. The lights will stay on. But the impact for New Jersey will be negative in almost every way.

Please recall what I described as a flawed design in the energy market. Today's markets recognize and reward the short-term marginal costs of natural gas – that is, the markets favor natural gas because it's plentiful and because it's cheap. When it comes to energy, however, short-term cost is by no means the only factor we should be focused on.

Nuclear has many beneficial long-term attributes the market fails to recognize – and these are attributes that are vitally important to New Jersey. Nuclear energy is carbon-free, it contributes to fuel diversity and a resilient energy supply, it fuels New Jersey's economy to the tune of more than $800 million a year and, if New Jersey's nuclear plants were to close and these important attributes are lost, it would cost more to replace them than it would to provide an economic safety net to preserve them.

Please don't misunderstand: Low-cost natural gas is good for New Jersey and good for our customers. The economy benefits from reduced energy costs. Our customers are enjoying the comforts of natural gas to heat their homes and cook their meals, while also saving on their monthly bills. But when it comes to generating electricity, there are other important considerations.

New Jersey customers consume electricity generated in a variety of ways, and nuclear is one of the largest fuel sources. Fuel diversity provides resiliency and price stability. If these nuclear plants retire prematurely, New Jersey's electricity supply will become almost entirely dependent on one source of fuel for electricity.

If New Jersey gets 90 percent of its power from one source, that leaves New Jersey vulnerable.

We would be vulnerable to price fluctuations and, as we nearly saw during the polar vortex in 2014, when natural gas supplies were in high demand for home heating, we would be vulnerable to power disruptions, as well.

Nuclear energy helps keep our air clean, and I think we can all agree that we want our air to be as clean as possible. Nuclear helps New Jersey avoid 14 million tons of carbon and other air pollution each year – that's the same as taking 3 million gas-burning cars off the road every single year. Nuclear power is the reason why transportation is the No. 1 source of air pollution in New Jersey, unlike other states where smokestacks are the primary source.

Nuclear is an engine that drives New Jersey's economy – especially in South Jersey.

The overall economic impact of our Salem and Hope Creek plants has been estimated at more than $800 million every year. And the loss of our nuclear plants would mean putting some 1,600 nuclear plant employees out of work – with a cascading effect that ultimately could affect 5,800 jobs statewide.

Additionally, all New Jersey customers will pay more for electricity if our nuclear plants are forced to close and their output is replaced by new fossil-fuel burning generation.

For all these reasons, it's cheaper to keep it.

I am reminded of my earliest high school lessons in supply and demand: Consider that nuclear energy provides nearly half of the electricity generated in New Jersey. Now if we remove that much supply, demand remains the same, then prices go up. Economics 101.

Research by The Brattle Group found that the loss of nuclear plants will cost an additional $400 million – per year – in higher energy bills. And, that doesn't include the impact of environmental costs, fuel diversity and other economic impacts.

If a market is designed in a way that it forces one asset out of business – in this case, New Jersey's nuclear generation units – and replaces it with a more expensive asset, that is evidence of a significantly flawed system. I would go so far as to say that a market that replaces a low-cost energy source with more expensive energy is, in fact, a broken system.

Let me be clear: I believe that healthy, productive nuclear plants are good for New Jersey's economy, for its environment, and for all energy customers.

And they are good for our company, as well. But, it takes $1 billion to operate our nuclear plants in any one year. No successful business would continue to make those kinds of investments without a glimmer of hope for an adequate return.

So if our nuclear plants are failing to cover their costs– which is the forecast trajectory as our hedge contracts roll off –and I am forced to make the decision to shut them down, it will not be a difficult decision from a business perspective.

But it will be a painful decision – for our employees, for our economy and for the other positive attributes that nuclear energy provides for the entire state of New Jersey.

Our competitors, of course, several of whom are here today, want our nuclear plants to close because electricity prices will rise – and they will benefit.

These are the same competitors who are telling you not to worry about this looming crisis and, if there is one, that the federal government will solve it.

Other advocacy groups are opposed to a safety net for nuclear, I suppose, because they don't believe that we will close our nuclear plants.

As the executive vested with the authority to make such decisions on behalf of our corporation and its shareholders, I am here to tell you that those plants are in trouble and that, if nothing changes, I will close them.

But we aren't here today to ask you to bail out our shareholders. In the very recent past, PSEG already has shut down 4,000 megawatts worth of power plants – more than the combined capacity of our nuclear plants. We made those decisions without asking the state to intervene. We are not averse to taking such steps, when necessary. And our shareholders, as in any other business, reward us when we retire underperforming assets.

This isn't about us. This is about what is best for New Jersey.

Let me make something else clear: We do not support a blank check and we're not asking for a bailout. What we believe is called for is a safety net – a framework that is regularly revisited to prevent the closure of an asset that is valuable to the state of New Jersey.

Without a safety net and without the important attributes of nuclear plants being valued, New Jersey's nuclear plants will close.

Now, any reasonable safety net, we believe, should come with strong consumer protections, such as a demonstration of financial need. We understand that any such needs test would require us to be as transparent as possible, and to open our books to state regulators. Such a safety net should also include offsets for payments made to us for environmental or fuel diversity attributes provided at a state, regional or national level, as well as regular retesting to ensure the safety net is not extended if the need no longer exists.

The timeline I have described this morning – the timeline during which our nuclear plants will become cash-negative – may seem like more than enough to wait and see, particularly as we read headlines about nuclear proposals at the regional and national levels. The U.S. Department of Energy, FERC and PJM, our regional grid operator, all are considering this problem, as well.

I have said often that this is a problem that calls for a broad regional or national solution. But the need to act on behalf of New Jersey's nuclear generation is an urgent one – one that cannot wait for these

organizations to reach a useful consensus. At least not in time to preserve nuclear's benefits for New Jersey customers.

The decision to shut down a nuclear plant is a long, expensive and deliberate process. Unlike other kinds of electric generation, a nuclear plant does not come with a switch that can be flipped on and off.

Once a nuclear plant is closed, it's permanent. The plant, its product and its jobs are gone for good.

I hope that I have persuaded you of the urgency for New Jersey to act ... just as your counterparts in New York, Illinois and Connecticut have already done.

PSEG has been serving this state for 114 years. We're committed to New Jersey. Our roots are deep. We invest in the economy, environment and infrastructure to help make the state a better place to live and work.

Today, our priority is to preserve nuclear energy as part of New Jersey's energy mix – and, more importantly, *for* New Jersey. A safe, clean and productive nuclear fleet is everyone's best interest.

Thank you.

JAMES J. FLORIO

Testimony to the Joint Committees
Assembly Telecommunications and Utilities Committee
Senate Environment and Energy Committee
Trenton, New Jersey
Dec. 4, 2017

I am very careful in deciding when to speak to legislative committees. I do so only when I think an issue is truly important to the future of this state. Understanding the benefits of nuclear power is one of those issues and I thank you for giving me the opportunity to talk to you today on this subject.

Speaking on behalf of nuclear power should not surprise those environmental activists I have worked alongside for many decades. While many of my generation's leading environmentalists cut their teeth picketing nuclear plants, we know much more about nuclear power than we did 40 years ago. We have learned that nuclear energy comes with many benefits – especially in helping combat climate change and reducing the harmful effects of air emissions on public health.

If you believe, as I do, that climate change is the most significant challenge confronting the world today, then you should also conclude – as I have – that nuclear energy must remain part of our state's energy supply.

Allowing New Jersey's nuclear plants to close would be an enormous step backward in our efforts to combat climate change. In New Jersey, nearly half of the electric generation in the state comes from Nuclear power, without polluting the air or harming our climate.

If New Jersey's nuclear plants were to shut down, they would mainly be replaced by fossil fuels – in the form of new natural gas generation and out-of-state coal. Air emissions would increase, as they have wherever nuclear plants have closed.
A recent report from the Brattle Group estimates that continued operation of the nuclear plants in South Jersey avoids 13.8 million tons of CO2 emissions per year. This is the equivalent of adding about 3 million combustion-engine cars to New Jersey's roads - a number that is roughly equal to all of the cars on the road in the state today.

But it's not just climate change gases -- burning fossil fuels releases nitrogen oxides, sulfur oxides, particulates and mercury into the air, which negatively impact public health such as asthma and other serious health problems.
This pollution comes with a cost. The Brattle Group estimates the value of air pollution avoided by New Jersey's South Jersey nuclear plants at $700 million. That does not include the value to the economy of thousands of jobs or the value of having a diverse fuel mix – it is just the value of the environmental benefits – almost three-quarters of a billion dollars a year.

Of course, the environmental community must remain committed to its longstanding core principles: encouraging more efficient use of energy, promoting renewable energy resources and advancing sustainable lifestyles and business practices.

In the future, solar and wind will produce most of the energy we need without harmful emissions. Nuclear energy is, however, fulfilling that clean energy role today.

If we allow our current nuclear plants to close, it will wipe out all of the environmental benefits from all of the solar and wind energy that New Jersey has invested in to date – and then some.

Without nuclear power, it will be impossible for New Jersey to reach the state's clean air targets and we will lose ground in our efforts to tackle climate change and reduce pollution that harms public health.

Nuclear energy is the backbone of New Jersey's safe, reliable and affordable electric grid. More importantly, it provides the energy we need without polluting the air or damaging the climate.

As nuclear plants in this state are threatened, it is important for all of us – especially those of us who are committed to a better environment – to put aside misperceptions and myths and recognize the critical role that nuclear power must provide for us to reach our environmental goals.

Thank you.

James J. Florio

THE HONORABLE JUDD GREGG
NUCLEAR MATTERS ADVOCACY COUNCIL AND FORMER U.S. SENATOR AND GOVERNOR
TESTIMONY FOR THE RECORD
JOINT HEARING OF THE SENATE ENVIRONMENT & ENERGY COMMITTEE AND ASSEMBLY TELECOMMUNICATIONS & UTILITIES COMMITTEE
DECEMBER 4, 2017

Good morning. I would like to thank Chairman Smith, Chairman DeAngelo and the members of the Senate and Assembly for holding this hearing and providing an opportunity for me to speak about the important role nuclear energy plays in the state of New Jersey.

My name is Judd Gregg. I am the former Governor of and a former Senator from New Hampshire. I currently am a member of the Advocacy Council of Nuclear Matters. Nuclear Matters is a national coalition of more than 17,000 members across the country that works to inform and educate the public and stakeholders about the clear benefits of nuclear energy. Together we support solutions that properly value nuclear energy as a reliable, affordable, safe and carbon-free electricity resource that is essential to America's energy future.

Our nation's nuclear power plants are vital national assets that provide reliable, carbon-free electricity to tens of millions of households and businesses around the country.

Despite their value, a combination of factors – including low natural gas prices and market rules that fail to recognize this value – have caused otherwise exemplary performing nuclear plants to close around the country and put the future of New Jersey's nuclear facilities in jeopardy.

As a former Senator and Governor in New Hampshire, I keenly understand the critical role nuclear energy can play for a single state and an entire region. Nuclear power provides high paying jobs and long-term energy security with a 60-year life for nuclear power stations and low operating costs. Nuclear energy is affordable and predictable in cost because there is little fluctuation in production costs and the average fuel cost is more economical compared to other energy sources. And nuclear energy produces no emissions during operation – contributing to cleaner air, less pollution and a healthier population.

Unfortunately, I am also keenly aware of the dire impacts that occur with the untimely closure of a key nuclear facility. In 2014, the Vermont Yankee Nuclear Power Plant closed, and its adverse effects on the environment and community in New England were significant. In New Jersey, nuclear accounts for more than 90 percent of the state's carbon free power generation. Given the large role nuclear plays in powering the state it is important to recognize this contribution before it is too late.

8x

The reality is that Vermont Yankee was an asset that benefited three states, contributing over $60 million to the local economy each year through financial contributions, taxes paid, and employee involvement. The nuclear plant saved New England customers (in Vermont, New Hampshire and Massachusetts) about $330 million in electricity rate savings versus purchasing the same power from the spot market since 2002. Vermont Yankee's shuttering resulted in hundreds of jobs lost, which was a blow to the local economy. Those jobs have not come back and those towns have been devastated. Sadly, small businesses are feeling that crunch the most, with reports as high as 20% in lost revenues. In addition, $58 million in payroll per year is no longer paid to the over 500 people Vermont Yankee once employed.

Unfortunately, after the closure of Vermont Yankee carbon dioxide emissions rates also increased in New England. According to the 2015 ISO New England Electric Generator Air Emissions Report, the loss of Vermont Yankee increased the use of natural gas- and oil-fired generation, which drove an increase in carbon dioxide emissions in 2015 compared with 2014.

We know that when nuclear plants close, they are replaced by natural gas-fired power plants. In New Jersey, where nuclear energy and natural gas are the predominant sources of power, the elimination of nuclear would make the state almost completely dependent on natural gas. It certainly gives credence to the saying: "Don't put all your eggs in one basket."

In New England, where utility rates are among the highest in the country, during some of our most frigid winters, the region experienced challenges in access to natural gas. Nuclear, unaffected by cold weather, was able to meet those challenges when Vermont Yankee was operating. Since that time, residents have seen huge spikes in their bills during these periods of extreme cold. A diverse energy mix helps consumers because it minimizes those volatile periods, helping ensure consistent and affordable electricity prices. This is not a zero-sum game. A robust nuclear industry in New Jersey complements natural gas and renewables to the ultimate benefit of residents through competitive rates.

The loss of nuclear will likely mean a greater reliance on natural gas–fired generation. According to a recent study prepared by IHS Markit for Nuclear Matters, titled "The Value to New Jersey Consumers of Salem and Hope Creek Nuclear Power Generation in Providing Reliable, Resilient, Affordable, and Environmentally Responsible Electricity" loss of Salem and Hope Creek will result in a net increase in CO_2, SO_2, and NO_x emissions from power generation of 13 million metric tons (MMt), 3,063 metric tons, and 118 metric tons, respectively, with an estimated environmental impact cost to New Jersey consumers of more than $530 million per year. While renewables like wind and solar represent a growing – and vital – share of New Jersey's electricity supply, these sources are still a small fraction of your total generation. I agree with the Nuclear Matters' study conclusion that New Jersey benefits from a diverse portfolio.

9x

On the issue of jobs and economic contributions, the nuclear industry is a shining example for states. Nuclear facilities can operate for 60-80 years and Salem and Hope Creek each have significant life ahead of them, if they are able to remain open. According to the Nuclear Matters IHS study the plants are responsible for over $800 million in real gross state product and provide over 6,000 direct and indirect jobs in the state.

During my time as a Senator and Governor, I recognized how critical it is to learn from lessons of the past. In this instance, it is important to learn from the lessons provided by Vermont Yankee. Earlier I mentioned specific financial hardships that the plant closing caused the community and surrounding area. However, it is important to note that the hardships extend well beyond the finances. When the nuclear facility closed, families lost their jobs and were forced to move. Programs for more at-risk community members that Vermont Yankee supported were lost. New England lost a backbone of its community, and because of that it will never be the same.

New Jersey does not have to suffer a fate similar. As you consider a potential solution, think about your state's and your community's future. While New England cannot turn back the clock, you can prevent something similar from happening here. I urge you to look at all options that help New Jersey consumers.

10x

Joint Hearing before the NEW Jersey Senate Environment and Energy Committee and Telecommunications and Utilities Committee

Testimony of

Robert Perciasepe, President of the Center for Climate and Energy Solutions (C2ES)

December 4, 2017

Background

Good morning, I am Bob Perciasepe, the president of the Center for Climate and Energy Solutions (C2ES). Before joining C2ES, I was most recently the Deputy Administrator of the U.S. Environmental Protection Agency (EPA) from 2009 through 2014. Before that I was the chief operating officer for the National Audubon Society and also the Secretary of Maryland's Department of Environment. A full biography is attached and submitted for the record.

The organization I now lead, C2ES, is the successor to the Pew Center on Global Climate Change, which was founded in 1998 and is widely recognized as an influential and pragmatic voice on climate issues. Our mission is to advance strong policy and action to reduce greenhouse gas emissions, promote clean energy, and strengthen resilience to climate impacts. A key objective is a national market-based program to reduce emissions cost-effectively. We believe a sound climate strategy is essential to ensure a strong, sustainable economy.

Our view is that in the long-term, a national market-based program to encourage a lower-carbon economy is the best approach to achieve the needed reductions in emissions. In the near-term, we have recognized the value of state leadership and in maintaining our existing nuclear fleet as we make this transition to a cleaner energy future. We view nuclear power as a vital element in a low carbon economy. In short, I and my organization have come to the unescapable conclusion that preserving the existing U.S. nuclear reactor fleet for as long as possible is a critical element in the transition to a low-carbon future. These units are just too big and too clean to replace quickly. States with the advantage of existing nuclear capacity should take reasonable steps to prevent the premature retirement of these essential clean energy sources while federal and regional policies are being developed.

Decisions today to assure the preservation of existing zero emission capacity is a "no regrets" strategy. We strongly encourage the Legislature to evaluate options with an eye toward the clean energy future the citizens of New Jersey deserve.

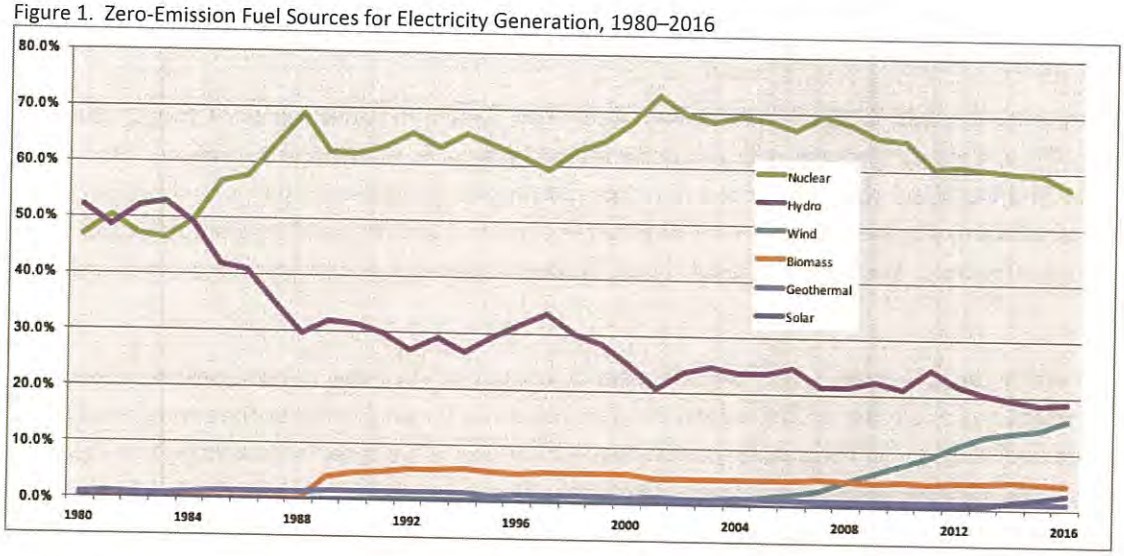
Value of Existing Nuclear Generation to Climate and Air Quality

Nuclear power is by far the largest source of zero-emission power in the United States (see Figure 1). The Center for Climate and Energy Solutions was somewhat neutral on the fate of nuclear energy, but in this past decade we have conducted several reviews of pathways to low-carbon electricity. Our key publication in 2014 found that the goals of significant reductions in greenhouse gas emissions over the next three decades would be severely handicapped if the zero-emissions from nuclear power had to also be compensated for rather than built on. C2ES has revised its view from neutral to seeing the preservation of existing zero emissions resources, including nuclear, as an irreplaceable foundation.

The existing nuclear fleet has enhanced its capacity greatly in the last two decades. Since 1990, nuclear has consistently supplied around one-fifth of U.S. electric power generation, even while total generation increased 33 percent, largely through power uprates (plant modifications that increase the electrical output of existing reactors), shorter refueling outages, and other efficiency improvements. Uprates alone have added over 6,000 MW of emission-free generating capacity since 1977.

The ninety-nine currently operational reactors, including four here in New Jersey, help avoid the emission of 320 million to 578 million metric tons of carbon dioxide each year. These numbers can seem too large to comprehend – for scale, this represents one-fifth to one-third as many emissions as the entire fossil-fired portion of the electric generating sector.[1] This means that premature retirement of any reactors make it tougher to meet emissions and climate goals.

Figure 1. Zero-Emission Fuel Sources for Electricity Generation, 1980–2016



[1] Extrapolated from https://www.eia.gov/tools/faqs/faq.php?id=77&t=11

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In New Jersey, about 97 percent of the state's emission-free electricity is delivered from those four reactors. (Oyster Creek is scheduled to retire prematurely in 2019.)

The situation for emission-free electricity after 2019 when Oyster Creek retires will continue to be overwhelmingly nuclear. The Salem and Hope Creek plants prevent substantial emissions and formation of CO_2, SO_2, NO_X, ozone, and particulate matter, compared to the alternative of natural gas and coal-fired generation that would most likely replace their output.

Similarly, overall NO_X and particulate emission and formation would all increase by more than current New Jersey emissions levels. Given the region's geography, much if not all of the replacement generation would be upwind, subjecting New Jersey to the associated pollution while giving up the economic benefits of hosting the generation (other speakers will specifically address the substantial economic benefits of these plants to the State of New Jersey).

Existing Nuclear Supports the Clean Energy Transition

As I've noted, the existing nuclear fleet provides a vast amount of zero-emissions electricity that is simply not replaceable quickly. In states that have recently seen nuclear retirements, Florida, California, and Wisconsin, significant amounts of the lost emission-free power was replaced with coal or natural gas, increasing emissions of CO_2 as well as traditional air pollutants that contribute to smog and other serious public health impacts. Looking at in-state power sector emissions in the year before and the year after nuclear power plant closures:

- Wisconsin saw a 2.6 million metric ton increase,
- Florida saw a 2.7 million metric ton increase, and
- California's saw a 9.6 million metric ton increase.

In response to the substantial emissions increases that followed the closure of San Onofre, the State of California is in the process of procuring energy efficiency and renewable energy to replace the 2,256 MW Diablo Canyon Nuclear Power Plant, currently scheduled to close over the 2024-25 timeframe. Procuring this much replacement power and ensuring it is carbon-free will take a decade to essentially get back to where the State is today, emissions-wise.

Therefore, the Legislature should consider how to prevent further retirements of New Jersey's reactors, which are licensed through 2036, 2040, and 2046, notwithstanding the pending early retirement of Oyster Creek Generating Station. Retiring any of the three remaining reactors would give up decades of carbon-free power. This in turn would place needed new and additional investment in renewable energy, energy efficiency, and storage in a position to have to first dig out of the pollution hole created by those retirements.

New Jersey is in a stronger position than most states to build on the existing zero-emission foundation with a broader green energy push to move into a national leadership position. Keeping these plants ensures these investments have time to get on the grid, but importantly also ensures they are additional, not just making up for lost nuclear – we need both to make the kind of difference the science tells us we need to make by mid-century.

For myself and my organization, planning to preserve the zero-emission capacity already in place is a necessary foundation to begin the discussion on moving New Jersey forward on clean energy. Without the existing nuclear fleet, any meaningful clean energy transition will be set back possibly decades. It is always good practice to have a solid foundation in place as you begin to build the house.

Bob Perciasepe
President, Center for Climate and Energy Solutions (C2ES)

Bob Perciasepe is President of the Center for Climate and Energy Solutions (C2ES), which is widely recognized in the United States and internationally as a leading, independent voice for practical policy and action to address our energy and climate challenges.

Mr. Perciasepe has been an environmental policy leader in and outside government for more than 40 years, most recently as Deputy Administrator of the U.S. Environmental Protection Agency (EPA). He is a respected expert on environmental stewardship, natural resource management, and public policy, and has built a reputation for bringing stakeholders together to solve issues.

While Mr. Perciasepe served as Deputy Administrator from 2009 to 2014, EPA set stricter auto emissions and mileage standards, increased protections for the nation's streams and rivers, and developed carbon emissions standards for power plants. Mr. Perciasepe was previously assistant administrator for both the agency's water and clean air programs, leading efforts to improve the safety of America's drinking water and development of a new infrastructure revolving fund for drinking water. He also led efforts to lower sulfur levels in gasoline and diesel fuel to reduce smog.

In 2002, Mr. Perciasepe joined the National Audubon Society, one of the nation's oldest conservation organizations, as its senior vice president for public policy. He served as the group's chief operating officer from 2004 to 2009, and worked to protect wetlands and expand environmental education, especially in urban areas.

He has also held top positions in state and municipal government -- as Secretary of the Environment for the state of Maryland from 1990 to 1993 and as a senior planning official for the city of Baltimore, where he managed the city's capital budget.

Mr. Perciasepe is a member of the Bank of America National Community Advisory Council, the National Academy of Science Board on Environmental Studies and Toxicology, a Fellow of the National Academy of Public Administration, and a member of the National Petroleum Council. He serves on the boards of the Keystone Policy Center and the Environmental Law Institute. He has received American University's William K. Reilly Award for Environmental Leadership, the Chesapeake Water Environment Association's Able Wolman Award, the American Lung Association's Distinguished Service award and the Walter G. Wells Conservation Award.

Mr. Perciasepe holds a master's degree in planning and public administration from the Maxwell School of Syracuse University and a Bachelor of Science degree in natural resources from Cornell University.

Before the Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee

Testimony Regarding New Jersey's Nuclear Power Plants

Armond Cohen
Executive Director
Clean Air Task Force
armond@catf.us
Mobile: 617.690.0341

December 4, 2017

Thank you for the opportunity to testify today regarding New Jersey's existing nuclear plants.

My name is Armond Cohen, and I am Executive Director of the Clean Air Task Force, a non-profit environmental organization[1] founded in 1996 to advocate for policies to fight air pollution and climate change. We have worked closely for two decades with leading environmental groups in New Jersey and other states to promote state and federal policies to curb harmful air emissions from power plants.

Today, I will focus on the role that New Jersey's power plants play in avoiding carbon emissions and climate change, and why reasonable policies should be considered to keep them operating in the coming decade.

Let's start with this fact: the world's climate, and New Jersey's, is changing rapidly. Whether directly caused or amplified by climate change or not, Superstorm Sandy was an example of extreme weather we can expect from our warming of the oceans.[2] Global warming has increased the probability and severity of extremely hot and wet weather worldwide. At present rates of change, half the world's population can expect, by 2030, to experience much different climates than we experienced in the late 20th century.[3]

While political shouting continues, there is a broad scientific consensus that these climatic changes are driven by the heating of Earth's atmosphere from carbon dioxide released by the burning of fossil fuels: oil, gas and coal.[4] If we are going to limit extreme climate change, we need to make every effort to utilize every non-fossil energy source we have. And timing matters.

Every molecule of carbon dioxide put in the atmosphere today will continue to warm the earth for centuries. So every molecule we emit today matters - essentially forever. And because carbon simply accumulates in the atmosphere, accelerating warming, the only way to avoid the worst climate change scenarios is, ultimately, to avoid emitting carbon altogether: We need a zero carbon energy system by 2050 or soon after and maximum feasible reductions possible until then.[5]

Figure 1 illustrates why. Consider the atmosphere as a bathtub. We are filling it quickly with carbon, approaching the spillover limit at which the atmosphere changes in ways that may alter Earth's climate beyond human experience – a limit generally reckoned to be two degrees Celsius increase above pre-industrial levels; this temperature correlates to about 450 parts per million of carbon dioxide in the atmosphere (we are at roughly 400 parts per million today). There is some draining of carbon through uptake in trees and the oceans, but it is occurring at a far slower rate than we are

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[1] See www.catf.us. CATF is financed entirely by charitable donations, and receives no funds from private sector companies or the U.S. government.

[2] See Trenberth, Kevin E., John T. Fasullo, and Theodore G. Shepherd. "Attribution of climate extreme events." *Nature Climate Change* 5.8 (2015): 725-730.

[3] See Diffenbaugh, Noah S., et al. "Quantifying the influence of global warming on unprecedented extreme climate events." *Proceedings of the National Academy of Sciences* 114.19 (2017): 4881-4886.

[4] See Intergovernmenal Panel on Climate Change, *Understanding and Attributing Climate Change* (2007), http://www.ipcc.ch/publications_and_data/ar4/wg1/en/spmsspm-understanding-and.html

[5] See Rockström, Johan, et al. "A roadmap for rapid decarbonization." *Science* 355.6331 (2017): 1269-1271.

putting carbon in. There is even some evidence that these "sinks" are becoming saturated and therefore the drain is becoming smaller or non-existent.[6]

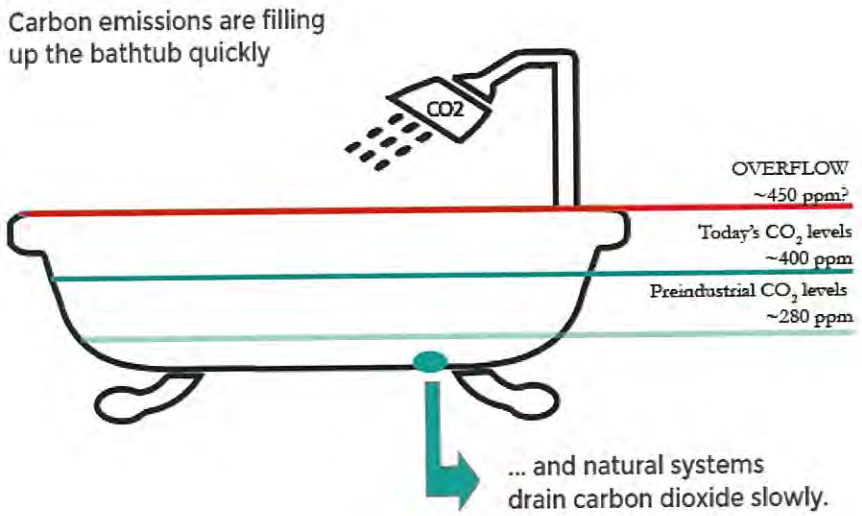

Figure 1: Carbon accumulates and disappears very slowly. Illustration source: Center for Carbon Removal.

The consequence is that to stabilize atmospheric temperature at 2 degrees Celsius beyond pre-industrial levels, we will need to effectively cut off the spigot, and limit our emissions during this century to no more than 1 trillion additional tons of carbon, as illustrated in Figure 2 below. The lesson: ***we must avoid if possible any emissions we can today to reduce the burden in the coming decades.***

[6] See, e.g. Baccini, A., et al. "Tropical forests are a net carbon source based on aboveground measurements of gain and loss." *Science* 358.6360 (2017): 230-234.

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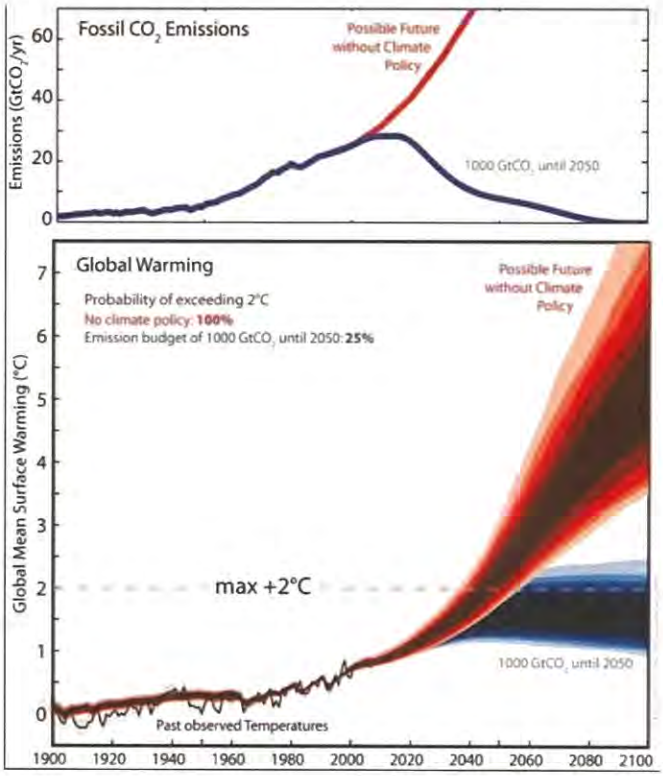

Figure 2: The century's "carbon budget" of 1 trillion tons: the bathtub only has so much space. Illustration source: Science Daily.

What does this have to do with New Jersey's nuclear plants? A lot.

Electricity production is the single largest industrial source of carbon dioxide emissions in New Jersey and the world. And, fortunately, in recent years, roughly half of New Jersey's electricity has come from a carbon dioxide-free source: nuclear power. That put New Jersey among the top three states in zero-carbon electricity share among those that lack large hydroelectric dams. Turning these plants off prematurely would substantially accelerate rather than slow the rate at which the atmospheric bathtub is filling with carbon.

Looking ahead, we can envision a future in which nuclear energy in New Jersey is joined at scale by other zero carbon electric sources such a wind, solar, and carbon capture and storage. But that will take time. Today, wind and solar account for about 5 percent of the state's electricity mix. They can and should be expanded, but this cannot be done overnight.

Consider that, just to ***replace*** the electricity output of the Hope Creek and Salem nuclear plants with other carbon-free electricity, and not even lower emissions from today, New Jersey would need to site 12 of the largest offshore windfarms operating in the world today, or 10 copies of California's largest onshore wind farm. (It is worth noting that America's only offshore wind farm operating today, off Rhode Island, would produce less than 1 percent of the electricity as Salem). Or the state would need to increase solar energy output by 15 times present levels, which took more than two decades to reach.

There will be substantial siting, financial and other challenges to achieving this level of wind and solar buildout, lasting decades. And, even then, New Jersey would have only just replaced the zero-carbon electricity capability that already exists; the feat would need to be doubled to supply the rest. Meanwhile, as this lengthy buildout occurs, without New Jersey's nuclear plants, carbon dioxide will pour into the atmosphere from gas and coal plants that replace them.

The magnitude of this problem can be seen in Figure 3. Governor-elect Murphy has indicated his intent[7] to have New Jersey join the Regional Greenhouse Gas Initiative (RGGI), a regional compact that today includes the six New England states plus New York, Maryland and Delaware. RGGI is committed to a relatively modest 10% reduction in CO2 emissions by 2020 from present levels. But retiring Salem and Hope Creek, and optimistically replacing them only with gas fired energy and no coal, regional emissions would grow by about 11 million tons annually. This increase will substantially increase the difficulty of meeting the 2020 cap, even if the cap baseline is adjusted to incorporate the state's current CO2 emissions.

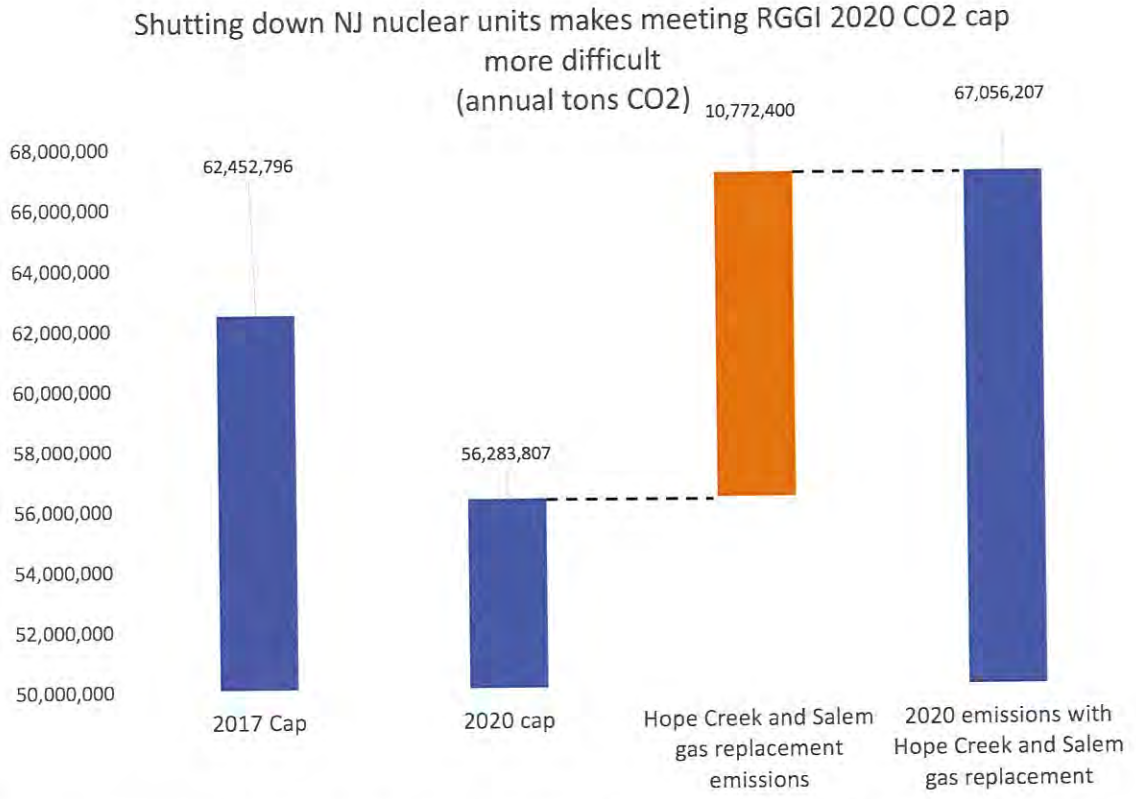

Figure 3: Consequences of turning off New Jersey nuclear plants to achieving CO2 emission caps under the Regional Greenhouse Gas Initiative. Source of figure: CATF, using cap data from RGGI, https://www.rggi.org/design/overview/cap and calculations on NJ nuclear output from FERC filings. It is assumed here that gas power plants replace lost nuclear output at an emissions rate of .4 tons CO2 per/MWH.

[7] See https://www.murphy4nj.com/issues/protecting-the-environment/

20x

Looking toward 2050, many considerations will drive which mix of technologies can best eliminate carbon from electricity in New Jersey. Wind and solar are, as noted, coming down in price but face many challenges at very high levels of penetration, including the need for some form of on-demand back-up power for the weeks and months when wind and sun are scarce in the Garden State (today's batteries, even at zero cost, won't do the job because they can only store a day's worth of energy at best). Technologies that use gas with no carbon dioxide emissions are being demonstrated today and could well be part of the solution.[8] And advanced nuclear plants that depart radically from today's designs and can be manufactured at lower cost are on the horizon.[9]

While maintaining New Jersey's nuclear power capability may require a transitional subsidy, that is true of nearly all zero carbon energy sources today, which must all compete against cheap natural gas power. While CATF does not offer an opinion on the particular mechanisms New Jersey should consider to maintain its nuclear fleet, Figure 4 shows that recent nuclear power subsidies enacted in New York and Illinois have been in the range of $15/MWH, which is substantially less than current effective state and federal subsidies for wind and solar.

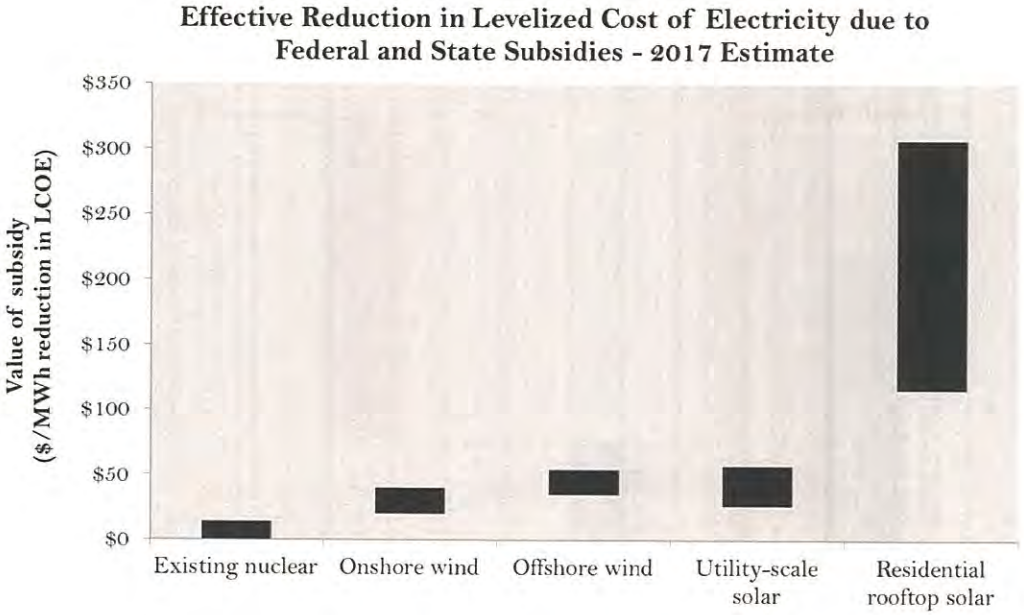

Figure 4: Effective subsidies for nuclear in recent NY and Illinois policies compared with state and federal subsidies for renewable power. Source: CATF calculations, from publicly available data.

[8] See http://www.sciencemag.org/news/2017/05/goodbye-smokestacks-startup-invents-zero-emission-fossil-fuel-power

[9] See Clean Air Task Force, *Advanced Nuclear Energy: Need, Characteristics, Projected Costs and Opportunities,* http://www.catf.us/resources/publications/files/Advanced_Nuclear_Energy.pdf; and Energy Innovation Reform Project, *What Will Advanced Nuclear Power Plants Cost?* (July 2017), http://innovationreform.org/wp-content/uploads/2017/07/Advanced-Nuclear-Reactors-Cost-Study.pdf

We can't know the future of energy technology for certain. But we do know that, over the next two decades, every molecule of carbon will matter. Whatever one's view of the state's ideal energy mix in 2050, one thing is clear: At least during the transition, New Jersey should find a way to maintain a very large climate-protection tool - nuclear energy.

Thank you for your attention, and I look forward to answering your questions.

African American Environmentalist Association

Testimony of Norris McDonald

President

African American Environmentalist Association

Before the

New Jersey Legislature

Senate Environment and Energy Committee

And

Assembly Telecommunications and Utilities Committee

Public Hearing On

Strategies to Prevent the Premature Retirement of Existing, Licensed, and Operating Nuclear Power Plants

Committee Room 4, 1st Floor, State House Annex

Trenton, NJ

Monday, December 04, 2017 - 10:00 AM

1629 K Street, NW, Suite 300, Washington, DC 20006 (443) 569-5102
www.africanamericanenvironmentalistassociation.org

Introduction

My name is Norris McDonald and I am the founder and president of the African American Environmentalist Association (AAEA). We are the nation's oldest African American-led environmental group and we are dedicated to protecting the environment, promoting the efficient use of natural resources, enhancing human, animal and plant ecologies, promoting increased African American ownership of energy resources and infrastructure and increasing African American participation in the environmental movement.

We support strategies to prevent the premature retirement of Hope Creek and Salem nuclear power plants. These existing, licensed, and operating nuclear power plants are an invaluable asset in mitigating air pollution in New Jersey. The state is in nonattainment for ozone, which is a component of smog, and negatively affects the health of New Jersey residents. Any support the New Jersey state legislature can provide would be a Godsend to people suffering from asthma and other air pollution related illnesses. Minority communities are particularly vulnerable to air related illnesses with the highest rates of asthma attack, emergency room visits and hospitalizations in the state. These vulnerable communities are helped by ability of Hope Creek and Salem nuclear facilities ability to deliver incredible amounts of baseload electricity without producing any of the air pollution that hurts these areas.

Nuclear power plants represent our most important facilities for efficiently producing large amounts of baseload electricity while not producing air polluting emissions. It is for these reasons that we support the PSEG Nuclear nuclear fleet. Hope Creek and Salem nuclear facilities are invaluable clean air assets in New Jersey. Hope Creek and Salem are also uncredited assets in New Jersey's ongoing goals to improve air quality.

We were the first environmental group in the United States to support nuclear power starting in 2001. We support nuclear power because operating the plants do not create smog-forming gases or greenhouse gases. We are also particularly interested in mitigating air pollution in New Jersey because African Americans represent most of the asthma hospitalizations in the vast majority of counties in New Jersey.

PSEG Nuclear Plants

Hope Creek Nuclear Generating Station

Hope Creek is located along with Salem Generating Station on a 740 acre site in Salem County, New Jersey. Salem County's western border is the Delaware River and Interstate 95 runs parallel to the river. Electricity generated by Hope Creek produces no greenhouse gas emissions. Hope Creek is the largest employer in Salem County with over 1,500 employees. Hope Creek is a single unit boiling water reactor (BWR) with a total generating capacity of 1,172 megawatts and generates enough electricity to power approximately one million homes each day. Construction began in 1974 with commercial service beginning in 1986. Its license has been renewed by the Nuclear Regulatory Commission (NRC) until 2046. PSEG owns 100% of Hope Creek.[1]

Salem Nuclear Generating Station

The Salem Nuclear Generating Station has dual unit pressurized water reactors (PWR) with a total generating capacity of 2,296 megawatts (MW) [PSEG portion 1,318 MW] and generates enough electricity to power approximately two million homes each day. Construction began in 1968 and Unit 1 began commercial service in 1977. The NRC has renewed its license until 2036. Unit 2 began commercial service in 1981 and its license has been renewed by the NRC until 2040. PSEG owns 57% of Salem. Exelon Corporation owns the remaining 43%.[2]

Air Pollution in New Jersey

Most people living in New Jersey live in counties with unhealthy levels of smog, according to an annual report by the American Lung Association, "The State of Air 2017." The group gave failing grades to 12 of New Jersey's 21 counties based on measurements of ozone, a pollutant that comes from power plant and vehicle emissions. The data was obtained from the U.S. Environmental Protection Agency's Air Quality System, which collects data for all of the state's counties.[3]

According to the report, the air quality in New Jersey ranks among the worst in the nation because of high concentrations of ground-level ozone pollution. The New York-Newark metro area was listed among the "25 Most Polluted Cities" for both ozone smog and fine-particle pollution. The Philadelphia metro region, which includes Camden County and other parts of western New Jersey, was ranked the 22nd worst

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[1] PSEG Power LLC, https://www.pseg.com/family/power/nuclear/hope_creek.jsp

[2] PSEG Power LLC, https://www.pseg.com/family/power/nuclear/salem.jsp

[3] American Lung Association, "The State of Air 2017," p. 121, http://www.lung.org/our-initiatives/healthy-air/sota/key-findings/

for ozone, even though it met the national standard for year-round particle pollution, the report says. In terms of ozone pollution, 11 New Jersey counties received an F grade, one received a D and three received a C.[4] The counties receiving F grades include:

- Bergen
- Camden
- Essex
- Gloucester
- Hudson
- Hunterdon
- Mercer
- Middlesex
- Monmouth
- Morris
- Ocean

According to the State of New Jersey Department of Environmental Protection Division of Air Quality, "New Jersey air quality...exceeds the current standards for ozone throughout the state and fine particles in urban areas."[5] Losing a nuclear power plant will only make that problem worse. No nuclear plant should be allowed to close as long as any area in a state is in noncompliance of the Clean Air Act.[6]

Asthma Rates and Race in the United States

In 2015, almost 2.6 million non-Hispanic blacks reported that they currently have asthma. African American women were 20 percent more likely to have asthma than non-Hispanic whites, in 2015. In 2014, African Americans were almost three times more likely to die from asthma related causes than the white population. In 2015, African American children had a death rate ten times that of non-Hispanic white children. Black children are 4 times more likely to be admitted to the hospital for asthma, as compared to non-Hispanic white children.

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[4] NJ Advance Media for NJ.com, April 20, 2017, http://www.nj.com/weather/index.ssf/2017/04/these_15_counties_have_the_worst_air_pollution_in.html

[5] State of New Jersey Department of Environmental Protection Division of Air Quality, http://www.nj.gov/dep/daq/

[6] U.S. Department of Health and Human Services, Office of Minority Health, "Asthma and African Americans." https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=15

26x

Asthma in New Jersey

According to Bhavini A. Doshi, Esq.,[7] in-house counsel at the City of Jersey City,

> It is well known that air pollution, particularly in densely populated urban areas with multiple sources of pollution, has real impacts upon short- and long-term human health. Children are especially vulnerable to asthma and other pollution-related symptoms, including death. Numerous studies have shown that Newark, for instance, faces "disproportionate impacts from multiple sources of air pollution." Other dense urban centers in New Jersey also suffer from multiple sources of air pollution and are home to significant minority and low-income populations. These communities are surrounded by NOx emitters — ports, airports, bridges, tunnels, sewage plants, garbage incinerators, and factories, to name a few — on all sides.[8]

New Jersey cannot reduce its asthma rates as long as its ambient air quality is in noncompliance with the Clean Air Act. According to the State of New Jersey Department of Health:

> In New Jersey, more than 600,000 adults and 167,000 children have asthma. Asthma affects all races, ages and genders. More boys have asthma than girls, but in adulthood, more women are diagnosed with asthma than men. Blacks, Hispanics and urban residents are more likely to be affected with asthma symptoms, as are individuals with a family history of the disease.[9]

Nuclear power plants do not add emissions into the atmosphere that lead to asthma symptoms.

According to the Village Voice, one in four Newark children suffers from asthma; the hospitalization rate is 150 percent greater for kids living in the city than in the rest of

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[7] Doshi has nearly 10 years experience in local government law. She is a member of the board of trustees, environmental section, for the New Jersey State Bar Association and sits on the Renewable Energy, Cleantech, and Climate Change Special Committee.

[8] New Jersey Spotlight, Op Ed: VW Settlement-An Opportunity For Environmental Justice, 9/28/2017. http://www.njspotlight.com/stories/17/09/27/op-ed-vw-settlement-an-opportunity-for-environmental-justice/

[9] State of New Jersey Department of Health, Chronic Disease Programs, http://nj.gov/health/fhs/chronic/asthma/in-nj/

the state, and more than thirty times the rate nationwide. Asthma attacks are now a leading cause of school absenteeism in the region.[10]

Nuclear Power Benefits Are Essential To Compliance with Clean Air Regulations

States are required to submit State Implementation Plans (SIPs) to show how they intend to comply with the federal air quality standards set in accordance with the Clean Air Act. According to the Clean Air Act:

> When the United States Environmental Protection Agency (USEPA) establishes a new or makes a revision to a National Ambient Air Quality Standards (NAAQS), the Federal Clean Air Act requires the states to submit to the USEPA a State Implementation Plan (SIP) revision or certification indicating that the State has the authority to develop, implement, and enforce an air quality management program that provides for attainment and maintenance of the NAAQS. These elements are sometimes compiled and submitted separately in what is referred to as an "Infrastructure" SIP.[11]

SIPs do not explicitly include emissions-free nuclear power as a compliance tool in meeting the requirements of the Clean Air Act. However they do implicitly include nuclear generation in that these resources avoid emissions the state must offset if they are lost, increasing the cost and complexity of attaining these important heath standards. Penalties for not achieving air standards include the possibility of losing highway construction funds and expensive permitting hurdles for new or expanded manufacturing and other facilities important to economic development. Therefore, preservation of existing nuclear power plants is an important compliance tool and numerous studies highlight the cost effectiveness of preserving existing power plants as compared to other emission reduction options.

Air Pollution and Environmental Justice in New Jersey

The State of New Jersey has an Office of Environmental Justice that is located at the Department of Environmental Protection (DEP). To help address environmental inequities, the New Jersey DEP launched the Environmental Justice Program to ensure fair treatment for people of all races, cultures, and incomes, in the development, implementation and enforcement of environmental laws, regulations and policies. The

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[10] The Village Voice, "Hell on Wheels: Port Authority's Broken Promise Is Choking Newark's Kids," May 3, 2016. https://www.villagevoice.com/2016/05/03/hell-on-wheels-port-authoritys-broken-promise-is-choking-newarks-kids/

[11] The State of New Jersey Department of Environmental Protection, Certification For Meeting the Infrastructure Requirements in the Clean Air Act, for 35 µg/m3 24-Hour (2006) Fine Particulate Matter National Ambient Air Quality Standard, January 2010, Page viii.
http://www.state.nj.us/dep/baqp/sip/Letter%20Infrastructure%20certification%20Appendices_FINAL.pdf

DEP's Environmental Justice Program aims to empower citizens who are often outside of the decision-making process of government, and strives to address environmental concerns to improve the quality of life in New Jersey's urban and older suburban communities.[12]

Unfortunately, the OEJ has no authority to enforce disproportionate air pollution impacts. The state legislature needs a law that regulates locating facility and thoroughfare development projects in environmental justice areas. AAEA authored and led the campaign to pass an environmental justice law for the City of New York. We intend to explore the feasibility of passing a similar law for the State of New Jersey. New Jersey Senator Cory Booker has introduced environmental justice legislation that would address the issue at the national level. The Environmental Justice Act of 2017 requires federal agencies to address environmental justice through agency actions and permitting decisions, and strengthens legal protections against environmental injustice for communities of color, low-income communities, and indigenous communities.[13] AAEA supports Senator Booker's bill.

New Jersey in Nonattainment for Ozone

New Jersey is required to meet air quality standards established by the United States Environmental Protection Agency (USEPA). These standards are known as National Ambient Air Quality Standards (NAAQS). On Oct. 1, 2015, the USEPA strengthened the air quality standard for ground-level ozone to improve public health and environmental protection. The NAAQS for ozone was reduced from 75 parts per billion (ppb) to 70 parts per billion, based on extensive scientific evidence about ozone's effects on public health and welfare. On May 21, 2012, the USEPA designated the entire state of New Jersey as nonattainment for the previous 0.075 ppm 8-hour ozone NAAQS. The entire state of New Jersey continues to be in nonattainment for ozone standards under the Clean Air Act.[14/15]

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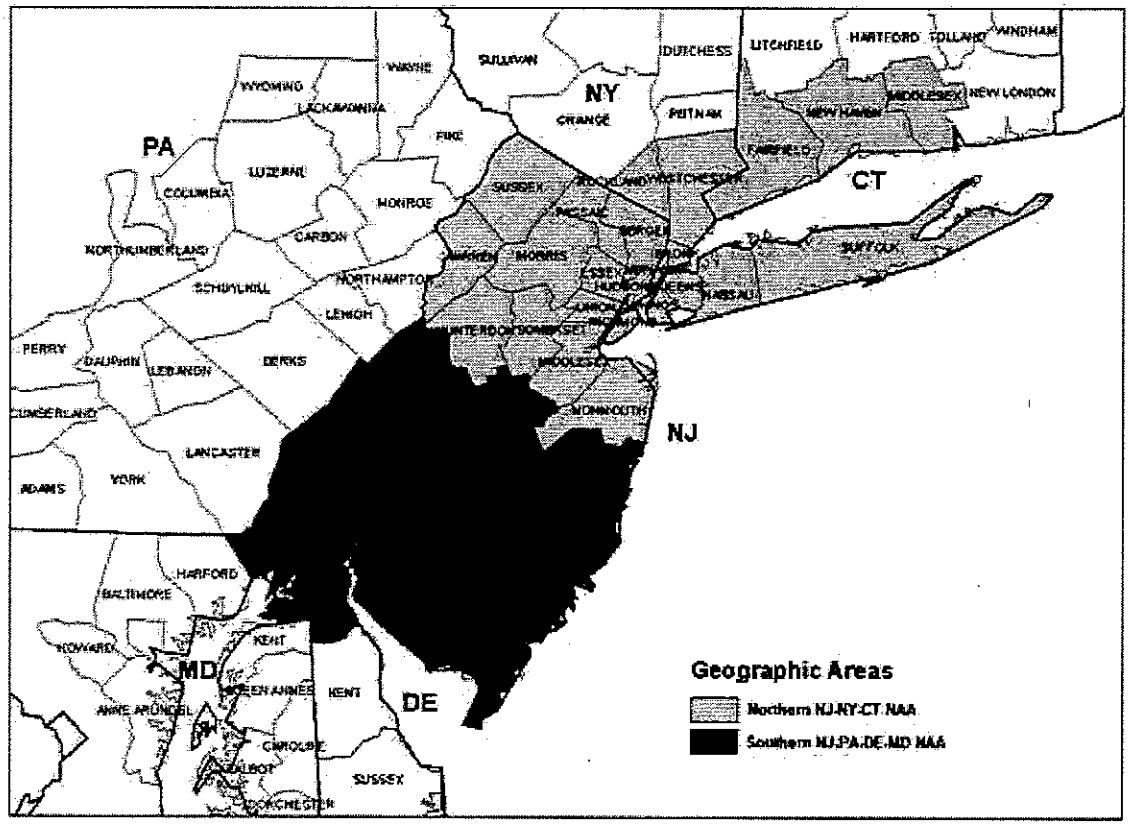
[12] State of New Jersey Office of Environmental Justice, Department of Environmental Protection, http://www.nj.gov/dep/ej/resources.html

[13] Cory Booker, United States Senator for New Jersey, Booker Announces Landmark Environmental Justice Bill, October 23, 2017. https://www.booker.senate.gov/?p=press_release&id=685

[14] NRC, New Jersey Department of Environmental Protection, Bureau of Air Quality Planning. https://www.nrc.gov/docs/ML1315/ML13157A142.pdf

[15] State of New Jersey Department of Environmental Protection, "Federal Standards for Ground Level Ozone." http://www.nj.gov/dep/cleanairnj/ozone.html

New Jersey 8-Hour Ground-Level Ozone Multi-State Nonattainment Areas



Source: State of New Jersey Department of Environmental Protection

Demographics and Asthma Rates in Select Cities in New Jersey

New Jersey is 15% African American and 20% Latino.[16] Much of New Jersey is in nonattainment for air pollution under the Clean Air Act. Ozone is a major problem, particularly in urban areas. New Jersey's larger cities have ozone problems that exacerbate asthma for its residents. Children are particularly vulnerable and miss school due to asthma attacks. Again, nuclear power plants do not contribute to ozone production and are a major asset in any state that happens to have them.

[16] United States Census Bureau, Quick Facts, New Jersey. https://www.census.gov/quickfacts/NJ

30x

Newark is 49% African American, 34% Hispanic and 13% White.[17] According to the Village Voice, "One in four Newark children suffers from asthma; the hospitalization rate is 150 percent greater for kids living in the city than in the rest of the state, and more than thirty times the rate nationwide. Asthma attacks are now a leading cause of school absenteeism in the region."[18] A New Jersey Department of Health study that assessed the associations of ozone and fine particulate matter (PM2.5) with pediatric emergency room visits in Newark, New Jersey concluded that, "Ozone was statistically positively associated with pediatric asthma emergency room visits in Newark, NJ."[19] Newark residents have disproportionately high rates of hospitalization and emergency room visits as a result of asthma attacks, according to the New Jersey Department of Health and Senior Services.[20]

Trenton is 51% African American, 32% Latino and 15% White.[21] The New Jersey Department of Health's analysis of asthma-related emergency department visits by municipality showed that Trenton's rate was 3.8 times the state average and accounted for 76 percent of Mercer County's asthma emergency department visits, although Trenton residents comprise only 23 percent of the county's population. Asthma affects all races, ages and genders. But, blacks, Hispanics and urban residents are more likely to be affected with asthma symptoms, as are individuals with a family history of the disease.[22]

Camden is 53% African American, 39% Latino and 17% White.[23] In Camden, 18% of residents suffer from asthma and the city reports some of the highest asthma

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[17] Census Reporter. https://censusreporter.org/profiles/06000US3401351000-newark-city-essex-county-nj/

[18] Village Voice, 5/3/2016. https://www.villagevoice.com/2016/05/03/hell-on-wheels-port-authoritys-broken-promise-is-choking-newarks-kids/

[19] New Jersey Department of Health, Jessie A. Gleason, "Associations of Daily Pediatric Asthma Emergency Department Visits With Air Pollution in Newark, NJ: Utilizing Time – Series and Case – Crossover Study Designs," July, 201S.
https://www.researchgate.net/publication/280537764_Associations_of_daily_pediatric_asthma_emergency_department_visits_with_air_pollution_in_Newark_NJ_Utilizing_time-series_and_case-crossover_study_designs

[20] RT Magazine, "EPA Funds Study to Look at Pollution, Psychological Asthma Triggers in Children," 1/27/2011. http://www.rtmagazine.com/2011/01/epa-funds-study-to-look-at-pollution-psychological-asthma-triggers-in-children/

[21] Statistical Atlas, "Race and Ethnicity in Trenton, New Jersey." https://statisticalatlas.com/place/New-Jersey/Trenton/Race-and-Ethnicity

[22] The Geraldine R. Dodge Foundation, The Dodge Blog, "Sustainable Jersey: School nurses take on asthma in Trenton providing needed link between healthcare, school and home," 7/19/2017.
http://blog.grdodge.org/2017/07/19/sustainable-jersey-school-nurses-take-on-asthma-in-trenton-providing-needed-link-between-healthcare-school-and-home/

[23] Area Connect. http://camdennj.areaconnect.com/statistics.htm

hospitalization rates in the state.[24] From 2002 to 2012, pediatric asthma-related hospitalizations nearly doubled in Camden, New Jersey.[25]

Asthma Hospitalizations by Racial Groups (County) in New Jersey

The 11 counties that received an 'F' grade from the American Lung Association in their report, "The State of Air 2017," have their asthma data by race and county listed below. African Americans top the list of asthma hospitalizations in all counties listed. Additional New Jersey counties are also listed after the failing grade counties.

In 2008, an estimated 572,877 adults in New Jersey had asthma. Adult lifetime asthma prevalence was 12.8% and adult current asthma prevalence was 8.6% compared with U.S. rates of 13.3% and 8.5%, respectively. In 2008 an estimated 174,346 children in New Jersey had asthma. Child lifetime asthma prevalence was 12.9% and child current asthma prevalence was 8.6% compared with the 38 participating states' rates of 13.3% and 9.0%, respectively. Adult current asthma prevalence was higher among non-Hispanic blacks and lower among non-Hispanic persons of other races than non-Hispanic whites in New Jersey; however, rates were higher among non-Hispanic multirace persons and non-Hispanic blacks throughout the U.S. Child current asthma prevalence was higher among non-Hispanic blacks than non-Hispanic whites in New Jersey; however, rates were higher among non-Hispanic blacks and non-Hispanic multirace persons throughout the 38 participating states.[26] These rates will go up if the nuclear plants do not continue to run because the replacement generation that will operate is emitting emissions that are upwind of Salem County.

County Specific Data

Salem County. Non-Hispanic black residents of Salem County had the highest asthma hospitalization rate—3.1 times the rate for non-Hispanic white residents and 3.7 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.84 times (16 percent below) the rate for non-Hispanic white residents. When comparing Salem County racial and ethnic groups to their state averages, the rate for Hispanic residents was 28 percent below the state average for Hispanic people.

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[24] Archive, "Breathe Easy Camden." http://archiveglobal.org/camden-new-jersey/

[25] University of Michigan Medical School, Mahshid Abir, MD, MSc, "Cluster Analysis of Acute Care Utilization Yields Insights for Tailored Pediatric Asthma Interventions." https://www.eventscribe.com/2017/SAEM/ajaxcalls/PresentationInfo.asp?efp=SFFWWIhCWFYzMzA1&PresentationID=267655&rnd=0.4069341

[26] CDC's National Asthma Control Program, Asthma In New Jersey. https://www.cdc.gov/asthma/stateprofiles/asthma_in_nj.pdf

The rate for non-Hispanic black residents was 41 percent above their state average and the rate for non-Hispanic white residents was 54 percent above their state average.[27]

Bergen County. As with rates of asthma emergency room visits, Bergen County's rate of asthma hospitalizations was highest for non-Hispanic black residents (3.2 times the rate for non-Hispanic white residents and 2.5 times the rate for Hispanic residents). The rates of asthma hospitalization for residents of all racial and ethnic groups were below their state averages (15 percent below for non-Hispanic white residents, 20 percent below for non-Hispanic black residents, and 30 percent below for Hispanic residents).[28]

Camden County. For all racial and ethnic groups examined, Camden County is above the state average for similar groups—by 36 percent for non-Hispanic black residents, 46 percent for non-Hispanic white residents, and 89 percent for Hispanic residents. The asthma hospitalization rate for non-Hispanic black residents of Camden County was 3.2 times the rate for non-Hispanic white residents and 1.5 times higher than the rate for Hispanic residents. The rate for Hispanic residents was twice the rate for non-Hispanic white residents.[29]

Essex County. As with rates of asthma emergency room visits, Essex County's rate of asthma hospitalizations was highest and exceeded the state average for both non-Hispanic black residents (10 percent higher than the state average for non-Hispanic black people) and Hispanic residents (42 percent above the state average for Hispanic people). For non-Hispanic white residents, Essex County's asthma hospitalization rate was three percent below the state average. Disparities between racial and ethnic emergency room groups in Essex County were less pronounced for asthma hospitalizations than for emergency room visits. The asthma hospitalization rate for non-Hispanic black residents was 3.9 times the rate for non-Hispanic white residents, and 1.7 times the rate for Hispanic residents. The rate for Hispanic residents was 2.3 times the rate for non-Hispanic white residents.[30]

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[27] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Salem County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Salem County Asthma Profile, p. 6. http://www.state.nj.us/health/fhs/chronic/documents/asthma_profiles/salem.pdf

[28] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Bergen County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Bergen County Asthma Profile, p. 7. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/bergen.pdf

[29] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Camden County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Camden County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/camden.pdf

[30] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Essex County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Essex County Asthma Profile, p. 6. http://www.state.nj.us/health/fhs/chronic/documents/asthma_profiles/essex.pdf

Gloucester County. Non-Hispanic black residents of Gloucester County had the highest asthma hospitalization rate—2.4 times the rate for non-Hispanic white residents and 2.8 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.88 times (12 percent below) the rate for non-Hispanic white residents. When comparing Gloucester County racial and ethnic groups to their state averages, the rate for Hispanic residents was below the state average for Hispanic people by 38 percent and the rate for non-Hispanic black residents was 20 percent below their state average. The rate for non-Hispanic white residents was above their state average by 12 percent.[31]

Hudson County. NonHispanic black residents of Hudson County had the highest asthma hospitalization rate—2.8 times the rate for non-Hispanic white residents and 2.2 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.3 times the rate for non-Hispanic white residents. When comparing Hudson County racial and ethnic groups to their state averages, the rate for Hispanic residents was five percent above the state average for Hispanic people, the rate for non-Hispanic black residents was eight percent above their state average, and the rate for nonHispanic white residents was 30 percent above their state average.[32]

Hunterdon County. For all racial and ethnic groups examined, Hunterdon County is below the state average (by 43 percent for non-Hispanic white residents, 60 percent for non-Hispanic black residents, and 75 percent for Hispanic residents). The rate of asthma hospitalization for non-Hispanic black residents of Hunterdon County was 2.4 times the rates for non-Hispanic white residents and 3.5 times the rate for Hispanic residents. The rate for Hispanic residents was 0.68 times (32 percent below) the rate for non-Hispanic white residents.[33]

Mercer County. Non-Hispanic black residents of Mercer County had the highest asthma hospitalization rate—3.4 times the rate for non-Hispanic white residents and 2.3 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.5 times the rate for non-Hispanic white residents. When comparing Mercer County racial and ethnic groups to their state averages, rates for non-Hispanic

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[31] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Gloucester County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Gloucester County Asthma Profile, p. 6.
http://www.state.nj.us/health/fhs/chronic/documents/asthma_profiles/gloucester.pdf

[32] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Hudson County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Hudson County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/hudson.pdf

[33] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Hunterdon County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Hunderton County Asthma Profile, p. 6. http://nj.gov/health/fhs/chronic/documents/asthma_profiles/hunterdon.pdf

black residents were six percent above the state average for non-Hispanic black people, those for non-Hispanic white residents were also six percent above their state average. Rates for Hispanic residents were less than one percent above their state average.[34]

Middlesex County. Non-Hispanic black residents of Middlesex County had the highest asthma hospitalization rate—2.4 times the rate for non-Hispanic white residents and 1.4 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.7 times the rate for non-Hispanic white residents. When comparing Middlesex County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was 37 percent below the state average for non-Hispanic black people, the rate for non-Hispanic white residents was 11 percent below their state average and the rate for Hispanic residents was five percent below their state average.[35]

Monmouth County. Non-Hispanic black residents of Monmouth County had the highest asthma hospitalization rate—4.2 times the rate for non-Hispanic white residents and 3.6 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.2 times the rate for non-Hispanic white residents. When comparing Monmouth County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was above the state average for non-Hispanic black people by 15 percent, while the rate for non-Hispanic white residents was below their state average by eight percent and the rate for Hispanic residents was below their state average by 31 percent.[36]

Morris County. Non-Hispanic black residents of Morris County had the highest asthma hospitalization rate—3.6 times the rate for non-Hispanic white residents and 2.8 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.3 times the rate for non-Hispanic white residents. When comparing Morris County racial and ethnic groups to their state averages, the rate for Hispanic residents was 59 percent below the state average for Hispanic people, the rate for non-

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[34] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Mercer County and the state of New Jersey for 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Mercer County Asthma Profile, p. 6. http://nj.gov/health/fhs/chronic/documents/asthma_profiles/mercer.pdf

[35] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Middlesex County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Middlesex County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/middlesex.pdf

[36] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Monmouth County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Monmouth County Asthma Profile, p. 7. http://nj.gov/health/fhs/chronic/documents/asthma_profiles/monmouth.pdf

Hispanic white residents was 50 percent below their state average and the rate for non-Hispanic black residents was 48 percent below their state average.[37]

Ocean County. As with rates of asthma emergency room visits, Ocean County's rate of asthma hospitalizations was highest for non-Hispanic black residents (2.5 times the rate for non-Hispanic white residents and 2.8 times the rate for Hispanic residents). The rate of asthma hospitalization for non-Hispanic black residents was five percent below the state average for non-Hispanic black people. The rate for Hispanic residents was 27 percent below their state average. For non-Hispanic white residents of Ocean County, however, the asthma hospitalization rate was 28 percent higher than their state average.[38]

Atlantic County. Non-Hispanic black residents of Atlantic County had the highest asthma hospitalization rate—3.4 times the rate for non-Hispanic white residents and 3.4 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.99 times (one percent below) the rate for non-Hispanic white residents. When comparing Atlantic County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was 22 percent above the state average for non-Hispanic black people, and the rate for non-Hispanic white residents was 24 percent above their state average. The rate for Hispanic residents was 23 percent below their state average.[39]

Cape May. NonHispanic black residents of Cape May County had the highest asthma hospitalization rate—3.6 times the rate for non-Hispanic white residents and 3.9 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.92 times (eight percent below) the rate for non-Hispanic white residents. When comparing Cape May County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was 37 percent above the state average for non-Hispanic black people, and the rate for non-Hispanic white residents was 29 percent above their state average. The rate for Hispanic residents was 25 percent below their state average.[40]

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[37] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Morris County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Morris County Asthma Profile, p. 7. http://state.nj.us/health/fhs/chronic/documents/asthma_profiles/morris.pdf

[38] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Ocean County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Ocean County Asthma Profile, p. 7. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/ocean.pdf

[39] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Atlantic County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Atlantic County Asthma Profile, p. 7. http://nj.gov/health/fhs/chronic/documents/asthma_profiles/atlantic.pdf

[40] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Cape May County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Cape May County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/capemay.pdf

Cumberland County. Non-Hispanic black residents of Cumberland County had the highest asthma hospitalization rate—2.2 times the rate for non-Hispanic white residents and 1.9 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.2 times the rate for non-Hispanic white residents. When comparing Cumberland County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was ten percent below the state average for non-Hispanic black people. The rate for Hispanic residents was one percent above their state average and the rate for non-Hispanic white residents was 38 percent above their state average.[41]

Passaic County. All groups had rates larger than the state average for similar groups—non-Hispanic white residents by four percent, Hispanic residents by 47 percent and non-Hispanic black residents by 56 percent. Non-Hispanic black residents had the highest rates, 5.1 times the rate for non-Hispanic white residents and 2.3 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents of Passaic County was 2.2 times the rate for non-Hispanic white residents.[42]

Somerset County. Non-Hispanic black residents of Somerset County had the highest asthma hospitalization rate—2.1 times the rate for non-Hispanic white residents and 2.2 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.98 times (two percent below) the rate for non-Hispanic white residents. When comparing Somerset County racial and ethnic groups to their state averages, rates for all groups were below their state averages (non-Hispanic black residents by 58 percent, Hispanic residents by 59 percent and non-Hispanic white residents by 33 percent).[43]

Sussex County. Non-Hispanic black residents of Sussex County had the highest asthma hospitalization rate—4.2 times the rate for non-Hispanic white residents and 4.6 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.91 times (nine percent below) the rate for non-Hispanic white residents. When comparing Sussex County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents differed less than one percent from the state average for non-Hispanic black people, while the rate for non-Hispanic white residents

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[41] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Cumberland County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Cumberland County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/cumberland.pdf

[42] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Passaic County and the state of New Jersey for 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Passaic County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/passaic.pdf

[43] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Somerset County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Somerset County Asthma Profile, p. 6. http://www.state.nj.us/health/fhs/chronic/documents/asthma_profiles/somerset.pdf

was below their state average by 18 percent and the rate for Hispanic residents was below their state average by 53 percent.[44]

Union County. Non-Hispanic black residents of Union County had the highest asthma hospitalization rate—2.5 times the rate for non-Hispanic white residents and 1.7 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 1.4 times the rate for non-Hispanic white residents. When comparing Union County racial and ethnic groups to their state averages, the rate for nonHispanic black residents was 44 percent below the state average for non-Hispanic black people, the rate for Hispanic residents was 29 percent below their state average and the rate for non-Hispanic white residents was 22 percent below their state average.[45]

Warren County. Non-Hispanic black residents of Warren County had the highest asthma hospitalization rate—2.7 times the rate for nonHispanic white residents and 4.9 times the rate for Hispanic residents. The asthma hospitalization rate for Hispanic residents was 0.55 times (45 percent below) the rate for non-Hispanic white residents. When comparing Warren County racial and ethnic groups to their state averages, the rate for non-Hispanic black residents was 17 percent below the state average for nonHispanic black people, and the rate for Hispanic residents was 63 percent below their state average. The rate for non-Hispanic white residents was five percent above their state average.[46]

Conclusion

Hope Creek and Salem nuclear power plants represent invaluable clean air assets in the Mid-Atlantic Region. New Jersey will never meet its Clean Air Act goals if any of these plants close. This means that citizen health will continue to deteriorate. The unique emission free generating characteristics of nuclear power plants make them state treasures. The plants represent direct health benefits to asthmatics. The plants are extra special in serving as a mitigating factor for air pollution for minorities in the state. New Jersey needs to do whatever is necessary to keep these power plants open.

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[44] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Sussex May County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Sussex County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/sussex.pdf

[45] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Union County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Union County Asthma Profile, p. 6. http://www.nj.gov/health/fhs/chronic/documents/asthma_profiles/union.pdf

[46] Asthma hospitalization rates per 100,000 population for select racial/ethnic groups in Warren County and the state of New Jersey from 2009–2012. New Jersey Department of Health, "Asthma in New Jersey," Warren County Asthma Profile, p. 6. http://www.state.nj.us/health/fhs/chronic/documents/asthma_profiles/warren.pdf

African American Environmentalist Association

Oral Statement of Norris McDonald

President

African American Environmentalist Association

Before the

New Jersey Legislature

Senate Environment and Energy Committee

And

Assembly Telecommunications and Utilities Committee

Public Hearing On

Strategies to Prevent the Premature Retirement of Existing, Licensed, and Operating Nuclear Power Plants

Committee Room 4, 1st Floor, State House Annex

Trenton, NJ

Monday, December 04, 2017 - 10:00 AM

1629 K Street, NW, Suite 300, Washington, DC 20006 (443) 569-5102
www.africanamericanenvironmentalistassociation.org

Chairmen and committee members, my name is Norris McDonald and I am the founder and president of the African American Environmentalist Association (AAEA). We are dedicated to protecting the environment, promoting the efficient use of natural resources, enhancing human, animal and plant ecologies, promoting increased African American ownership of energy resources and infrastructure and increasing African American participation in the environmental movement.

We support strategies to prevent the premature retirement of Hope Creek and Salem nuclear power plants. These existing, licensed, and operating nuclear power plants are an invaluable asset in mitigating air pollution in New Jersey. The state is in nonattainment for ozone, which is a component of smog, and negatively affects the health of New Jersey residents. Any support the New Jersey state legislature can provide would be a Godsend to people suffering from asthma and other air pollution related illnesses. Minority communities are particularly vulnerable to air related illnesses with the highest rates of asthma attack, emergency room visits and hospitalizations in the state. These vulnerable communities are helped by Hope Creek and Salem nuclear facilities ability to deliver incredible amounts of baseload electricity without producing any of the air pollution that hurts these areas.

We were the first environmental group in the United States to support nuclear power starting in 2001. We support nuclear power because operating the plants do not create smog-forming gases or greenhouse gases. We are also particularly interested in mitigating air pollution in New Jersey because African Americans represent most of the asthma hospitalizations in the vast majority of counties in New Jersey.

Nuclear power plants represent our most important facilities for efficiently producing large amounts of baseload electricity while not producing air polluting emissions. It is for these reasons that we support the PSEG nuclear fleet. Hope Creek and Salem nuclear facilities are invaluable clean air assets in New Jersey. Hope Creek and Salem are also uncredited assets in New Jersey's ongoing goals to improve air quality.

Air Pollution in New Jersey

Most people living in New Jersey live in counties with unhealthy levels of smog, according to an annual report by the American Lung Association, "The State of Air 2017." The group gave failing grades to 12 of New Jersey's 21 counties based on measurements of ozone, a pollutant that comes from power plant and vehicle emissions.

According to the report, the air quality in New Jersey ranks among the worst in the nation because of high concentrations of ground-level ozone pollution. In terms of ozone pollution, 11 New Jersey counties received an F grade. The counties receiving F grades include:

Bergen, Camden, Essex, Gloucester, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, and Ocean

According to the State of New Jersey Department of Environmental Protection Division of Air Quality, "New Jersey air quality...exceeds the current standards for ozone throughout the state and fine particles in urban areas." Losing a nuclear power plant will only make that problem worse. No nuclear plant should be allowed to close as long as any area in a state is in noncompliance of the Clean Air Act.

Asthma in New Jersey

According to Bhavini A. Doshi, Esq., in-house counsel at the City of Jersey City,

> It is well known that air pollution, particularly in densely populated urban areas with multiple sources of pollution, has real impacts upon short- and long-term human health. Children are especially vulnerable to asthma and other pollution-related symptoms, including death. Numerous studies have shown that Newark, for instance, faces "disproportionate impacts from multiple sources of air pollution."

New Jersey cannot reduce its asthma rates as long as its ambient air quality is in noncompliance with the Clean Air Act. According to the State of New Jersey Department of Health:

> In New Jersey, more than 600,000 adults and 167,000 children have asthma. Asthma affects all races, ages and genders. More boys have asthma than girls, but in adulthood, more women are diagnosed with asthma than men. Blacks, Hispanics and urban residents are more likely to be affected with asthma symptoms, as are individuals with a family history of the disease.

These rates will go up if the nuclear plants do not continue to run because the replacement generation that will operate is emitting emissions that are upwind of Salem County. Nuclear power plants do not add emissions into the atmosphere that lead to asthma symptoms.

Nuclear Power Benefits Are Essential To Compliance with Clean Air Regulations

States are required to submit State Implementation Plans (SIPs) to show how they intend to comply with the federal air quality standards set in accordance with the Clean Air Act.

SIPs do not explicitly include nuclear power as a compliance tool in meeting the requirements of the Clean Air Act. However they should include nuclear generation in that these resources avoid emissions the state must offset if they are lost, increasing

the cost and complexity of attaining these important health standards. Penalties for not achieving air standards include the possibility of losing highway construction funds and expensive permitting hurdles for new or expanded manufacturing and other facilities important to economic development. Therefore, preservation of existing nuclear power plants is an important compliance tool and numerous studies highlight the cost effectiveness of preserving existing power plants as compared to other emission reduction options.

Air Pollution and Environmental Justice in New Jersey

The State of New Jersey has an Office of Environmental Justice that is located at the Department of Environmental Protection (DEP) but that office has no authority to enforce disproportionate air pollution impacts. The state legislature needs a law that regulates locating facility and thoroughfare development projects in environmental justice areas.

Conclusion

Hope Creek and Salem nuclear power plants represent invaluable clean air assets in the Mid-Atlantic Region. New Jersey will never meet its Clean Air Act goals if any of these plants close. This means that citizen health will continue to deteriorate. The unique emission free generating characteristics of nuclear power plants make them state treasures. The plants represent direct health benefits to asthmatics. The plants are extra special in serving as a mitigating factor for air pollution for minorities in the state. New Jersey needs to do whatever is necessary to keep these power plants open.

Testimony of Dean Murphy, Ph.D. and Mark Berkman, Ph.D.

Before the New Jersey Legislature, Joint Assembly Telecommunications & Utilities (ATU) and Senate Environment & Energy (E&E) Committee

December 4, 2017

Qualifications

We are Principals of The Brattle Group, an economic and financial consulting firm headquartered in Boston, Massachusetts. Dr. Murphy has over 25 years of experience in energy economics, competitive and regulatory economics and finance, focusing on the electric industry. Dr. Berkman has more than 30 years of experience as an environmental economist with substantial experience regarding the environmental and economic impacts of power plants. Our backgrounds are summarized briefly in Exhibit 1.

Purpose

We have been asked by PSEG and Exelon to summarize the findings of our recent study of the economic and environmental contributions of the Salem and Hope Creek nuclear power plants in New Jersey. [1] A third New Jersey nuclear plant, Oyster Creek, will be retired in 2019 and was not analyzed in our study. The Executive Summary of our study is provided as Exhibit 2. We have completed several similar studies that have been cited and utilized by policymakers in New York, Illinois, Pennsylvania and Ohio.[2]

Summary of Findings

While keeping the Salem and Hope Creek nuclear plants operating might be expected to be costly for consumers, it could in fact save them money on their electricity bills – even if the plants need financial support to remain viable. In addition to keeping emissions down, these nuclear plants also keep electricity prices lower, which provides broader economic benefits in terms of GDP, jobs and state tax receipts. We modeled both the power sector and New Jersey's economy, first with and then without the Salem and Hope Creek nuclear plants, to estimate their effects on emissions, power prices and New

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1 This study was funded by PSEG and Exelon, the owners of the Salem and Hope Creek nuclear plants.

2 See "New York's Upstate Nuclear Power Plants' Contribution to the State Economy," December 2015; "Electricity Cost and Environmental Effects of Retiring the Quad Cities and Clinton Nuclear Plants," October 2016; "Pennsylvania Nuclear Power Plants' Contribution to the State Economy," December 2016; and "Ohio Nuclear Power Plants' Contribution to the State Economy," April 2017.

Jersey's economy. We found that these plants provide significant benefits to New Jersey that would be lost if the plants retire prematurely. Losing these plants would:

- Increase pollution, raising annual CO_2 emissions by almost 14 million tons, and other pollutants by tens of thousands of tons, adding an estimated $733 million a year in environmental and human health costs;
- Cause electricity prices to rise, costing New Jersey families and businesses $400 million more per year for electricity, on average over 10 years;
- Harm New Jersey's economy, reducing annual state GDP by $809 million on average;
- Result in the loss of 5,800 jobs across New Jersey's economy;
- Cause a reduction in state tax receipts estimated at $37 million.

These are gross economic benefits, before accounting for any cost of supporting the plants; of course any such costs must be balanced against these benefits.

Background

New Jersey's nuclear plants provide nearly half the power generated in the state, and account for over 90 percent of its emission-free power. While New Jersey is part of the much larger PJM power grid that stretches from New Jersey to Virginia and west to Illinois, the New Jersey nuclear plants nonetheless provide substantial economic and environmental value locally for New Jersey, as well as directly employing about 1,600 workers and paying substantial state and local taxes.

But around the country a number of nuclear plants are facing financial challenges that put them at risk of retiring prematurely. The root cause is low wholesale electricity prices, driven primarily by the shale gas revolution which has created an abundance of low-cost natural gas to fuel gas-fired power plants. Low electricity prices are good for consumers, but where they cause the loss of a nuclear plant, power prices rebound and pollution rises as additional fossil generation replaces the zero-emission output of the nuclear plant. Consequently, several states including New York and Illinois have recognized this and have chosen to support their nuclear plants in order to preserve their benefits.

Method

We estimate the economic and environmental impacts of the Salem and Hope Creek plants by simulating the regional power grid and New Jersey's economy, first with the nuclear plants operating, then a second time without them. We characterize power system operations of the entire Eastern Interconnection over the next ten years using a sophisticated capacity planning model. It shows, both with and without the nuclear plants, which plants operate how much and when, their carbon and criteria pollutant emissions, and new plant additions when necessary. It also characterizes wholesale electricity prices by region over time, for both energy and capacity products. The differences on these dimensions between the with-nuclear and without-nuclear cases are the effects attributable to the nuclear plants. These power sector effects have subsequent economic impacts on New Jersey, which we analyze using REMI, a commercially available and widely used macroeconomic model, to measure impacts on state GDP and employment.

Economic Impacts

While keeping these two nuclear plants operating to avoid a large emissions increase might be expected to be costly for consumers, the reality is that it could actually save consumers significantly on their electricity bills – even if the plants need financial support to remain viable. This is because in addition to keeping emissions down, these nuclear plants also keep electricity prices lower. The gross economic benefits noted above – $400 million in electricity cost savings, over $800 million in GDP and 5,800 jobs – are before accounting for any cost of supporting the plants, which of course must be netted against the benefits in evaluating any particular proposal.[3] But the magnitude of the gross economic benefits provided by these plants, which are in addition to their environmental benefits, suggests that any such proposal would warrant careful consideration.

Given that abundant inexpensive natural gas has driven wholesale power prices down so far that nuclear plants may not be able to recover their ongoing operating costs, it may seem counterintuitive that losing the nuclear plants would increase power costs. Yet it is a natural consequence of the interaction between supply and demand. The two South Jersey nuclear plants are very large suppliers of electricity that together provide a substantial share of New Jersey's total electricity needs, so their closure would cause a major reduction in regional supply. Because nuclear plants generate at full capacity all the time, they accept whatever hourly price the market offers; this keeps overall power prices low. If these plants close, the market would turn to other more costly generators, mostly outside New Jersey, which would push up the market price that everyone pays. As is the case in any market, a reduction in supply causes price to rise.

An increase in wholesale electricity prices would translate directly to higher costs for New Jersey electricity consumers. We estimate the price increase to be about 0.5¢/kWh, equivalent to a $3.64 per month increase in the utility bill of a typical New Jersey residential customer. While this may seem modest, this cost increase affects everyone who buys electricity – residences, businesses, commercial and industrial customers, government entities, non-profits – and totals $400 million per year in higher electricity costs across the state. Higher electricity costs leave businesses and consumers with less money to invest and spend in other ways, stifling economic output, jobs, and the overall economy. The loss of these plants would also reduce in-state productive activity, contributing further to the negative economic effect. About 79 percent of the lost nuclear generation replacement generation would be replaced by imports from other states, mostly from existing gas-fired generation, turning New Jersey into a large net importer that relies on out-of-state power sources for about a third of its electricity.

Higher electricity prices and the loss of in-state production would combine to reduce New Jersey's state GDP by $809 million per year, cause a loss of 5,800 jobs, and reduce state tax revenue by about $37 million. Both the GDP and the jobs effects would extend well beyond the nuclear and electricity sectors; much of the impacts would occur indirectly in other sectors as a result of the higher cost of electricity, which is distributed throughout the entire economy. So in addition to the nuclear plants' employees, suppliers and contractors, the general reduction in economic activity across New Jersey would cause job losses in virtually every sector of the economy. By preventing these higher electricity costs and keeping production within New Jersey, the South Jersey nuclear plants support the New Jersey economy.

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[3] It is also important to consider the effect on producers, as well as consumers, to understand the total social welfare effect.

Environmental Impacts

Of course, the premature closure of the Salem and Hope Creek plants would also have significant environmental consequences. Nuclear plants do not emit air pollutants, but shutting them down would mean replacing their output with fossil-fired generation, which does pollute. Even though most of the replacement would be gas-fired, which is cleaner than coal, replacing the very large output of these nuclear plants would mean a substantial increase in pollutants. Emissions of the criteria pollutants, SO_2, NO_X and particulates (PM_{10} and $PM_{2.5}$), would increase by tens of thousands of tons, and CO_2 emissions would increase by nearly 14 million tons. This is nearly a 70% increase over New Jersey's current power sector CO_2 emissions, making it considerably more difficult for the state to achieve its long-term CO_2 reduction goals, which may become more ambitious in light of governor-elect Murphy's call for 100% clean energy by 2050. It would certainly undo much of the recent progress that has been made in cutting emissions; the loss of the nuclear plants would add 14% to current total statewide CO_2 emissions. Put another way, these two nuclear plants are the CO_2 equivalent of 3 million cars – which is slightly more than the total number of automobiles registered in New Jersey.

The total social cost of this increase in pollution can be estimated using the social costs of each of the pollutants, which consider their environmental damage and human health impacts. We estimated the total social costs of the additional pollution to be $733 million per year across all these pollutants, using values calculated by the Interagency Working Group on Social Cost of Greenhouse Gases and the National Research Council of the National Academy of Sciences. These costs are independent of and in addition to the economic impacts discussed above. They reflect costs incurred by society and not directly by the economy; although these environmental and health costs would themselves have additional economic implications, those second-order impacts are not included here.

These impacts reflect total emission changes, including those that occur outside of New Jersey. We also examined the changes in emissions that would occur at a more local level. Although most of the replacement power would come from out of state, some of it would come from within New Jersey. We identified which in-state plants would increase their output and what increased emissions this would cause, for the criteria pollutants. We also identified the counties within New Jersey that are not currently in compliance with federal air quality standards for these pollutants and observed where this overlaps with an emissions increase. These overlaps would likely result in increased exposures and the associated health risks, and/or make it more costly to bring these pollutant levels into attainment with federal standards. Twelve northern New Jersey counties are in non-attainment for Ozone, which has been linked to a range of health effects from throat irritation to asthma, bronchitis and emphysema, and NO_x is the primary precursor of Ozone. The closure of the nuclear plants would increase NO_x emissions in many of these non-attainment counties, which would likely make it more difficult to meet the Ozone standard.

While we did not find counties out of attainment with respect to the other criteria pollutants, we did observe that emissions increases arise at plants located in or near some densely populated New Jersey counties, including the Newark metropolitan area. Although these increases might result in violations of federal standards and increase health risks, we could not make these determinations at a local level absent a detailed emissions impact study, which was beyond the scope of this study.

Hox

Conclusion

Our research has found that the Salem and Hope Creek nuclear plants provide significant economic and environmental benefits to New Jersey; those benefits would be lost if the plants retire prematurely. Losing these plants would:

- Increase pollution, raising annual CO_2 emissions by almost 14 million tons, and other pollutants by tens of thousands of tons, adding an estimated $733 million a year in environmental and human health costs;
- Cause electricity prices to rise, costing New Jersey families and businesses $400 million more per year for electricity, on average over 10 years;
- Harm New Jersey's economy, reducing annual state GDP by $809 million on average;
- Result in the loss of 5,800 jobs across New Jersey's economy;
- Cause a reduction in state tax receipts estimated at $37 million.

These nuclear plants hold down emissions of CO_2 and other air pollutants; without them, greater reliance on fossil-fueled power plants would cause a substantial increase in emissions, and accompanying environmental and human health damages. But rather than consumers having to pay for these environmental benefits, these nuclear plants also keep electricity prices lower and save consumers money. This benefits New Jersey's economy; state GDP will be higher with these plants operating than without them. The plants also keep jobs in New Jersey; this includes the direct plant employees and indirect suppliers and contractors, of course, but also many additional jobs spread throughout the economy and across the state. While the costs of keeping the plants operating must be balanced against the benefits, the size of the gross benefits suggests that a proposal to keep these plants operating would deserve serious consideration.

Summary of Qualifications

Dr. Dean Murphy is an economist with a background in engineering. He has expertise in energy economics, competitive and regulatory economics and finance, as well as quantitative modeling and risk analysis. His work centers on the electric industry, encompassing issues such as resource and investment planning (including power and fuel price forecasting), valuation for contract disputes and asset transactions, climate change policy and analysis, competitive industry structure and market behavior, and market rules and mechanics. He has addressed these issues in the context of business planning and strategy, regulatory hearings and compliance filings, litigation and arbitration. Dr. Murphy has examined these matters from the perspectives of investor-owned and public electric utilities, independent producers and investors, industry groups, regulators, system operators, and consumers. Dr. Murphy holds a Ph.D. in Industrial Engineering and Engineering Management and an M.S. in Engineering-Economic Systems, both from Stanford University, and a B.E.S. in Materials Science and Engineering from the Johns Hopkins University. Prior to joining The Brattle Group in 1995, Dr. Murphy worked as an associate with Applied Decision Analysis, Inc.

Dr. Mark P. Berkman is an expert in applied microeconomics. His experience spans the areas of the environment, energy, and natural resources; environmental health and safety; labor and employment; intellectual property; antitrust; commercial litigation and damages; and public finance. He has assisted both public and private clients and provided testimony before state and federal courts, arbitration panels, regulatory bodies, and legislatures. His environmental work has involved the review of proposed air, water, solid waste, and worker and product safety regulations. Dr. Berkman has quantified the costs and benefits of these regulations, as well as toxic tort and product liability claims. In addition, he has valued natural and water resources as well as property damages associated with pollution from Superfund sites, landfills, and power plants. His work on energy matters includes the valuation of coal resources, power plants, and transmission rights-of-way, and he has prepared energy demand and price forecasts. Prior to joining Brattle he was a co-founder and director at Berkeley Economic Consulting and a vice president at both Charles River Associates and NERA Economic Consulting.

Exhibit 2

Salem and Hope Creek Nuclear Power Plants' Contribution to the New Jersey Economy

Executive Summary

PREPARED BY

Mark Berkman, Ph.D.

Dean Murphy, Ph.D.

November 2017

THE Brattle GROUP

In recent years, wholesale electricity prices have declined significantly, due in large part to the shale gas revolution. Natural gas is the price-setting fuel in many U.S. electricity markets, and the dramatic reduction in its price has brought down electricity prices as well. Negligible demand growth and substantial amounts of new policy-driven renewable generation have also contributed. While lower power prices are generally a positive development for consumers, persistently low prices can threaten the economic viability of existing generators, whose premature retirement could offset much of the price reductions that have occurred. Nuclear generators in particular, because of their high fixed costs and effectively zero variable costs, tend to keep market prices low when they are operating, but are themselves financially vulnerable to sustained low power prices. Indeed, in the past few years, several nuclear plants have been retired prematurely for purely economic reasons, and a number of others are threatened. Because of the economic and environmental consequences that accompany the loss of nuclear generation, some states have implemented and others are considering policy mechanisms that would support existing nuclear power plants and prevent their premature retirement.

In this context, The Brattle Group has evaluated the contribution that the Salem and Hope Creek nuclear power plants in New Jersey make to the state's economy. We considered how these plants affect electricity markets and prices as well as in-state productive activity, and studied the resulting ramifications of these factors throughout the New Jersey economy. We found that these plants keep electricity prices lower than they would otherwise be, and also keep productive economic activity in-state. As a result, New Jersey's GDP will be higher with these plants operating than it would be without them. These plants also maintain jobs within New Jersey; not only the direct employees of the plants and the indirect jobs at suppliers and contractors that support plant operations, but also additional jobs throughout the economy that result from the overall economic boost associated with lower electricity prices and more in-state production. In addition, the continued operation of these nuclear plants holds down emissions of CO_2 and other air pollutants both within and outside New Jersey. In their absence, correspondingly more power would be produced by fossil-fueled power plants, causing a substantial increase in emissions.

In this analysis, we have not considered the structure or cost of any potential policy mechanism that may be necessary to ensure the continued operation of these nuclear plants. As a result, this analysis effectively calculates the gross economic benefits of preserving these plants, not the net benefit of a proposed policy that would do so.[1]

Our analysis has determined that over the next ten years (2018–2027), the Salem and Hope Creek plants operating in New Jersey:

- **Contribute approximately $809 million annually** to state gross domestic product (GDP).
- **Account for 5,800 in-state jobs** (direct and secondary).
- **Help keep electricity prices low.** New Jersey consumers would pay $400 million more for electricity annually, about $3.3 billion more in present value over the next ten years, without these two plants.
- **Are responsible for $37 million in state tax revenues** annually.
- **Avoid 13.8 million metric tons of CO_2 emissions annually** over the next ten years, valued at $585 million per year.
- **Avoid significant amounts of other air pollutants annually**, valued at $148 million per year over the next ten years.

These measures reflect the significance of these two nuclear power plants for the New Jersey economy, and are determined by comparing the performance of New Jersey's economy with

[1] A full analysis of any particular policy or proposal that would support these nuclear plants would need to incorporate the costs of that support, as well as any other aspects of the policy proposal. Also, while reductions in electricity costs do benefit consumers, the offsetting impact on producer revenues must also be considered to determine whether they improve total social welfare. Our analysis of economic impacts—GDP, jobs, and tax revenues—does account for the producer revenue impacts.

these plants operating to its performance without them. This approach nets out the economic contribution of the alternative generation that would substitute for these two plants—both the greater utilization of existing plants and the construction of new plants, as necessary—to determine the plants' incremental economic contribution. Absent the energy from these nuclear power plants, New Jersey and the broader region would rely more heavily on natural gas and coal-fired generating plants, many of which are outside New Jersey, leading to considerably greater reliance overall on out-of-state generation, and transforming New Jersey from being a modest importer, producing almost as much electricity as it consumes, to being a substantial net importer, procuring over a third of its electricity requirements from out of state. The increased reliance on fossil generation that would occur in the absence of these nuclear plants would cause higher emissions of carbon and other air pollutants, including in some current non-attainment areas of New Jersey. It would also raise power prices; without these two nuclear power plants, wholesale electricity prices in New Jersey and throughout the broader region would be higher. Higher prices would flow through to residential, commercial and industrial consumers as higher electricity bills. It is this effect on electricity prices that accounts for about half of the overall incremental economic impact; the reduction of in-state generation and associated economic activity is also important. Note that these measures reflect only the impacts within New Jersey, although the absence of these two New Jersey nuclear power plants will have significant additional negative consequences in the form of higher power prices beyond the state's borders.

Emissions of carbon dioxide (CO_2) and "criteria pollutants" identified by the Clean Air Act, such as nitrogen oxides (NOx) and sulfur dioxide (SO_2), would also be much higher in the absence of the Salem and Hope Creek plants, because the replacement generation would be almost entirely fossil-fired. Compliance with national ambient air quality standards (NAAQS), such as for ozone season nitrogen oxides (NOx) and small particulate matter ($PM_{2.5}$), could become more costly for other generators, both in-state and out of state. It would likely be more difficult for New Jersey to achieve targeted CO_2 reductions under any future climate policy. Further, the pollutant impacts are not limited to New Jersey, first because much of the replacement generation would come from outside New Jersey, and second because air pollution impacts can cross state borders—they are often regional in the case of criteria pollutants, and are global in the case of carbon dioxide.

Salem and Hope Creek Nuclear Power Plants' Contribution to the New Jersey Economy

PREPARED BY

Mark Berkman, Ph.D.

Dean Murphy, Ph.D.

November 2017

THE Brattle GROUP

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This report was prepared for PSEG and Exelon Generation. All results and any errors are the responsibility of the authors and do not represent the opinions of The Brattle Group or its clients.

The authors would like to acknowledge the invaluable assistance of Mike Kline, Andrew O'Brien, Duncan O'Brien, Paul Organ, and David Christopher in preparing this analysis.

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Executive Summary

In recent years, wholesale electricity prices have declined significantly, due in large part to the shale gas revolution. Natural gas is the price-setting fuel in many U.S. electricity markets, and the dramatic reduction in its price has brought down electricity prices as well. Negligible demand growth and substantial amounts of new policy-driven renewable generation have also contributed. While lower power prices are generally a positive development for consumers, persistently low prices can threaten the economic viability of existing generators, whose premature retirement could offset much of the price reductions that have occurred. Nuclear generators in particular, because of their high fixed costs and effectively zero variable costs, tend to keep market prices low when they are operating, but are themselves financially vulnerable to sustained low power prices. Indeed, in the past few years, several nuclear plants have been retired prematurely for purely economic reasons, and a number of others are threatened. Because of the economic and environmental consequences that accompany the loss of nuclear generation, some states have implemented and others are considering policy mechanisms that would support existing nuclear power plants and prevent their premature retirement.

In this context, The Brattle Group has evaluated the contribution that the Salem and Hope Creek nuclear power plants in New Jersey make to the state's economy. We considered how these plants affect electricity markets and prices as well as in-state productive activity, and studied the resulting ramifications of these factors throughout the New Jersey economy. We found that these plants keep electricity prices lower than they would otherwise be, and also keep productive economic activity in-state. As a result, New Jersey's GDP will be higher with these plants operating than it would be without them. These plants also maintain jobs within New Jersey; not only the direct employees of the plants and the indirect jobs at suppliers and contractors that support plant operations, but also additional jobs throughout the economy that result from the overall economic boost associated with lower electricity prices and more in-state production. In addition, the continued operation of these nuclear plants holds down emissions of CO_2 and other air pollutants both within and outside New Jersey. In their absence, correspondingly more power would be produced by fossil-fueled power plants, causing a substantial increase in emissions.

In this analysis, we have not considered the structure or cost of any potential policy mechanism that may be necessary to ensure the continued operation of these nuclear plants. As a result, this analysis effectively calculates the gross economic benefits of preserving these plants, not the net benefit of a proposed policy that would do so.[1]

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Our analysis has determined that over the next ten years (2018–2027), the Salem and Hope Creek plants operating in New Jersey:

- Contribute approximately **$809 million annually** to state gross domestic product (GDP).
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- Help keep electricity prices low. New Jersey consumers would pay $400 million more for electricity annually, about $3.3 billion more in present value over the next ten years, without these two plants.
- Are responsible for **$37 million in state tax revenues** annually.
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- Avoid **significant amounts** of other **air pollutants annually**, valued at $148 million per year over the next ten years.

These measures reflect the significance of these two nuclear power plants for the New Jersey economy, and are determined by comparing the performance of New Jersey's economy with these plants operating to its performance without them. This approach nets out the economic contribution of the alternative generation that would substitute for these two plants—both the greater utilization of existing plants and the construction of new plants, as necessary—to determine the plants' incremental economic contribution. Absent the energy from these nuclear power plants, New Jersey and the broader region would rely more heavily on natural gas and coal-fired generating plants, many of which are outside New Jersey, leading to considerably greater reliance overall on out-of-state generation, and transforming New Jersey from being a modest importer, producing almost as much electricity as it consumes, to being a substantial net importer, procuring over a third of its electricity requirements from out of state. The increased reliance on fossil generation that would occur in the absence of these nuclear plants would cause higher emissions of carbon and other air pollutants, including in some current non-attainment areas of New Jersey. It would also raise power prices; without these two nuclear power plants, wholesale electricity prices in New Jersey and throughout the broader region would be higher. Higher prices would flow through to residential, commercial and industrial consumers as higher electricity bills. It is this effect on electricity prices that accounts for about half of the overall incremental economic impact; the reduction of in-state generation and associated economic activity is also important. Note that these measures reflect only the impacts within New Jersey, although the absence of these two New Jersey nuclear power plants will have significant additional negative consequences in the form of higher power prices beyond the state's borders.

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the Salem and Hope Creek plants, because the replacement generation would be almost entirely fossil-fired. Compliance with national ambient air quality standards (NAAQS), such as for ozone season nitrogen oxides (NOx) and small particulate matter ($PM_{2.5}$), could become more costly for other generators, both in-state and out of state. It would likely be more difficult for New Jersey to achieve targeted CO_2 reductions under any future climate policy.[2] Further, the pollutant impacts are not limited to New Jersey, first because much of the replacement generation would come from outside New Jersey, and second because air pollution impacts can cross state borders—they are often regional in the case of criteria pollutants, and are global in the case of carbon dioxide.

I. Background

Three nuclear power plants, comprising 4 nuclear reactors, operate in New Jersey; see Figure 1. The Oyster Creek Nuclear Generating Station, a single-unit boiling water reactor plant located about 75 miles south of New York City, is scheduled to be shut down permanently at the end of 2019. The Salem Nuclear Power Plant consists of two pressurized water reactors and is located 30 miles south of Wilmington, Delaware; Units 1 and 2 are licensed to operate until 2036 and 2040, respectively. The Hope Creek Nuclear Generating Station, a single-unit boiling water reactor adjacent to the Salem plant, is licensed to operate until 2046. Together, these four reactors represent 4,100 megawatts (MW) of generating capacity and almost 32 million megawatt hours (MWh) of annual electricity generation, as shown in Table 1. After the closure of Oyster Creek, the remaining two plants will account for 3,500 MW of capacity and almost 27 million MWh of annual generation.

New Jersey is a part of the PJM Interconnection, the electric region operated by the PJM independent system operator.[3] PJM encompasses much more than just New Jersey, both geographically and electrically; New Jersey accounts for about 10% of PJM's total generation and load. Within New Jersey itself, these three nuclear power plants represent a very large share of generation and capacity at 43% and 26%, respectively, as illustrated in Figure 2.

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[2] We do not consider a national climate policy in this study. Although the Clean Power Plan, EPA's rule to limit greenhouse gas emissions from existing power plants, nominally would take effect in 2022, the Trump administration has announced its intention to reverse it.

[3] The PJM ISO operates the power system, as well as establishing and operating markets for electric capacity and energy.

Figure 1: Locations of New Jersey Nuclear Power Plants

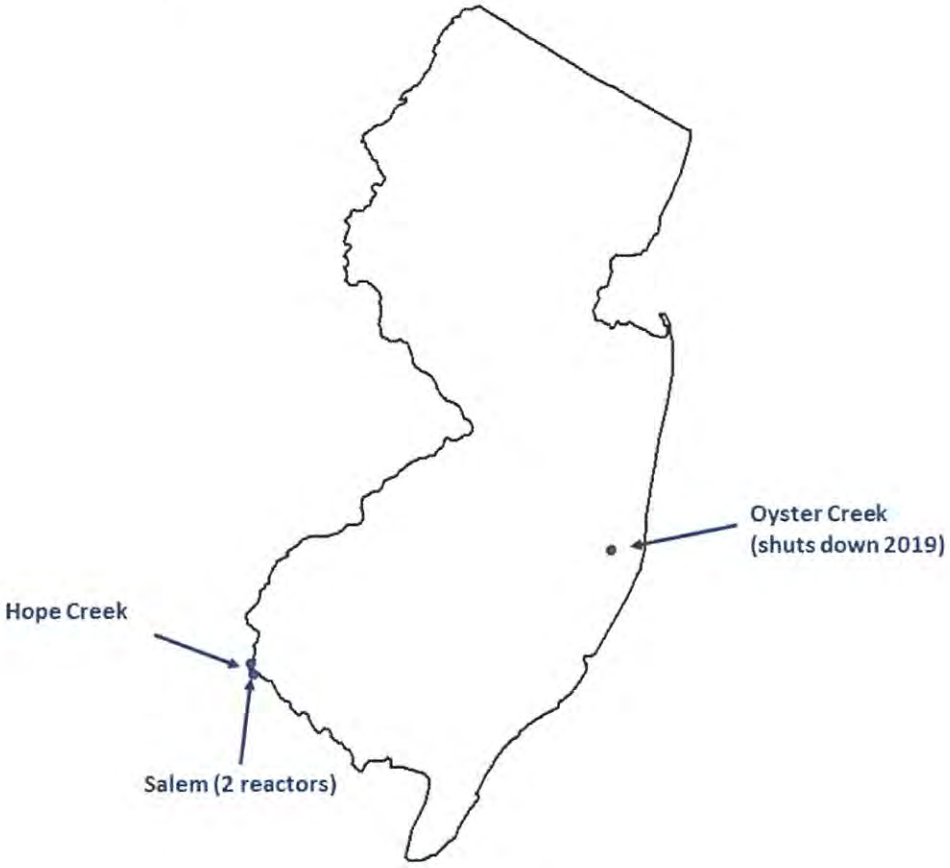


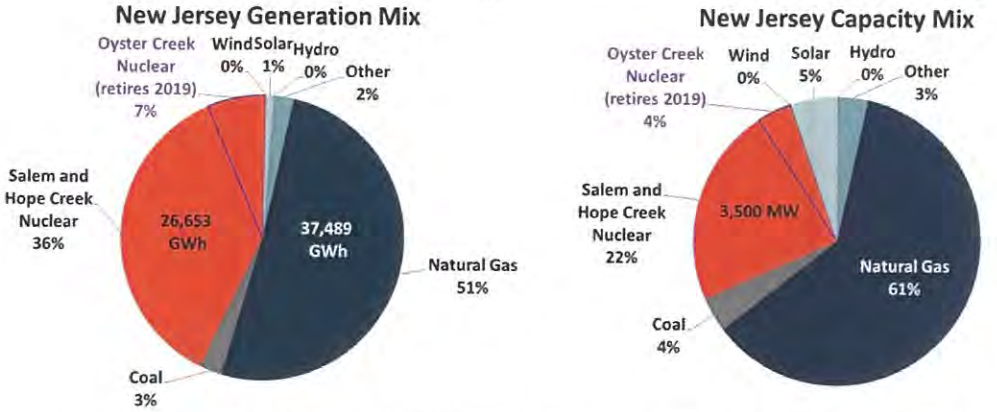
Table 1: Summary of New Jersey Nuclear Power Plants

Item	Oyster Creek	Salem	Hope Creek	**Total New Jersey Nuclear through 2019***	**Total New Jersey Nuclear after 2019***
Number of Units	1	2	1	**4**	**3**
Total Net Summer Capacity (MW)	608	2,328	1,172	**4,108**	**3,500**
Average Annual Generation (GWh)	4,898	16,858	9,796	**31,551**	**26,653**

Sources & Notes: Data from ABB, Inc., Energy Velocity Suite. Average annual generation is the average of 2014–2016.

*Oyster Creek is scheduled to shut down permanently at the end of 2019; only Salem and Hope Creek remain beyond 2019.

Figure 2: New Jersey Electricity Generation and Capacity Shares, by Fuel



Sources & Notes: EIA Form 923, via ABB, Inc., Energy Velocity Suite. Generation is average 2014-2016 historical values; capacity is as of September 2017.

II. New Jersey's Nuclear Power Plants Make a Considerable Contribution to the State's Economy and Environment

We have estimated the economic value of the Salem and Hope Creek plants to the state of New Jersey using REMI, a widely-used regional economic model.[4] Our analysis covers a ten year period, 2018-2027. The effect of these two plants on the New Jersey economy occurs through two main channels. First, electricity costs are lower for New Jersey consumers with the nuclear power plants operating than they would be without them. The absence of the Salem and Hope Creek plants would increase wholesale prices for energy and capacity in the region, since it would reduce the available supply of both (more costly plants would need to operate, setting higher energy prices; although the nuclear plants' capacity would not need to be replaced immediately, their absence would diminish the current capacity surplus, raising capacity prices). Higher wholesale prices translate directly to higher retail prices and customer costs in a restructured state like New Jersey. The second major economic effect is that with its nuclear power plants operating, New Jersey produces almost as much power as it consumes, but it would become a significant net importer without them. The loss of in-state power production would mean a material reduction in economic activity within the state.

A major non-economic effect of these nuclear power plants is to hold down emissions of CO_2 and criteria pollutants. Virtually all of the replacement power that would substitute for the output of these two plants would be fossil-fired generation; these effects are discussed in Section II.F.

To characterize the electricity market effects that drive the economic effects, we utilize a proprietary power market simulation model, Xpand, which models capacity expansion and retirement as well as dispatch to capture the dynamics of power system operation, power

[4] For more details on the REMI model, see www.remi.com.

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markets, and prices. We use this power sector model to characterize the effects of these two nuclear power plants on power prices, power costs to consumers, power plant revenues, and new plant construction activity. These power sector impacts then become inputs to the REMI economic model. This approach allows us to develop the most accurate picture of the plants' incremental contribution to the economy, in terms of economic output, employment, and tax revenues. Although we simulate the power system for the entire Eastern Interconnection to best capture the interstate electricity market effects, only the economic impacts that occur within New Jersey are reported.

We analyze the power sector and the economy both with and without the Salem and Hope Creek plants, to determine the economic effects attributable to them (the Oyster Creek plant is modeled as operating through 2019 in both cases). Our analysis indicates that keeping these two plants operating will keep electricity costs lower in New Jersey, as well as in the broader PJM region, and the resulting lower electricity costs are a substantial contributor to the gross economic benefit of these plants to the New Jersey economy. The other key contributor to economic impact is the productive economic activity associated with these plants. Even after netting out the economic contribution of the alternative electric generation that would substitute for them in their absence, these two nuclear power plants are responsible for a GDP impact of $809 million dollars annually, and accompanying employment and tax revenue effects (they also avoid significant environmental costs, as discussed later). Table 2 summarizes our findings for the economic impacts of these plants within New Jersey. Again, these represent the gross impacts of these nuclear plants, without accounting for the cost of any policy that may be necessary to maintain their operation.

Table 2: Gross Contribution of Salem and Hope Creek Plants to the New Jersey Economy (10-Year Average Annual Impacts, 2018–2027)

Direct and Secondary GDP *(2017 dollars)*	$809 million
Direct and Secondary Employment *(jobs)*	5,800
Direct	1,400
Secondary	4,400
State and Federal Taxes *(2017 dollars)*	
Direct and Secondary State Tax Revenues	$37 million
Direct and Secondary Federal Tax Revenues	$204 million

Our analysis shows that the Salem and Hope Creek plants are responsible for $809 million in state GDP and 5,800 jobs (considerably more secondary jobs than direct jobs, as discussed below). Much of the GDP and jobs effect is indirect, based in part on the plants' effect on electricity costs to consumers, rather than resulting from economic activity that is directly associated with the

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plants themselves. Because every sector of the economy depends on electricity, the power price effect is extraordinarily widespread, thus contributing to a substantial overall impact.[5]

The owners of these two nuclear power plants also pay significant federal and state taxes, as do businesses providing goods and services to the plants and their employees. In addition, the plants' incremental contributions to the state's economy account for additional tax revenues to state and local governments—considerably more than the direct taxes paid by the plants. The effect of these two nuclear power plants on the economy leads to about $37 million in incremental state tax revenues and $204 million in federal tax revenues, beyond the tax revenues that would be available in their absence.

Below, we provide further detail regarding the impact of the Salem and Hope Creek plants on:

- The electricity generation mix
- The price and cost of electricity
- Economic output and GDP
- Employment
- Federal and state tax revenues
- Emissions of CO_2 and other pollutants.

A. Impact on Electric Generation Mix

With the Salem and Hope Creek plants operating, New Jersey is a modest net importer of power, producing slightly less than it consumes, as shown in the left panel of Figure 3 below. The right panel shows the situation in New Jersey without these nuclear plants; the state would become a significant net importer of power, relying on out-of-state sources for over a third of its aggregate electricity needs. The missing nuclear generation would be replaced by increased reliance on natural gas and coal-fired generation. Some of this would come from in-state sources, but the large majority would be imported from other states.[6] The reduction in economic activity that

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5 Our analysis reflects current expectations for natural gas prices, as represented by the Reference natural gas price projection from the U.S. Energy Information Administration's Annual Energy Outlook 2017. We also examined the sensitivity of our results to materially higher or lower natural gas prices, since natural gas is a key factor in regional electricity markets. We found that in a higher gas price environment, these nuclear power plants would have a somewhat larger effect on GDP, and lower gas prices would slightly decrease their economic impact. The plants' effects on electricity price and emissions go in the other direction, being somewhat smaller at high gas prices, and larger at low gas prices.

6 New Jersey is part of the large, multi-state PJM power market, which dispatches generators to serve load without regard to state boundaries. In normal power system operation, the most economic

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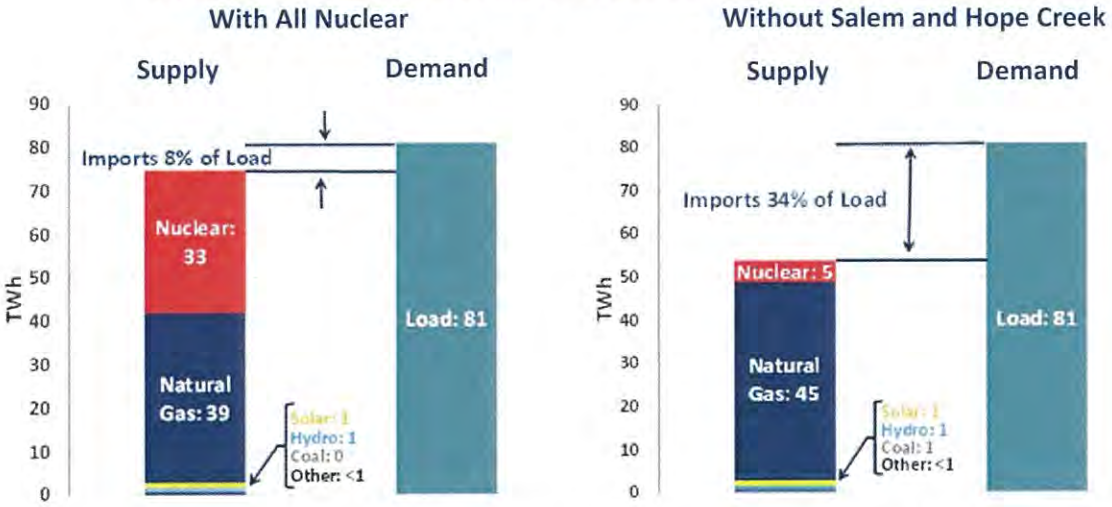
accompanies the loss of in-state generation is responsible for a significant share of the overall economic effect.

Large-scale renewable energy probably would not increase significantly in the near term beyond the additions that would occur if the nuclear plants do continue operating. Because of the significant magnitude of nuclear output relative to the small current scale of renewables and the likely pace of renewable additions, it is unlikely that enough incremental new renewable generation could or would be added to offset a significant share of the lost emission-free generation of the nuclear plants.

Figure 3: Electric Generation and Load in New Jersey (2018 Projection)



Note: This characterization precedes Oyster Creek's 2019 shutdown, after which its 5 TWh of generation will be removed from both panels, replaced by a mix of mostly imports and some in-state gas generation.

B. Impact on Electricity Prices

As noted above, absent the Salem and Hope Creek plants, electricity demand would be met by increased utilization of natural gas and coal-fired plants, some within New Jersey but most from outside the state. The reduction in supply would increase wholesale energy and capacity prices, which means higher electricity prices for customers in New Jersey and across PJM.[7] As shown in

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available generation is used to meet load. If the nuclear plants are absent, the next most economical source of generation to replace their output will often be outside New Jersey.

7 Wholesale electricity prices can be characterized as energy and capacity price. Energy price is the cost of providing an additional small unit of electric energy over time horizons as short as an hour; it is based on the variable cost of the last unit providing power at a given time, typically in units of dollars per megawatt-hour. Since short-term energy can only be provided if there is enough generating capability installed and ready to operate, there is also value in the longer term to having sufficient

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Table 3, average power prices in New Jersey would be $4.99/MWh higher without these two nuclear power plants.[8] Because the PJM-East region that includes New Jersey needs its own local generating capacity, the loss of the large amount of capacity from these plants causes a notable increase in capacity prices within this region. (There is currently a modest capacity surplus in PJM-East; the loss of these two plants would eliminate much of that surplus in the near term, raising capacity prices.[9]) In fact, the capacity price effect accounts for over half of the total electricity price effect in PJM-East. The overall average price effect in PJM as a whole is considerably smaller at $1.30/MWh; outside PJM-East, the energy price effect is smaller, and the capacity price effect is slightly negative.

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available capacity for when it may be needed. This capacity value (the capacity payment that may be earned by a kilowatt of generating capacity) is often expressed in terms of dollars per kilowatt-year.

8 The electricity sector model used here depicts six sub-regions within PJM. New Jersey is contained entirely within one of these, PJM-East, which also includes the Philadelphia metro area in south-eastern Pennsylvania, and the Delmarva Peninsula (Delaware, the Eastern Shore of Maryland and the Eastern Shore of Virginia). The New Jersey average effect is assumed to be the same as the PJM-East average effect (*i.e.*, we do not consider transmission congestion within the PJM-East sub-region). The PJM average is the load-weighted average across all six PJM sub-regions.

9 Capacity price effects can be difficult to ascertain with confidence, because the market response can be hard to predict (*e.g.*, the extent to which market forces will offset a loss of one source of capacity by retaining others or adding new capacity). Our analysis here finds that the market response is significant and the loss of nuclear capacity would be largely offset; this mitigates the capacity price response, yielding a conservatively small overall price effect.

Table 3: Salem and Hope Creek Plants Avoid Higher Electricity Prices (All-in Power Price and Cost Differences due to Salem and Hope Creek Plants)

	% of Utility Load[1]	Power Price Change without Nuclear ($/MWh)[2]	Wholesale Electric Demand (millions of MWh)	Annual Electricity Cost Change (2017 $millions)	Total Electricity Cost Increase Over 10 Years (2017 $millions)[3]
New Jersey Average		**$4.99**	**80**	**$400**	**$3,311**
Residential	39%		31	$155	$1,283
Commercial/Industrial	61%		49	$245	$2,028
PJM Average		**$1.30**	**823**	**$1,073**	**$8,949**
Residential	37%		306	$399	$3,324
Commercial/Industrial	63%		518	$674	$5,626

[1]Load share by customer class is based on data from 2015, EIA Form 861.

[2]The reported Power Price Change includes only energy and capacity cost effects; does not include transmission costs, customer costs, etc. Power Price Effects are assumed to be the same, on an average per-MWh basis, for all customer classes; differences in load shape and billing determinants are not distinguished here.

[3]Present value for the 10-year period at a 3% discount rate.

This $4.99/MWh price increase in New Jersey translates to about $3.64 per month for a typical residential ratepayer; across all New Jersey consumers, this represents an increase of $400 million per year in electricity costs, or about $3.3 billion in present value over ten years.[10] Across the state, about 39% of these increased costs would fall on residential customers, and 61% on commercial and industrial customers. Preventing higher electricity prices is a major means by which these nuclear power plants benefit New Jersey's economy. By keeping electricity prices lower, these plants leave residential, commercial, and industrial consumers with more money to spend and invest in other ways; this boosts jobs, output, and the overall economy (though again, these are the gross impacts, without accounting for the cost of any nuclear support mechanism).

C. Impact on Economic Output

The Salem and Hope Creek plants contribute an average of $809 million to annual state GDP ($1.29 billion in gross output), in part through the electricity price effects shown above, and also

[10] Electricity transmission requirements might affect the level and the geographic distribution of electricity costs. Although local and possibly regional transmission needs could differ in the absence of these nuclear power plants, this report does not consider the effects on the transmission system nor potential changes in transmission investments. Transmission costs could, however, be substantial if a premature transition from nuclear to natural gas were to occur, as noted by a PJM study regarding the closure of nuclear plants in Illinois. See PJM Response to Illinois Commerce Commission (ICC) Request to Analyze the Impact of Various Illinois Nuclear Power Plant Retirements, 10/21/2014. PJM found that premature retirement would require "substantial time to correct"; "would require substantial construction activity and could significantly inconvenience Illinois citizens"; and "[transmission] costs would be significant—in the hundreds of millions of dollars or more" (page 7).

through the economic activity associated with in-state electricity production. This GDP effect includes both direct and secondary economic activity attributable to these plants, netting out the economic activity associated with alternative generation in their absence, to the extent this replacement generation occurs within New Jersey. The largest effect is found in the utilities sector, as expected, followed by the construction and manufacturing sectors, as shown in Table 4.

Table 4: GDP and Gross Output Impacts by Sector in New Jersey
(10-Year Average Annual Direct and Secondary Impacts in Millions of 2017 Dollars, 2018–2027)

Sector	Output Impact
Utilities	$411
Construction	$184
Manufacturing	$154
Retail Trade	$69
Professional, Scientific, and Technical Services	$68
Real Estate and Rental and Leasing	$62
Health Care and Social Assistance	$45
Wholesale Trade	$39
Accommodation and Food Services	$30
Information	$29
Other	$201
Gross Economic Output Impact, Direct and Secondary*	$1,292
GDP Impact, Direct and Secondary	$809

* Gross economic output is an aggregate measure of total industry sales, which includes sales to final users and intermediate sales to other industries. Summing output across sectors can lead to a form of double counting when the output of one sector is the input of another. GDP, the most widely-used measure of economic performance, reflects value added, which includes industry sales to other industries and to final users, net of the value of purchases from other industries. It removes this double counting and is thus a better measure of the aggregate economic effect.

D. Impact on Employment

The Salem and Hope Creek plants account for 5,800 direct and secondary jobs in the state's economy, as shown in Table 5. Direct jobs include those positions necessary for plant operations such as engineers and technicians as well as security and administration. We find a net loss of about 1,400 jobs in the power sector.[11] As with the economic impact, the overall jobs impact

[11] There are roughly 1,600 direct employees at the plants, not including contractors and suppliers such as the 1,000 temporary jobs associated with twice-annual refueling and maintenance outages. If the plants close, the lost direct jobs are partly offset by an increase of about 200 jobs associated with the increase in in-state non-nuclear generation that partly offsets the loss of the nuclear output.

occurs in large part indirectly; not necessarily as employment within the nuclear and electricity sectors, but as enhanced secondary employment in other sectors, caused largely by the economic effect of lower power prices. As shown in Table 5, in addition to the occupations directly impacted by the nuclear plants, the employment sectors most influenced are sales, construction, and business and financial occupations.

Table 5: Net Employment Impacts by Category in New Jersey
(Direct and Secondary Impacts, Number of Jobs, 10-Year Average, 2018–2027)

Category	Employment Impact
Sales and related, office and administrative support occupations	1,220
Construction and extraction occupations	780
Management, business, and financial occupations	510
Installation, maintenance, and repair occupations	350
Food preparation and serving related occupations	330
Building and grounds cleaning and maintenance, personal care and service occupations	280
Transportation and material moving occupations	270
Production occupations	260
Healthcare occupations	250
Computer, mathematical, architecture, and engineering occupations	240
Other	1,310
Total	5,800

Note: Numbers may not sum due to independent rounding.

E. Impact on Federal and State Tax Revenues

The Salem and Hope Creek plants and the businesses providing goods and services to these plants pay substantial state and federal taxes. In addition, since these plants keep electricity prices lower and keep productive activity within the state, they create incremental economic output and associated tax revenues throughout the economy. We used the recent historical relationship between New Jersey GDP and tax payments at both the state and federal levels to estimate the tax revenue impact of the plants. Using this approach, average incremental annual state tax payments attributable to these plants are estimated at $37 million, and average annual federal tax payments at $204 million, as shown in Table 6.

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Table 6: Annual Federal and State Tax Payments Attributable to Economic Activity Related to the Salem and Hope Creek Plants (10-Year Average Annual Impacts, in 2017 Dollars, 2018-2027)

Direct and Secondary State Tax Revenues	$37 million
Direct and Secondary Federal Tax Revenues	$204 million
Total Federal and State Tax Revenues	$241 million

F. Salem and Hope Creek Plants Prevent Substantial Carbon Dioxide and Criteria Pollutant Emissions within and outside the State

The Salem and Hope Creek plants prevent substantial emissions of CO_2, SO_2, NO_X, and particulate matter ($PM_{2.5}$ and PM_{10}), compared to the alternative of natural gas and coal-fired generation that would replace their output. We have not included a national climate policy in our simulations. Although broad climate policy rules such as the Clean Power Plan (CPP) or alternative greenhouse gas restrictions might affect the emissions impacts of nuclear power plants, the Trump administration has initiated activities to review and potentially reverse the CPP, which had been stayed pending legal challenges even before that. We do represent existing state-level policies such as Renewable Portfolio Standards and the Regional Greenhouse Gas Initiative (RGGI), where they apply.

To understand the potential emissions effects, it is helpful to characterize the differences in generation with and without the Salem and Hope Creek plants. The entire Eastern Interconnection is an integrated power system, and most of the power needed to replace the output of these two plants would come from outside New Jersey (simply because New Jersey supply accounts for a small share of total Eastern Interconnection supply, not because New Jersey's swing supply is necessarily less economic). Natural gas is typically the marginal electricity fuel in the region, which means that most of the replacement energy would come from gas. Table 7 shows that 79% of the replacement generation would come from outside New Jersey, and that 85% of the total replacement energy would be fired by natural gas.

Table 7: Changes in Generation to Replace Salem and Hope Creek Plants (10-Year Average Annual GWh, 2018-2027)

	New Jersey	Outside New Jersey	Total
Gas	4,328	19,070	23,398
Coal	1,529	2,616	4,145
Wind	0	18	18
Solar	0	77	77
Other	2	31	33
Total	5,858	21,813	27,671

The corresponding emissions offsets provided by these two nuclear power plants are summarized in Table 8. Average annual power sector CO_2 emissions would be about 13.8 million metric tons greater absent these two plants.[12] To put this in perspective, this would be equivalent to adding about 3 million cars to the road – which would about double the total number of automobiles in New Jersey.[13] Alternatively, this would represent a 69% increase relative to New Jersey's current power sector CO_2 emissions. The magnitude of this increase reflects the fact that these two nuclear power plants account for a large initial share (36%) of New Jersey's generation mix. If they were absent, fossil-fired power, much of it imported, would increase by a very large amount relative to the historical New Jersey fossil baseline. Overall power sector SO_2 emissions would increase by more than 4,000 tons; this increase is 88% of the current in-state SO_2 emissions, which are relatively low since New Jersey has little coal.[14] Similarly, overall NOx, PM_{10}, and $PM_{2.5}$ would all increase by more than current New Jersey emissions levels.[15]

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[12] Throughout this paper, references to tons are in metric tons; 1 metric ton = 1.10231 short tons. Emissions of CO_2 and criteria pollutants will already experience an increase when the Oyster Creek nuclear power plant retires at the end of 2019. The Oyster Creek effect does not contribute to the differences shown here, however, since it is modeled as retiring at the same time regardless of the status of the Salem and Hope Creek plants.

[13] This is based on EPA's estimate of 4.7 tons CO_2 annually per automobile. EPA, "Greenhouse Gas Emissions from Passenger Vehicles," May 2014, EPA 420-F-14-040a. In 2015, 2.92 million automobiles were registered in New Jersey; Federal Highway Administration, Highway Statistics 2015.

[14] The effect of these nuclear power plants on SO_2 emissions is limited by the EPA's Cross-State Air Pollution Rule (CSAPR), which caps the allowed emissions of SO_2 from some units. This cap is binding even with the nuclear power plants operating, and so in their absence, additional operational changes are required. These changes partly mitigate the direct effects on SO_2 emissions, which would otherwise be larger.

[15] In comparing these emissions increases with current New Jersey emission levels, note that although the emissions increase would be triggered by the absence of nuclear generation in New Jersey, only part of the total emissions increase actually occurs within New Jersey, since most of the replacement generation comes from outside the state.

Table 8: Emissions and Social Cost Prevented by the Salem and Hope Creek Plants in the Eastern Interconnection (10-Year Average Annual Impacts, 2018–2027)

Pollutant	Avoided Emissions (tons)	Social Cost ($/ton)	Avoided Emissions Value (2017 $millions)
CO_2	13,779,652	$42	$585
SO_2	4,331	$7,546	$33
NO_x	6,367	$2,082	$13
PM_{10}	9,537	$598	$6
$PM_{2.5}$	7,778	$12,360	$96
Total			$733

Sources: Social cost of carbon is from the Interagency Working Group on the Social Cost of Carbon, United States Government. Social costs of other pollutants are from "Hidden Cost of Energy: Unpriced Consequences of Energy Production and Use," National Research Council, 2010.

The overall social cost of these incremental emissions can be estimated using the federal government's social cost of carbon ($42/ton)[16] and the National Academy of Science's externality cost estimates for SO_2, NO_X, PM_{10}, and $PM_{2.5}$. Evaluated at these rates, which are shown in Table 8, the average annual avoided social cost of CO_2 is $585 million, and the avoided costs of SO_2 and NO_X are $33 million and $13 million, respectively. The avoided costs of PM_{10} and $PM_{2.5}$ emissions are approximately $6 million and $96 million, respectively. These costs reflect environmental and human health damages and are independent of and in addition to the direct and secondary economic impacts, assessed above, that result from higher power prices and reduced in-state power production. They reflect costs incurred by society, not directly by the economy; the subsequent economic implications of these social costs are not reflected in the economic results above, but would be in addition to those values.

Because most of the replacement generation comes from outside New Jersey, most of the increase in emissions also occurs outside the state. Even so, the incremental criteria pollutants that are emitted within New Jersey may have substantial local impacts. In Appendix A, we discuss some of the potential local emissions effects of criteria pollutants, including how they may impact non-

[16] The social cost of carbon used here, $42 per ton of CO_2, is the central value (based on a 3% discount rate) determined by the Interagency Working Group on Social Cost of Greenhouse Gases, for 2015, converted to 2017 dollars. See the EPA Fact Sheet, Social Cost of Carbon, December 2015. Although President Trump issued an Executive Order that withdrew documentation of the working group's social cost of carbon estimate, it does not provide an alternative value. Nonetheless, the social cost of carbon has always been associated with significant uncertainty, and is now more controversial.

attainment areas in New Jersey—those areas that are currently in non-attainment for federal air quality standards for one or more of the criteria pollutants.

Appendix A. Local Environmental Impacts

Since criteria pollutants can affect local air quality, it is also important to consider the location of these emissions impacts. We have done so by mapping all of the power plants in New Jersey, locating them within New Jersey counties, and determining what change, if any, they would experience in generation and emissions in the absence of the Salem and Hope Creek plants. The locations of the New Jersey power plants are presented in Figure A-1, and the plants are identified in Table A-1.

Figure A-1: New Jersey's Power Plant Locations

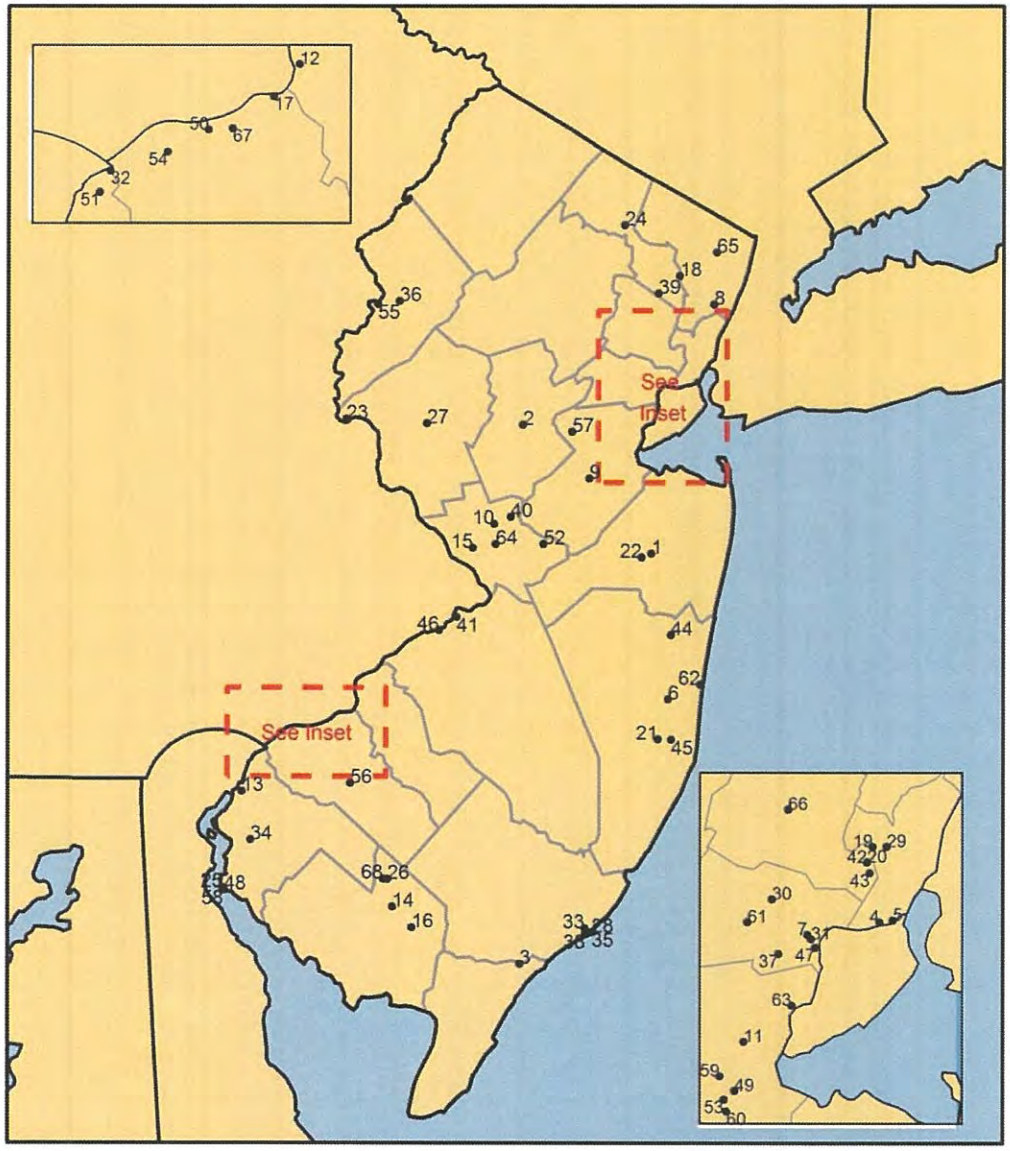

Table A-1: New Jersey's Power Plant Key

Item	Plant	Item	Plant
1	Asbury Park Press Inc	35	Marina Energy
2	Aventis Pharmaceuticals	36	Masterfoods USA
3	B L England	37	Merck Rahway Power Plant
4	Bayonne Cogeneration Plant	38	Midtown Thermal Control Center
5	Bayonne Energy Center	39	Montclair Cogeneration
6	Bayville Central Facility	40	NRG Energy Center Princeton Hospital
7	Bayway Refinery	41	National Gypsum CHP
8	Bergen	42	Newark Bay Cogeneration Project
9	Bristol Myers Squibb	43	Newark Energy Center (NJ)
10	Bristol Myers Squibb Lawrenceville	44	Ocean Peaking Power LP
11	CPV Woodbridge Energy Center	45	Oyster Creek Nuclear Generating Station
12	Camden Cogeneration	46	PSEG Burlington Generating Station
13	Carneys Point Generating Plant	47	PSEG Linden Generating Station
14	Clayville Switch GT	48	PSEG Salem Generating Station
15	College of New Jersey	49	Parlin
16	Cumberland (NJ)	50	Paulsboro Refinery
17	Eagle Point Cogeneration	51	Pedricktown Cogeneration Plant
18	Elmwood Park	52	Princeton University West Windsor Solar
19	Essex (NJ PSEG)	53	Red Oak
20	Essex County Correctional Facility	54	Repauno Products
21	Forked River	55	Roche Vitamins Inc
22	Freehold Ashbury Park Press	56	Rowan University
23	Gilbert	57	Rutgers University Busch Cogeneration
24	Hoffmann Laroche Inc	58	Salem Nuclear Power Plant
25	Hope Creek Nuclear Power Plant	59	Sayreville
26	Howard M Down	60	Sayreville Cogeneration Facility
27	Hunterdon Cogeneration	61	Schering Cogen Facility
28	Inlet District Energy Center	62	Seaside Heights Power Plant
29	Kearny Generating Station	63	Sewaren
30	Kenilworth Energy	64	Trigen Trenton
31	Linden Cogen Plant	65	United Water
32	Logan Generating Plant	66	Univ Medicine Dentistry
33	MTF Combined Heat & Power Facility	67	West Deptford Power Project
34	Mannington Mills Cogen	68	West Station

Note: Includes plants currently operating. Plants that have announced a shutdown date are removed from the study at that date.

We also considered whether the county is in attainment with Clean Air Act standards for criteria pollutants, and checked for instances where a plant that is located within a non-attainment area for a particular pollutant would increase its emissions of that pollutant in the absence of the Salem and Hope Creek plants. This analysis is illustrated in a series of maps below. Each map illustrates, for a given pollutant, the New Jersey generating plants, indicating whether their emissions increase (red dot), stay the same (black dot) or fall (blue dot), in the absence of the Salem and Hope Creek plants. The size of the dot indicates the magnitude of the change in emissions. We pay particular attention to those counties that are not currently in attainment with U.S. EPA standards under the Clean Air Act for one or more of the criteria pollutants; these counties are shaded on the relevant maps.

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This analysis reveals that absent the Salem and Hope Creek plants, there are a number of instances in which fossil plant emissions of a criteria pollutant would increase in a county that is already in non-attainment for that pollutant. This can be seen where there is a red dot within a shaded county, indicating that a power plant located in a non-attainment area is increasing its emissions. In fact, because those locations are already out of compliance, additional actions may be required to mitigate these emissions increases, possibly including redispatch to utilize more costly generation sources located outside the non-attainment area, or to add costly emissions controls to the affected plants. These additional actions could increase the electricity cost effect beyond our estimates. Emissions increases in locations that are currently in compliance with federal standards could potentially push some of them into non-compliance, creating similar issues in additional locations.

Table A-2 presents the aggregate change in emissions within New Jersey absent the Salem and Hope Creek plants (this excludes incremental emissions that occur outside New Jersey, in contrast with Table 8, which showed the emissions impact for the entire Eastern Interconnection). It is important to note that airborne transport could spread criteria pollutants to nearby and downwind locations; our analysis does not account for such transport and is thus only indicative of the types of problems that may arise. The table also does not present the increase in emissions at power plants that are outside of New Jersey, but might affect New Jersey air quality due to airborne pollutant transport. The table does show that criteria pollutant emissions within the state represent about $30 million in annual social costs (harm to health, the environment, *etc.*). Almost half of this ($14 million) is attributed to $PM_{2.5}$. The location and change in emissions by type and New Jersey county are discussed below.

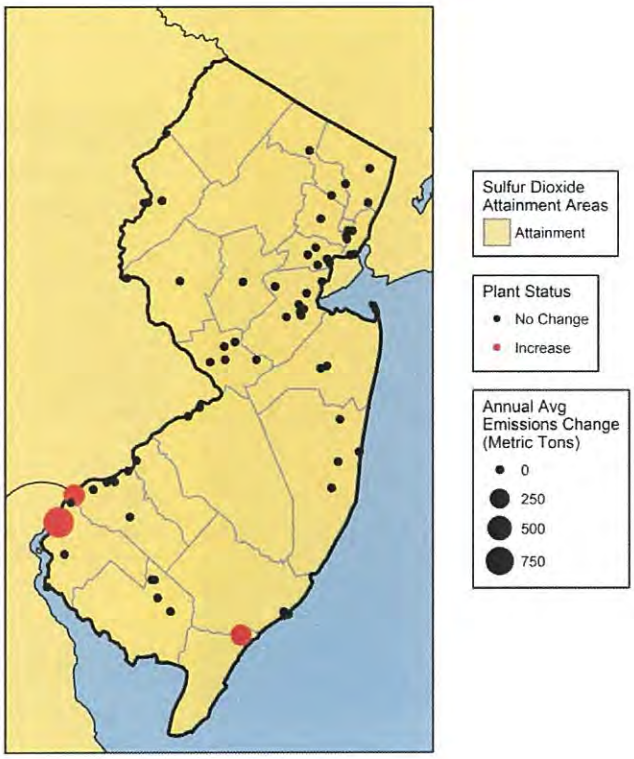
Table A-2: Emissions and Social Cost Prevented by Salem and Hope Creek Plants within New Jersey (10-Year Average Annual Impacts, 2018–2027)

Pollutant	Avoided Emissions (tons)	Social Cost ($/ton)	Avoided Emissions Value (2017 $millions)
CO_2	3,323,263	$42	$141
SO_2	1,529	$7,546	$12
NO_x	1,637	$2,082	$3
PM_{10}	1,382	$598	$1
$PM_{2.5}$	1,115	$12,360	$14
Total			$171

SO_2

The SO_2 annual emissions increase of 1,529 tons within New Jersey incurs an overall social cost of $12 million annually. At present, no New Jersey counties are in non-attainment for SO_2. Absent the Salem and Hope Creek plants, net emissions would increase in three of New Jersey's 21 counties, as shown in Figure A-2. This might result in non-attainment in some of those counties, though that was not analyzed here.

Figure A-2: SO_2 Emissions Increase absent Salem and Hope Creek Plants



NOx

The overall social cost of the increase in New Jersey NOx emissions absent these nuclear power plants is $3 million annually, but NOx is also a precursor of ground level ozone.[17] At present, no

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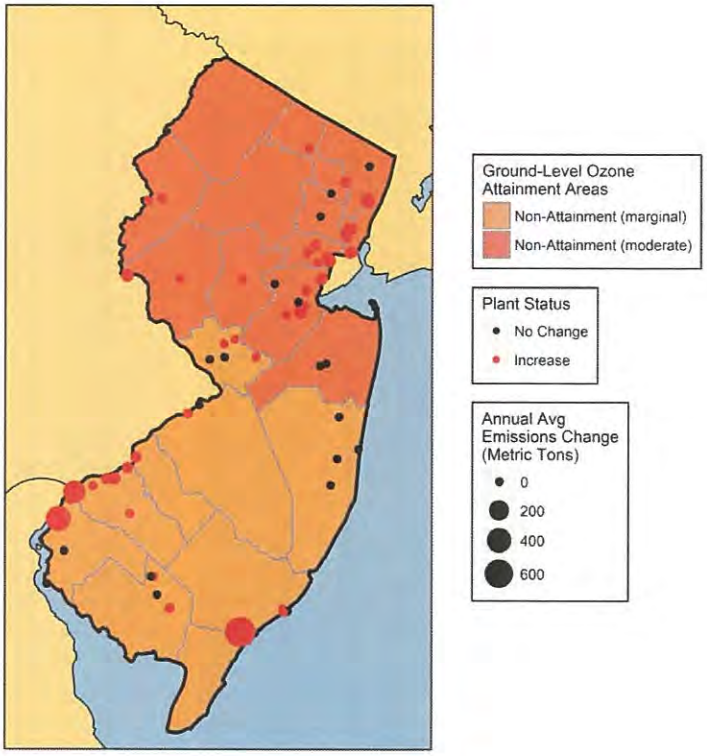
17 Ground level or tropospheric ozone occurs when nitrogen oxides (NOx), carbon monoxide (CO) and volatile organic compounds (VOCs), react in the atmosphere in the presence of sunlight. Ozone imposes social costs in the form of adverse health effects, particularly to those with pulmonary system problems including asthma. Ground level ozone has also been found to negatively affect agriculture. Reducing NOx is generally the preferred means to lower ozone levels. Determining the impact of

Continued on next page

New Jersey counties are in non-attainment for NOx, but 12 are in non-attainment for ozone. NOx emissions in New Jersey are projected to increase by 1,637 tons per year, absent the Salem and Hope Creek plants. This increase may raise the cost of bringing many of these counties into attainment for ozone. The locations of NOx increases are overlaid on the non-attainment areas for ozone in Figure A-3. Much of the increase in NOx emissions occurs in the more populous areas of New Jersey, which would exacerbate population exposures.

Figure A-3: NO_X Emissions Increase absent Salem and Hope Creek Plants



PM_{10}

The increase in PM_{10} emissions that would occur in New Jersey, absent the Salem and Hope Creek plants, is 1,382 tons, imposing social costs of $1 million annually. No counties are in non-attainment for PM_{10}.

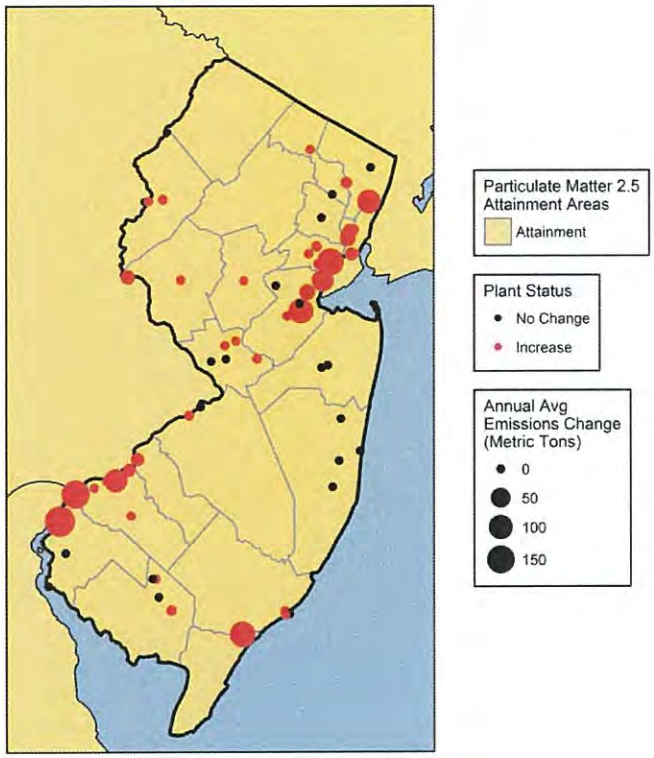
Continued from previous page

power plant NOx emissions on ozone levels is beyond the scope of this report, but increased NOx emissions is likely to compromise efforts to reduce ozone across much of the state.

$PM_{2.5}$

As Table A-2 indicates, the $PM_{2.5}$ emissions increase of over 1,000 tons annually within New Jersey results in a social cost of $14 million, the highest among the criteria pollutants, reflecting its significant impacts on human health. At present, no New Jersey counties fail to meet air quality standards for $PM_{2.5}$. Without other actions, in the absence of the Salem and Hope Creek plants, $PM_{2.5}$ emissions would increase in 17 of 21 counties statewide due to increased fossil generation, as shown in Figure A-4 (again, this does not account for airborne transport). These increases could place some counties into non-attainment with the Clean Air Act.

Figure A-4: $PM_{2.5}$ Emissions Increase absent Salem and Hope Creek Plants



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Testimony of Lawrence J. Makovich, PhD before the New Jersey Legislature, December 4, 2017.

Qualifications

I am the Chief Power Strategist at IHS Markit, a global provider of information and analyses in critical industries, including the energy industry. I have worked as an electric industry economist for more than 30 years. I currently work in Cambridge, Massachusetts and my credentials are included in Exhibit 1.

Purpose

I led an IHS Markit study for Nuclear Matters regarding the causes and consequences of the potential premature closure and replacement of the Salem and Hope Creek nuclear generating plants. A copy of the study is included as Exhibit 2.

Summary of findings

The probability of the uneconomic closure of the Salem and Hope Creek nuclear power plants is increasing due to due to the current lack of harmony between climate policy initiatives and PJM wholesale market operations. The consequences of premature New Jersey nuclear power plant closures are less resilient power supply, higher and more volatile New Jersey electricity prices, negative impacts to the New Jersey economy, and increased environmental impacts from electric generation.

The Salem and Hope Creek nuclear power plants located in New Jersey operate in the PJM wholesale power market that balances demand and supply across New Jersey along with all or part of twelve other states. Consumers in New Jersey are at risk of permanently losing the benefits of the state's nuclear generation owing to the lack of harmonization between public policies and PJM market operations and rules. This lack of harmonization suppresses wholesale market prices compared to with the levels expected from an efficient market outcome. Since PJM operates a capacity market alongside its energy market, PJM market distortions that suppress wholesale electric energy prices and the associated energy market cash flows cause underinvestment in electric production efficiency rather than in installed capacity. The bottom line is that an undistorted PJM market outcome would efficiently pace the size and mix of cost-effective power supply investment by generating prices for capacity and energy that internalize all costs, including the cost of carbon dioxide (CO_2) and other pollutant emissions. Such an undistorted, efficient market outcome would lead to a diverse technology and fuel electric supply portfolio of cost effective peaking, cycling, base-load, and intermittent resources. As a result, the power supply portfolio would not lose base-load nuclear power plants that are lower cost to continue to operate than the costs associated with the new supply being added to the marketplace.

Current PJM market distortions are not likely to go away and their persistence shapes a higher cost electric generation mix with too few relatively low cost nuclear power plants and too many less efficient peaking power plants.

New Jersey is at a critical juncture. To do nothing to preserve nuclear generation in New Jersey will lead to a less diverse and less efficient generation mix with too few nuclear base-load resources. If New Jersey does not act to offset the consequences of PJM wholesale market distortions, then the

uneconomic closure of the Salem and Hope Creek nuclear power plants will have five predictable consequences:

1. **Less resilient power supply**—the Salem and Hope Creek nuclear power plants provide valuable fuel and technology diversity in power supply. A back cast of PJM operations during the 2014 Polar Vortex indicates that **New Jersey nuclear power resources provided between 70 to 230 million dollars of resiliency benefits.**
2. **More varied monthly New Jersey consumer power bills.** The electric variable cost of production accounts for about 15% of consumer power bills. Backcasting indicates that the variation (standard deviation) of PJM variable production costs would increase by 11% if the base-load nuclear power plants with stable generation fuel costs of about 0.7 cents per kWh were closed and replaced primarily by natural gas–fired generating plants whose monthly fuel costs per kilowatt-hour varied in the past four years from a low of 1.1 cents in March 2016 to a high of 10.4 cents in January 2014. The annual cost to replace the portfolio diversity effect of the Salem and Hope Creek nuclear resources on variable production cost variation with financial hedges of natural gas prices amounts to $77–112 million per year in PJM. **The New Jersey consumers' share of this cost is $8.6–12.6 million per year,** indicating the implicit value of the more stable and predictable power bills produced by having nuclear generation in the supply portfolio rather than a higher exposure to natural gas–fired generator cost variability.
3. **Negative statewide impacts on economic activity.** The retail power price increase in New Jersey associated with the closures of Salem and Hope Creek causes economic adjustments involving **real gross state product declines of 0.14%, equal to $820 million in 2017 prices.** The increase in retail power prices hurts the New Jersey labor market, **contributing to total job losses of 6,100 per year.**
4. **Negative environmental impacts**—replacing the Salem and Hope Creek nuclear output that account for 95 percent of New Jersey's non-CO_2 emitting generation with a 15%/85% mix of renewables and natural gas-fired generation increases annual New Jersey electric sector CO_2 emissions by 13 million metric tons. To put this into perspective, the 2015 emission level was 19.4 million metric tons. Applying the mid-range-based estimate of the social cost of carbon of 42 $ per metric ton of CO_2 emissions yields a New Jersey **CO_2 abatement value from Salem and Hope Creek of around $530 million per year.** Using the 2016 Cross-State Air Pollution Rule market allowance prices in New Jersey for **NOx and SO_2 emissions adds $420,000 per year of environmental benefits** from the continued operation of the Salem and Hope Creek nuclear power plants.
5. **Higher New Jersey consumer power bills.** Without Salem and Hope Creek generation, the annual average cost of electric production in PJM would increase by about $1.6/MWh under PJM market conditions similar to 2013–16. New Jersey nuclear closures would also eliminate a $3.8/MWh locational marginal price (LMP) benefit for electric energy in New Jersey compared with the rest of PJM operating under 2016 PJM market conditions with delivered natural gas prices to generators reflecting the $3.29/MMBtu average price level for 2013–16. Altogether, the higher PJM average cost of electric production and the loss of the LMP differential would increase the cost of New Jersey wholesale electricity by $5.4/MWh. **This annual cost increase adds $404 million in New Jersey consumer power payments that would involve a 4% increase in the average retail power price.**

Conclusion

The IHS Markit analysis indicates that the continued operation of Salem and Hope Creek nuclear power plants provides significant benefits for New Jersey consumers. The current PJM market construct encourages underinvestment in electric generation production efficiency and increases the probability of uneconomic nuclear power plant closures. Since the elimination of current PJM market distortions is unlikely, an economic argument exists to support market interventions designed to offset the predictable consequences from the premature closure and replacement of these New Jersey nuclear power resources.

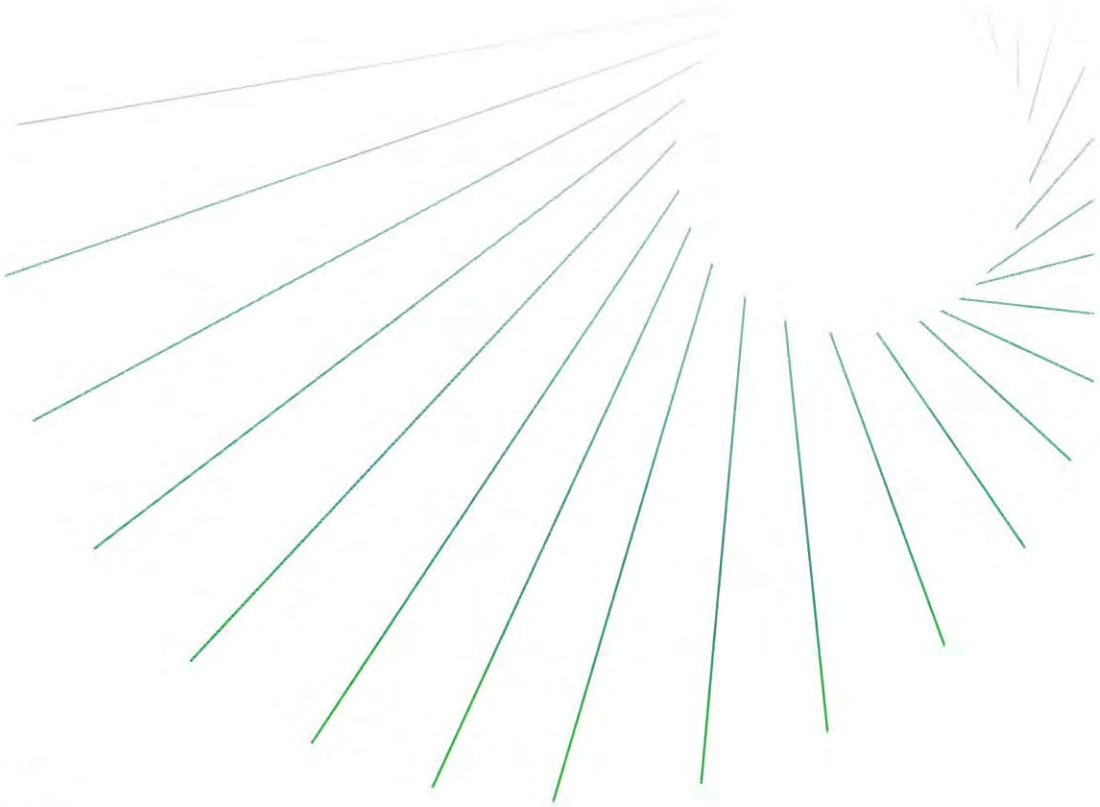
Exhibit 1

Lawrence Makovich, IHS Markit Chief Power Strategist. His current research focuses on cost-effective pathways to reduce electric sector carbon footprints, evolving electric power market structures, electricity demand and supply trends, emerging technologies, asset valuations, and electric strategies. Dr. Makovich is currently advising or has recently advised several large utilities in major strategic engagements. He has testified numerous times before the US Congress on electric power policy. He has advised the government of China on electric power deregulation and transmission in competitive markets, and the Brazilian Congress invited him to testify on power liberalization. Dr. Makovich directed several studies including Crisis by Design: California's Electric Power Crunch; Beyond California's Power Crisis: Impact, Solutions, and Lessons; Beyond the Crossroads: The Future Direction of Power Industry Restructuring; Crossing the Divide: The Future of Clean Energy; Smart Grid: Closing the Gap Between Perception and Reality; The Value of US Power Supply Diversity; Fueling North America's Energy Future: The Unconventional Natural Gas Revolution and the Carbon Agenda; and Ensuring Resilient and Efficient Electricity Generation: The value of the current diverse US power supply portfolio. He has been a lecturer on managerial economics at Northeastern University's Graduate School of Business. Dr. Makovich was a Senior Fellow at the Mossavar-Rahmani Center for Business and Government, John F. Kennedy School of Government, Harvard University. He holds a BA from Boston College, an MA from the University of Chicago, and a PhD from the University of Massachusetts.

IHS Markit™

The Value to New Jersey Consumers of Salem and Hope Creek Nuclear Power Generation in Providing Reliable, Resilient, Affordable, and Environmentally Responsible Electricity

November 2017



Lawrence Makovich
Vice President and Chief Power Strategist

Benjamin Levitt
Associate Director

North American Power

About the report

The Value to New Jersey Consumers of Salem and Hope Creek Nuclear Power Generation in Providing Reliable, Resilient, Affordable, and Environmentally Responsible Electricity report from IHS Markit utilizes the company's extensive knowledge and proprietary models of the interaction between regional power system demand and supply to assess the impact on New Jersey consumers and the New Jersey economy of the premature retirement of the Salem and Hope Creek nuclear power plants. This research was supported by Nuclear Matters.

This report was prepared for Nuclear Matters. IHS Markit is exclusively responsible for all of the analysis and content.

Contents

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The Value to New Jersey Consumers of Salem and Hope Creek Nuclear Power Generation in Providing Reliable, Resilient, Affordable, and Environmentally Responsible Electricity

Lawrence Makovich, Vice President and Chief Power Strategist

Benjamin Levitt, Associate Director

Executive summary

Operation of the Salem and Hope Creek nuclear power plants in New Jersey produces benefits for New Jersey consumers. The plants make power supply more resilient to major system failures, such as natural and manmade disasters, and limit the environmental impact of electric production, particularly the electricity carbon footprint. In addition, the continued operation of Salem and Hope Creek produces lower and more stable power supply costs compared with the outcome if the plants closed prematurely.

Consumers in New Jersey are at risk of permanently losing the benefits of the state's nuclear generation owing to the lack of harmonization between public policies and PJM market operations and rules. In particular, market failures to fully compensate New Jersey nuclear generators for contributions that ensure power system security of supply and lower emissions, coupled with market distortions like mandates of subsidized renewable generation, result in lower electric generator cash flows compared with the levels expected from an undistorted, efficient market outcome. The cumulative impacts to New Jersey of the premature closures and replacements of the Salem and Hope Creek nuclear plants are summarized in Table 1.

Since PJM operates a capacity market alongside its energy market, PJM market failures and distortions that suppress wholesale electric energy prices and the associated energy market cash flows cause underinvestment in electric production efficiency rather than in installed capacity. The bottom line is that an undistorted PJM market outcome would efficiently pace the size and mix of cost-effective power supply investment by generating prices for capacity and energy that internalize all costs, including the cost of carbon dioxide (CO_2) and other pollutant emissions. Such an undistorted, efficient market outcome would lead to a diverse technology and fuel electric supply portfolio of cost-effective peaking, cycling, base-load, and intermittent resources. As a result, the power supply portfolio would not lose base-load nuclear power plants that are lower cost to continue to operate than the costs associated with the new supply being added to the marketplace.

Table 1

Cumulative impacts to New Jersey consumers from the premature retirements of the Salem and Hope Creek nuclear plants

Description	Cost
Less resilient power supply	• **$70–230 million** per disruptive event of similar severity and duration as the 7 January 2014 polar vortex
	• **$440–790 million** per 24-hour disruption of similar severity as the 7 January 2014 polar vortex
Less statewide economic activity	• **$820 million** annual decline in real gross state product
	• **6,100** fewer jobs per year
More variable consumer power bills	• **$8.6–12.6 million** annual cost to New Jersey to stabilize PJM production cost variability
Increased CO_2, SO_2, and NO_x emissions	• **$530 million** annual increase in CO2 emission costs
	• **$420,000** annual increase in SO2 and NOX emission costs
Higher consumer power bills	• **$404 million** annual increase in annual power payments

Source: IHS Markit

Nationally, awareness is growing regarding the rising challenge of maintaining grid resiliency as more base-load nuclear and coal power plants are retired prematurely. In September 2017, Secretary of Energy Rick Perry issued a letter to

the Federal Energy Regulatory Commission recommending new rules to offset market distortions caused by a lack of harmonization between public policies and electricity market operations, noting that

> Distorted price signals in the Commission-approved organized markets have resulted in under-valuation of grid reliability and resiliency benefits provided by traditional baseload resources, such as coal and nuclear. ... The proposed rule requires the Commission-approved organized markets to develop and implement market rules that accurately price generation resources necessary to maintain the reliability and resiliency of our Nation's electric grid.[1]

Although the specifics of the approach are not yet available, the initiative shows that the discord between public policies and market operations is currently high on the electricity policy agenda.

New Jersey is at a critical juncture. To do nothing to address current PJM market failures and distortions will lead to underinvestment in electric production efficiency, moving the electric supply portfolio toward a less efficient generation mix with too few nuclear base-load resources. As a result, not addressing the existing disharmony between public policies and market operations increases the probability of uneconomic closure decisions and the replacement of the Salem and Hope Creek nuclear power plants. These closures would predictably result in

- **Less resilient power supply.** The number of possible low-probability but high-impact events and their statistical independence means that some kind of significant disruptive event is likely to confront the PJM power system within the coming decade, such as another polar vortex episode, a Sandy-type hurricane landfall, a natural gas pipeline or storage facility failure, a foreign or domestic terrorist attack, or legislative or court interventions constraining the natural gas supply chain. Therefore, prudent planning ought to incorporate resilience to the range of possible significant deviations from expected normal operating conditions. A retrospective analysis of the 2014 polar vortex conditions in PJM illustrates the resilience benefits provided by the New Jersey nuclear power plants at the time. Our analysis finds that **the cost to New Jersey consumers, had the New Jersey nuclear plants retired prior to the 7 January 2014 polar vortex, would have been between $70 million and $230 million.** Because New Jersey's nuclear plants provide resilience benefits to all PJM consumers, the total cost of the loss of the New Jersey nuclear plants is around 10 times higher. Since 2014, the PJM power supply has become more reliant on natural gas pipelines and operations and is therefore less resilient to similar events. The upper end of this range reflects how recent changes in the PJM power supply portfolio have increased the resilience benefits provided by the New Jersey nuclear plants. Going forward, other high-impact events may cause a loss of load for an even longer duration. The benefit to New Jersey of preventing a similar loss of load lasting 24 hours averages $440–790 million.

  The polar vortex of January 2014 is just one example of the type of events that can stress the power supply. Events in the future may occur with more or less frequency and with more or less disruptive force. Therefore, the analysis of the polar vortex alone cannot be used to define resiliency planning. However, this analysis demonstrates that the New Jersey nuclear plants are important to the resilience of the PJM power supply and that their importance has increased following the power supply portfolio's recent increase in dependency on the natural gas supply chain.

- **Negative statewide impacts on economic activity.** The retail power price increase in New Jersey associated with the closures of Salem and Hope Creek causes **real gross state product to decline 0.14%, equal to $820 million in 2017 prices.** The increase in retail power prices hurts the New Jersey labor market, **contributing to total job losses of 6,100 per year.**

- **More varied monthly New Jersey consumer power bills.** The electric variable cost of production accounts for about 15% of consumer power bills. Backcasting indicates that the variation (standard deviation) of PJM variable production costs would increase by 11% if the base-load nuclear power plants with stable generation fuel costs of about 0.7 cents per kWh were closed and replaced primarily by natural gas–fired generating plants whose monthly fuel costs per kilowatt-hour varied in the past four years from a low of 1.1 cents in March 2016 to a high of 10.4 cents in January 2014. The annual cost to replace the portfolio diversity effect of the Salem and Hope Creek nuclear resources on variable production cost variation with financial hedges of natural gas prices amounts to $77–112 million per year in PJM. **The**

1. Secretary of Energy Rick Perry, Letter to the Federal Energy Regulatory Commission Chairman and Commissioners, 28 September 2017, Subject: Secretary of Energy's Direction that the Federal Energy Regulatory Commission Issue Grid Resiliency Rules Pursuant to the Secretary's Authority Under Section 403 of the Department of Energy Organization Act.

New Jersey consumers' share of this cost is $8.6–12.6 million per year, indicating the implicit value of the more stable and predictable power bills produced by having nuclear generation in the supply portfolio rather than a higher exposure to natural gas–fired generator cost variability.

- **Greater environmental impacts from electric production.** New Jersey nuclear generation accounts for 95% of the state's zero-emission, non–CO_2-emitting electric generating resources. Replacing the 28,750 GWh/y of electric output from the Salem and Hope Creek nuclear power plants with a 15%/85% mix of renewable and natural gas–fired generation increases annual electricity sector CO_2 emissions by 13 million metric tons (MMt). To put this into perspective, New Jersey electric generation emitted 16.1 MMt and 19.4 MMt of CO_2, respectively, in 2012 and 2015. Using a midrange estimate of $42 per metric ton for the social cost of carbon puts the environmental impact value of the CO_2 emission abatement provided by the continued operation rather than replacement of the Salem and Hope Creek nuclear power plants at **$530 million per year.** In addition, the replacement of Salem and Hope Creek with the same mix of renewable and natural gas–fired generation will increase annual electricity sector nitrogen oxide (NO_x) and sulfur dioxide (SO_2) emissions by 3,063 metric tons and 118 metric tons per year, respectively. Using the 2016 Cross-State Air Pollution Rule market allowance prices in New Jersey for NO_x and SO_2 emissions puts the additional environmental impact of emissions at **$420,000 per year.**

Table 2

Annual increase in bills by customer class in New Jersey due to retirement of Salem and Hope Creek nuclear plants

Customer class	2016 retail price of electricity ($/kWh)	Increase in electricity prices due to the retirement of Salem and Hope Creek nuclear plants	Increase in total electricity costs due to the retirement of Salem and Hope Creek nuclear plants (million dollars)
Residential	15.75	3.4%	158
Commercial	12.42	4.3%	207
Industrial	10.14	5.3%	39

Source: IHS Markit, Energy Information Administration

- **Higher New Jersey consumer power bills.** Without Salem and Hope Creek generation, the annual average cost of electric production in PJM would increase by about $1.6/MWh under PJM market conditions similar to 2013–16. New Jersey nuclear closures would also eliminate a $3.8/MWh locational marginal price (LMP) benefit for electric energy in New Jersey compared with the rest of PJM operating under 2016 PJM market conditions with delivered natural gas prices to generators reflecting the $3.29/MMBtu average price level for 2013–16. Altogether, the higher PJM average cost of electric production and the loss of the LMP differential would increase the cost of New Jersey wholesale electricity by $5.4/MWh. **This annual cost increase adds $404 million in New Jersey consumer power payments that would involve a 4% increase in the average retail power price.** The percent increases to specific customer classes from 2016 retail price levels are summarized in Table 2.

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Overview

In 2016, New Jersey electricity consumers spent $10.1 billion to purchase 74,769 million kWh at an average retail price of 13.5 cents per kWh. Analyses of household and business purchasing decisions reveal that consumers valued grid-based electricity purchases significantly more than the amount that they paid for them. The high value-to-cost ratio is not surprising for a commodity that is considered a necessity in a modern, developed economy in the digital age. Consequently, the high ratio of electric service value to cost unsurprisingly drives consumers to demand a high degree of reliability and resilience in grid-based power supply. In addition, consumers reveal a preference for stable and predictable power bills as well as a desire to address the environmental challenge of global warming.

The continued operation of the Salem and Hope Creek nuclear generating resources in New Jersey aligns with consumer preferences. The electric capacity and energy from the Salem and Hope Creek nuclear power plants made overall PJM power supply more resilient and New Jersey consumer power bills lower and less variable from month to month compared with the expected alternative outcome from premature closure and replacement. In addition, replacing the Salem and Hope Creek nuclear power plant output with the 15%/85% mix of renewable and natural gas–fired generation constituting the current PJM new power supply pipeline would increase annual carbon dioxide (CO_2), nitrogen oxide (NO_x), and sulfur dioxide (SO_2) emissions.

Consumer preferences for affordable electricity prices extend beyond their power bills, because the price of electricity affects the level of economic activity in the New Jersey economy. The New Jersey electricity price relative to other states and nations affects the competitive position of New Jersey business in the national and global economy. Consequently, increases in New Jersey's relative electricity price result in declines in the level of per capita gross state product (GSP), in-state jobs, and consumer disposable income.

The consumer benefits from the operation of the Salem and Hope Creek nuclear power plants are at risk because of a lack of harmony between public policies and wholesale electricity market operations. The 4 million New Jersey electricity consumers are among the more than 27 million consumers that rely on the PJM electricity system for grid-based electricity supply. But here is the rub: mandates of subsidized intermittent renewable generation are suppressing wholesale power prices, and current PJM wholesale price formation rules do not fully incorporate the cost of the necessary adjustments to ensure security of power system operations. The combined impact is that wholesale market cash flows fail to fully compensate generators for the efficiency and resilience attributes provided by existing resources.

The five predictable consequences for New Jersey electricity consumers if PJM market distortions cause the premature closure of the Salem and Hope Creek nuclear power plants are

- **Less resilient market supply.** Premature base-load power plant retirements and replacement with natural gas–fired generating resources increase the natural gas generation share beyond the share expected in an efficient market outcome. This larger share of natural gas–fired generating resources therefore increases the power supply portfolio's exposure to the availability risks of the natural gas fuel supply chain. The greater risk exposure translates into higher probabilities for power outages when natural gas deliverability conditions deviate from normal, as happened during the polar vortex in 2014, when the contributions of New Jersey nuclear resources averted a $73–230 million outage cost for New Jersey consumers.

- **Negative statewide economic impacts.** Higher retail power prices relative to other states and nations lower the competitive position of New Jersey businesses and reduce jobs and the value of the GSP. The continued operation of Salem and Hope Creek prevents power price increases that cut in-state jobs by about 6,100 and reduce New Jersey GSP by more than $800 million per year.

- **More varied monthly power bills.** Premature base-load power plant closures result in a greater reliance on natural gas–fired resources. When the marginal cost of natural gas–fired resources sets wholesale power prices an increasing percentage of the time, New Jersey consumers face added exposure in their monthly power bills to the impacts from natural gas price spikes, seasonal price movements, and multiyear natural gas price cycles. The cost to replace the stability that Salem and Hope Creek provide to monthly New Jersey power bills is about $8.6–12.6 million per year.

- **Greater environmental impacts.** Mandates of intermittent renewable technologies cause premature nuclear power plant retirements and a greater reliance on natural gas–fired generation that results in a net increase in CO_2, SO_2, and NO_x emissions from power generation of 13 million metric tons (MMt), 3,063 metric tons, and 118 metric tons, respectively, with an environmental impact cost of more than $530 million per year.

- **Higher power bills.** The cost of electric supply increases when electric service is less reliable and when the suppression of nonpeaking power plant cash flows causes nuclear power plants to retire even though the cost of continued operation is lower than the cost of the replacement power supply coming from mandated renewable and new natural gas–fired generating technologies. Suppression of wholesale power prices in the short run leads to higher wholesale power prices in the long run as the power supply portfolio mix becomes less efficient with too many peaking power plants and too few base-load power plants. The premature closure and replacement of the Salem and Hope Creek nuclear power plants would increase New Jersey retail electricity prices by 4% and add $404 million to New Jersey consumers' power bills.

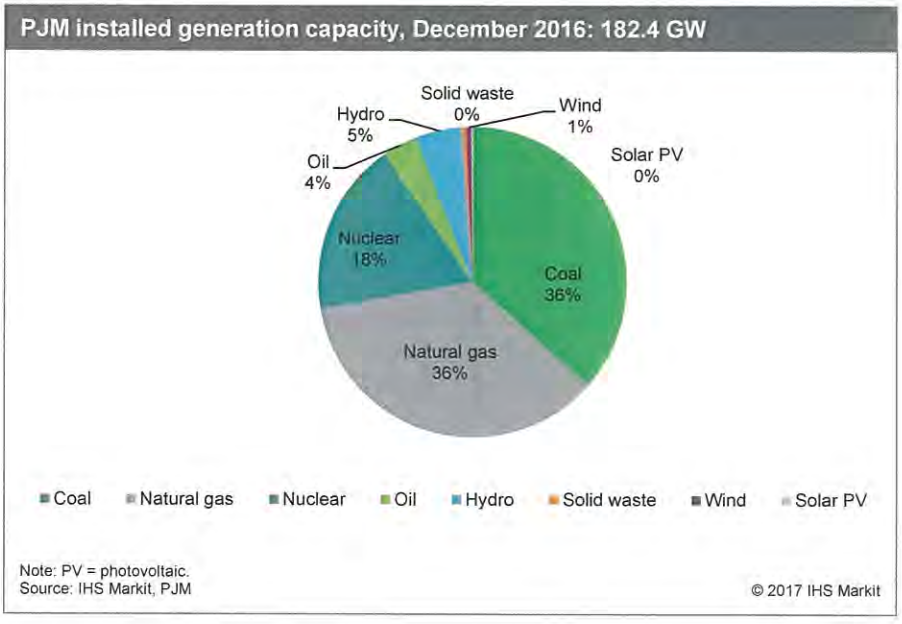
New Jersey is at a critical juncture. To do nothing to harmonize state policies and PJM market operations allows market distortions to erode nonpeaking power supply resource cash flows. These conditions increase the probability that the Salem and Hope Creek nuclear power plants will close prematurely and that New Jersey consumers will face higher and more varied monthly power bills, less power system resilience, greater environmental impacts, and strains on the state economy.

New Jersey's link to PJM

New Jersey is one of the 13 states (Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) and the District of Columbia that rely, in whole or part, on the PJM Interconnection for grid-based electricity supply.

New Jersey electricity consumers account for 4 million of the more than 27 million consumers that rely on the PJM electricity system to produce reliable, resilient, affordable, and environmentally responsible grid-based electricity supply. The 74,769 million kWh that New Jersey electricity consumers purchased in 2016 accounted for 11% of aggregate consumer load supplied by the PJM generating portfolio. On the supply side, New Jersey power plants provided more than 19 GW of generating capacity to the PJM portfolio shown in Figure 1. These New Jersey electric generating resources currently account for 11% of the net dependable capacity deployed to reliably meet PJM demand at all times throughout the year.

Figure 1



Current utilization of the New Jersey generating capacity provides more than 8% of annual PJM electric generation, and the New Jersey nuclear power plants currently account for 95% of New Jersey non-CO_2-emitting generation.[2]

PJM manages the grid that physically connects consumer demands to producer supplies, and it employs markets for electric energy, capacity, and ancillary services to coordinate the interaction of aggregate demand and supply with market price signals. PJM employs a bid-based competitive

2. Source: US Energy Information Administration (EIA), Frequently Asked Questions, http://www.eia.gov/tools/faqs/faq.php?id=74&t=11, accessed 21 September 2017.

89x

process to centrally dispatch generation resources to meet the aggregate consumer load. Competitive forces drive rival power generators to bid electric supply based on their short-run marginal costs (SRMC). These SRMC reflect the incremental variable costs of fuel and variable operation and maintenance costs expressed as a cost per unit of output. As a result, the electric supply curve in the PJM market reflects the SRMC of rival generators ordered from lowest to highest.

PJM balances demand and supply in real time but does not determine a single price to clear the energy market. As the grid operator, PJM must coordinate the power system security-constrained movement of wholesale electricity between producers and consumers. Since PJM operating conditions involve dynamic transmission constraints, PJM system operators must alter generation dispatch to manage transmission flows, voltage, frequency, and system security. This security-constrained dispatch of available supply to demand in real time prevents market forces from completely closing the SRMC differences across all PJM generators throughout the year. Therefore, PJM determines the locational marginal price (LMP) at more than 9,000 load and 2,000 generation pricing points in day-ahead and real-time electric energy markets and determines locational prices for capacity in 27 locational deliverability areas.

The PJM energy market produces an efficient dispatch because market forces push to minimize the SRMC differentials among generating resources at any point in time. As conditions change, market operations shift electric production toward producers with lower SRMC–based supply bids and away from producers with higher SRMC–based supply bids whenever the transmission and security of supply constraints allow these cost-effective generation shifts to occur within the grid. As a result, the PJM LMPs are highly correlated through time. For example, the correlation between the hourly New Jersey LMPs and the rest of PJM's average LMPs across 2014 to 2016 was 0.936, indicating that as relative fuel prices changed, market forces created constant pressure to minimize SRMC differentials and, thus, maximize efficient dispatch.

Owing to security of supply and transmission constraints, market forces cannot eliminate LMP price differentials in PJM. PJM transmission and security of supply constraints prevent some electric generation with lower marginal costs from flowing out of constrained transmission zones to displace higher–marginal cost generation elsewhere in PJM. However, these LMP differentials do not necessarily indicate an inefficient PJM market outcome. PJM LMPs reflect the differences in locational SRMC of generation resources, and, thus, the PJM LMP differentials indicate the benefit of relieving security of supply and transmission constraints. Since the benefits of relieving a transmission constraint can be less than the cost to do so, some transmission constraints within PJM are not cost-effective to relieve. As a result, economic transmission constraints can cause persistent LMP differentials in an efficient security-constrained PJM market outcome.

PJM power plant retirement and replacement trends indicate that in the past decade, PJM has lost proportionately more low-SRMC supply than New Jersey. In particular, the nuclear share of the New Jersey–based electricity supply curve is much larger than the nuclear generation share in the rest of PJM's supply curve. Nuclear generation is a base-load technology incorporating significant up-front investment in the efficiency of transforming primary energy into electricity. As a result, the nuclear generation SRMC is typically lower than a natural gas–fired combined-cycle (CC) generating technology that is increasingly characterizing the marginal generating resource in the rest of PJM. The PJM State of the Market Report indicates that the average SRMC of PJM nuclear power plants was 44% lower than the SRMC of a natural gas–fired CC technology in 2016.[3]

The existing transmission constraints between New Jersey and the rest of PJM currently prevent some of the lower–marginal cost nuclear electric generation from flowing out of New Jersey to displace higher–marginal cost generation elsewhere in PJM. Hourly 2016 LMPs indicate that the generating resources with incremental costs lower than those of a natural gas–fired CC generating resource were setting the LMP price 18% of the time within New Jersey compared with only 11% of the time within the rest of PJM.

The 2016 market data indicate that current transmission constraints distribute a disproportionate share of the benefit from the relatively lower–marginal cost New Jersey nuclear generation to New Jersey consumers by lowering the percentage of time when the higher SRMC of natural gas–fired generators is setting the energy price at the New Jersey LMPs compared with the rest of PJM. As a result, in 2016 the load-serving entities (LSEs) within New Jersey purchased electric energy for consumers at the PSEG, Atlantic City Electric, and Jersey Central pricing points with an average LMP

3. Monitoring Analytics, LLC, *2016 State of the Market Report for PJM*, p. 283.

90x

that was $3/MWh less than the average LMP for the rest of PJM. The disproportionate benefit to New Jersey consumers accruing from the New Jersey nuclear generation and the transmission constraints provided a $224 million savings to New Jersey consumers in 2016.

Transmission constraints limit but do not eliminate the flow of benefits from the Salem and Hope Creek nuclear generating resources to the rest of PJM. Therefore, New Jersey consumers do not capture all of the benefits of the New Jersey nuclear power plants; instead, they share the benefits, with the New Jersey nuclear generation lowering the average generating cost in the rest of PJM. Backcasting PJM total electric production costs for 2013–16 with all conditions held constant, except with the New Jersey nuclear power plants closed and replaced by a 15%/85% mix of renewable and natural gas–fired CC generation, indicates that the overall PJM electric production costs would have been about $1.2 billion higher. The Salem and Hope Creek nuclear power plants accounted for 85% of this overall PJM electric production cost impact.

Analysis of 2016 PJM market data illustrates that the benefit of nuclear power generation to New Jersey consumers as well as the rest of PJM is sensitive to the SRMC cost difference between nuclear generation resources and natural gas–fired CC power plants. This relationship is important, because the delivered price of natural gas varies considerably through time. In just the past three years, the annual average delivered price of natural gas was as low as $2.13/MMBtu in 2016 and as high as $4.60/MMBtu in 2014. As a result, if the delivered price of natural gas had been $4.60/MMBtu in 2016 rather than $2.13/MMBtu with all other conditions held constant, then the incremental fuel generation cost differential would have expanded from $8/MWh to $26/MWh between New Jersey nuclear generation and natural gas CC generating plants operating in the rest of PJM (based on an average natural gas–fired generator heat rate of 7,100 Btu/kWh). If the natural gas price had been $4.60/MMBtu rather than $2.13/MMBtu in 2016, then the difference in incremental fuel costs across the 7% of the time when the natural gas–fired CC SRMC is setting prices in the rest of PJM and not at the New Jersey LMPs would have increased the annual LMP differential between New Jersey and the rest of PJM from $3/MWh to $4.8/MWh. The implication is that with PJM market conditions similar to those in 2016, each $1/MMBtu increase in natural gas prices would result in an average New Jersey LMP being $0.7/MWh lower compared with the rest of PJM.

The average delivered price of natural gas to New Jersey electric generators over 2013–16 was $3.29/MMBtu, and this four-year average price level is closer to the level expected in the future than the cyclically low delivered price of $2.13/MMBtu in 2016. Therefore, the estimate of the ongoing value to New Jersey consumers of the LMP differential created by current transmission constraints and the SRMC differences between New Jersey nuclear resources and natural gas–fired resources in the rest of PJM is about $3.8/MWh.

Premature closure of Salem and Hope Creek results in less resilient power supply

Engineering and economic principals consistently indicate that an efficient electric supply portfolio comprises a diverse set of technologies and fuels. This diversity of a cost-effective electric supply portfolio inherently provides resilience to a wide range of risk factors associated with each type of generating resource. The resilience of a diverse power supply portfolio arises from the independence among the risk factors across generating technologies and fuels. For example, the polar vortex in 2014 prevented fuel deliveries to natural gas–fired generators in PJM, but it did not affect the availability of fuel to nuclear power plants. Because of this lack of correlation among power supply risk factors, not having all of your eggs in one basket in a power supply portfolio generates valuable power supply resilience to myriad power supply risk factors across all fuels and technologies.

Resilience created from diversity is an inherent attribute of a cost-effective electric supply portfolio, because there is no "one-size-fits-all" electric generation technology or fuel source that can reliably meet the recurring annual real-time pattern of power system aggregate consumer demand at the lowest cost.[4]

Although a simple levelized cost of energy (LCOE) metric can indicate that a single generating technology provides the lowest LCOE on a stand-alone basis under a given set of conditions, a cost-effective supply portfolio would not be made up of this technology alone. Such a single-source supply portfolio ignores the time dimension of power supply and

4. Appendix A summarizes the current available state of technology for a variety of power generation technologies that bring different performance characteristics to an electric supply portfolio.

9/x

potential deviations from normal operating conditions. For example, advances in solar PV technologies continue to lower the stand-alone cost of generating electricity when the sun shines. However, a recent study by the US Department of Energy's (DOE) National Renewable Energy Laboratory finds that about 65% of a typical rooftop solar energy customer's electricity demand is noncoincidental with the electricity generated from the rooftop solar PV units.[5] Therefore, if solar PV provided the lowest LCOE compared with other electric supply technologies, a 100% solar PV power supply portfolio would neither be capable of meeting peak demands nor be capable of supplying consumers connected to the grid with the electricity that they want, whenever they want it.

The time dimension of balancing electric demand and supply limits the cost-effective generation share of an intermittent renewable resource such as solar PV. Similarly, a 100% solar PV power supply would not be robust during deviations from normal operating conditions, such as the predictable reduction in the output of 1,900 utility-scale PV resources that were in the path of the 21 August 2017 solar eclipse. The US power system's resiliency to this event illustrated the value of the current diversified power supply portfolio.

The implication is clear—a power supply portfolio comprising the technology with the lowest time-ignorant, stand-alone LCOE would not deliver either reliable electricity to consumers or electric supply that is resilient to the changes expected in the power system operating environment.

The resources available to instantaneously match electric supply and demand involve operable generating capacity as well as grid-level electric storage technologies and demand-side resources. Since the availability of any of these resources is uncertain at any point in time, providing reliable electric service requires operating with some of these resources in reserve. Therefore, a robust reserve uses diversity of capacity to mitigate potential deviations from normal operating conditions affecting the availability of a given generating technology or fuel source. For example, an operating reserve made up entirely of natural gas–fired resources supplied from a common pipeline could provide power supply reliability under normal pipeline operating conditions. However, the reserve would not be resilient to a pipeline disruption. By contrast, a diverse operating reserve comprising dual-fueled capacity (pipeline natural gas and on-site liquid fuel inventory) would be capable of reliable generation while also being resilient to a potential significant deviation from normal natural gas pipeline operating conditions.

A well-structured electricity market will produce an efficient market outcome by generating both the level and variability of capacity and the energy prices necessary to provide investment signals to produce a cost-effective electric supply portfolio. By contrast, the lack of harmonization between public policy and market operations that causes a distorted marketplace that suppresses energy market price signals compared with the efficient market outcome will produce less efficient diversity of power supply. In particular, market distortions that reduce the cash flows from the energy market will lead to underinvestment in electric production efficiency and produce an electric supply portfolio with too many peaking resources and too few base-load resources.

PJM market distortions reduce the cash flows from the energy market and increase the probability of premature base-load power plant retirements. When this happens, the cost and performance profiles of alternative generating technologies indicate that natural gas–fired generating technologies will be the primary source of replacement generation. This trend moves the PJM supply portfolio toward a greater reliance on natural gas–fired generating technologies than expected in an efficient market outcome. As the portfolio mix becomes increasingly dominated by natural gas–fired generation technologies, the power supply portfolio becomes more exposed to the risks of the natural gas supply chain than would be the case with an efficient market outcome. As this unfolds, the concern becomes having an electric supply portfolio with too many eggs in one basket.

The expected operating lives of natural gas–fired electric generating plants typically range from two to four decades. Figure 2 shows the multiyear natural gas price cycles that characterized natural gas market outcomes over the past three decades. The long-run drivers of natural gas price cycles are technology changes, demand uncertainty, public policy shifts, market participant recognition lags, and market demand and supply adjustment lags.

5. Lori Bird, Carolyn Davidson, Joyce McLaren, and John Miller, *Impact of Rate Design Alternatives on Residential Solar Customer Bills: Increased Fixed Charges, Minimum Bills and Demand-Based Rates*, National Renewable Energy Laboratory, US DOE, September 2015, https://www.nrel.gov/docs/fy15osti/64850.pdf, retrieved 13 October 2017.

In addition to persistent long-run price cycles, natural gas–fired power generators face the risk of seasonal or shorter-duration natural gas price run-ups as well as brief episodes of days, weeks, or months when natural gas prices spike at multiples of the normal price level, as shown in the monthly data displayed in Figure 3. The lesson from natural gas markets is that the most influential factor driving significant short-term excursions of expected natural gas price levels is the deviation in weather from normal conditions.

Figure 2

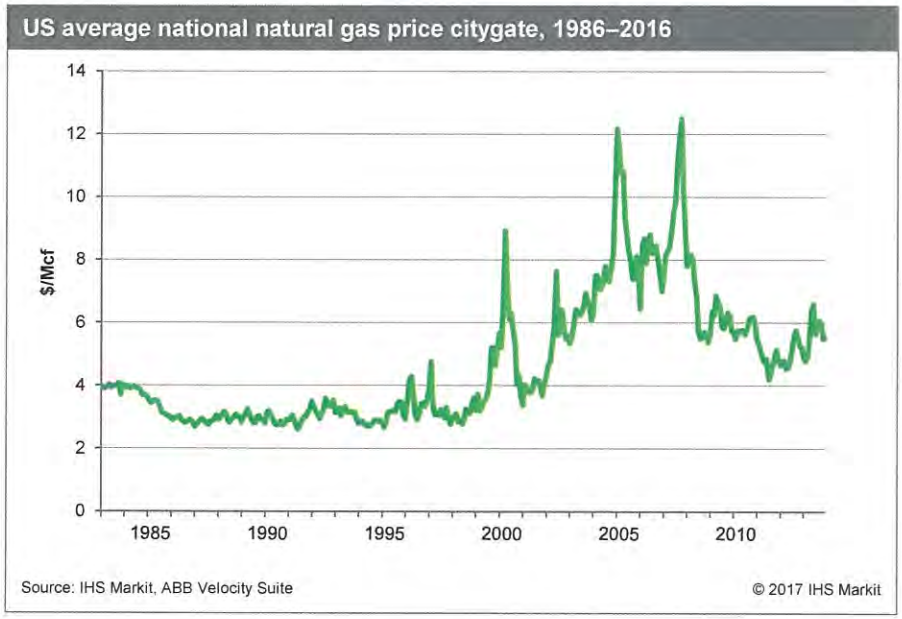
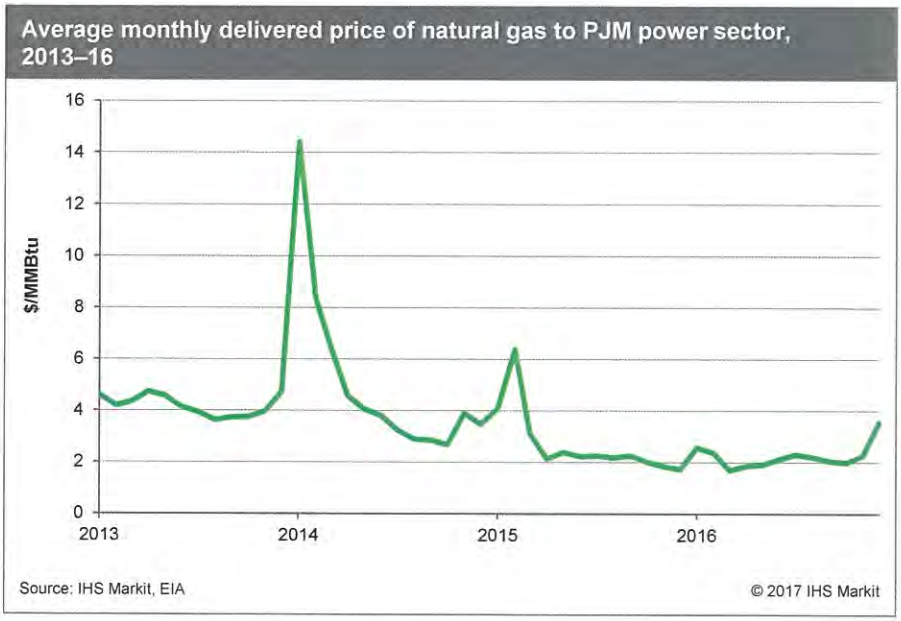


Figure 3



Ideally, short-run natural gas price spikes function to allocate a limited amount of natural gas to the most highly valued applications. However, sometimes prices alone cannot bring short-run demand and supply into balance. Sometimes when the conditions cause natural gas prices to spike, deliverability constraints are severe enough that some generators are unable to secure natural gas supply at any price. Such conditions arose in PJM during the polar vortex in 2014, when some natural gas–fired generators in PJM were unable to obtain all of the natural gas they wanted even though they had firm natural gas supply contracts in place. As the US DOE recently noted, "Capacity challenges on existing pipelines combined with the difficulty in some areas of siting and constructing new natural gas pipelines, along with competing uses for natural gas such as for home heating, have created supply constraints in the past. Supply constraints can create increased price risk and, in extreme cases, impact grid reliability."[6]

New Jersey electricity consumers face potential significant costs when severe weather, grid overloading, power station failures, and other significant deviations from normal operating conditions exceed the resilience level of the power system to avoid electric service interruptions. When Hurricane Sandy hit New Jersey in October 2012 and interrupted electric service across several days, the cost associated with electric service interruptions became apparent to a large

6. Staff Report to the Secretary on Electricity Markets and Reliability, August 2017, US DOE.

93x

number of New Jersey consumers. In response, the high value that consumers place on resilient power supply triggered a surge in installations of backup generation technologies in the following year.[7]

New Jersey consumers' decisions to install backup generation systems reveal just how highly they value critical grid-based electric supply. US grid-based power supply is typically available 99.97% of the time, and the typical backup generation cost per kilowatt-hour to provide electric service during the 2.33 hours per year of expected annual grid-based supply disruptions is roughly 100 times the average price of 13.5 cents per kWh that New Jersey households pay for grid-based power supply. Many commercial and industrial customers—especially customers with critical electric applications in hospitals and data centers—install backup generation, and these actions reveal high valuations on resilient electricity supply similar to the residential consumers.

Electricity markets incorporate the estimates of the value consumers place on lost electric services. For example, in 2014 the Electric Reliability Council of Texas (ERCOT) began employing an estimate of the value consumers place on electric service reliability in its implementation of the operating reserve demand curve real-time electric wholesale market intervention to compensate for the reserves employed to reduce the probability of electric system outages. ERCOT employed an estimate of the value of lost load of $9,000/MWh, a value that was about 100 times the 2015 average retail power price of 8.7 cents per kWh.

Estimates of the high values consumers place on electricity services align with estimates of annual power outage costs in the United States. The track record indicates that past electric service interruption costs exceeded hundreds of billions of dollars per year.[8] Of course the timing and duration of outages affect consumer impacts, but simply taking estimates of the annual costs and dividing by the annual average outage duration indicates that increasing the frequency of the typical electric service disruptions in the United States involves about $75 billion per hour of electric service interruption costs.[9]

The cost of an electric outage in the PJM territory is about 17% of the total US outage costs and roughly $12.6 billion per hour, or $170/kWh (in 2016 dollars). This is simply an allocation of estimates of national outage costs to PJM based on electric consumers in PJM accounting for about 17% of US power supply and the economic activity powered by PJM grid-based electric supply accounting for about 20% of the US total GDP. Similarly, New Jersey's share of outage costs would indicate about a $1.4 billion per hour electric outage cost.

The cost of the current level of power system reliability is only part of the $0.135/kWh average retail price of electricity in New Jersey. Since the benefit of avoiding electric outage in New Jersey is about $170/kWh, the high ratio of electric service value to the electric service cost helps to explain the consumer demand for a high degree of reliability and resilience in grid-based power supply.

From the reliability perspective, resiliency is the capability of the power supply portfolio to continue to provide consumers with electric services when operating conditions deviate from normal. For example, a deviation from normal winter conditions occurred on 7 January 2014 in the PJM power system. Polar vortex weather conditions drove the power system demand for electricity to an all-time high winter peak demand. These abnormal winter conditions caused significantly higher-than-normal unavailability from natural gas–fired generating units linked, in many cases, to abnormally high natural gas delivery constraints. Under these conditions, the diversity in the generation portfolio allowed nuclear power plants and oil- and coal-fired power plants to back up and fill in for the natural gas–fired resource limitations.

Since the polar vortex in 2014, the New Jersey generation mix has become majority natural gas–fired and the PJM generation mix also has become more natural gas dependent. Much of this broader PJM trend reflects the closure and replacement of base-load generating resources primarily by natural gas–fired generating technologies. Between the polar

7. Marianne Lavelle, "After Hurricane Sandy, Need for Backup Power Hits Home," National Geographic, 29 October 2013, http://news.nationalgeographic.com/news/energy/2013/10/131029-hurricane-sandy-aftermath-need-for-backup-power/, retrieved 13 October 2017.

8. Kristina Hamachi LaCommare and Joseph H. Eto, "Cost of Power Interruptions to Electricity Consumers in the United States," *Energy: The International Journal 31* (7 April 2005); and Primen, "The Cost of Power Disturbances to Industrial and Digital Economy Companies," TR-1006274 (available through EPRI), 29 June 2001.

9. Michael J. Sullivan, Josh A. Schellenberg, and Marshall Blundell, *Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States,* Ernest Orlando Lawrence Berkeley National Laboratory, January 2015, https://emp.lbl.gov/publications/updated-value-service-reliability, retrieved 29 August 2017.

94.

vortex in 2014 and the end of 2016, PJM added 11,715 MW of natural gas–fired generating capacity and closed 8,922 MW of coal-fired capacity. A retrospective look at the polar vortex indicated that 5,573 MW of coal-fired capacity that was planned for retirement at the time of the polar vortex provided some of the critical resiliency in PJM during the event.[10]

Backcasting under polar vortex conditions in PJM illustrates the benefits of the resilience provided by the technology- and fuel-diverse electric supply portfolio in place at that time. Figure 4 shows the aggregate consumer hourly load on 7 January 2014 when the polar vortex caused a significant deviation from expected normal operating conditions for the PJM power system and caused PJM to hit a record wintertime peak demand of 141,846 MW.

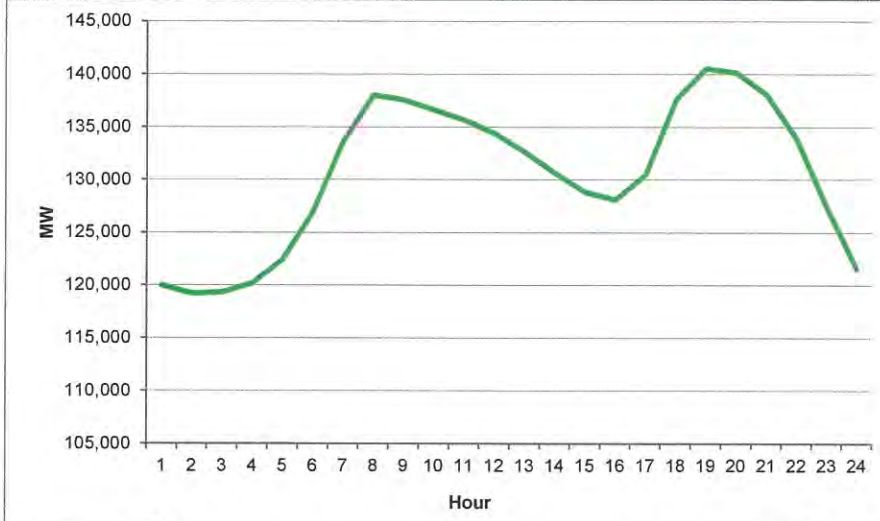
Tables 3 and 4 compare and contrast two PJM net dependable capacity portfolios. The first capacity portfolio shown in Table 3 reflects the actual PJM installed capacity in January 2014, derated by technology and fuel type based on the actual outage rates experienced during the polar vortex on 7 January 2014.[11] The second scenario, shown in Table 4 reflects a change in the installed capacity portfolio to reflect the closure of 4,107 MW of New Jersey nuclear capacity.

Backcasting the outcome during the polar vortex with the alternative PJM power supply portfolio in place while holding all else equal, and exercising the remaining limited PJM emergency operating procedures, results in an expected loss of load across four hours at an average level of about 1 GW, as shown in Figure 5. The benefits of the diverse power supply portfolio that was actually in place and capable of avoiding this loss of load was more than $650 million across PJM and $73 million in New Jersey.

Table 5 shows the new portfolio that reflects the closure and replacement of 8.9 GW of base-load coal capacity with natural gas–fired generation in PJM as well as the closure of 4.1 GW of New Jersey nuclear capacity. Maintaining the forced outage rate of 36% for the incremental 8.9 GW of natural gas–fired capacity in this polar vortex scenario implies that the natural

Figure 4

PJM hourly load on 7 January 2014



Source: IHS Markit, PJM

Table 3

PJM net dependable capacity on 7 January 2014

Generator fuel type	Installed capacity, 1 January 2014		Forced outages		Other nonforced outages	Net dependable capacity
	MW	Percentage of total installed capacity	MW	Percentage of installed capacity	MW	MW
Coal	75,545	41%	13,700	18%		61,845
Gas	53,395	29%	19,000	36%		34,395
Nuclear	33,077	18%	1,400	4%		31,677
Hydro	8,107	4%				8,107
Oil	11,314	6%				11,314
Renewables	956	1%				956
Other	701	0%				701
Not classified			6,100	na	2,412	(8,512)
Total	**183,095**		**40,200**		**2,412**	**140,483**

Source: PJM, IHS Markit

10. Matthew L. Wald, "Coal to the Rescue, but Maybe Not Next Winter," *The New York Times*, 10 March 2014, https://www.nytimes.com/2014/03/11/business/energy-environment/coal-to-the-rescue-this-time.html, retrieved 13 October 2017.

11. In the May 2014 report *Analysis of Operational Events and Market Impacts During the January 2014 Cold Weather Events*, PJM quantified power supply reserves available to its system during the peak period on 7 January 2014, including 500 MW of 10-minute synchronized reserves; 1,167 MW of 10-minute nonsynchronized reserves; and 1.1–2.0 GW of temporary voltage reduction. Although other actions may have been available, such as purchasing additional emergency energy or recalling shared reserve obligations from neighbors, this analysis does not include the potential for PJM to purchase additional energy or recall additional obligations that PJM provided to neighbors.

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gas supply chain and deliverability expanded in proportion to the increase in natural gas–fired generation. If the development of pipeline and storage lagged the increase in natural gas–fired generation, then the natural gas–fired power plant forced outage rate would be higher and the size and duration of the associated outage would be greater.

Backcasting the outcome during the polar vortex with the PJM power supply portfolio more closely reflecting today's less resilient power supply mix while holding all else equal, and exercising the remaining limited PJM emergency operating procedures, results in an expected loss of load across seven hours at an average level of about 1.7 GW, as shown in Figure 6. The benefits of the diverse power supply portfolio that was actually in place and capable of avoiding this loss of load was more than $2 billion across PJM and $230 million in New Jersey. The implication is that if PJM faced a similar extreme weather event, New Jersey nuclear plants contribute even more value to the resiliency of PJM.

Table 4

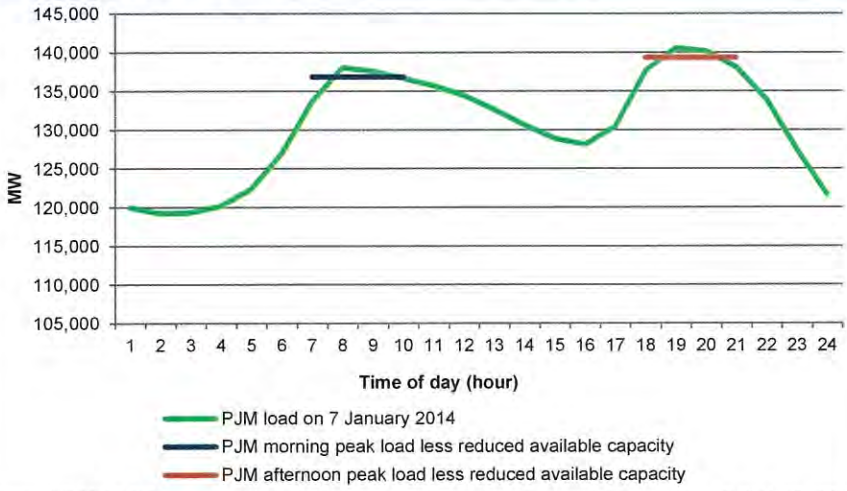
PJM net dependable capacity on 7 January 2014 less New Jersey nuclear power capacity (4.1 GW)

Generator fuel type	Installed capacity on 7 January 2014 less all New Jersey nuclear power capacity (4.1 GW)		Forced outages		Other nonforced outages	Net dependable capacity
	MW	Percentage of total installed capacity	MW	Percentage of installed capacity	MW	MW
Coal	75,545	42%	13,700	18%		61,845
Gas	53,395	30%	19,000	36%		34,395
Nuclear	28,969	16%	1,226	4%		27,743
Hydro	8,107	5%				8,107
Oil	11,314	6%				11,314
Renewable	956	1%				956
Other	701	0%				701
Not classified			6,100	na	2,412	(8,512)
Total	**178,987**		**40,026**		**2,412**	**136,549**

Source: PJM, IHS Markit

Figure 5

Expected loss of load on 7 January 2014 due to retirement of all New Jersey nuclear capacity (4.1 GW)



Source: IHS Markit, PJM

The probability of another polar vortex episode like 2014 may be 1 in 10 years or less. Such a low probability can lead to complacency regarding power supply resilience. Similarly, the probability of another hurricane like Sandy in 2012 hitting New Jersey may also be 1 in 10 years or less. Likewise, the probability of another pipeline disruption such as the 2016 Texas Eastern pipeline failure may also be 1 in 10 years. Other low-probability but high-impact possible deviations from normal operating conditions include a natural gas storage failure similar to what recently happened at the Aliso Canyon natural gas storage facility as well as a wildfire, heat wave, drought, and physical or cyber attack. In addition, the political risks exist that a severe seismic event associated with hydraulic fracturing wastewater injections somewhere in the United States could lead to a widespread ban on hydraulic fracturing for natural gas production. Although the probability of any one of these events happening in any given year is low, the probability of some type of high-impact event that challenges electric system resilience is much higher, because the probability of at least one of these events happening is the sum of the probabilities of these independent risk factors. Further, the consequences of extreme and catastrophic scenarios increase when two or more high-impact events occur simultaneously. The bottom line is that a better than even chance exists that a major disruptive event affecting the availability of one type of electric generating resource in the PJM supply portfolio will occur within the next decade, and some of the most troubling potential low-probability but high-impact risks exist in the natural gas fuel supply chain. Consequently, the investment in electric system resilience is a prudent response to the aggregate risk profile of low-probability but high-

impact disruptive events to PJM normal operating conditions.

Evaluating the benefits of electric system resilience involves assessing a power system's ability to sustain the impact of major risk factors. Such electric system reliability assessments underpin the development of power system configurations capable of sustaining, adapting, and recovering from the most disruptive excursions from normal operating conditions.

Prudent planning of power system capacity reserves needs to reflect resilience considerations. The resources available to instantaneously match electric supply and demand all involve uncertain availability at any point in time. Therefore, providing reliable electric service requires operating with a diverse mix of resources in reserve. A robust reserve uses diversity to mitigate potential deviations from normal operating conditions affecting the availability of a given generating technology or fuel source. For example, an operating reserve made up entirely of natural gas–fired resources supplied from a common pipeline could provide reliable operating capacity levels under normal pipeline operating conditions. However, the reserve would not be resilient to a pipeline disruption. By contrast, a diverse operating reserve comprising dual-fueled capacity (pipeline natural gas and on-site liquid fuel inventory) would be capable of providing reliable available capacity that is also resilient to a potential significant deviation from normal natural gas pipeline operating conditions.

Table 5

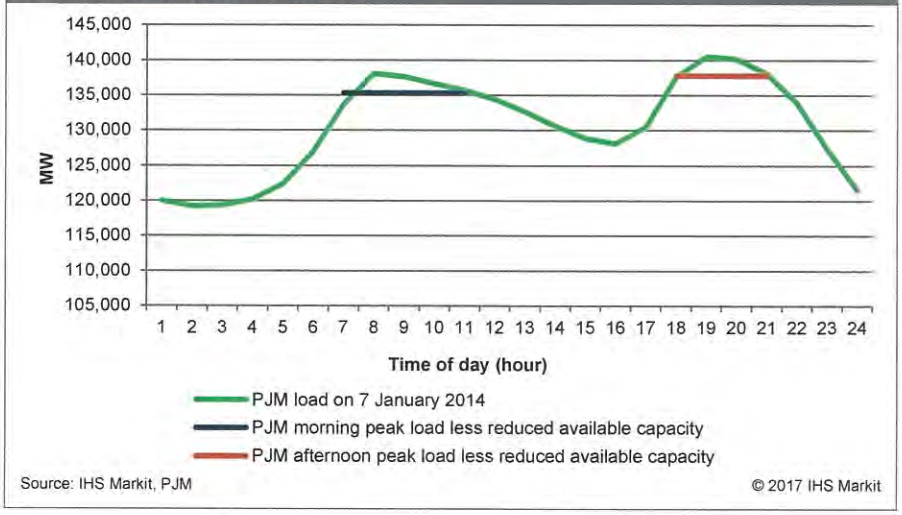
PJM peak capacity analysis for 7 January 2014: Lower base load and no New Jersey nuclear power capacity (4.1 GW)

Generator fuel type	Installed capacity on 7 January 2014 less all New Jersey nuclear power capacity (4.1 GW)		Forced outages		Other nonforced outages	Net dependable capacity
	MW	Percentage of total installed capacity	MW	Percentage of installed capacity	MW	MW
Coal	66,622	37%	12,082	18%		54,540
Gas	62,317	35%	22,175	36%		40,142
Nuclear	28,969	16%	1,226	4%		27,743
Hydro	8,107	5%				8,107
Oil	11,314	6%				11,314
Renewable	956	1%				956
Other	701	0%				701
Not classified			6,100	na	2,412	(8,512)
Total	**178,987**		**41,583**		**2,412**	**134,992**

Source: PJM, IHS Markit

Figure 6

Expected loss of load on 7 January 2014 due to retirement of all New Jersey nuclear capacity, and reduction and replacement of 8.9 GW of coal with natural gas–fired generation



Source: IHS Markit, PJM

In an undistorted efficient market outcome, profitable competitive electric generators trying to maximize expected returns would be expected to invest their positive cash flows in resilience capabilities where the expected benefits exceed the costs. By contrast, underinvestment in resilience is a predictable consequence for unprofitable competitive generators with market cash flows suppressed by market distortions. For example, profitable natural gas–fired CC generators would likely contract for more resilient natural gas supply via purchases of firm pipeline capacity or fuel storage facilities. Consequently, current market conditions that suppress cash flows diminish the capability to make these resilience investments. The bottom line is that underinvestment in power supply resilience is a predictable result of market distortions that reduce wholesale electricity market cash flows.

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Negative statewide economic impacts

The microeconomic impacts drive broader statewide impacts that reflect the pace of premature uneconomic nuclear power plant closures generating a cost to the New Jersey economy from diverting capital from other productive uses and increasing the retail price of electricity. The IHS Markit baseline regional economic outlook provides a reference case for evaluating the employment and state GDP impacts of an electricity price shock due to the nuclear plant shutdowns.[12] In the scenario of closing and replacing the power produced by the Salem and Hope Creek nuclear power plants, annual retail electricity prices in New Jersey would increase by an average of 4% from 2013 to 2016. The analysis also incorporates a reduction in direct employment at the two closed nuclear plants to 10% of current levels.

These direct effects of the nuclear plant closures spread through the New Jersey economy in two ways:

- **As businesses pay more for electric power, they reduce their purchases of other inputs from suppliers (indirect effects).** Supplying firms experience lower sales and reduce demands for inputs from their suppliers. Businesses may try to pass some or all of the higher power costs to their customers, depending on conditions in the markets they serve, which results in a decline in sales.

- **As businesses experience reduced sales and higher costs, they reduce employment levels and payroll expenditures, either directly by eliminating jobs at facilities in New Jersey or indirectly by moving activities to other states (induced effects).** In the short run, New Jersey businesses reduce the number of in-state jobs. In the long run, they move jobs or expand activities to other states. Payroll declines lead to drops in local expenditures of disposable income by affected workers. Because households incur higher electricity prices, with disposable incomes remaining fixed in the short run, they will have to reduce spending for other discretionary items such as entertainment, food, and clothing. The negative impacts will be higher among low-income households that pay proportionately more for electricity than the average household.

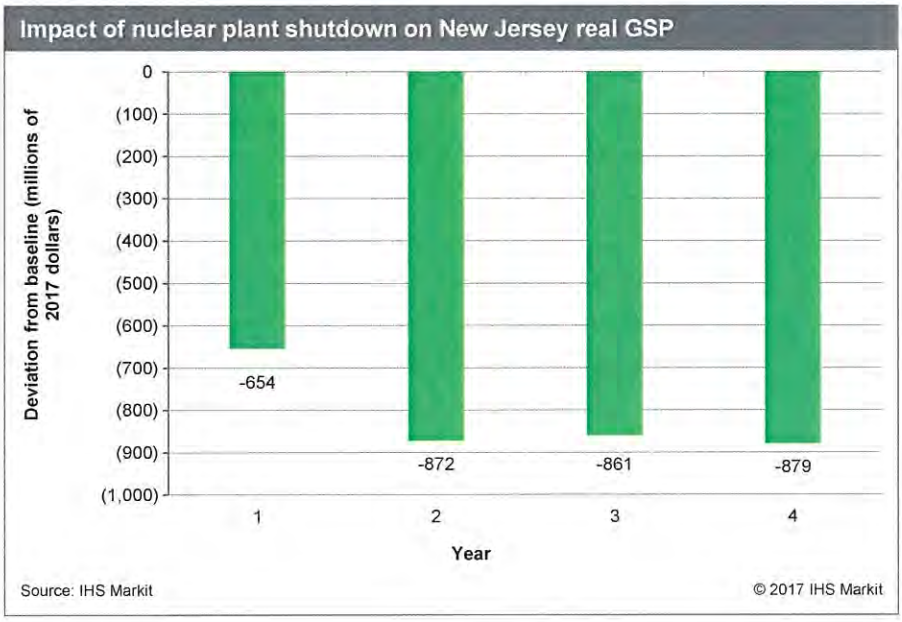
Together, these effects will result in lower production, employment, income, and consumption in New Jersey.

The IHS Markit forecasting model for New Jersey captures the econometric relationships between economic variables and simulates total net change in the levels of economic activity in the state. In other words, the model incorporates the net impact of the direct, indirect, and induced effects. The economic impacts are cumulative as businesses and households make dynamic adjustments to the higher electricity prices over time.

Impact on real GSP

Figure 7 shows that higher power prices resulting from the closure of the Hope Creek and Salem nuclear power plants lower real GSP in New Jersey by about $820 million in 2017 prices, or 0.14% of potential annual baseline output. Businesses will face the dual challenge of higher operating costs in conjunction with decreased demand for their products and services. Employment will decline as businesses eliminate or relocate jobs to reduce costs. The employment drop will also result in a decline in wage and salary earnings that lowers disposable income. Consumers will reduce discretionary consumption levels when faced with higher power bills.

Figure 7



12. The IHS Markit baseline regional outlook reflects the retail price and employment impacts of the anticipated closure of the Oyster Creek nuclear generating station.

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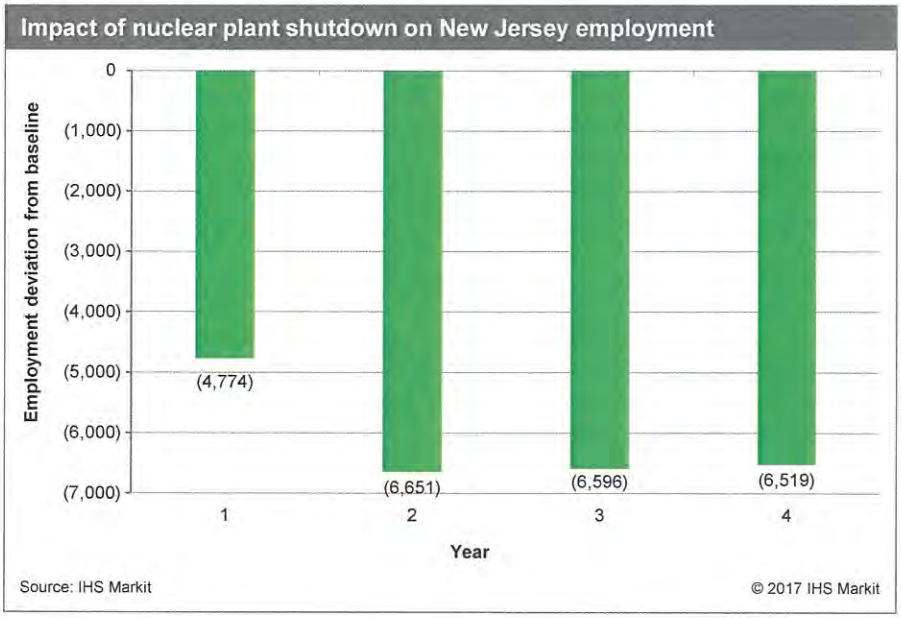
Impact on employment

Figure 8 shows that the premature retirement of the Hope Creek and Salem nuclear plants would reduce total employment by 6,100 jobs annually relative to the reference scenario. It also shows that employment drops continue in year 2 through year 4, indicating that businesses affected by persistently higher electricity prices will make continual adjustments, such as reducing jobs in New Jersey or moving jobs to other states.

Figure 8



More varied monthly power bills

One of the cost components of consumer monthly electricity bills is the cost of energy purchased by PJM LSEs. Backcasting indicates that the energy cost component of New Jersey consumers is sensitive to the delivered price of natural gas. This price varied considerably from 2013 to 2016. The spot price of natural gas at the New Jersey pricing hub (Transco Zone 6 non-NY) spiked at more than $25/MMBtu in January 2014 during the polar vortex episode. Figure 9 shows the monthly variability of New Jersey spot and delivered natural gas prices across 2013–16.

Figure 9

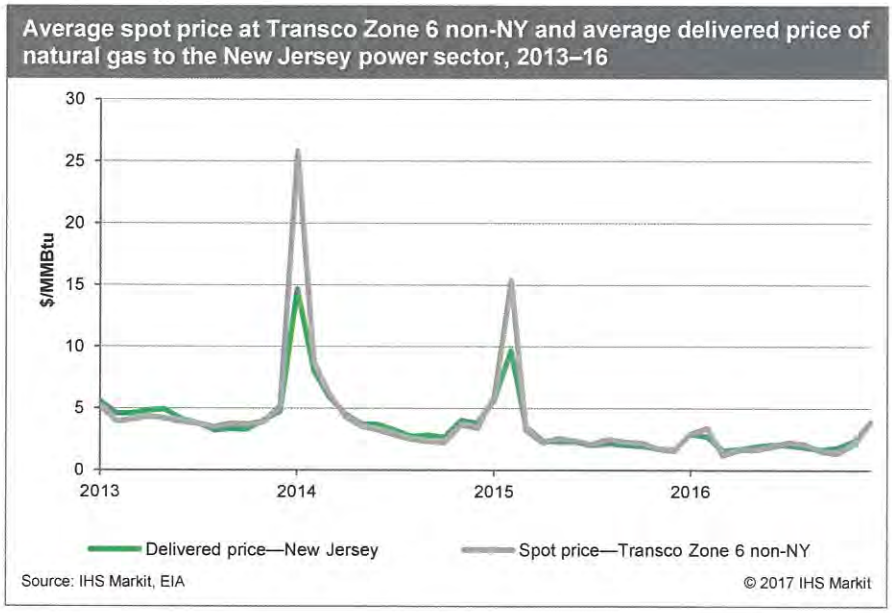


Figure 10 illustrates the sensitivity of the changes in the PJM monthly average cost of production per megawatt-hour to the changes in monthly average delivered natural gas prices. The increase in PJM production costs were greatest in 2014, when natural gas market conditions produced an average annual delivered price of natural gas of $4.58/MMBtu and a monthly average price high of $14.39/MMBtu.

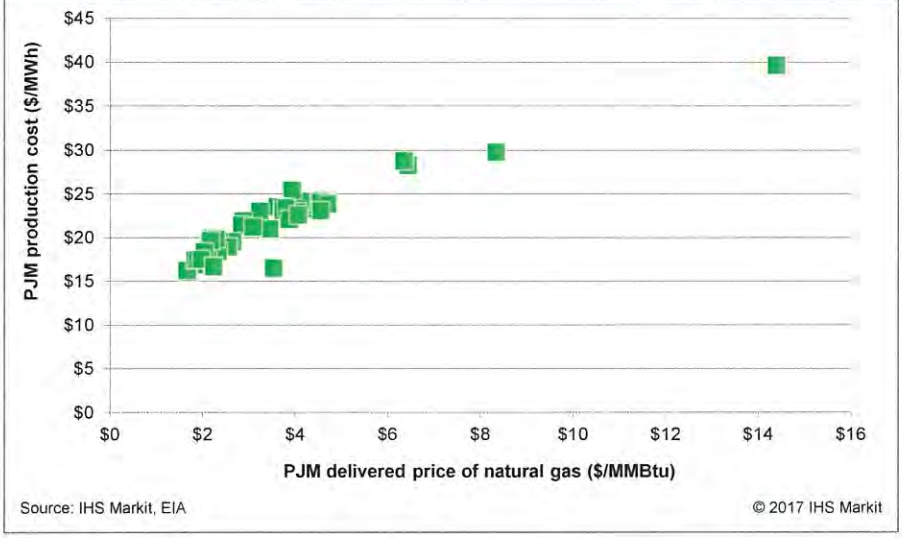
The linkage of PJM electric production costs to natural gas prices means that LSE purchases of electric energy at LMP prices will also fluctuate as the fuel component of incremental variable costs of electric production changes. Backcasting shows that nuclear generation in the PJM supply portfolio mitigates some of the production cost variability in PJM, driven primarily by natural gas price changes. Since the energy cost is one of the components of the New Jersey consumer monthly power bill, the reduction in the variability of the energy component lessens the variability in monthly power bills. The implication is clear—the premature closure and replacement of the Salem and Hope Creek nuclear power plants results in not only an expected increase in monthly power bills but also an expected increase in the monthly variation in consumer power bills.

99.

The premature closure of the Oyster Creek nuclear power plant and the replacement of its output with a 15%/85% mix of renewable and natural gas–fired generation increase the annual PJM natural gas–fired generation share and, thus, increase the exposure of overall PJM variable production cost per kilowatt-hour to the greater variability of delivered natural gas prices. As Table 6 shows, the closure and replacement of the Oyster Creek nuclear power plant produces a 2% greater variability (standard deviation) in monthly PJM variable electricity production cost per megawatt-hour compared with the actual variability during 2013–16. Similarly, the closure and replacement of the Salem and Hope Creek nuclear generation stations increases annual PJM natural gas–fired generation by about 15% and increases the variability in PJM monthly variable production costs per megawatt-hour by an additional 11%.

Figure 10

PJM monthly production cost per megawatt-hour change versus delivered price of natural gas, 2013–16



Source: IHS Markit, EIA

Table 6

PJM market outcomes: Backcast from 2013 to 2016

Scenario	Monthly standard deviation in variable production costs ($/MWh)
Actual	4.25
No Oyster Creek	4.33
No Oyster Creek, Salem, or Hope Creek	4.82

Source: IHS Markit, EIA

Consumers reveal a preference for stable and predictable monthly electricity bills. For example, the widespread deployment of smart metering technologies enabled the expansion of time of use pricing that reflects the underlying real-time variability of the marginal cost of electricity production. Although voluntary pilot programs indicated some consumer interest, when broader implementation initiatives of time-differentiated price schemes went under way and provided consumers with the choice of more varied real-time pricing, the vast majority of consumers chose to remain with the more stable and predictable traditional retail power pricing schemes.[13]

The consumer preference for stable and predictable monthly power bills means that consumers value having the Salem and Hope Creek nuclear power plants in the power supply portfolio to provide resilience in PJM monthly production costs to changes in the delivered natural gas prices. How much this resilience is worth can be estimated by assessing the cost to replace the resilience to natural gas price changes that the Salem and Hope Creek nuclear plants provide to PJM production costs. Resilience of PJM electricity production costs to natural gas price changes can be accomplished through the use of financial instruments that hedge the price of natural gas to produce the same overall PJM production cost variability.

Hedging natural gas prices with financial instruments can be accomplished in a variety of ways. Hedging strategies can employ long-term contracts for natural gas supply with fixed or indexed prices, as well as employ futures contracts of varying terms along with call options or other derivatives. A simple hedging strategy could employ natural gas price call options. Purchasing a call option provides the right, but not the obligation, to purchase a specified amount of natural gas at a specified price and at a specified future point in time. Appendix B provides an example of applying this approach to create a rolling month-ahead call option on the delivered price of natural gas in PJM across 2013 to 2016, employing a

13. See the IHS Markit Multiclient Study *The "Smart Grid Narrative" and the "Smarter Grid": Revolution versus Evolution—Which Way Forward?*

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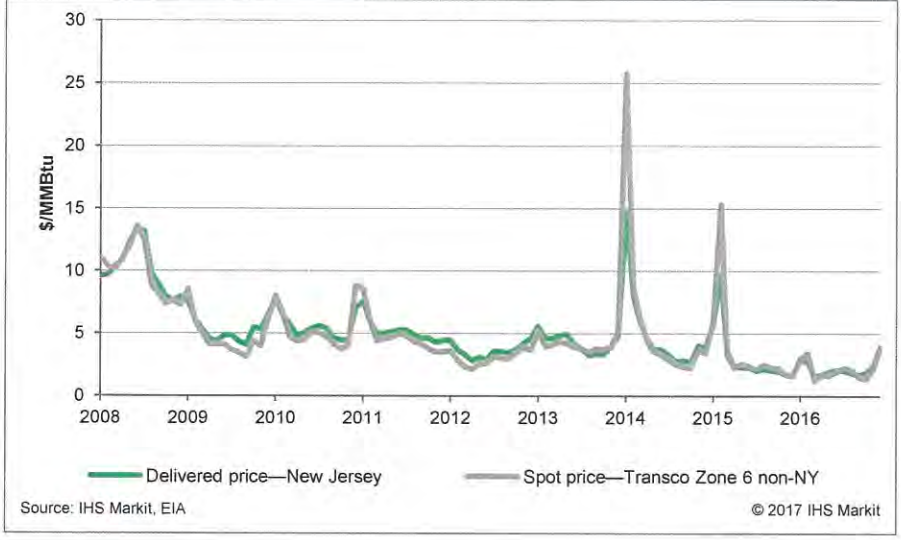
strike price set to limit the price paid for natural gas to a level 50% above the three-month trailing average delivered price of natural gas across PJM. The option cost assessment employs a variant of the Black-Scholes option pricing formula to estimate the cost of reducing the variability of the delivered price of natural gas in PJM with this hedging strategy. The assessment indicates that hedging PJM natural gas prices across 2013 to 2016 with options involves an average cost of $11.2 million to reduce the variability of monthly PJM production cost variability by 1%.

To put this estimate of hedging costs into perspective, Figure 11 shows monthly data from January 2008 to December 2016 for the average delivered price of natural gas to power generators in New Jersey along with the spot price of natural gas delivered to New Jersey at the Transco Zone 6 non-NY pricing point. The delivered cost of natural gas to power generators reflects a mix of spot purchases along with prices hedged by contracts and financial instruments. As the price patterns indicate, the partially hedged average delivered prices are much lower during the brief but extreme price spikes but are a bit higher on average across all months. Since the delivery points are geographically close, the primary difference in these price series can be interpreted as revealing the cost of hedging natural gas spot prices to reduce the variability of the delivered price of natural gas.

Figure 11

New Jersey monthly average delivered natural gas prices and Transco Zone 6 non-NY spot prices, January 2008–December 2016



Source: IHS Markit, EIA

Table 7

Comparison of the New Jersey average delivered price of natural gas to the power sector and Transco Zone 6 non-NY spot prices, 2008–16

Comparison: Price and variation	Average monthly delivered natural gas price to New Jersey ($/MMBtu)	Average monthly Transco Zone 6 non-NY spot price ($/MMBtu)	Difference ($/MMBtu)	Percentage
Average monthly price	4.43	4.36	0.07	
Variability in monthly prices (standard deviation)	2.67	3.42	(0.76)	(22%)

Source: IHS Markit, EIA

Table 7 shows differences in the variation and price level between the New Jersey average monthly delivered natural gas price and the Transco Zone 6 non-NY spot price from January 2008 to December 2016. As Table 7 shows, the higher average price level and the lower price variability of the delivered prices compared with the spot indicate an implicit $0.003/MMBtu cost to reduce natural gas price variability by 1%.[14]

The analyses indicate that the cost to hedge PJM natural gas prices as a substitute for the stability that Salem and Hope Creek provide to the variable production cost in PJM is $77–112 million per year. This amount is the cost required to keep the month-to-month variation in power bills the same as the PJM base case in which Salem and Hope Creek continue to operate. Such a hedging strategy would benefit all PJM consumers. Therefore, if New Jersey consumers paid their share, the cost to New Jersey consumers would be about $8.6–12.6 million per year.

14. To reduce variability in monthly spot prices by 22% costs $0.07/MMBtu. Therefore, to reduce spot price variability by 1% costs $0.003/MMBtu ($0.07/MMBtu * 0.01/0.22).

Environmental impacts

Closing the 3,500 MW of nuclear capacity at Salem and Hope Creek reduces nuclear generation in PJM by about 28,750 GWh/y. The equivalent firm capacity replacement involves 3,469 MW of natural gas–fired CC plus 344 MW of wind and 13 MW of solar producing the same amount of energy, with natural gas–fired generation providing an annual average output of 27,622 GWh. With an average of 1,003 lbs of CO_2 emissions per megawatt-hour for natural gas–fired CC generation, the annual increase in electricity sector CO_2 emissions is 12.6 MMt. To put this into perspective, New Jersey electric generation emitted 19.4 MMt in 2015 and 16.1 MMt in 2012.

The social cost of carbon is an estimate of the economic value of alterations in human health, ecosystems, agriculture, and other facets of life that result from a marginal change in CO_2 emissions. Current estimates of the social cost of carbon range from $6 to $75 (2014 dollars) per metric ton.[15] The midrange estimate is about $42 (2014 dollars) per metric ton. Applying this midrange estimate to the CO_2 emission mitigation associated with the continued operation of Salem and Hope Creek yields an environmental impact value of about $530 million per year.

In addition, the replacement of Salem and Hope Creek with the same mix of renewable and natural gas–fired generation will produce an annual increase in electricity sector NO_x and SO_2 emissions of 3,063 metric tons and 118 metric tons per year, respectively.[16] Using the 2016 Cross-State Air Pollution Rule market allowance prices in New Jersey for NO_x emissions of $137 per metric ton and SO_2 emissions of $2 per metric ton puts the additional environmental impact cost for these emissions at $420,000 per year.

Higher New Jersey consumer power bills

Looking back over the most recent four years indicates that if New Jersey nuclear power plants closed prematurely and were replaced by a 15%/85% mix of renewable and natural gas–fired resources, then electricity production costs across PJM would be higher. Further, the current underlying basis for the New Jersey LMP differential to the rest of PJM would diminish because the New Jersey SRMC of electric production would be similar to the rest of PJM.

PJM market outcomes from 2013 to 2016 provide a base case to evaluate the impact of closing some or all of the nuclear power generating plants in New Jersey. Backcasting PJM electricity sector outcomes across 2013–16 with all conditions held constant, except with the New Jersey nuclear power plants closed and replaced by a current PJM new supply pipeline mix of 15%/85% renewable and natural gas–fired generation, results in an increase in average overall PJM production costs. Therefore, the PJM base case for backcasting holds all else constant but closes and replaces the Oyster Creek nuclear power plant. The closure and replacement of the Salem and Hope Creek nuclear generating stations results in an additional $1,059 million average annual production cost increase. Table 8 shows the backcasting results.

Closing the New Jersey nuclear power plants and replacing the output with a 15%/85% mix of intermittent renewable and natural gas–fired generation makes the generation cost profile of New Jersey similar to the rest of PJM. As a result, the premature closure of the Salem and Hope Creek nuclear power plants results in a loss of the New Jersey LMP differential to the rest of PJM.

Backcasting indicates that the incremental cost associated with prematurely closing and replacing the Salem and Hope Creek nuclear units would have typically added 0.16 cents per kWh to the overall PJM average cost of electric production. If transmission constraints did not exist in PJM, all LMP prices across PJM would increase equally by 0.16 cents per kWh. However, owing to the transmission constraints in PJM, certain lower-SRMC resources can be shared only locally because congestion prevents the export of lower-cost power to zones with higher LMP prices. For example, in 2016 transmission constraints in PJM contributed to New Jersey LMP prices that were lower than LMP hub prices in western PJM more than 70% of the time.[17] This meant that lower-SRMC resources in New Jersey, largely the nuclear units, could

15. Michael Greenstone, Elizabeth Kopits, and Ann Wolverton, "Developing a Social Cost of Carbon for US Regulatory Analysis: A Methodology and Interpretation," *Review of Environmental Economics and Policy 7*, no. 1 (1 January 2013), doi: https://doi.org/10.1093/reep/res015.

16. Numbers are calculated based on electric generation NO_x and SO_2 2014 emission data from the Environmental Protection Agency's National Emissions Inventory, natural gas consumed by the electric power sector in 2014 from the EIA's "Table 2.6 Electric Power Sector Energy Consumption," and a natural gas CC heat rate of 7,100 Btu/kWh.

17. In 2016, hourly LMP prices in the PSEG, JCPL, and AECO zones were at least 5% lower than the PJM Western Hub day-ahead LMP prices.

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not export enough of their lower-cost power to the rest of PJM to equilibrate prices. As a result, LMP power prices in New Jersey were on average 0.3 cents per kWh lower than the rest of PJM, with an average delivered natural gas price of $2.13/MMBtu in 2016. The premature closure and replacement of the Salem and Hope Creek nuclear power plants would eliminate the basis for the LMP differential, reflecting the nuclear versus natural gas–fired generation SRMC differential arising from the existing transmission constraints. In this case, the closure would eliminate an average 0.38 cents per kWh differential in favor of New Jersey consumers, reflecting the typical average delivered natural gas price of $3.29/MMBtu of 2013–16.[18]

Table 8

Backcast of PJM market outcomes, 2013–16

Scenarios	2013	2014	2015	2016	2013–16 average
Actual					
Annual retail sales (GWh)	670,813	672,428	670,457	663,711	669,352
Average annual real retail price (cents per kWh)	9.94	10.32	10.42	10.35	10.26
No Oyster Creek					
Total annual production cost change (millions, 2015 dollars)	173	209	118	100	150
Percent change in average real retail electricity price	0.22	0.26	0.15	0.13	0.19
No Oyster Creek, Salem, or Hope Creek					
Total annual production cost change (millions, 2015 dollars)	1,371	1,610	989	867	1,209
Percent change in average real retail electricity price	1.78	2.03	1.29	1.14	1.56
No Salem and Hope Creek versus no Oyster Creek					
Total annual production cost change (millions, 2015 dollars)	1,198	1,400	871	767	1,059
Change in cost (cents per kWh)	0.18	0.21	0.13	0.12	0.16

Source: IHS Markit, EIA

Altogether, the impact of the higher PJM average cost of electric production and the loss of the LMP differential would increase the cost of New Jersey wholesale electricity by $5.4/MWh under operating conditions similar to 2016 and fuel costs reflecting the four-year average from 2013 to 2016. This annual cost increase adds $404 million in New Jersey consumer power payments that would involve a 4% increase in the average retail power price. The percent increases to specific customer classes from 2016 retail price levels are summarized in Table 1.

Opportunities to harmonize New Jersey policy with PJM market operations

New Jersey is at a critical juncture. Doing nothing to address current PJM market flaws and distortions leads to underinvestment in electric production efficiency that moves the electric supply portfolio toward a less efficient and resilient generation mix comprising too many relatively inefficient and fuel-insecure peaking power plants and too few more efficient, fuel-secure base-load resources.

Concerns about addressing wholesale electric market distortions led the US DOE and Secretary of Energy Rick Perry to call for new rules to offset market distortions by allowing for the full recovery of costs of fuel-secure power generation units, including nuclear. Although the specifics of the approach are not yet available, the initiative shows that the discord between public policies and market operations is currently high on the electricity policy agenda.

What happens next will shape electricity markets for decades to come. In particular, a lack of resolution of the current disharmony between public policies and market operations increases the probability that current market distortions will lead to the uneconomic closure and replacement of the Salem and Hope Creek nuclear power plants.

18. Even if transmission constraints cause LMP prices in New Jersey to increase relative to the rest of PJM, the continued operation of the Salem and Hope Creek nuclear power plants would minimize the basis differential because they have an SRMC that is lower than the natural gas–fired generation alternative.

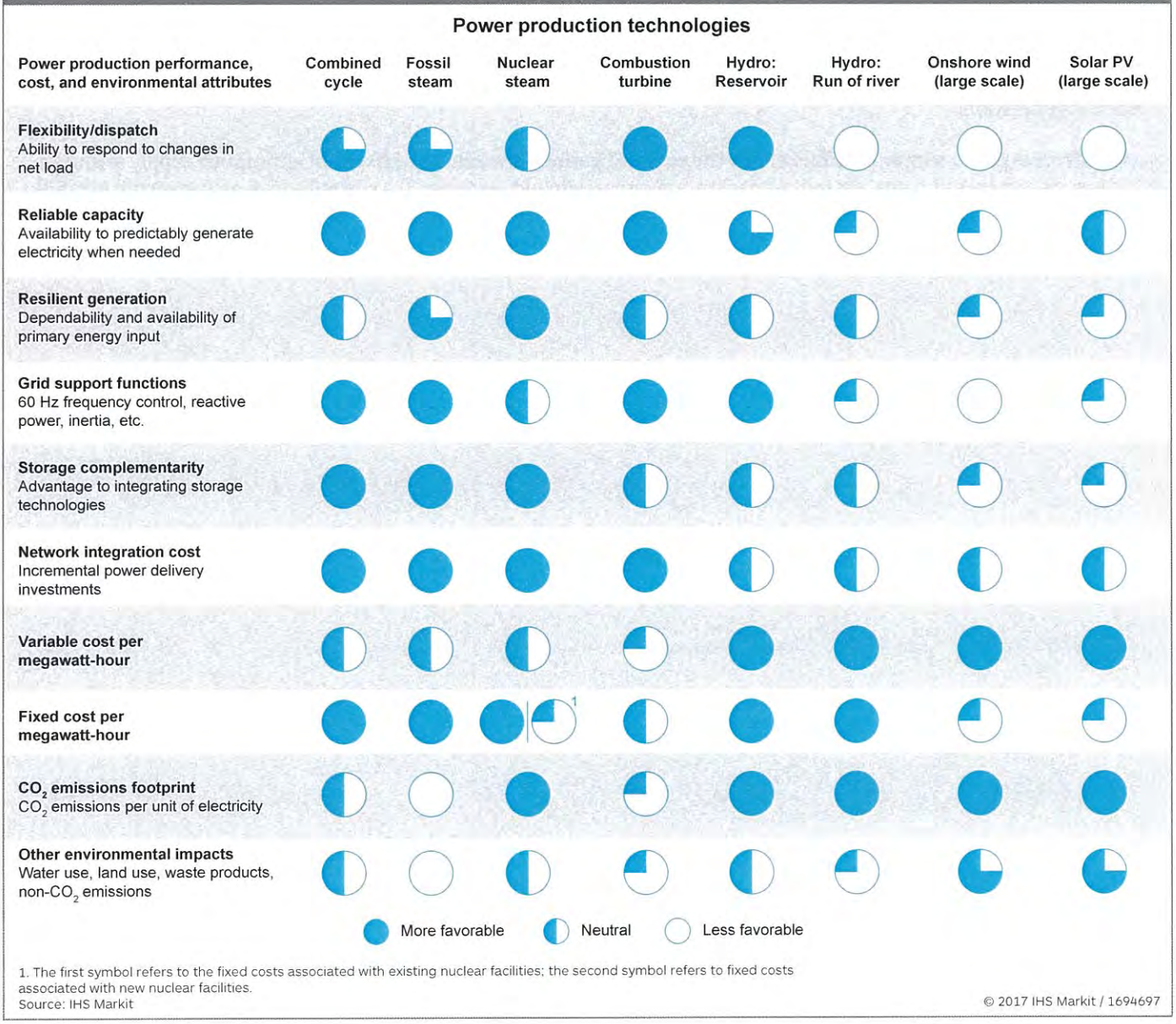
Appendix A: Performance characteristics of an electric supply portfolio

A cost-effective electric supply portfolio generates benefits by integrating the different cost and performance characteristics of alternative power supply resources. As Figure 12 shows, the current available state of technology for power supply includes a variety of technologies that bring different performance characteristics to an electric supply portfolio.

- **Flexibility/dispatch.** The capability to vary electric output to follow net load through time.
- **Reliable capacity.** The capability to provide capacity when needed.
- **Resilient generation.** The security of the primary energy input supply chain for electric production. For example, fuel inventory at a plant site increases the security of electric supply from short-run fuel supply chain disruptions.

Figure 12

Performance, cost, and environmental attributes of power production technologies



1. The first symbol refers to the fixed costs associated with existing nuclear facilities; the second symbol refers to fixed costs associated with new nuclear facilities.
Source: IHS Markit

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- **Grid support functions.** The capability to manage grid electricity voltage and frequency, for example, from automatic generation controls.
- **Storage complementarity.** The degree to which linkage to an electric energy storage technology can enhance the cost-effectiveness of the technology in a supply portfolio. For example, reservoir hydro provides the inherent capacity to forgo generation and store water to generate electricity at a later time and, therefore, has less to gain from linking to a storage technology than other technologies. In the case of intermittent renewables, a linkage to storage improves the cost-effectiveness of the power supply, but the improvement in cost-effectiveness is even greater for the linkage of a high-utilization generating technology with a storage technology.
- **Network integration costs.** The impact of a generating technology addition to the supply portfolio on the generating costs of the rest of the power supply mix.
- **Variable cost per unit of output.** The electric supply costs linked to the level of electric energy output.
- **Fixed cost.** The electric supply costs independent of the level of electric energy output.
- **CO_2 emission footprint.** The level of CO_2 emissions per unit of electric energy output.
- **Other environmental impacts.** The per-unit cost of non–greenhouse gas environmental impacts associated with electric generation.

A cost-effective power supply portfolio aligns the cost and performance characteristics of alternative supply resources to different segments of power system aggregate consumer demand. As a result, a cost-effective power supply portfolio will include power plants with relatively high utilization rates and more efficiency in transforming primary energy into electricity to serve the steady base-load segment of consumer demand.

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Appendix B: Natural gas call option hedging analysis

Consumers in PJM, including New Jersey, will be exposed to greater power price variability owing to the increased reliance on natural gas fuel supply if the Hope Creek and Salem power plants retire. The implicit value to New Jersey consumers of greater power price stability from the continued operation of the Hope Creek and Salem nuclear plants can be comparable to the cost of using financial instruments as a substitute for a more efficient power supply portfolio to hedge the higher production cost variability in the scenario with no New Jersey nuclear generation over 2013–16.

The analysis used natural gas call options to hedge the increased production cost variability in PJM under the less efficient power supply portfolio. Call options are financial instruments that provide holders with the right, but not the obligation, to purchase a certain amount of an underlying commodity on a specified date at a specified price. The specified date is called the *expiration* date, and the predetermined price is called the *strike price*, which sets an upper limit to the future price of the underlying commodity. If, on the expiration date, the price of the underlying commodity is greater than the strike price, the holder of the call option will exercise the right to purchase the commodity at the strike price. Alternatively, if the price of the underlying commodity is less than the strike price on the expiration date, the holder will not exercise the call option. Therefore, natural gas call options place an upper limit on the future price of natural gas and reduce the variability of natural gas and the overall cost of electricity production (as long as some of the call options are exercised).

Backcasting the purchase of natural gas call options on a monthly basis at a rolling strike price set at 1.5 times the average delivered price of natural gas to PJM over the preceding three months reduces the variability (standard deviation) of the variable cost of electricity production in PJM by 23% from 2013 to 2016. The average annual cost of purchasing the natural gas call options based on this strategy is $261 million. Therefore, the average cost to reduce production cost variability by 1% is $11.2 million. Because the production cost variability in PJM is 10% higher in the scenario without the Hope Creek and Salem nuclear plants, the cost to use natural gas call options to achieve the same level of production cost variability is $112 million; New Jersey's share is $12.6 million based on the share of retail sales in PJM in 2016.

The formula used to calculate the theoretical price of an option is shown below and is based on a variant of the Black-Scholes option pricing formula:[19]

$$C_T = \max\{0, (S_T - X)\}$$

$$PV(C_T) = \frac{((F_{0,T} N\{a\} - X N\{b\}))}{(1 + r)^T}$$

$$a = \left(\frac{\ln\left(\frac{F_{0,T}}{X}\right)}{\sigma\sqrt{T}} \right) + \tfrac{1}{2} * \sigma\sqrt{T}$$

$$b = a - \sigma\sqrt{T}$$

Where

C_T is the value of the call option contract.

S_T is the strike price.

X is the natural gas spot price.

$F_{0,T}$ is the forward price.

r is the risk-free rate of return.

19. James Read and Art Altman, "Energy Derivatives and Price Risk Management," in *Pricing in Competitive Electricity Markets*, eds. Ahmad Faruqui and Kelly Eakin (Springer US, 2000). Retrieved from http://www.springer.com/us/book/9780792378396.

106x

σ is the volatility of the spot price of natural gas.

N{} denotes the cumulative probability for a standard normal variable.

/07x

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Americas: +1 800 IHS CARE (+1 800 447 2273)
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Testimony by Michael Shellenberger, Founder and President, Environmental Progress.

December 4, 2017

Mr. Chairperson and members of the committee: thank you for accepting my testimony.

As background, I am a Time Magazine "Hero of the Environment," Green Book Award-winner, and president of Environmental Progress, an independent nonprofit organization funded entirely by individuals and philanthropic foundations.

I am here today because I am very concerned by the threat that nuclear plant closures pose to the environment, public health, and jobs.

I was against nuclear energy for most of my life and only changed my mind after confronting key facts about the limitations of renewables.

New Jersey gets electricity from three nuclear plants. If they close, emissions in New Jersey will rise the equivalent of adding 2.7 million cars to the road. Children, the sick, and the elderly who suffering from asthma or respiratory diseases will pay the highest price.

The New York-Newark region is already among the 25th most polluted cities in America in ozone and particulate matter. The American Lung

Association this year gave 11 New Jersey counties an "F" grade for ozone pollution.[1]

If you allow your nuclear plants to close, electricity prices will rise and high-skill, high-paying jobs will be lost.

My home state stands as a stark warning. Our electricity prices have risen from 13 cents to 18 cents per kilowatt hour since 2011. By contrast, electricity rates nationally rose from just 10 to 11 cents during the same period.[2]

High electricity prices have driven manufacturers out of California and we today have the highest poverty rate in the country, according to the US Census Bureau.[3]

What happened to California? It's simple: we closed one of our two nuclear plants, which generate power at a cost of about 5.5 cents per kilowatt-hour[4], and increased the amount of electricity we receive from natural gas, solar, and wind.

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[1] Len Melisurgo, "Eleven counties with highest air pollution," New Jersey Advance Media, April 201, 2017. http://www.nj.com/weather/index.ssf/2017/04/these_15_counties_have_the_worst_air_pollution_in.html

[2] United States, Energy Information Administration (EIA), November 2017

[3] Chris Nichols, "TRUE: California has the nation's highest poverty rate, when factoring in cost-of-living, Polifact, January 2017. http://www.politifact.com/california/statements/2017/jan/20/chad-mayes/true-california-has-nations-highest-poverty-rate-w/

[4] David Baker, "Nuclear's Last Stand?" *San Francisco Chronicle*, November 14, 2015. http://www.sfchronicle.com/business/article/Nuclear-power-s-last-stand-in-California-Will-6630933.php

The best available peer-reviewed economic research finds that the value of wind drops 40 percent once it becomes 30 percent of electricity and the value of solar drops by half when it gets to just 15 percent.[5]

What about the battery revolution we've heard so much about? There isn't one. As a result, Californians have to *pay* Arizona to take our unneeded solar electricity so it doesn't blow-out our grid.[6]

What about carbon emissions? They rose in California by 11 million metric tonnes while they declined 174 million metric tonnes in the U.S. as a whole.[7]

The share of New Jersey's electricity from natural gas already doubled since 2010, and last year provided 56 percent of your electricity last year. Nuclear provided 39 percent of your electricity last year and is the critical bulwark against over-dependence on natural gas.[8]

Natural gas is cheap now, but if it becomes 90 percent of your electricity you can expect prices to spike. Once a nuclear plant is closed it's closed forever. You can't just go start it up again once natural gas prices rise.

I encourage you to join New York and Illinois in taking sensible measures to safeguard public health, jobs, and consumers by ensuring the continued operation of your nuclear plants. Thank you.

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[5] Leon Hirth, Source: Leon Hirth, "Market Value of Variable Renewables," EUI Working Paper, 2013, http://cadmus.eui.eu/bitstream/handle/1814/27135/RSCAS_2013_36.pdf?sequence

[6] Ivan Penn, "California invested heavily in solar power. Now there's so much that other states are sometimes paid to take it," *Los Angeles Times*, June 22, 2017.

[7] US EIA, November 2017

[8] US EIA, "New Jersey," https://www.eia.gov/state/?sid=NJ

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Michael Maloney

New Jersey State Association of Pipe Trades 12-4-17

Good morning Chairmen Smith and DeAngelo, committee members my name is Michael Maloney and I am the President of New Jersey State Association of Pipe Trades. I represent the skilled men and women that are proud to be plumbers, pipefitters, sprinkler fitters and HVAC technicians in the State of New Jersey. I'm here to provide our perspective on the value of retaining PSEG Salem and Hope Creek nuclear power plants.

I am also the Business Manager of Plumbers and Pipefitters local union # 9. Our members have experienced a similar situation with the imminent closure of Oyster Creek in Lacey Township. The plant is slated to close in the year 2019, which is 10 years before the operating license expiration date. The plant provides roughly 7% of generation to New Jersey. The facility employs approximately 700 people including several members of our Association along with members of other trades. It has one more ½ outage.

When that nuclear plant closes, those jobs are going for good never to come back.

The implications of a plant closure exceed the narrow focus of my interest. The nuclear plant closure has a ripple effect across the economy of Ocean County and the rest of the State.

I recognize that the implications of the closure of Oyster Creek are different than those being considered today for PSEG's nuclear power plants. However, it is important to recognize that the nuclear power plants in Salem County are several times larger than Oyster Creek and the likely economic and environmental impact on the region and the State are multiplied as well.

The nuclear plants in South Jersey have been one ray of good news and good jobs in an otherwise tepid economy. They have provided steady jobs throughout the year and twice a year, during a refueling outage, the plant calls an additional 1,000 contractors and workers to the site – many of them our members.

It will impact people well beyond those who lose their jobs. It will hurt New Jersey in lost wages and taxes. It will devastate local town budgets. It will impact real estate as more people try to sell homes than people who want to buy them.

You have heard of the tremendous benefits of these plants today – the impact on the environment, their role in ensuring the resiliency and reliability of electricity and the increased costs that consumers will pay if the plants go away.

Those are all good reasons to keep these plants running.

However, when you are making your decision on the future of these plants, we want you to remember that you are also deciding on the future of thousands of New Jersey workers who depend on those plants to provide employment. And that this employment is what allows these workers to pay mortgages, buy food for their families, provide an education or training for their children – and in essence stay in New Jersey.

We believe that New Jersey needs nuclear and we encourage you to find a way to protect consumers while also protecting thousands of jobs.

Testimony of Wyatt Earp
On behalf of the New Jersey State Electrical Workers Association
Before the Senate Environment & Energy Committee and the
Assembly Telecommunications & Utilities Committee
December 4, 2017

Good Morning. My name is Wyatt Earp. I am the international representative for the 3rd District of the IBEW.

I am also the secretary of the New Jersey State Electrical Workers Association, which comprises 20 locals representing 35,000 members of the IBEW.

You heard Bud Thoman talk about the importance of nuclear to his local.

You should also know that the Salem and Hope Creek generating plants provide work for hundreds more.

At any given time, in addition to the 750 members of Local 94, there can be more than one hundred members of IBEW Local 351 on-site, helping to keep the plants running smoothly.

And when the plants are being refueled, as many as 1,000 more are needed. They come from the pipe trades, ironworkers, operating engineers – practically every one of the construction trades.

That's extremely important in Salem County where the unemployment rate remains above the state average and in neighboring Cumberland County, which has the worst unemployment rate in the state.

I'll let the economists talk about the multiplier effect in the local economy – from burger flipping to real estate sales. I just know that the direct effect of these union jobs is vitally important in South Jersey.

Keep those nuclear plants in operation generating both reliable, clean electric power and hundreds of skilled, good-paying jobs.

Testimony of Kenneth Thoman
On behalf of Local 94 of the International Brotherhood of Electrical Workers
Before the Senate Environment & Energy Committee and the
Assembly Telecommunications & Utilities Committee
December 4, 2017

Good Morning. My name is Bud Thoman. I am the president and business manager of Local 94 of the International Brotherhood of Electrical Workers.

Local 94 represents more than 3,600 brothers and sisters who are employed by Public Service Enterprise Group in electric generation, electric distribution and transmission, gas distribution and appliance service, and other work in support of those operations.

750 of the members of Local 94 work at PSEG Power's three nuclear plants at Artificial Island – Salem I & II and Hope Creek.

I am here today to talk about the importance of those plants to New Jersey.

The demand for electricity continues to increase – everything is plugged-in these days.

That's why the members of Local 94 who work in nuclear, work in three shifts. Those plants run 24/7/365 generating safe, reliable, clean electricity.

Those plants provide baseload power – nearly 50% of New Jersey's electricity. They run day and night, whether the sun shines or it's pouring rain.

We need our electric power to be reliable. That's nuclear.

We also need our electric power to be clean. That's nuclear.

By law, New Jersey must reduce CO2 emissions to 1990 levels by 2020 and must meet a much tougher target of 80% reduction below 2006 levels by 2050.

I was a member of DEP's Clean Air Council for 14 years. I believe we're still on track to meet that 2020 target.

Hope Creek and Salem I and II produce no greenhouse gas emissions. They also produce no NOx, no SOx and no particulates.

But we must keep those plants running if New Jersey is going to meet future clean air targets.

Solar and other sources of renewable energy are great for New Jersey. Members of my local build some of PSEG's solar power plants.
But solar and other renewables are use it or lose it. We do not have the technology to store electricity in any significant amount.

Renewables today are not a substitute for round-the-clock power.

If the market puts nuclear at risk, it also puts clean air and reliability at risk.

And it puts jobs at risk.

We are talking about 750 full-time, good quality jobs running those plants. And that's just within the IBEW.

There are many hundreds more working full-time at Hope Creek and Salem I and II, and hundreds more on top of that who provide vital work when the plants are refueled.

For all those reasons – to meet the demand for reliable electric power, to help clear the air, an to provide good, high-quality jobs – I support nuclear power in New Jersey.

James Kirkos, President & CEO

Meadowlands Regional Chamber

201 RT 17 North

Rutherford, NJ 07070

201-939-0707

Good Morning/Afternoon.

My name Jim Kirkos, and I am the President & CEO of the Meadowlands Regional Chamber of Commerce.

I'm here today to testify about the importance of nuclear energy to the State's economy. But first, a little background about my organization.

The Meadowlands Regional Chamber is a business service organization whose sole purpose is dedicated to the success and business growth of our members. We advocate for a positive economic atmosphere that improves the quality of life in the greater Meadowlands communities for all who live and work there. For the past 40 years, the Chamber has taken a leadership role in many aspects of economic development. Our public affairs advocacy has become a hallmark of this organization as we strive to be a leader on critical issues facing the Meadowlands region and sometimes the state. This advocacy provides the membership with representation and a voice that may not otherwise be heard. The Chamber now speaks for close to 1,200 companies representing over 140,000 employees in the greater Meadowlands region."

It is in that spirit that I am providing comments today.

So you all may be asking yourselves: Why is this North Jersey business leader talking about power plants in South Jersey? That's because clean and efficient nuclear energy is not a South Jersey issue, or a North Jersey issue – it is a <u>New</u> Jersey issue. And the ability for NJ to have a safe, secure and resilient energy infrastructure will be a key factor if we want to attract, retain and grow businesses in our great state.

Nuclear generated electricity is essential to the Garden State's economy. The Salem and Hope Creek units are an economic engine that contributes over $800M per year in GDP, and $37M in annual tax revenues. The State cannot afford to lose that type of revenue. Nor can we afford to lose the nearly 6,000 jobs the nuclear industry supports. In addition, without nuclear energy prices are likely to rise – not just for South Jersey but for the entire State. It does not take an economist to understand that if you remove half of the supply of a product without reducing demand the cost of the product will rise. This impact could be substantial on my members and businesses in general.

Outside of stated economic impacts, there are other elements to consider. Nuclear energy powers roughly every other home in the State. I repeat: It supplies nearly half of our electricity – from Camden to New Brunswick to Jersey City and Paterson. Without it, the State would be left with one primary fuel source in its generation mix. That would be poor planning and could lead to resiliency issues not to mention the millions of metric tons of CO2 and pollutants that would be released by neighboring states as they produce our energy with coal and natural gas. Preserving energy generation diversity is critically important to mitigating extreme threats to the electricity supply and important to my members who need a resilient electricity source to survive economically. In a December 2016 study, the North American Electric Reliability Corporation (NERC), pointed out that "reliance on a single fuel to generate energy increases vulnerabilities, particularly during extreme weather conditions." New Jersey itself has experienced severe weather events in recent years, including Superstorm Sandy in 2012, and the 2014 Polar Vortex that crippled much of the northeast. Preserving a diverse generation mix that relies on multiple sources of fuel is essential to reducing the risk these potential common failures posed to the power grid.

So let's act now. Let's preserve the value of nuclear generating plants for their economic benefits and for the resiliency they provide to the electric grid that many of my members rely upon to run their businesses and that many of us rely upon in our daily lives.
Thank you.

New Jersey
ALLIANCE for ACTION INC.®

PHILIP K. BEACHEM
President

Raritan Center Plaza II • 91 Fieldcrest Avenue, Suite A24 • Edison, New Jersey 08837
(732) 225-1180
www.allianceforaction.com

GERALD T. KEENAN
Executive Vice President

CHRISTIAN HARTMAN
Assistant Vice President

Statement of

Philip K. Beachem, President New Jersey Alliance for Action

Before a Joint Meeting of the

Senate Environment & Energy & Assembly Telecommunications and Utilities Committee

Monday, December 4, 2017

Good Morning/Afternoon,

My name is Philip Beachem and I have been the President of the New Jersey Alliance for Action for the last 30 years. I have had the privilege of having worked with officials from the federal, state and local level on economic and infrastructure issues important to the citizens of New Jersey and the region. During this time I have served on numerous commissions including the New Jersey Economic Development Authority, New Jersey Transportation Trust Fund Authority and the USEPA's Environmental Finance Advisory Board.

The New Jersey Alliance for Action was established in 1974 has a non-profit, non-partisan association focused on infrastructure and economic development. As such, utility infrastructure and its impact upon the State's economy is a critically important issue for our 2,400 members.

New Jersey's remaining nuclear power plants are in a precarious situation caused by an uncertain energy marketplace. The premature closing of any one of the remaining plants would irreparably harm the local economies of the region, in addition to leading to higher electricity costs for New Jersey customers.

Preserving New Jersey's nuclear plants will, unavoidably, come with some cost. But allowing them to close will be even more expensive

A recent report pegs the economic value of New Jersey's nuclear plants at more than $800 million per year. That includes energy production, the purchase of goods and services, payroll for 1,600 direct employees and millions of dollars in annual tax revenues. That economic activity has a ripple effect throughout the economy. But economics should not be our only consideration.

Nuclear power is a critical part of the state's energy infrastructure – providing almost half of all the electricity generated in the state without producing air pollution or greenhouse gases.

Nuclear energy also contributes to the fuel diversity that keeps New Jersey's energy supply reliable.

I think we can all agree that safe, clean, reliable and affordable energy is something worth preserving.

But unless state policies do the same, our nuclear plants may disappear. Lawmakers in New York, Connecticut and Illinois already have enacted policies to support their struggling nuclear plants. New Jersey lawmakers would be wise to follow suit. I urge the state's policymakers to protect the state's electric customers from higher bills and increased air pollution by throwing our nuclear plants a crucial safety net. New Jersey's nuclear plants are worth saving.

TESTIMONY OF

CHRISTINA M. RENNA

VICE PRESIDENT

CHAMBER OF COMMERCE SOUTHERN NEW JERSEY

SENATE ENVIRONMENT AND ENERGY COMMITTEE

&

ASSEMBLY TELECOMMUNICATIONS & UTILITIES COMMITTEE

DECEMBER 4, 2017

120x

Chamber of Commerce Southern New Jersey
Testimony Before The Senate Environment and Energy Committee and Assembly Telecommunications and Utilities Committee
Trenton, N.J. -- Dec. 4, 2017

Good morning Chairman Smith, Chairman DeAngelo and members of the Senate Energy Environment and Assembly Utilities Committee. I am Christina Renna, Vice President of the South Jersey Chamber of Commerce.

The CCSNJ represents more than 1,000 businesses located in the in the seven southern counties of New Jersey, as well as Greater Philadelphia and Northern Delaware. We are proud to be the largest business organization in the region and to serve as the voice of the South Jersey business community. We routinely weigh in on legislation that impacts upon the operations and profitability of our members. While there is no actual legislation today, what I'd like to offer is how PSEG Power's nuclear plants contribute to the greater Southern New Jersey economy.

We understand that the nuclear industry faces challenges that threaten the profitability –and, therefore – the continued operations of nuclear plants, including those in Salem County. In fact, this issue is of such importance that our Chamber has formed a special ad hoc subcommittee of our Board of Directors representing a wide range of stakeholders who will examine any legislation that will address the future of nuclear power in our State.

I'm here today to talk about the positive economic impacts that the Salem nuclear plants have upon our region. And, let me say that I have had the opportunity to have toured these plants along with a group of teachers for the past three summers. PSEG Nuclear has a fantastic Energy & Environmental Resource Center that is open to groups – including school children – to educate them about energy. We've also toured the virtual operations center that mimics the real operations center of the plant. It is surely an eye-opening experience!

On these tours, we have learned that the plants employ 1,600 full time employees with salaries above the regional average. These employees are augmented twice a year by a virtual army of contractors who are hired to assist with refueling and maintenance outages. All of these employees – fulltime workers and contractors – fuel the local economy and support local businesses. In fact, these plants account for close to 6,000 jobs – direct and indirect – in our state. Further, the plants contribute more than $800 million annually to the New Jersey economy through payroll, locally purchased goods and services, as well as in state and local taxes.

Needless to say, these plants are integral to the continued economic well-being of our region.

Thank you for the opportunity to address the important economic contribution the Salem nuclear plants make to South Jersey.

Jennifer Jones, Executive Director, Salem County Chamber of Commerce
Legislative Testimony
Dec. 4, 2017

My name is Jennifer Jones; I am the executive director of the Salem County Chamber of Commerce. Our chamber membership includes more than 400 businesses and community organizations.

Our members include only a handful of large businesses like PSEG Nuclear. The heart of our chamber is our small business community. Knowing our members, I am confident when I say that most if not all of our chamber members' benefit from the economic impact of the Salem and Hope Creek nuclear plants.

As many of you know, Salem County is one of New Jersey's most economically challenged communities. When any large company closes, it has a devastating effect on the community.

Several years ago, Ardaugh Glass closed in Salem City putting 300 people out of work. The magnitude of this loss is still felt. I cannot imagine how devastating it would be if PSEG Nuclear's nuclear plants and its more than 1500 employees were no longer here.

However, it's more than just the nuclear plants. Our community would be hard pressed to recover and those mom-and-pop small businesses would also be closing their doors.

There are a lot of people here today. Many of them want the nuclear plants to go away.

If I could, I'd like to get personal.

I've lived in Salem County my entire life. I remember when Salem and Hope Creek were in the construction phase, and I remember the huge, positive impact it made on our community. The influx of construction workers boosted our local economy, especially for small business retail, restaurants and housing rentals.

Since childhood, I can't remember anything significant taking place in the community that did not include participation and assistance from PSEG Nuclear and their employees. The company has always been a terrific community partner not only providing financial support but also volunteers who make our community possible.

For those who say nuclear is scary, I've lived with the nuclear plants in my back yard my entire life. I've never been afraid.

I wonder how many of those here today have ever visited a nuclear plant. I have. I have visited Salem and Hope Creek and toured the plants. I know the people who work there. They are our friends, our neighbors, our loved ones. They are Salem County.

Salem County needs nuclear. South Jersey needs nuclear. And most importantly, New Jersey needs to take action to ensure there is nuclear power for many years to come.

Thank you for your time and the opportunity to provide the Salem County Chamber of Commerce's feedback on this important issue.

GOOD MORNING.

CHAIRMAN SMITH, CHAIRMAN DEANGELO, AND MEMBERS OF THE JOINT COMMITTEE.

MY NAME IS WILLIAM HARLA. I AM A PARTNER AT DECOTIIS, FITZPATRICK, COLE AND GIBLIN.

I REPRESENT THE NEW JERSEY COALITION FOR FAIR ENERGY.

THIS COALITION IS COMPOSED OF INDEPENDENT ENERGY PRODUCERS—(SPECIFICALLY, NRG, WHICH HAS ITS NATIONAL HQ JUST UP ROUTE 1 IN PRINCETON, CALPINE, DYNEGY AND THE NATIONAL ELECTRIC POWER SUPPLY ASSOCIATION—A TRADE ASSOCIATION REPRESENTING THE INTERESTS OF OTHER INDEPENDENT POWER PRODUCERS).

AS MR. IZZO NOTED, THESE COMPANIES COMPETE AGAINST PSEG—AND EACH OTHER—IN THE ELECTRIC GENERATION MARKETPLACE.

A CORPORATE SUBSIDY TO PSEG FOR ITS NUCLEAR PLANTS WILL DISTORT THAT MARKET AND CREATE AN UNFAIR ADVANTAGE AND AN UNLEVEL PLAYING FIELD BENEFITING ONE COMPANY—PSEG—AT THE EXPENSE OF ITS COMPETITORS.

WE ARE OPPOSED FOR REASONS OF PROCESS AND SUBSTANCE.

AS NOTED, THE PLANTS ARE PROFITABLE. THERE IS NO IMMINENT RISK OF CLOSURE OR JOB LOSS. THEY ARE SUBJECT TO CONTRACTS AND PJM OVERSIGHT THAT WILL KEEP THEM OPERATING FOR YEARS TO COME.

BASED ON THE ILLINOIS MODEL, A SUBSIDY COULD EASILY COST $450 MILLION PER YEAR, OR $4.5 BILLION OVER A DECADE.

TODAY IS A GOOD TIME TO START THE DEBATE, BUT THERE IS NO IMMEDIATE NEED TO DECIDE AN ISSUE OF SUCH COMPLEXITY AND UNEXPLORED REPERCUSSIONS IN THE WANING DAYS OF THIS LEGISLATIVE SESSION.

CHAIRMAN SMITH, YOU HAD THE RIGHT IDEA LAST MAY WHEN YOU PROPOSED BPU STUDY THIS COMPLEX ISSUE.

IN THE ABSENCE OF IMMEDIATE HARM TO THESE PROFIT-MAKING PLANTS, WE URGE YOU TO PAUSE AND TAKE A THOUGHTFUL, COMPREHENSIVE LOOK AT THE COST OF WHAT PSEG IS SEEKING, THE IMPACT ON THE ELECTRIC MARKETS, THE IMPACT ON THE STATE'S BUSINESS

CLIMATE AND THE AFFORDABILITY OF LIVING AND DOING BUSINESS IN NEW JERSEY.

PSEG HAS BEEN VERY QUIETLY PROMOTING THE NOTION OF A NUCLEAR SUBSIDY TO ITS INVESTORS AND SHAREHOLDERS FOR OVER A YEAR. HOWEVER, EVEN AFTER ALL OF THAT TIME, NO PROPOSED LEGISLATION HAS BEEN PRESENTED FOR PUBLIC EXAMINATION. TODAY IS THE FIRST TIME WE HAVE HEARD DETAILS OF A PLAN.

NOW IT IS TIME FOR THE COMPANY, ONE OF OUR STATE'S OLDEST AND MOST RESPECTED HOMEGROWN CORPORATE CITIZENS, TO OPEN ITS FINANCIALS AND EXPLAIN IN A TRANSPARENT WAY—TO ITS RATEPAYERS AND TO THE PUBLIC—THE REASONS AND JUSTIFICATIONS FOR ITS EXTRAORDINARY REQUEST. MR. IZZO SAID THE COMPANY WOULD OPEN ITS BOOKS. THAT IS WELCOME NEWS, BUT THE "DEVIL IS IN THE DETAILS", AND WE HAVE NOT SEEN A BILL.

CAUTION NOW WILL PERMIT A FULLER EXAMINATION OF EMERGING SOLUTIONS. THE GOVERNOR ELECT HAS PROPOSED REJOINING RGGI. PJM HAS ANNOUNCED A PLAN THAT WOULD BENEFIT PSEG. MR. IZZO MENTIONED OTHER EFFORTS AT THE FEDERAL LEVEL.

IF THESE SOLUTIONS ARE NOT GIVEN A CHANCE TO WORK, WE MAY BE HERE A YEAR FROM NOW REGRETTING THE SPEED OF THESE DELIBERATIONS AND QUESTIONING WHETHER WE "JUMPED THE GUN" AND UNFAIRLY ASKED NEW JERSEY RATEPAYERS TO PAY FOR A SOLUTION THAT COULD HAVE BEEN SHARED AMONG THE REGION'S RATEPAYERS IF WE HAD JUST WAITED.

THERE IS TIME TO LOOK AT A BILL WHEN ONE IS MADE PUBLIC—AND TO SEEK THE INPUT OF THE INCOMING ADMINISTRATION TO ENSURE THIS PROPOSAL FITS WITH THE NEW GOVERNOR'S WIND AND SOLAR INITIATIVES.

LASTLY—PSEG'S PROPOSAL SHOULD NOT BE CONSIDERED IN AN HISTORICAL VACUUM.

IN 1999/2000, PSEG LED THE CHARGE FOR ELECTRIC DEREGULATION. IT RECEIVED BILLIONS OF DOLLARS TO FACILITATE THE TRANSITION TO A COMPETITIVE MARKET. ITS NEW PROPOSAL REPRESENTS A RETURN TO A RE-REGULATED MARKET.

—FINALLY, AND IN CONCLUSION, ONE LAST BIT OF HISTORY—SIX YEARS AGO THIS COMMITTEE AND THE LEGISLATURE CONSIDERED AND PASSED A LAW TO SUBSIDIZE THE CONSTRUCTION OF NEW POWER PLANTS THROUGH GUARANTEED LONG-TERM LOANS. (LCAPP—"THE LONG-TERM CAPACITY AGREEMENT PILOT" PROGRAM).

THE FEDERAL COURTS DETERMINED THAT LAW WAS AN ILLEGAL INTRUSION ON FERC'S REGULATORY AUTHORITY OVER THE WHOLESALE ELECTRIC MARKET.

THE MEMBERS OF THE COALITION FOR FAIR ENERGY—NRG, CALPINE, DYNEGY AND THE ELECTRIC POWER SUPPLY ASSOCIATION—EACH OPPOSED THE LEGISLATION THEN BECAUSE IT CREATED AN UNFAIR AND UNLEVEL COMPETITIVE ELECTRIC MARKET.

WE OPPOSED A SUBSIDY THEN, AND WE OPPOSE ONE NOW.

IN SUMMARY OF THE COALITION'S POSITION—HERE IS WHAT PSEG SAID AT THE TIME, IN 2011, IN OPPOSING THE LOAN GUARANTY LEGISLATION:

—QUOTE. "THIS IS ESSENTIALLY AN ENERGY TAX THAT WILL COST NEW JERSEY RESIDENTIAL AND BUSINESS CUSTOMERS MORE THAN A BILLION DOLLARS."

—QUOTE. "CUSTOMERS HAVE BEEN PUT THROUGH THIS BEFORE WITH DISASTROUS RESULTS FOR CUSTOMERS."

—QUOTE. "THE RESULTING CUSTOMER SURCHARGES WILL HAVE LONG-TERM IMPACTS. SUBSIDIES ARE A SLIPPERY SLOPE AND WILL DRIVE AWAY OTHER NON-SUBSIDIZED PRIVATE INVESTMENT IN NEW JERSEY"

—QUOTE. "THIS BILL IS TRYING TO FIX A PROBLEM THAT DOES NOT EXIST."

AND—QUOTE. "IT IS BEST WHEN INVESTORS, NOT GOVERNMENT, DETERMINE WHEN NEW GENERATION IS NEEDED, WHERE IT IS BUILT, WHAT TECHNOLOGY TO USE AND WHAT PRICE TO PAY FOR IT."

THESE QUOTES ARE FROM PSEG. PSEG WAS RIGHT IN 2011, BUT IT IS WRONG TODAY.

THANK YOU FOR YOUR TIME TODAY.

TESTIMONY OF THE NJ PETROLEUM COUNCIL

Chairman Smith, Chairman DeAngelo, and members of the Joint Committee..

My name is James Benton with me is my colleague Scott Ross representing the New Jersey Petroleum Council.

We are here today to represent the oil and natural gas industry engaged in exploration, production, refining, pipeline, and businesses that provide energy and are backed by consumers throughout New Jersey and the nation.

Today we call on the members of this Legislature to reject efforts to pursue special legislation that would provide subsidies to nuclear plants in this state.

An examination of the current standing of the nuclear facilities clearly shows that they remain profitable to 2021. They are subject to government oversight, contracts and closure considerations that will work to keep them operable for years to come.

The competitive electrical generation market places that include much needed support from natural gas generation have worked to lower prices and provide much needed relief to our state at a time when our residents and our state economy needed that support.

Consideration of this measure during this time period creates a rush to assemble and move special legislation in response to an artificial sense of urgency. This initiative would be done at the expense of transparency and certainty that has been the hallmark of past considerations such as the utility deregulation initiative passed years ago after much deliberation.

The goal of Legislature should be to consider solutions that works to make New Jersey a more affordable competitive state fFor our residents, for our commercial and industrial stake holders.

We urge this committee take time to examine carefully the initiatives from regional solutions including the PJM initiative and the potential federal solution.

Opposition to subsidies to nuclear plants is not simply our view it is the view of polls from bipartisan voters throughout New Jersey that oppose a financial subsidy.

We encourage you to embrace a longer term view that there is time let the Board of Public Utilities and PJM do their assigned work and provide us with the best expertise to work to address this solvable problem.

December 4, 2017

CHEMISTRY COUNCIL OF NEW JERSEY

Testimony of Dennis Hart
Executive Director
Chemistry Council of NJ
December 4, 2017

Good Morning Chairman Smith and Chairman DeAngelo and committee members. Thank you for giving me the opportunity to testify today. My name is Dennis Hart and I am the Executive Director of the Chemistry Council of New Jersey and we are a member of the NJCANT, the New Jersey Coalition against Nuclear Taxes. Chemical and Pharmaceutical manufacturing at $21.7 Billion is the second largest industry in New Jersey. The industry employs over 49,000 direct employees and 27,000 indirect jobs and invests over $650 million each year in equipment and facilities and contributes hundreds of millions of dollars each year in federal, state and local property taxes. The chemical and pharmaceutical manufacturing business is very important to New Jersey's economic well-being but for a whole host of reasons it is getting more and more difficult for companies to justify building new facilities in New Jersey or investing in expansions of the existing sights. One of those reasons is the high cost of electricity. New Jersey's industries currently pay on average 54% higher energy bills than the national average. For a manufacturer making energy intensive products, the price of energy can account for about 85% of its total production costs. New Jersey's high energy costs continue to have a substantial impact on a company's bottom line. Increasing the already high energy bills with nothing to show for it will only hasten the decline in investments in New Jersey. Recognizing the importance of manufacturing to our state's economy the legislature recently formed the Manufacturing Caucus. In his announcement of the creation of the caucus Senate President Sweeney stated that "the caucus will be tasked with developing legislation and strategies to make New Jersey more competitive for manufacturers to expand and locate their operations in New Jersey and will be seeking to advance important policies to improve New Jersey's economic competitiveness."

Passing legislation which will force individual taxpayers and industries to pay additional subsidies to PSEG will absolutely lead to less investments and the loss of good jobs in New Jersey. This is in direct conflict to the goals of the manufacturing caucus. When PSEG requested to deregulate their energy generation business everyone was required to pay them for their stranded investment costs and many of our members paid between $400,000 to $800,000 annually to PSEG.

Preparing for this hearing has been extremely difficult since there is no proposal to review nor legislation to comment upon. All we have had to go on is over a year's worth of PSEG publicity events where they have discussed the need for taxpayers to give them billions of dollars to keep their three nuclear plants operating while at the same time discussing with Wall Street the bright outlook for continued profits for the company. Throughout this past year they have not provided any real financial information to support the need for a massive taxpayer subsidy. In August of 2016 NJ Spotlight ran an article about the NY State approval of nuclear credits. The article discusses that between 10 to15 nuclear power plants were at risk of closing in the near future. I repeat, the discussion is about At Risk nuclear power plants!

The article went on to say that it is an issue Public Service Enterprise Group is trying to raise, but it faces a bigger hurdle in getting policy makers' attention. Let me quote from the article:

"PSEG CEO and President Ralph Izzo acknowledged as much during an earning call with analysts last week. For one thing, PSEG's plants are profitable, unlike their counterparts in New York and other states, Izzo conceded. "It does impair our ability to have the same level of interest and participation in the discussion," he said, when asked about prospects for similar incentives in New Jersey."

In 2016 Mr. Izzo discussed that the plants were profitable and in May of this year they cleared the PJM market and received a much higher price for their electricity than they received in the prior year making them even more profitable. And that price is for delivering electricity three years from now so there is no eminent situation that would cause them to put you in the unenviable position of deciding between giving billions of taxpayers' dollars to PSEG in exchange for not closing the plants and putting their employees out of work. This is not fair to you, not fair to the taxpayers and extremely not fair to use the lives of the hard working employees at the Salem Nuclear Plants who are being used as pawns in a negotiation.

The chemical and pharmaceutical manufacturing industries in New Jersey agree that NJ needs a reliable and resilient source of energy production. We do not favor one source of energy generation over another and we recognize the important place nuclear power has in overall energy and environmental goals. As you discuss the taxpayer funded bailouts of nuclear plants approved in Illinois and New York you must remember that those subsidies are being provided for plants that are aging and non-competitive. PSEG's three plants don't meet either of these criteria. PSEG has stated that they have improved the efficiencies of these plants to their highest levels. These are well run, efficient and profitable plants. So what are we really talking about? PSEG's CEO has discussed that in three years the plants will not be "Earning the Cost of Capital". Those are his words. Earning the Cost of Capital means that they can make more money investing in other ventures than they can make running the nuclear plants. That doesn't mean that they are losing money on the nuclear plants. It means that they are not making as much money as they would like to make as returns to the Wall Street Investors. So, under the guise of impacts on reliability and impacts on renewable goals and difficulty operating in a competitive energy environment without any verified financial reports the taxpayers of New Jersey are being asked to shell out billions of dollars to be passed through to investors.

A matter like this which is of monumental significance to New Jersey's economy, energy and environmental future should not be rushed through without a thorough evaluation of all of the issues and the financial condition of the company. We could end up in a situation like the State of Illinois taxpayers now find themselves whereby they are required to pay the subsidies even when the plants are profitable and don't need the subsidy. The State of Connecticut recently enacted legislation to address this situation. The Connecticut State Legislature and Governor agreed to provide subsidies to a nuclear plant provided that the company can legitimately demonstrate the financial need. As this debate goes forward we should do no less than have a clear an open review of the financial situation of the company prior to demanding that taxpayers turn over billions of dollars to PSEG.

Competitive
Power Ventures, Inc.

50 Braintree Hill Office Park, Suite 300
Braintree, MA 02184

Testimony

Delivered by:	Thomas Rumsey, VP of External & Regualtoy Affairs, Competitive Power Ventures (CPV)
To:	Joint Hearing of the Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee
Date:	Monday, December 4, 2017

About CPV

CPV is a collection of approximately 80 experienced energy professionals dedicated to increasing America's energy sustainability by providing safe, reliable, cost-effective and environmentally-responsible electric power. To achieve our goal, we focus on optimizing existing resources, and when necessary, partnering with the world's leading technology companies and financial institutions to deliver new state-of-the-art renewable and natural gas-fired facilities where they are needed most. Our sustained track record of success has enabled us to grow into one of the premier energy companies in the United States.

CPV made the decision to invest in New Jersey because it fit within our development profile. In October of 2013, CPV and our partners, joined by Governor Chris Christie, Senate President Stephen Sweeney and Woodbridge Township Mayor John McCormac, celebrated the ground breaking and beginning of construction of the $845 million, 725-megawatt CPV Woodbridge Energy Center. The facility began commercial operations in January 2016 and is currently generating enough electricity to power over 700,000 homes, helping New Jersey meet its energy demand while improving the state electric system's reliability and environmental profile.

This significant investment was done entirely with private investment. Based upon detailed market analysis, CPV and our partners viewed New Jersey as an attractive place to invest. We continue to view New Jersey as an attractive location for investment and are actively pursuing other opportunities in the state. However, government-led bailouts of existing generation like the ZEC legislation being proposed will have a significant chilling effect on those efforts.

As we have advocated consistently in other states, we strongly urge New Jersey to move cautiously as it considers the dramatic departure from competitive principles that the suggested legislation represents. We respectfully offer the following for your consideration:

Need

Before any increase to electricity rates are imposed on businesses and private customers, we strongly suggest that the recipient of subsidies clearly demonstrate the need for a taxpayer bailout. As we've advocated in other states, any company receiving state subsidized revenue should first be required to "open its books" to state regulators and clearly demonstrate they are indeed required. Specific to New Jersey, the nuclear fleet has stated they will be profitable for the next several years. Simply put, there is no need to rush any legislation through without proper vetting and discussion. Such analysis will also provide the opportunity to fully consider the impact of New Jersey's reentry into the Regional Greenhouse Gas Initiative, a step that will add significant revenue to the nuclear fleet.

Cost

Any tax on consumers and the industry comes with both direct and indirect costs. In other states, the direct costs associated with a bailout similar to the one being suggested in New Jersey has exceeded half-a-billion dollars per year. This additional cost is incremental to current electricity costs and will disadvantage those least capable of absorbing increased energy rates. The indirect cost to the state includes the loss of future investment from power generation. Our investment of nearly $850 million dollars in a power project that employed over 500 union workers and will continue to support the Woodbridge community for the next 30 years would be exceedingly more difficult to make with this level of regulatory uncertainty.

Allow the Markets to Work

The value of zero emitting nuclear power generation is significant, as are the jobs and tax support they provide. However, these nuclear plants are within the PJM operational footprint which is actively working to improve the market structure to recognize and reward these attributes. There is currently a nationwide focus on providing additional revenue through competition to resources that provide reliable power with reduced or zero emissions. The Department of Energy and the Federal Energy Regulatory Commission are actively engaged on this effort, as is PJM and neighboring grid operators. Competition has and will continue to provide the most efficient results and we must allow that process to work.

In closing, we strongly urge that any undertaking such as the one being suggested includes the appropriate level of due diligence that such a significant decision warrants. There is no demonstrable need to rush the process and numerous stakeholders deserve the opportunity to participate. This analysis should include the options available beyond tax payer subsidies such as the impact of current market reforms and New Jersey's reentry into the Regional Greenhouse Gas Initiative. Finally, we feel any private company requesting a tax payer bailout must first demonstrate the need to state regulators. A profitable company should not be entitled to funds collected from other businesses and private citizens including lower and fixed income customers.

Monitoring Analytics

Statement

Subsidies for Selected Nuclear Power Plants in New Jersey

Before the New Jersey Senate Environment and Energy Committee

Joseph Bowring
The Independent Market Monitor for PJM

December 4, 2017

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I am the Independent Market Monitor for the PJM wholesale power markets. I do not speak for PJM. The role of the independent market monitor (IMM), as defined by FERC and included in the PJM tariff, is to help ensure that the PJM markets are competitive by proposing market rules that incent competition, by monitoring for the exercise of market power and by reporting on the markets to regulators and market participants. I support efficient, competitive wholesale power markets which bring clear benefits to customers as well as to suppliers of power.

The PJM Interconnection, L.L.C. (PJM) operates a centrally dispatched, competitive wholesale electric power market that, as of June 30, 2017, had installed generating capacity of 183,089 megawatts (MW) and 1,007 members including market buyers, sellers and traders of electricity in a region including more than 65 million people in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

The goal of competition in the wholesale power markets is to provide customers wholesale power at the lowest possible price, but no lower. The PJM markets work. The PJM markets bring customers the benefits of competition. But the PJM markets face new challenges that threaten the viability of competitive markets.

A benefit of competitive power markets is that they are dynamic, flexible and resilient. The PJM market has resulted in a reliable system despite significant changes in underlying market forces. Technical innovation and significantly lower gas costs have been key market forces. In PJM, there have been substantial unit retirements and there has been substantial new market entry as a result of market forces. In New Jersey, there have been both unit retirements and new market entry based on market signals. The PJM market design has worked flexibly to address both market exit and entry without preferences for any technologies. The result of new entry has been lower costs and increased reliability.

Particularly in times of stress on markets and on some generating technologies, nonmarket solutions may appear attractive. Top down, integrated resource planning approaches are tempting because it is easy to think that experts know exactly the right mix and location of generation resources and the appropriate definition of resource diversity and the appropriate definition of reliability and therefore which technologies should be favored through exceptions to market rules. Subsidies are tempting because they maintain existing resources and provide increased revenues to asset owners in uncertain markets. Cost of service regulation is tempting because guaranteed rates of return and fixed prices may look attractive to asset owners in uncertain markets.

But once the decision is made that market outcomes must be fundamentally modified, it will be virtually impossible to return to markets. The subsidy model is inconsistent with the PJM market design and constitutes a significant threat to PJM markets.

The issue of external subsidies continued to evolve in 2017. The Ohio subsidy proceedings and the Illinois ZEC subsidy proceeding originated from the fact that competitive markets result in the exit of uneconomic and uncompetitive generating units. Regardless of the specific rationales offered by unit owners, the proposed solution for all such generating units has been to provide out of market subsidies in order to retain such units. These subsidies were not requested to accomplish broader social goals. Broader social goals can all be met with market based mechanisms available to all market participants on a competitive basis and without discrimination.

The proposed legislation in New Jersey to subsidize specific nuclear power plants represents a significant expansion of the rationale for subsidies beyond the already unsupported rationales advanced in Ohio and Illinois. The proposed subsidies in New Jersey would result in a market intervention that would have a negative impact on PJM's competitive wholesale power markets and would provide subsidies to units that have not demonstrated that they are not financially viable.

Nuclear and coal plants face strong competitive pressures in the PJM markets as a result of low gas prices and efficient combined cycle units, including new combined cycle units in New Jersey. But there is no evidence that PSEG's nuclear plants are uneconomic and facing a retirement signal from the PJM markets. A plant is economic if it covers the annual expenditures required to operate the unit because it is more profitable to continue to operate the plant than to shut it down.

The results for nuclear plants are very sensitive to small changes in PJM prices. In 2016, PJM prices were at the lowest level since the introduction of competitive markets in 1999. In 2016, PSEG's Hope Creek plant fell short of covering its annual avoidable costs. But Hope Creek covered its annual avoidable costs on average over the last six years by a substantial margin even when 100 percent of NEI's capital expenditures are included. Hope Creek has higher annual avoidable costs than many other nuclear plants, including Salem, because it has a less efficient one unit configuration. In 2016, the Salem plant also fell short of covering its annual avoidable costs. But the Salem plant covered its annual avoidable costs on average over the last six years by a more substantial margin than Hope Creek even when 100 percent of NEI's capital expenditures are included. Neither plant is defined as at risk according to the criteria that the IMM applies to all units in the IMM's annual PJM State of the Market Report. The reported results are based on public data including LMP, capacity market prices and cost data from the Nuclear Energy Institute (NEI).

The same conclusions about subsidies apply whether the New Jersey plants are economic or uneconomic. The proposed subsidy solutions ignore the opportunity cost of subsidizing uneconomic units. Such subsidies suppress energy and capacity market prices and therefore suppress incentives for investments in new, higher efficiency thermal plants but also suppress investment incentives for innovation in the next generation of energy supply technologies and energy efficiency technologies. These impacts are large and long lasting.

Subsidies are contagious, as this legislation illustrates. If subsidies are provided to one generating plant, this will suppress prices for all generating plants and create a need for additional subsidies for the remaining units. Competition in the markets will be replaced by competition to receive subsidies. Subsidies to economic units are simply a way to increase prices to individual plants at the expense of customers, with no impact on the operational status of the units.

There is no reason to intervene in the markets in order to provide reliability and resilience. If PJM or FERC or DOE identify a need for greater reliability, it can be addressed using market mechanisms.

Competitive markets were introduced as an alternative form of regulation to ensure that wholesale power is provided to customers at the lowest possible price. The PJM markets are working. The PJM markets provide competitive, reliable and resilient outcomes. The PJM markets should be permitted to continue to work.

EDF
ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Testimony of the
Environmental Defense Fund
Before the New Jersey Senate Committee on Environment & Energy and the Assembly Committee on Telecommunications and Utilities
December 4, 2017

Good morning. My name is Mary Barber and I'm the Director, New Jersey Clean Energy for the Environmental Defense Fund. EDF is a national non-profit membership organization engaged in linking science, economics and law to create innovative, equitable and cost-effective solutions to society's most urgent environmental problems. Thank you for this opportunity to comment on this very important issue.

Some nuclear plants are struggling to compete economically with low-cost natural gas and renewables, raising the prospect that they may retire before their licenses expire. There are legitimate reasons to be concerned about the premature retirement of nuclear power plants including the loss of low-carbon emitting resources before a transition to clean energy resources is complete, the loss of jobs and contributions to the local tax base, and the overall economic impacts on the state's residents and businesses. Some states have acted to comprehensively address the transition from aging and uneconomic nuclear plants to a clean and affordable energy future and New Jersey can learn from those processes and outcomes and take appropriate steps to protect ratepayers, jobs and the environment.

This issue is far too complex and too important to decide anything in a rushed lame duck session. Right now the focus is solely on PSEG's nuclear plants in isolation and without consideration of the impact on ratepayers, clean energy investment, and jobs and economic development both in the directly affected communities and state-wide. Today there are far more questions than there are answers.

257 Park Avenue South
New York, NY 10010
T 212 505 2100
F 212 505 2375
edf.org
New York, NY / Austin, TX / Bentonville, AR / Boston, MA / Boulder, CO / Raleigh, NC
Sacramento, CA / San Francisco, CA / Washington, DC / Beijing, China / La Paz, Mexico

For the last eighteen months, PSEG has run a public campaign promoting the benefits of nuclear power while at the same time claiming that their New Jersey plants, which they admit are currently profitable, are becoming uneconomic and must receive state subsidies in order to continue operating. During these 18 months, PSEG has not released any information or analysis that supports this claim. Yet today we understand that the legislature is considering a bill for which there's been no opportunity for public review and that sets the stage for PSEG to receive billions of dollars in subsidies with no demonstration of need and without consideration of the impact on ratepayer bills, clean energy investment and jobs and economic development.

Before any debate can begin, PSEG must provide the data and information on their plants and an independent analysis using all available market data must be conducted. And the legislature must not pass legislation that cedes responsibility for performing this analysis to the Board of Public Utilities (BPU) or any other state agency to complete at some future date without providing specific direction, parameters and criteria for such analysis.

The New Jersey legislature isn't the only venue in which PSEG is seeking a bailout. PSEG was one of a handful of electric utilities that submitted comments in support of U.S. Energy Secretary Rick Perry's proposed rule currently before FERC to prop up aging coal and nuclear plants.

Secretary Perry's proposal has attracted nearly universal opposition – from gas, solar and wind companies, environmental and consumer advocacy organizations to free-market advocates and others in the business community.

New Jersey's assembly members and state senators should press the pause button during this lame duck session rather than encourage PSEG's "double-dipping" for state and federal bailouts.

In addition to FERC, the economics of nuclear power generation is also being explored in a proceeding at PJM. Illinois, New York, California and Connecticut have addressed the issue of the premature retirement of nuclear plants through legislative and regulatory processes. EDF has been actively engaged on this issue in other states where we worked to ensure that retiring nuclear plants are replaced by clean energy sources and where we have

supported subsidies for existing nuclear plants for a ***finite*** period of time, ***if*** these plants will otherwise be replaced by more polluting generation, like coal or natural gas. Emerging best practices to address these issues include: 1) Demonstration of financial distress: plant owners must open their books, 2) narrowly defined subsidy eligibility criteria that reflects the electricity wholesale market price as well as any cost of carbon; 3) the subsidy program is time-limited; 4) a large scale emission reduction commitment to accelerate the adoption of clean energy including energy efficiency, renewable energy, grid modernization and peak demand reductions; and 5) commitments to address worker and community transitions on the glide-path to plant retirements.

Let's take a step back and pause. The plants are profitable...PSEG acknowledges this to be true. They are not at risk of closing immediately. PSEG must open their books for independent review and analysis and the legislature, the new Governor and his administration must consider the question of subsidies in the larger context in which they exist.... the context of a changing power sector that must not deviate from a path of maximum greenhouse gas reductions, protect and create jobs and ensure the fair treatment of New Jersey citizens and businesses.

New Jersey Business & Industry Association

Michele N. Siekerka, Esq.
President & CEO

TO: Members of the Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee

FR: Michele N. Siekerka, Esq. President and CEO

DATE: December 4, 2017

RE: Energy Generation Strategies in New Jersey

The New Jersey Business & Industry Association (NJBIA), on behalf of our members, appreciates the opportunity to share with the joint committees our thoughts on generation in New Jersey and potential strategies for our energy markets moving forward. We consider energy policy through the lens of how will it make New Jersey affordable and competitive for the business ratepayer.

Today's hearing is focused on proposing solutions. Since energy generation is a regional issue, any long term solution must be one that is strategized and advanced at a regional or federal level. However, absent that strategy, New Jersey must be prepared with contingencies to provide energy resiliency and access for New Jersey rate payers in an affordable manner. To that end, NJBIA is presenting factors we suggest that must be analyzed and resolved as part of any long term solution, as well as interim short term contingency. Further, as the issue of energy generation is a complex one, we must also ensure that the process that will result in policies and legislation addressing long term solutions and the potential for interim contingencies, be a process that provides for full and complete analysis and stakeholder input.

As the committees may be aware, the Commercial and Industrial (C&I) Ratepayer consumes 64% of the electricity in the state. Today 24% of the electric bill for a C&I customer is government imposed taxes and fees. A reliable, affordable energy market is essential to the robust economic growth of the state. Baseload power drives the economy of our state for electric delivery. The business community has a vested interest in the energy markets and state policies that impact them.

If one looked back on the last twenty years of energy policy in the state, there has been much change. Deregulation of the generation sector was the first dramatic shift in the established stable electric industry. At the time it was viewed as a necessary break to help consumers and to move the utility sector to a more modern approach. In New Jersey, the business ratepayer saw many changes to their bill including the addition of the Transitional Energy Facilities Assessment (TEFA) which was a "temporary tax", stranded assets, the Societal Benefits Charge (SBC) and the Retail Margin Adder if they did not find a third party supplier. In exchange, companies could go out to find competitive supply on the open market and hope to be able to negotiate a lower price than the BGS auction provided.

New Jersey's generation landscape has also changed in the past twenty years. In 1997, the State did not generate enough power in state to meet all of the demands. There were 4 nuclear power reactors, 3 main coal plants, little renewable generation, and limited transmission lines. Nuclear baseload power was the dominant source.

Today, that picture has changed. New Jersey exports power and generates enough in state to meet its needs. While there are still 4 nuclear reactors, Oyster Creek will be closing in 2019. Hudson and Mercer, the state's largest coal plants have been closed even after $1 billion was spent to retrofit them. Natural gas plants have expanded and now dominate the generation portfolio. Ratepayers across the PJM grid have funded transmission upgrades like the Susquehanna Roseland Line. According to the Energy Information Administration (EIA) "In 2016, for the first time, natural gas provided more than half the electricity generated in New Jersey. Nuclear power provided 39%, and, together, the two fuels provided 95% of the state's net electricity generation." Similarly the renewables market has become dominated by solar power with it accounting for 74%. And the State is pursuing resiliency strategies that include micro grids, battery storage, and distributed generation.

Generation has also been impacted by new technologies. New plants and control technologies have enabled lower emitting generation to be built. Older plants are being replaced by more efficient, cleaner technology in many cases. New Jersey has seen the retirement of coal plants and creation of combined cycle natural gas plants.

New Jersey consumers have also seen a shift in pricing. Economic conditions, especially in 2008, have impacted the load growth for energy. Advances in energy efficiency measures have helped offset cost increases. The average price per kWh has also changed. In 1997 it was 12.08 cents per kWh for Residential, 8.11 cents for Industrial and 10.35 cents for Commercial. In 2017, it is 15.34 cents for Residential, 10.23 cents for Industrial and 12.39 cents for Commercial. Climate change has led to state policies that seek to curb greenhouse gas emissions. The Regional Greenhouse Gas Initiative was started in 2005 and continues today. New Jersey's generation mix has a history of reducing emissions and is the lowest emitter in the PJM grid.

As the energy revolution continues, the future of baseload generation must also become part of the discussion. At the state level, there are certain states that have decided to pursue ratepayer obligated subsidies for nuclear generation. At the independent system operator level, PJM for New Jersey, has proposed changing its rules for nuclear and coal plants. In addition there are proposed changes at the federal level by the FERC. The Regional Greenhouse Gas Initiative (RGGI) also allows for non-carbon generation to receive an increased clearing price which amounts to an increase in profits due to reduced compliance costs.

All of these ideas have an impact on ratepayers. PJM is currently estimating a potential 5% increase for ratepayers. We must understand what that economic impact will be and as such the following considerations must be resolved:

- Long term solution:
  Energy generation is a regional challenge requiring a regional solution. The State must continue to call on PJM and FERC to advance a regional solution that is not borne by NJ Ratepayers alone.
- Interim contingent solution:
  Absent a regional solution, legislation advanced to address the gap must clearly articulate the economic scenario significant enough to trigger the need for the state to step in with subsidies in order to ensure energy resiliency. Any such solution must be temporary in nature and expire at the time a regional or national policy is put in place and after an established time period. This subsidy should not be allowed to be taken with other payments such as Reliability Must Run or increases in price from the State's participation in the Regional Greenhouse Gas Initiative. Any such solution must also expire if the economics triggering its need no longer exist.
- Analysis of the economic impact is needed in either scenario:
  How will the State evaluate and study possible solutions and alternatives to see what is the most affordable to ratepayers? If business consumes 64% of the electricity and is 68% of the customer base of a utility, how does a price increase impact those numbers? PJM estimates a 2-5% price increase for retail sales. How does that impact the competitiveness of business in New Jersey versus other states? What will be the overall impact on New Jersey's economy given any one alternative over another?
- Analysis of ways to offset increase to ratepayers:
  If New Jersey were to implement a policy, there needs to be consideration on ways to help alleviate increased costs to ratepayers. Are there ways to reduce the 24% government imposed taxes and fees? To help the business community could energy used in manufacturing be exempt from the sales tax? What are ways to help mitigate potential cost increases?

NJBIA looks forward to learning more about the possible solutions and impacts to ratepayers. It is critical that policy makers aim to keep New Jersey affordable and economically competitive within our region and world. We welcome the opportunity to continue the dialogue with you and bring detailed input forward on any legislative actions yet to come.

State of New Jersey
DIVISION OF RATE COUNSEL
140 EAST FRONT STREET, 4TH FL
P. O. BOX 003
TRENTON, NEW JERSEY 08625

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

STEFANIE A. BRAND
Director

Remarks of Stefanie A. Brand, Director, Division of Rate Counsel, Regarding Strategies to Prevent the Premature Retirement of Nuclear Power Plants

Presented at the Joint Meeting of the Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee December 4, 2017

Good morning. My name is Stefanie Brand, and I am the Director of the Division of Rate Counsel. I would like to thank Chairman Smith, Chairman DeAngelo and members of the committees for the opportunity to testify today.

The Division of Rate Counsel represents and protects the interest of all utility consumers -- residential customers, small business customers, small and large industrial customers, schools, libraries and other institutions in our communities. Rate Counsel is a party in cases where New Jersey utilities seek changes in their rates and/or services. Rate Counsel also gives consumers a voice in setting energy, water and telecommunications policy that will affect the rendering of utility services well into the future.

As an advocate for ratepayers, who have a direct interest in the continued provision of electricity at reasonable rates, Rate Counsel certainly has no interest in seeing nuclear plants shuttered at this time, or at any time prior to when we no longer need the electricity they generate. However, the system that is in place already includes safeguards to prevent that from happening, and other measures are being worked on as

Tel: (609) 984-1460 • Fax: (609) 292-2923 • Fax: (609) 292-2954
http://www.nj.gov/rpa E-Mail: njratepayer@rpa.state.nj.us

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we speak to address these concerns within the market structures that we have relied upon since this Legislature decided to deregulate generation in 1999. It is important that we let these processes work so that we do not disrupt those markets and so that ratepayers do not end up paying more than is necessary.

You may recall that in 1999, this Legislature made a decision to deregulate electricity generation and move to a competitive market-based system. While that system is certainly complicated and in some respects flawed, it has served the State well in that reliability has been maintained and prices have come down. It has led to competition on both the wholesale and retail level. You may also recall that in 2011, this Legislature, through the LCAPP statute, tried to provide out-of-market incentives to generation in order to spur the construction of new plants, to enhance reliability and move away from coal and toward a more renewable portfolio. That statute – largely due to efforts by PSEG itself- was struck down, as inappropriately interfering with federal jurisdictional markets. Any out of market solution that might be considered to buttress the profits of our nuclear plants may have the same effect and may suffer the same fate.

As you analyze the issue, it is important, especially in this political era, to focus on the facts. We need for the actual facts – not fears or speculation – to guide the policymaking here. So in that vein, I would like to offer some facts for you to consider:

Fact #1: We have no information to verify that New Jersey's nuclear plants are in financial distress.

At the outset, it is important to note that while some nuclear plants are uneconomic or are headed in that direction, that is not the case in New Jersey. For

good or for bad, we have higher prices than other parts of PJM and thus our nuclear plants are currently economic. It is not possible for anyone to say definitively that we are headed toward market prices that are insufficient for these plants to continue to make money. In fact, there are a number of reasons to believe that capacity and energy prices in New Jersey will increase over the next few years rather than decrease. Thus, Rate Counsel strongly maintains that it is not enough to simply accept PSEG's assertions regarding the plants' profitability, and that even if the plants are shown to be at risk of losing money in the future, the solutions must be found within the federally-administered markets and not through out-of-market payments for plants that are already profitable.

PSEG has not opened its books as the nuclear plant owners have been required to do in other states. PSE&G has admitted that its plants are currently profitable, as it must since we know that these plants have cleared in PJM's capacity markets year after year and they have been willing to accept the local clearing price in those auctions. As a result, the plants are committed to provide electricity at least three years into the future at that price. Just because nuclear plants in other parts of the country are not profitable, doesn't mean that plants in New Jersey – the state with the highest prices in PJM – are also unprofitable. It is unlikely that PSEG would bid into these auctions or accept prices that are less than their costs, and thus we need to verify the Company's claim that these particular nuclear plants are or will be in financial distress. Before any strategy is considered to protect these plants, the Companies that own them should be

required to open their books and justify their claim that these plants are in financial distress.

Also, it is important to remember that the system is not structured so that a Company can simply shut down a plant unless it gets subsidies. Although PJM has said continued reliability is not an issue if these plants shut down, if they are needed for reliability, PJM can order them to continue to run. They can enter into a "Reliability Must Run" contract for whatever period they are needed.

Fact #2: This issue is best addressed through in-market solutions on the Federal level and *is* being addressed there.

The regional grid, PJM, has released its proposal to utilize an in-market solution to correct what some perceive as a flaw in price formation that does not adequately value the attributes of some generating plants, like the nuclear facilities. Beginning next week, the proposal will go through the PJM stakeholder process in which PSEG and all other stakeholders will participate and advocate for their interests. That process is intended to compensate baseload facilities like the nuclear plants to more accurately value what they bring to the system. The outcome is likely to increase energy prices in the federal market and is also likely to impact the earnings for these plants. Any out-of-market proposal should await the outcome of that process because otherwise ratepayers in New Jersey will be saddled with paying for both solutions.

PSE&G is also very active in the FERC proceeding in which the Company is allied with DOE Secretary Perry and the Trump administration to advocate for out-of-market subsidies for both coal and nuclear plants. That proceeding is on a short

timeline and some action is expected from FERC on December 11. It may lead to changes that will also alleviate the need for any in-state subsidies. If the Legislature goes forward with a subsidy proposal now, and these federal processes also end up with measures to address the concerns, PSEG may end up double or triple dipping, forcing New Jersey's ratepayers to spend significantly more than necessary to prop up coal and nuclear plants throughout PJM.

This raises an important point. The electricity from these plants does not only go to New Jersey. So passage of this bill means that New Jersey ratepayers will be subsidizing electricity for Maryland, Delaware, Pennsylvania, and perhaps even further afield. This is not New York where there is only one state that has the burden and benefit. We will have all of the burden and only part of the benefit. For this reason as well, we should wait to see what happens on the federal level before considering any state level out-of-market subsidies.

Fact #3: This is only one of many areas in which the PSEG Companies are seeking to vastly increase the rates of New Jersey consumers.

Besides the PJM and FERC proceedings I just mentioned, PSE&G has a petition in to replace aging gas mains at a cost of $2.68 billion that, if approved as they have proposed it, will raise customers' total bill about 20% over five years. In addition, PSE&G's transmission rates are through the roof. From 2009 to 2017 PSE&G's Transmission rates have increased 465%. These increases are expected to continue. This vastly outpaces other transmission owners in PJM. By way of comparison, PEPCO's rates increased by 90.7% over that period and Rockland Electric's increased by 54.7%. On top of this, PSE&G is coming in for a rate increase in February and they

will also be filing additional petitions, including a petition for a second storm hardening program on top of the $1.2 billion they already received for this work. All of these filings are in addition to all of the other PSE&G clauses and programs we already fund.

Fact #4: We've already paid for this.

When the state deregulated in 1999 the utilities complained that they had built their generation – including these nuclear plants – with the expectation that they would be paid for in rates. The BPU ordered ratepayers to pay billions of dollars in "stranded costs" – for PSEG's plants alone we estimate the stranded cost bill was over $2.5 billion. But those costs ended up not being stranded. In the early years, PSEG made triple their costs and reaped huge returns on their generation in the market. There was a lawsuit asking for refunds or at least to stop the stranded cost payments, but the Courts rejected it – saying a deal is a deal. Well, now that the market isn't working as well for PSEG, they want to change the deal.

So the question is – are we a deregulated state or not? Do we support competitive markets for generation? If we do, we cannot hand out out-of-market payments whenever the market changes. We need to let the markets work. PJM is working on ways to solve the issue within the market and we should let that process play out. We should also see what the impact will be if New Jersey re-enters RGGI as the incoming governor has proposed. Because RGGI places a price on carbon that some of the nuclear plants' competitors will have to pay, reentering RGGI may also impact the plants' profitability. We should allow that process to play out also before

asking ratepayers to pay both a carbon price and an out-of-market subsidy to nuclear plants.

Fact #5: We cannot afford this.

New Jersey already has the highest residential electricity prices of any state in PJM. We are in the top 10 in the country. It is important to remember that all New Jersey ratepayers – not just PSE&G ratepayers – will pay for this. I have heard some say that we need to subsidize nuclear plants to serve as a "bridge" to a future renewable portfolio. The opposite is true. Our renewable energy future is upon us now. We need to spend our money today on advancing renewable energy and energy efficiency not on padding the profits of already profitable existing generation. We need to replace aging gas mains and shore up our distribution system to protect us from storms and integrate distributed energy resources. Clean energy jobs are a huge part – 79% of the jobs in the electricity sector in New Jersey and that number is likely to grow. We can't afford to pay billions of extra dollars just for the electricity we already have and still have enough money to take on the clean energy agenda we hope to accomplish. We need nuclear power but we also need to move our economy toward the future. We don't need to overpay in order to maintain existing generation.

I have also heard very real concerns about a potential loss of jobs. That is more complicated that simply looking at the direct and secondary jobs that could be impacted by the closure of the nuclear plants. Small and large businesses are ratepayers too, and they do not have endless resources. If rates climb too high because we have to pay more than is necessary for any of these worthy goals, small and large businesses

will close, and residents will be unable to afford to live here. If employers leave the state because New Jersey's energy present becomes unaffordable, that will result in a loss of jobs too. You may not be able to see it as clearly as when a single plant closes, but the overall job losses could be just as significant.

I understand that PSEG considers its primary duty to be to its shareholders. I wish they cared more about their customers, but I understand that they consider their shareholders their first priority. But you were elected by your constituents. Your job is to put them first. I have met residential customers who can't use their air conditioning in the summer because they can't afford it, and both small businesses and large aren't sure they can continue to do business in New Jersey if their rates keep going up at this pace. Let the federal, in-market solutions have a chance to work. That's what is best for those who are your priority.

Thank you for the opportunity to testify today. Rate Counsel looks forward to continued dialogue to achieving goals that meet the state's energy needs and protect utility customers. I am available to answer any questions you may have.

Frank von Hippel, Princeton University, Prepared statement
Joint hearing of the NJ Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee on strategies to prevent the premature retirement of existing, licensed, and operating nuclear power plants,
4 Dec. 2017, 10 AM, State House Annex, 1st Floor, Committee Room 4

I am Frank von Hippel, an emeritus professor and expert on reactor-safety on the staff of Princeton University. When the accident at Three Mile Island occurred in 1979, Governor Brendon Byrne called me in to advise him. More recently, from 2012 to 2016, I served on the Congressionally-mandated National Academy Sciences study on lessons to be learned from the Fukushima accident for improving the safety of U.S. nuclear power plants.

I have a brief statement on the opportunity that the proposed rate payer subsides for the continued operation of the Salem and Hope Creek nuclear power plants also could be used to increase their safety.

The most important thing our National Academy of Sciences study learned was about an accident that almost happened at Fukushima but didn't: a spent fuel fire following the uncovering of the fuel one of the pools there.

The U.S. Nuclear Regulatory Commission staff found that the release from a fire in a dense-packed pool such as those at the Salem and Hope Creek plants would be 100 times worse than the actual Fukushima accident. The chairman of Japan's Atomic Energy Commission warned Prime Minister Kan that such an accident could force the evacuation of Tokyo.

The NRC found that, if such an accident occurred in the US, *on average* 3.5 million people would have to be relocated. They assumed, however, a contamination threshold for relocation 3 times higher than the Environmental Protection Agency recommends. With the EPA contamination threshold, the average number of people relocated would be 8 million and the area interdicted would be twice the area of New Jersey.

The NRC staff found this danger could be dramatically reduced if spent fuel in the pools that had cooled for 5 years were moved to dry-cask storage such as already exists at Salem and Hope Creek.

The nuclear utilities pushed back, however. They did not want to pay the $50 million per reactor that the NRC estimated this would cost. The NRC therefore caved and came up with a skewed cost-benefit analysis that showed that the costs to the utilities would exceed the probability-weighted benefits to the public.

In order to arrive at this cost-benefit conclusion, the NRC assumed that the risk of terrorism was zero and left out of its analysis property losses more than 50 miles from the reactor. It also assumed that decontaminated could be accomplished and the relocated population could be back to their homes in less than a year. The NRC later admitted that it had no basis for its assumption and that it was grossly inconsistent with Japan's experience in Fukushima.

$50 million per reactor would be six months of the subsidy from the rate payers that I understand is being considered here.

You therefore have the leverage to condition this subsidy on PSE&G and Exelon ending their dangerous practice of dense-packing their spent fuel pools in New Jersey.

Conditioning subsidies for nuclear power in New Jersey on safe spent nuclear fuel management

Frank von Hippel
Professor of Public and International Affairs emeritus and Senior Research Physicist
Program on Science and Global Security, Princeton University

For a joint meeting of the NJ Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee on strategies to prevent the premature retirement of existing, licensed, and operating nuclear power plants
Committee Room 4, 1st Floor, State House Annex, Trenton, NJ
4 December 2017, 10 AM

Based on my participation as a member of the National Academy of Sciences study on *Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of U.S. Nuclear Power Plants* (2012-2016) and articles I have co-authored on the subject, most recently "Nuclear Safety Regulation in the Post-Fukushima Era: Flawed analyses underlie lax U.S. regulation of spent fuel," *Science*, 26 May 2017.

Outline

- Interest in subsidies for nuclear power in and around NJ
- Spent fuel
- Spent fuel storage
- A spent fuel pool fire that almost happened at Fukushima
- Consequences of a spent fuel pool fire at Peach Bottom, PA nuclear power plant
- The NRC's probabilistic cost-benefit assessment corrected

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Interest in subsidies for nuclear power plants in and Near NJ

- **Indian Point 2,3.** Exelon, to be shut down in 2020-2021.[1]
- **Susquehanna 1&2,** Talen (90%).
- **Three Mile Island 1**, Exelon, to be shutdown in 2019 in the absence of subsidies.[2]
- **Limerick 1,2,** Exelon wants subsidies.[2]
- **Oyster Creek,** Exelon, to shut down in 2019.
- **Peach Bottom 2,3,** Exelon wants subsidies.[2]
- **Hope Creek 1**, PSE&G wants subsidies (1.1 GWe).[3]
- **Salem 1&2,** PSE&G, Exelon, want subsidies (3.3 GWe).[3]

[1] http://www.safesecurevital.com/entergy-ny-officials-agree-on-indian-point-closure-in-2020-2021
[2] http://www.npr.org/sections/thetwo-way/2017/05/30/530708793/three-mile-island-nuclear-power-plant-to-shut-down-in-2019
[3] http://www.njspotlight.com/stories/17/03/06/pseg-warns-that-without-subsidies-nuclear-plants-could-go-dark/

Nuclear subsidies in New York and Illinois

New York, $500 million/year ($125 million/reactor-year)[1]

- Nine-Mile Point 1&2 (Exelon, 1.9 GWe)
- R.E. Ginna (Exelon, 0.6 GWe)
- James A. Fitzpatrick (Exelon, 0.8 GWe)/Total: 3.3 GWe vs. 4.4 GWe in Salem, Hope Cr

Illinois, $235 million/yr ($78 million/reactor-year)[2]

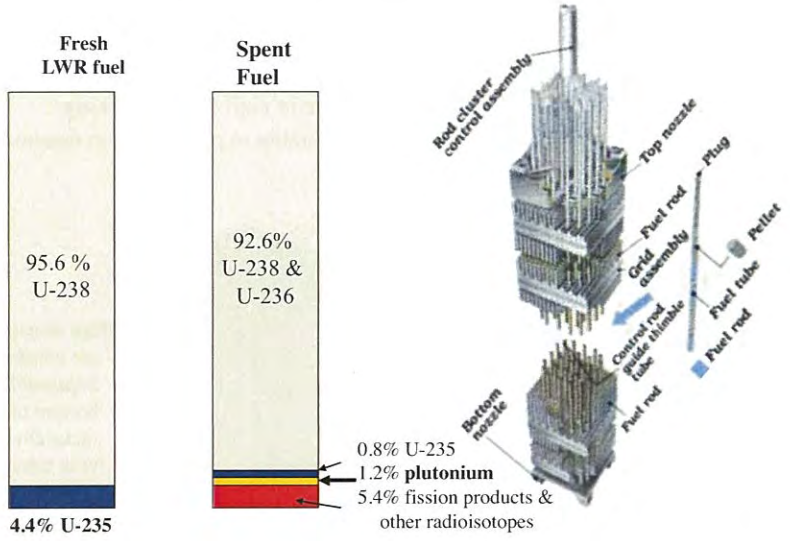
- Clinton (Exelon, 1.1 GWe)
- Quad Cities 1,2, (Exelon, 1.9 GWe)

Pennsylvania, being requested

- Beaver Valley 1,2 (First Energy, 1.8 GWe)
- Limerick 1,2 (Exelon, 2.4 GWe)
- Peach Bottom 2,3 (Exelon, 2.7 GWe)
- Susquehanna 1,2 (Talen [90%], 2.7 GWe)
- Three Mile Island 1 (Exelon, 0.8 GWe)/ Total: 10 GWe

[1] https://www.nytimes.com/2016/08/02/nyregion/new-york-state-aiding-nuclear-plants-with-millions-in-subsidies.html?_r=0
[2] http://www.elp.com/articles/2016/12/illinois-pass-subsidy-bill-to-save-state-s-nuclear-power-plants.html

Power reactor fuel before and after



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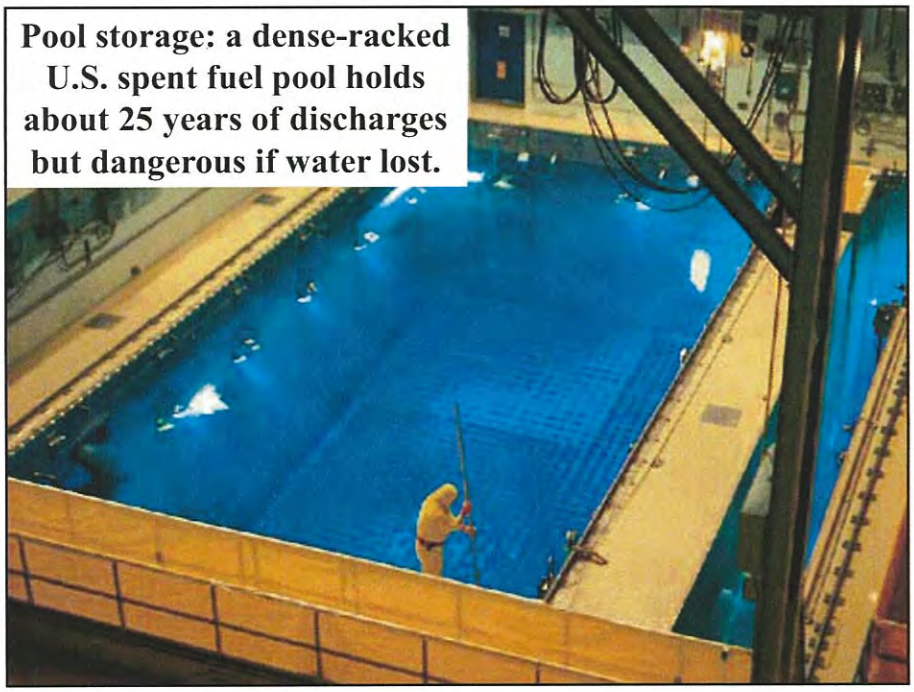
Pool storage: a dense-racked U.S. spent fuel pool holds about 25 years of discharges but dangerous if water lost.



157x

The history and danger of dense racking

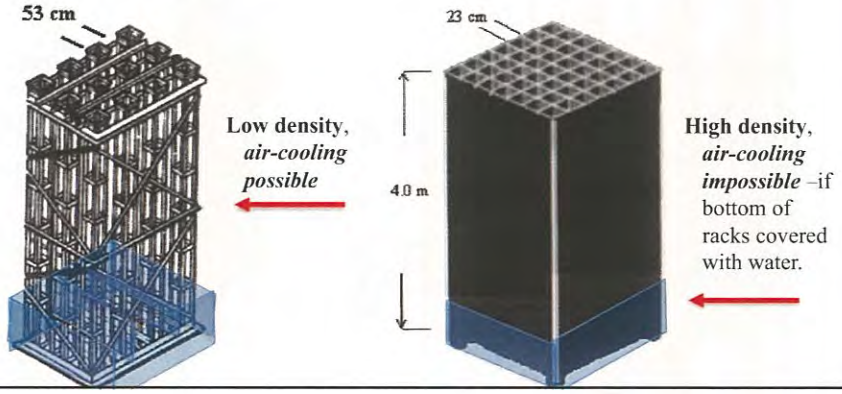
Spent fuel pools originally designed to hold fuel for a few years until it could be shipped to a reprocessing plant.

But, as a result of huge price increases, utilities found that too costly and in most countries were allowed to shift to on-site storage.

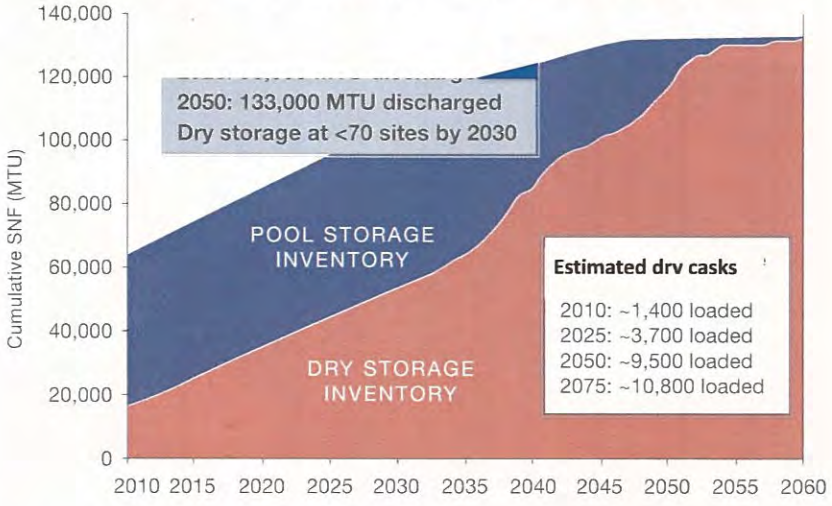
Utilities decided to go from low-density open racking to high-density racking.

Neutron-absorbing partitions added around each assembly to prevent chain reaction.

Safety implications ignored.



U.S. spent fuel pools are now full – and are projected to be until the nuclear power plants shut down



Aug 2010, Energy Resources International, Inc.

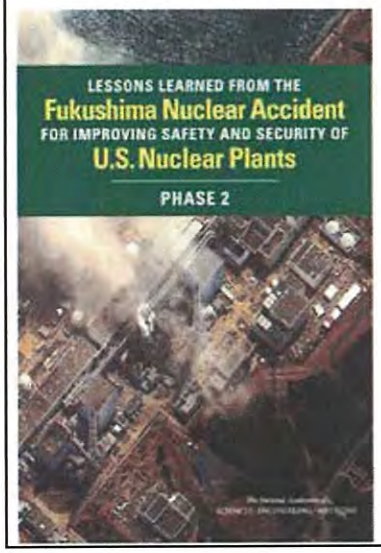
When a dense-packed spent fuel pool is full in the U.S., spent fuel cooled 20-30 years is moved to dry-cask air-cooled storage

(Connecticut Yankee Nuclear Power Plant, historical)

Two recent studies on Lessons from Fukushima

U.S. National Academy of Sciences

(November 2016)



Science Magnitude Article

26 May 2017

POLICY FORUM

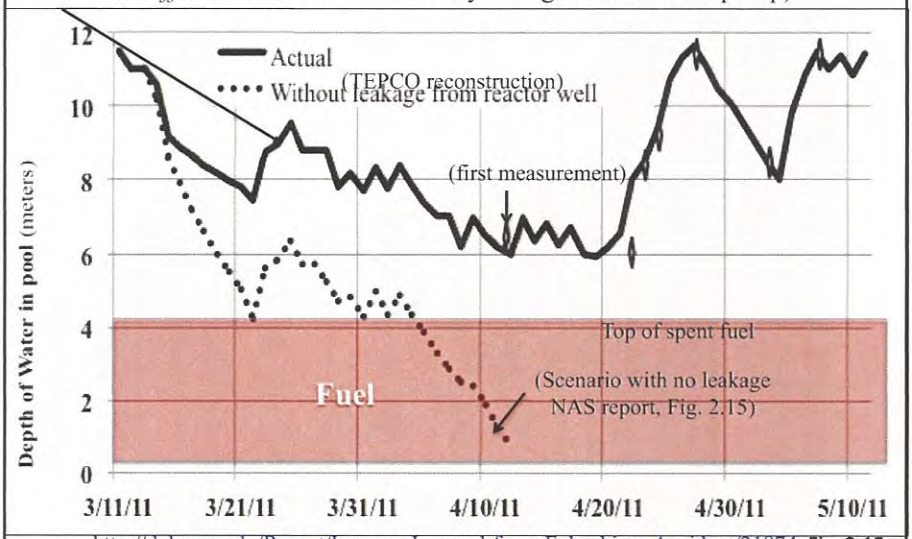
NUCLEAR POWER

Nuclear safety regulation in the post-Fukushima era

Flawed analyses underthe lax U.S. regulation of spent fuel

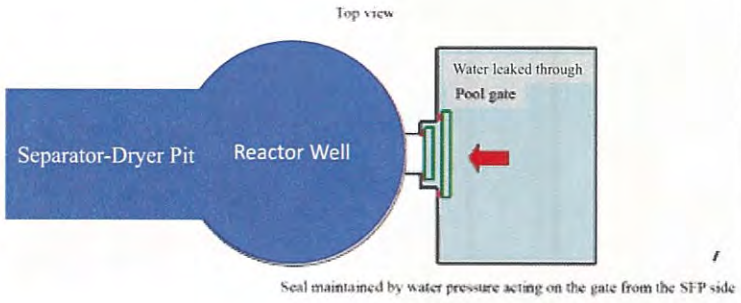
159x

Fukushima Pool #4 saved from dryout because of leakage *into* the pool from the adjacent reactor pit (peaks due to *insufficient* additions of water by the "giraffe" cement pump)



- http://dels.nas.edu/Report/Lessons-Learned-from-Fukushima-Accident/21874, Fig. 2.15

Source of water that kept the spent fuel in pool #4 covered



(TEPCO, 2012 Report, Attachment 9-5, Figure 3)

Radioactive releases from spent fuel pool fires potentially much larger than from reactor accidents.

Land contamination by 30-year half-life Cesium-137 dominates long-term population radiation dose and cancer risk and can force long-term or permanent evacuation of large areas.

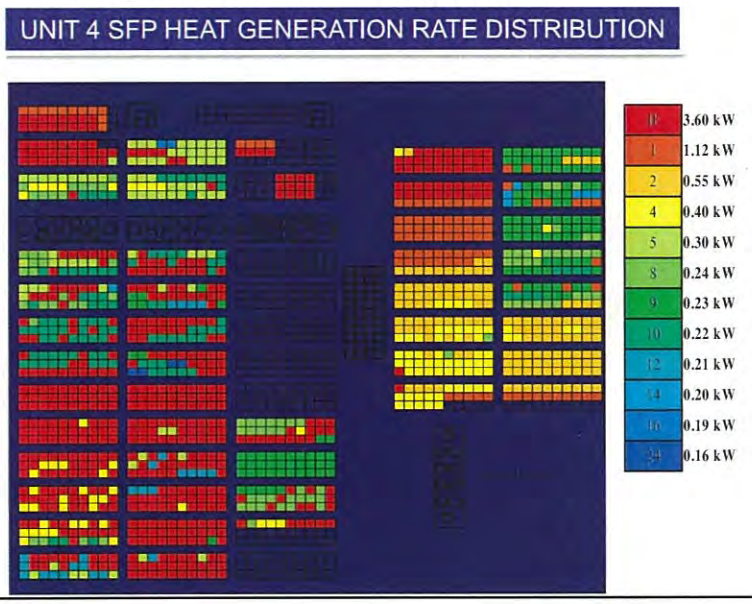
700 PBq* of Cs-137 in melted cores of Fukushima 1-3 but their containment structures released only 1 to 3 percent to atmosphere.

Spent fuel pool #4 contained 900 PBq but, after hydrogen explosion, it was open to the atmosphere and, in a spent fuel fire, ~90% would have been released to the atmosphere.

*1 Becquerel (Bq) = 1 disintegration per second
1 MBq = million disintegrations per second
1 PBq = 1000-trillion disintegrations per second

Reactor Building #4, 1 May 2011

Spent fuel pool #4 was partially dense racked
U.S. spent fuel pools are fully dense-packed



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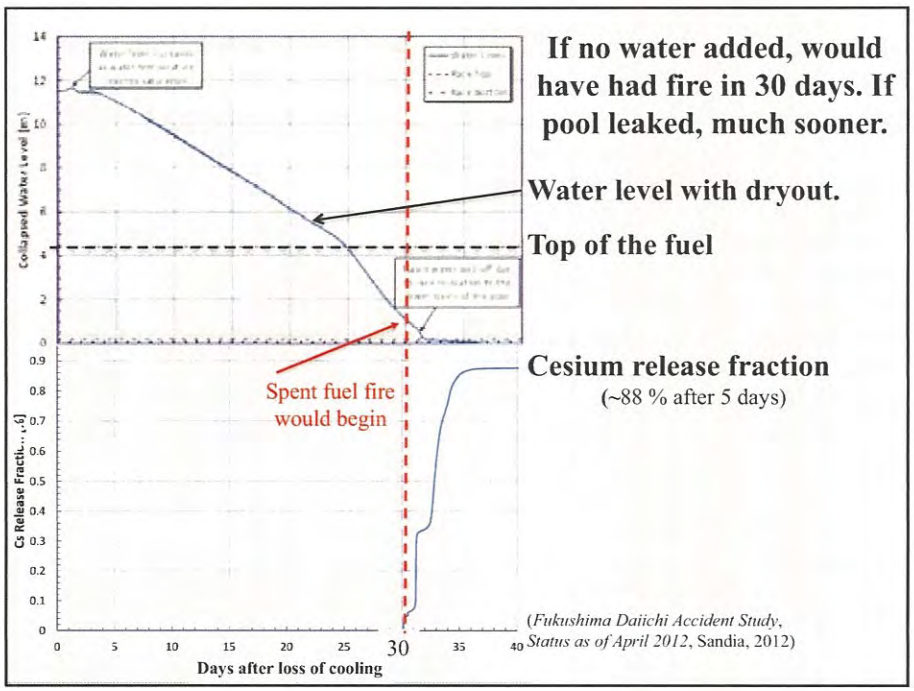
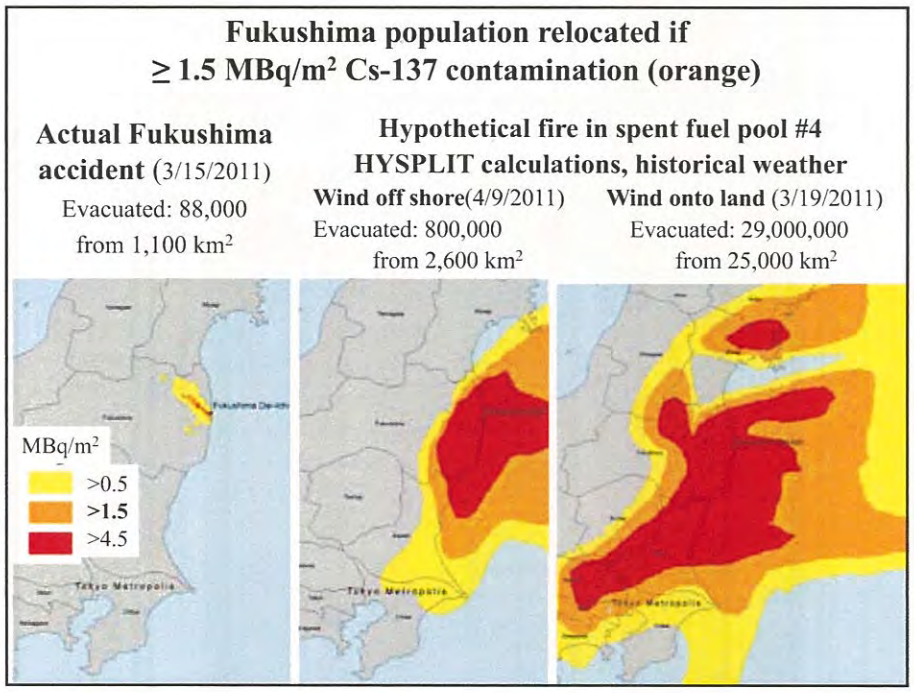
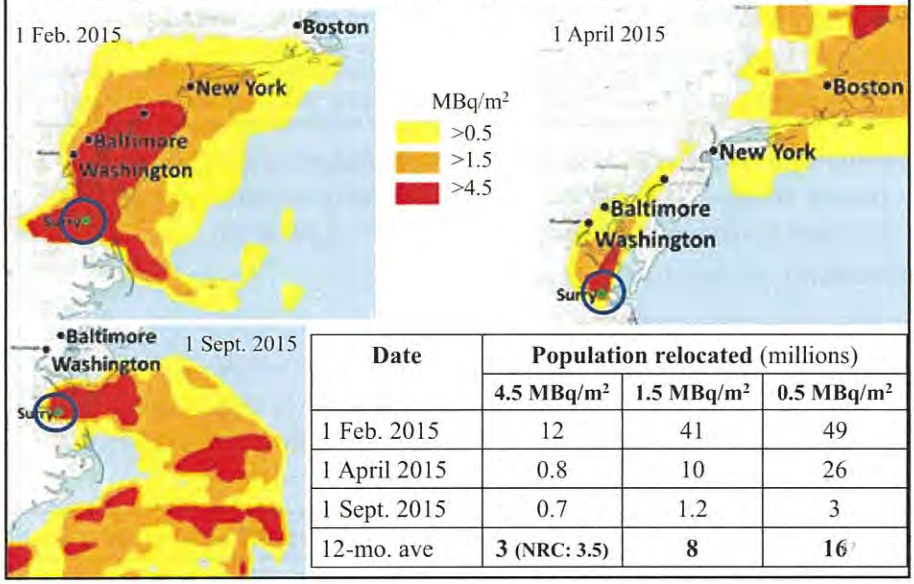

If no water added, would have had fire in 30 days. If pool leaked, much sooner.
Water level with dryout.
Top of the fuel
Spent fuel fire would begin
Cesium release fraction
(~88 % after 5 days)
Collapsed Water Level [m]
Cs Release Fracti... [-]
Days after loss of cooling
30
(Fukushima Daiichi Accident Study, Status as of April 2012, Sandia, 2012)


Fukushima population relocated if
≥ 1.5 MBq/m² Cs-137 contamination (orange)
Actual Fukushima accident (3/15/2011)
Evacuated: 88,000
from 1,100 km²
Hypothetical fire in spent fuel pool #4
HYSPLIT calculations, historical weather
Wind off shore(4/9/2011)
Evacuated: 800,000
from 2,600 km²
Wind onto land (3/19/2011)
Evacuated: 29,000,000
from 25,000 km²
MBq/m²
>0.5
>1.5
>4.5
Tokyo Metropolis

1/02x

Relocation areas (orange and red) for spent fuel fire in a dense-packed pool at the Surry, VA nuclear power plant



Date	Population relocated (millions)		
	4.5 MBq/m²	1.5 MBq/m²	0.5 MBq/m²
1 Feb. 2015	12	41	49
1 April 2015	0.8	10	26
1 Sept. 2015	0.7	1.2	3
12-mo. ave	**3** (NRC: 3.5)	**8**	**16**

2003 Proposal to transfer spent fuel to dry-cask storage after 5 years to allow return to open-rack storage

Proposal: Transfer of spent fuel to dry casks after 5 years pool cooling and return to open-rack storage.*

U.S. Congress requested a National Academy of Sciences (NAS) review. NAS report recommended U.S. Nuclear Regulatory Commission (NRC) consider within the context of terrorism vulnerability assessments (2006).** NRC did nothing.

After Fukushima, NRC asked its staff to study the proposal further.

Staff decided to do a probabilistic cost-benefit analysis.

* Robert Alvarez, Jan Beyea, Klaus Janberg, **Jungmin Kang**, Ed Lyman, Allison Macfarlane, Gordon Thompson & **Frank von Hippel**, "Reducing the Hazards from Stored Spent Power-Reactor Fuel in the United States," *Science & Global Security*, Vol. 11 (2003) pp. 1-51.

** *Safety and Security of Commercial Spent Nuclear Fuel Storage* (National Academy Press, 2006). There also was a classified version in 2004 that detailed possible terrorism scenarios.

163x

NRC probabilistic cost-benefit analysis corrected

NRC staff estimated average release of ***1600 PBq from fire in a high-density pool with a hydrogen explosion and 20 PBq from a low-density pool without a hydrogen explosion: 80 times less!***

Cost of extra casks to go to low-density racking ~ $50 million per pool

Estimated average economic costs for a high-density pool fire in the United States ~ $125 billion and probability of accident at 1/10,000 per pool during next 20 years [x100 pools = 1 percent]).

Possibility of terrorism ignored.

1. Excluded consequences beyond 50 miles
2. Assumed decontamination would take less than a year
3. Assumed population relocation dose threshold 3x higher than Fukushima, Chernobyl & U.S. Environmental Protection Agency.
4. Discounted future benefits by factor of two.

Corrected: $2.2 trillion/10,000 = $220 million benefit (large uncertainty)

Why did they underestimate the consequences? "Regulatory Capture"

1. ***Aggressive regulators cannot be confirmed to the US today because of influence of industry on Senate, which must confirm the President's nominations.***
2. ***When industry complains about too aggressive regulation, Congress can use its control of the NRC's budget.*** In 1998, Senator Domenici, chairman of Senate Appropriations subcommittee, threatened to cut the NRC's budget by one third because of industry complaints and the NRC became much less aggressive.*

*Pete Domenici, *A Brighter Tomorrow: Fulfilling the Promise of Nuclear Energy* (2004), "The NRC's Day of Reckoning."

My recommendations

1. Regulatory objective should be to minimize danger of large releases.

NRC estimates probability of a spent fuel pool fire in U.S. in next 20 years as between 0.14 and 6%, with no terrorism.[1]

2. Require nuclear utilities to transfer spent fuel that has cooled for more than 5 years to dry cask storage at ~$50 million per reactor.[2]

Better than paying for the consequences of an accident that would displace millions of people. [Average cost of accident, ~ $2 trillion. Maximum collective insurance liability of nuclear utilities; $0.0136 trillion.[3]]

3. Nuclear Regulatory Commission will not require with recent or current appointees but the states could as a condition of a subsidy.

1. NRC, "Staff Evaluation and Recommendation for Japan Lessons-Learned Tier 3 Issue on Expedited Transfer of Spent Fuel," COMSECY-13-0030, Enclosure 1, op. cit., Table 43.
2. COMSECY-13-0030, Enclosure 1, op. cit., Tables 11–14.
3. Nuclear Energy Institute, "Price-Anderson Act prodes effective liability insurance at no cost to the public," [Nuclear Energy Institute factsheet] (NEI, Washington, DC, 2014); http://bit.ly/2oUniNh

Spent fuel management: A very contentious subject

Ultimate disposal deep underground but "not in my back yard."

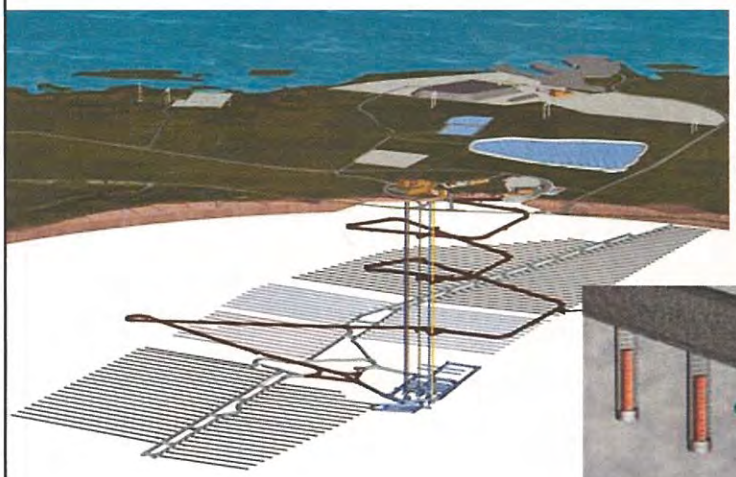
Interim options:

- ***Currently, on-site in spent fuel pools*** but danger of a spent fuel pool fire if loss of water.
- ***On site in passively air-cooled casks*** but does that mean it will never leave?
- ***In central interim storage after nuclear power plant decommissioned*** (Texas, New Mexico border)*
- ***Reprocessing*** (France and Japan) but is just a more costly interim storage option.

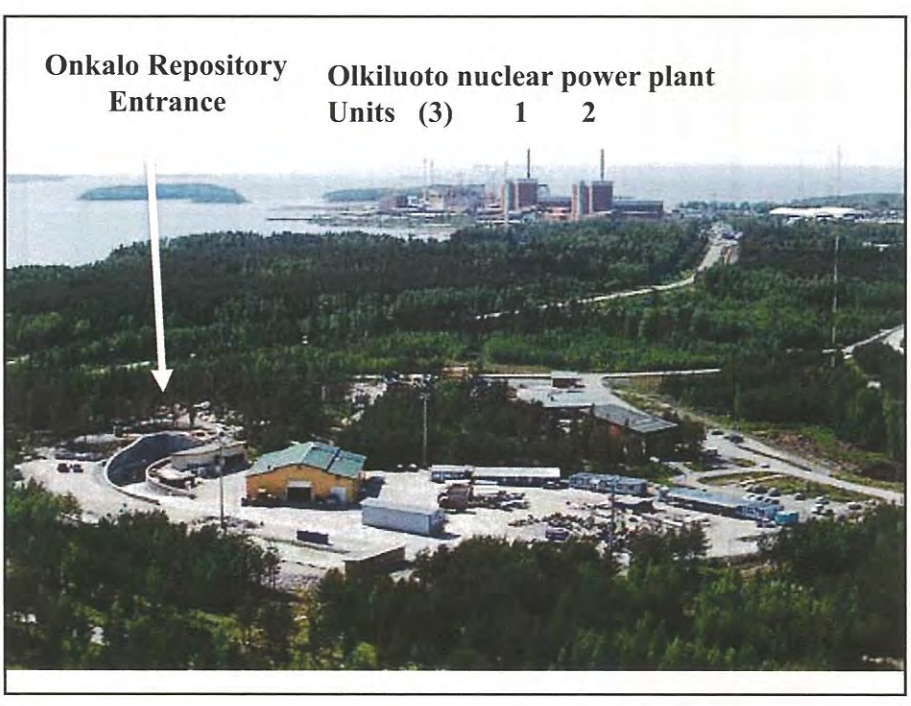
* https://neutronbytes.com/2016/05/01/texas-firm-files-with-nrc-for-interim-storage-site-license-for-spent-nuclear-fuel/; https://holtecinternational.com/2015/04/30/holtec-partners-with-elea-llc-in-new-mexico-to-build-consolidated-interim-storage-facility/

1165

After spent fuel storage or reprocessing:
Burying it ~ 500 meters underground



Finland's Onkalo repository under construction

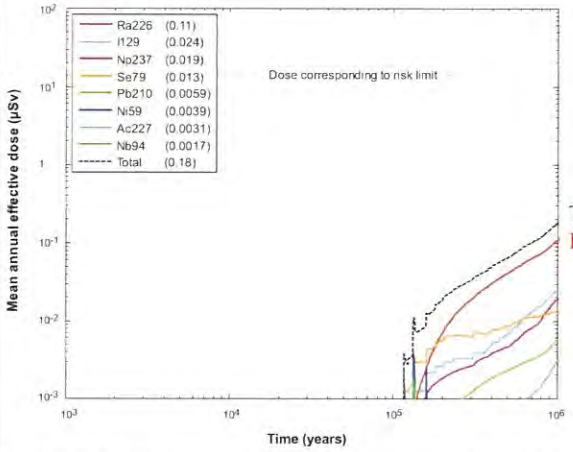


16/ax

Deep burial much safer than indefinite surface storage

Repository leakage hazard (Sweden repository company, 2011)

Radon from natural uranium in earth's crust



Total

Radon from U-238 in spent fuel

Figure 13-18. Far-field mean annual effective dose for the same case as in Figure 13-17. The legends are sorted according to descending peak mean annual effective dose over one million years (given in brackets in μSv).

167x

Testimony of Evelyn Liebman, AARP NJ Director of Advocacy

Before the Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee Concerning Nuclear Power Plants

December 4, 2017 State House Annex, Trenton, New Jersey.

Good morning. My name is Evelyn Liebman. I am the AARP New Jersey Director of Advocacy. Chairmen Smith and DeAngelo and Members of the joint committee, thank you for the opportunity to testify today. AARP believes no one's possibilities should ever be limited by their age and seeks to find new solutions so that more people can live and age as they choose.

We have very serious concerns about both the process and the substance of today's hearing and attempts by the nuclear power industry to enact a new ratepayer funded subsidy or tax. We trust you, like AARP, are concerned about the need for objective information and analyses, a fair and open process within which to make decisions that affect our entire economy and the impact of taxes on AARP New Jersey's 1.3 million Garden State members and all New Jersey electric ratepayers.

All consumers must be able to rely on the availability of safe, affordable, and high-quality utility services, indeed these are lifeline services that impact the health and safety of all. We also believe utility rates should reflect prudent use of ratepayer money and fairly distribute costs and savings among consumers, while taking into account households with lower incomes.

In the face of a more competitive electricity marketplace driven by a natural gas boom that has lowered energy prices, the nuclear power industry has seen a decrease in their payments for the power generated by their nuclear power plants. As a result, PSEG, Exelon, and other energy corporations are waging a campaign to increase our electric bills by forcing ratepayers to pay subsidies to increase the profitability of their aging nuclear power plants.

While the public has yet to see actual bill language here in New Jersey, we anticipate proponents will propose schemes similar to Ohio, Illinois and New York (dubbed zero emission credits). AARP opposes these schemes because they result in unnecessary and unjust charges on the bills of electricity customers.

And the charges can be enormous – literally in the billions of dollars.

New Jerseyan residents and employers cannot afford a new nuclear tax on top of the electric bills we are currently paying, (not to mention high property taxes, a new gas tax and one of the highest costs of living in the country). NJ's electricity rates are the 11th highest in the nation, or 30% above the national average, for residential ratepayers, and the 9th highest, or 54% above the national average, for industrial ratepayers. Under a ZEC scheme enacted in Illinois, ratepayers will

AARP New Jersey, Forrestal Village, 101 Rockingham Row, Princeton, NJ 08540 (609) 452-3906
www.aarp.org/nj

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be paying an additional $2.35 billion over 10 years to subsidize uneconomic nuclear plants and similarly in New York, residential ratepayers and employers will be paying an additional $7.6 billion over 10 years to prop up uneconomic nuclear plants in those states.

Today AARP released the results of a Rutgers Eagleton poll on this issue. Overall, an overwhelming majority of NJ voters (72%) are worried about the cost of electric bills going up and fully 75% say they are unwilling, (not willing at all or not too willing), to subsidize PSEG's already profitable nuclear plants. The poll results are attached.

We urge you to listen to New Jersey voters.

PSEG's nuclear power plants are profitable. These generating stations are clearing the PJM market, which means they are earning a profit and will remain profitable for at least the next three years. PSEG is contractually obligated to produce energy at a profitable market clearing price through 2020. In the May 2017 PJM Auction, wholesale capacity prices for New Jersey and parts of neighboring states increased to $187.87 per megawatt-day, up from $119.77 per megawatt-day. Beginning in June, 2020 PSEG will be paid capacity payments that are 56% higher per megawatt-day than current prices.

We understand the Committees' concerns relative to the retirement of existing, licensed, and operating nuclear power plants. While they will close some day, (and we should look at how other communities have best planned for this inevitability), there is no independent, objective analysis to suggest they will not continue to be economically viable well into the future. Rather than take the word of the industry – one that likes the rewards of deregulation but is now unhappy with the results of competition - we urge you, who must also consider the needs of consumers and New Jersey's entire economy, to require an open and independent assessment of the economic viability of New Jersey's nuclear plants as a necessary step to determining any further course of action. Such an independent assessment, requiring PSEG to open its books, must also include the total cost impact of single state subsidies in our regional, multistate marketplace.

It is also worth exploring why states including California, Vermont, Michigan and Wisconsin have seen nuclear plants close with apparently no impact on reliability and with no request for a subsidy in order to keep the plant open. This matter certainly needs further study.

Indeed, New Jersey's voters expect no less. The Rutgers Eagleton poll finds that 69% of voters agree that an independent and public assessment should be made to determine if it is economically feasible for PSEG to continue operating its nuclear plants without a subsidy before deciding if New Jerseyans should pay more for their electricity.

This assessment must also consider the impact of actions in Washington and PJM, our regional grid operator. The Federal Regulatory Energy Commission (FERC) is considering subsidies for the nuclear industry and could act as early as next week. NJ's BPU President Mroz has argued in support of the estimated $28 billion FERC Grid resiliency surcharge. PJM is considering in-market adjustments to address the nuclear industry concerns. We don't know that any subsidy is warranted, but certainly we shouldn't be saddled with multiple subsidies and rate increases. If New Jersey imposes an off-market subsidy, our residential consumers and employers will be faced with the prospect of paying more for their electricity not just once, but twice or three times.

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AARP NJ is a member of the Coalition Against Nuclear Taxes. While CANT does not oppose nuclear energy generation, or oppose fuel diversity, the Coalition is opposed to any special ratepayer financed tax or subsidy for nuclear power plants because:

- Out-of-market subsidies distort the working of the wholesale power market (PJM), discourage construction of new sources of power, discourage conservation, are detrimental to consumers and employers and may be detrimental to long term reliability.
- Lower energy prices are not a problem for residential, commercial and industrial customers.

For AARP members, indeed all consumers, lower energy prices afford us a little bit of budgetary wiggle room where we had to stretch before. Many continue to stretch even as prices are lowered.

A recent New Jersey Department of Human Services report, ***Living Below the Line 2017,*** finds that nearly six in ten NJ retired elder-only households' lack sufficient annual incomes to insulate them against poverty as they age. The average monthly Social Security benefit in New Jersey is $1,377 or about $16,500 a year. 30% of all NJ seniors rely on social security as their sole source of income. 21.3% rely on Social Security for 90% or more of income. 43.1% rely on Social Security for 50% or more of income.

This is why, even for those of us in this room who are fortunate enough to live way above the poverty line might consider a modest rate increase, rising electric bills are so burdensome for too many of New Jersey's residents. It means threatening one's health and safety by turning down the heat in the winter, not using air-conditioning in the summer, closing off rooms, not taking a trip to see children and grandchildren and/or cutting one's prescriptions.

There is no immediate need, indeed no crisis compelling this legislature to act on this issue now, in the waning days of the lame duck session.

We respectfully urge you, all members of the legislature and our Governor to demand a full, public, transparent and independent vetting of these matters including the cost impact on consumers and employers of single state subsidies. New Jersey should not embrace a scheme that creates winners and losers.

We look forward to a robust dialogue well beyond today's hearing. New Jersey deserves no less.

Thank you.

AARP is the nation's largest nonprofit, nonpartisan organization dedicated to empowering Americans 50 and older to choose how they live as they age. With nearly 38 million members and offices in every state, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands, AARP works to strengthen communities and advocate for what matters most to families with a focus on health security, financial stability and personal fulfillment. AARP also works for individuals in the marketplace by sparking new solutions and allowing carefully chosen, high-quality products and services to carry the AARP name. As a trusted source for news and information, AARP produces the world's largest circulation publications, AARP The Magazine and AARP Bulletin. To learn more, visit www.aarp.org or follow @AARP and @AARPadvocates on social media

AARP New Jersey, Forrestal Village, 101 Rockingham Row, Princeton, NJ 08540 (609) 452-3906
www.aarp.org/nj

AARP Real Possibilities in
New Jersey

EMBARGOED FOR RELEASE at 12:01 am, ET, Monday, December 4, 2017

Evelyn Liebman, AARP NJ Director of Advocacy
202-664-6984/ eliebman@aarp.org

AARP New Jersey:
Independent Research Shows New Jersey Voters Oppose Nuke Tax

Princeton - Research by the Rutgers Eagleton Center for Public Polling, Eagleton Institute of Politics released today shows that the residents of New Jersey, regardless of party and age, are worried about the high cost of electricity and that they do not support subsides to nuclear power companies. Overall, almost three quarters of respondents (72%) indicate that they are worried about the cost of electric bills going up and an overwhelming majority (75%) says they are not interested in subsidizing already profitable nuclear power companies.

According to AARP New Jersey State Director, Stephanie Hunsinger, "The evidence is very clear that the people of New Jersey are worried about the high cost of their electricity bills and that they do not support subsidies to nuclear power companies."

The New Jersey State Senate Environment and Energy Committee and Assembly Telecommunications and Utilities Committee are holding a joint session on the nuclear issue today. According to observers, the legislature is looking to act on the utility issue in the lame duck session that will end in January.

69% of voters agree that an independent and public assessment should be made to determine if it is economically feasible for PSEG to continue operating its nuclear plants without a subsidy before deciding if New Jerseyans should pay more for their electricity.

"We are hoping," Hunsinger added that "our elected representatives in Trenton can agree that this issue is too important to be rushed through the lame duck session and the citizens of New Jersey are paying enough already for their electricity service. We don't need what would be in effect a 'nuke tax'."

# # #

About the Poll

The Rutgers-Eagleton Poll was conducted by telephone using live callers Nov. 15-27, 2017 with a scientifically selected random sample of 1,203 New Jersey adults, 18 or older. The poll can be found at www.eagletonpoll.rutgers.edu

About AARP

AARP is the nation's largest nonprofit, nonpartisan organization dedicated to empowering Americans 50 and older to choose how they live as they age. With nearly 38 million members and offices in every state, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands, AARP works to strengthen communities and advocate for what matters most to families with a focus on health security, financial stability and personal fulfillment. AARP also works for individuals in the marketplace by sparking new solutions and allowing carefully chosen, high-quality products and services to carry the AARP name. As a trusted source for news and information, AARP produces the world's largest circulation publications, AARP The Magazine and AARP Bulletin. To learn more, visit www.aarp.org or follow @AARP and @AARPadvocates on social media.

RUTGERS
Eagleton Center for
Public Interest Polling

Eagleton Institute of Politics
Rutgers, The State University of New Jersey
191 Ryders Lane
New Brunswick, New Jersey 08901-8557

eagletonpoll.rutgers.edu
poll@eagleton.rutgers.edu
848-932-8940
Fax: 732-932-6778

Questions and Tables

The questions covered in the release for December 4, 2017 are listed below. Column percentages may not add to 100% due to rounding. Respondents are New Jersey adults; all percentages are of weighted results.

Q. Which company delivers your electricity?

PSE&G	59%
JCP&L	22%
Atlantic City Electric Company	10%
Rockland Electric Company	1%
Other (specify)	2%
Don't know (VOL)	6%
Unweighted N=	1192

[One random half of the sample was asked the following question before any other nuclear plant-specific questions, while the other half was asked this question after all other nuclear plant-specific questions]

Q. And how concerned are you about the costs of your electricity going up? Are you very concerned, somewhat concerned, not very concerned or not at all concerned?

	BEFORE and AFTER Versions Combined	Asked BEFORE Plant Questions	Asked AFTER Plant Questions
Very concerned	40%	34%	47%
Somewhat concerned	32%	32%	31%
Not very concerned	16%	18%	14%
Not at all concerned	10%	13%	7%
Don't know	2%	2%	1%
Unweighted N=	1199	602	597

[BEFORE AND AFTER COMBINED]

	Party ID			Gender		Race		Age				Income			
	Dem	Ind	Rep	Male	Female	White	Non-wht.	18-29	30-49	50-64	65+	<$50K	$50K-<$100K	$100K-<$150K	$150K+
Very	40%	40%	40%	37%	43%	33%	53%	36%	43%	44%	35%	49%	40%	34%	32%
Somewhat	30%	34%	30%	30%	33%	36%	24%	34%	32%	32%	30%	28%	35%	36%	35%
Not very	17%	15%	17%	17%	15%	19%	12%	15%	15%	14%	21%	14%	15%	22%	17%
Not at all	11%	9%	11%	14%	7%	11%	9%	9%	10%	9%	12%	8%	9%	8%	15%
Don't know	2%	1%	2%	2%	2%	2%	2%	6%	1%	0%	1%	1%	1%	1%	1%
Unwt N=	452	506	221	619	580	800	366	194	385	369	251	282	374	174	202

	Education				Region					Electric Provider		
	HS or Less	Some Coll	Coll Grad	Grad Work	Urban	Suburb	Exurban	Phil/South	Shore	PSE&G	JCP&L	Atlantic City
Very	47%	44%	34%	25%	46%	38%	37%	37%	46%	42%	38%	44%
Somewhat	32%	28%	32%	41%	27%	36%	31%	35%	26%	32%	32%	34%
Not very	9%	18%	21%	22%	18%	15%	19%	14%	16%	16%	19%	13%
Not at all	10%	7%	12%	13%	8%	10%	11%	12%	9%	9%	9%	9%
Don't know	2%	2%	1%	0%	1%	1%	2%	2%	2%	1%	2%	1%
Unwt N=	286	338	345	217	189	431	176	199	204	702	271	117

PSEG Power owns and operates the Salem and Hope Creek Nuclear Power plants in New Jersey. These plants generate electricity used by homes and business in New Jersey, as well as power for other states in the region. PSEG claims these plants are not as profitable as they once were and may decide to shut them down; others question this claim.

Q. PSEG is proposing that all New Jersey businesses and consumers, regardless of electric provider, pay an additional fee on top of what they already pay for electric to keep the state's nuclear plants operational. How willing would you be to pay this additional fee? Would you be very willing, somewhat willing, not too willing, or not willing at all?

Very willing	3%
Somewhat willing	16%
Not too willing	24%
Not willing at all	51%
Don't know	2%
Unweighted N=	1198

	Party ID			Gender		Race		Age				Income			
	Dem	Ind	Rep	Male	Female	White	Non-wht.	18-29	30-49	50-64	65+	<$50K	$50K-<$100K	$100K-<$150K	$150K+
Very	3%	3%	3%	5%	2%	4%	2%	5%	2%	3%	3%	2%	3%	2%	5%
Somewhat	18%	16%	14%	16%	17%	18%	13%	23%	12%	14%	20%	16%	12%	17%	20%
Not very	28%	22%	20%	22%	26%	22%	28%	28%	24%	24%	20%	22%	26%	25%	25%
Not at all	47%	52%	58%	52%	50%	50%	53%	34%	57%	56%	50%	54%	54%	51%	46%
Don't know	4%	7%	4%	6%	6%	7%	4%	10%	5%	3%	6%	6%	4%	5%	4%
Unwt N=	451	506	220	619	579	801	363	193	385	369	251	282	374	174	202

	Education				Region					Electric Provider		
	HS or Less	Some Coll	Coll Grad	Grad Work	Urban	Suburb	Exurban	Phil/South	Shore	PSE&G	JCP&L	Atlantic City
Very	2%	3%	4%	4%	3%	4%	4%	1%	3%	3%	3%	3%
Somewhat	15%	14%	19%	21%	15%	20%	13%	17%	12%	18%	11%	19%
Not very	23%	26%	23%	24%	28%	25%	24%	20%	20%	27%	24%	12%
Not at all	54%	51%	48%	47%	49%	44%	50%	57%	61%	48%	56%	61%
Don't know	7%	5%	6%	5%	6%	7%	8%	4%	4%	5%	7%	5%
Unwt N=	286	338	343	217	188	430	178	199	203	701	271	117

Q. Please tell me if you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with each of the following statements:

[RANDOMIZE ORDER]

[PROMPT IF NEEDED: Do you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with this statement?]

A. If a subsidy paid by consumers is approved, all of those buying power from PSEG should pay a part, rather than only those customers who live in New Jersey.

B. Before deciding on a subsidy for PSEG, an independent and public assessment should be made to determine if it is economically feasible for PSEG to continue operating the Salem and Hope Creek nuclear power plants without a subsidy.

	All of those buying should pay	Assessment should be made
Strongly agree	33%	43%
Somewhat agree	27%	26%
Somewhat disagree	14%	11%
Strongly disagree	15%	8%
Don't know	11%	11%
Unweighted N=	1186	1180

If a subsidy paid by consumers is approved, all of those buying power from PSEG should pay a part, rather than only those customers who live in New Jersey.

	Party ID			Gender		Race		Age				Income			
	Dem	Ind	Rep	Male	Female	White	Non-wht.	18-29	30-49	50-64	65+	<$50K	$50K-<$100K	$100K-<$150K	$150K+
Strongly agree	34%	31%	39%	36%	31%	35%	30%	23%	35%	35%	38%	29%	35%	40%	37%
Somewhat agree	28%	28%	24%	27%	27%	26%	28%	34%	29%	25%	20%	30%	28%	24%	27%
Somewhat disagree	16%	13%	10%	12%	15%	12%	18%	18%	12%	13%	12%	14%	11%	14%	16%
Strongly disagree	12%	17%	20%	16%	15%	16%	15%	10%	16%	17%	17%	19%	15%	16%	11%
Don't know	10%	12%	7%	10%	11%	11%	10%	14%	8%	10%	13%	8%	10%	6%	10%
Unwt N=	447	502	218	610	576	793	360	193	382	363	248	280	369	173	200

	Education				Region					Electric Provider		
	HS or Less	Some Coll	Coll Grad	Grad Work	Urban	Suburb	Exurban	Phil/South	Shore	PSE&G	JCP&L	Atlantic City
Strongly agree	26%	33%	40%	41%	29%	33%	37%	31%	37%	32%	36%	35%
Somewhat agree	25%	29%	27%	29%	33%	28%	21%	29%	23%	29%	24%	25%
Somewhat disagree	16%	13%	11%	13%	15%	14%	13%	13%	12%	15%	11%	10%
Strongly disagree	20%	15%	12%	12%	13%	14%	14%	17%	22%	14%	18%	21%
Don't know	13%	9%	11%	5%	10%	11%	15%	10%	7%	9%	10%	9%
Unwt N=	284	335	339	215	187	426	173	199	201	696	268	117

Before deciding on a subsidy for PSEG, an independent and public assessment should be made to determine if it is economically feasible for PSEG to continue operating the Salem and Hope Creek nuclear power plants without a subsidy.

	Party ID			Gender		Race		Age				Income			
	Dem	Ind	Rep	Male	Female	White	Non-wht.	18-29	30-49	50-64	65+	<$50K	$50K-<$100K	$100K-<$150K	$150K+
Strongly agree	41%	43%	45%	50%	36%	45%	40%	35%	46%	49%	37%	33%	45%	53%	52%
Somewhat agree	29%	23%	29%	22%	30%	27%	26%	33%	24%	23%	28%	30%	25%	26%	27%
Somewhat disagree	12%	12%	7%	9%	13%	9%	14%	12%	11%	11%	11%	16%	12%	9%	8%
Strongly disagree	5%	11%	11%	10%	7%	9%	7%	4%	10%	9%	10%	9%	10%	5%	7%
Don't know	12%	12%	8%	9%	14%	11%	13%	16%	10%	8%	14%	13%	8%	8%	7%
Unwt N=	445	498	218	609	571	790	358	192	380	360	248	277	367	174	201

	Education				Region					Electric Provider		
	HS or Less	Some Coll	Coll Grad	Grad Work	Urban	Suburb	Exurban	Phil/South	Shore	PSE&G	JCP&L	Atlantic City
Strongly agree	33%	42%	49%	57%	39%	46%	45%	38%	44%	43%	45%	38%
Somewhat agree	24%	28%	29%	24%	26%	26%	25%	31%	23%	26%	26%	27%
Somewhat disagree	15%	10%	10%	5%	14%	13%	7%	10%	9%	13%	7%	11%
Strongly disagree	13%	7%	4%	7%	9%	6%	11%	7%	14%	8%	11%	11%
Don't know	15%	13%	7%	7%	13%	10%	13%	14%	10%	10%	11%	14%
Unwt N=	282	330	340	215	186	423	174	197	200	691	268	116

The Rutgers-Eagleton Poll was conducted by telephone using live callers Nov. 15-27, 2017 with a scientifically selected random sample of 1,203 New Jersey adults, 18 or older. Respondents within a household are selected by asking randomly for the youngest adult male or female currently available. If the named gender is not available, the youngest adult of the other gender is interviewed. The poll was available in Spanish for respondents who requested it. This telephone poll included 516 landline and 687 cell phone adults, all acquired through random digit dialing. Distribution of household phone use in this sample is:

Cell Only:	31%
Dual Use, Reached on Cell:	26%
Dual Use, Reached on LL:	41%
Landline Only:	2%

The data were weighted to be representative of New Jersey adults. The weighting balanced sample demographics to population parameters. The sample is balanced to match parameters for sex, age, education, race/ethnicity, region, and phone use. The sex, age, education and race/ethnicity parameters were derived from 2015 American Community Survey PUMS data. The region parameter was derived from 2011-2015 American Community Survey 5-Year Estimates

based on total population. The phone use parameter derived from estimates provided by the National Health Interview Survey Early Release Program.[123] Weighting was done in two stages. The first stage of weighting corrected for different probabilities of selection associated with the number of adults in each household and each respondent's telephone usage patterns. This weighting also adjusts for the overlapping landline and cell sample frames and the relative sizes of each frame and each sample. The second stage of weighting balanced sample demographics to match target population parameters. Weights were trimmed at the 3rd and 97th percentile to prevent individual interviews from having too much influence on the final results. The use of these weights in statistical analysis ensures that the demographic characteristics of the sample closely approximate the demographic characteristics of the target population.

All surveys are subject to sampling error, which is the expected probable difference between interviewing everyone in a population versus a scientific sampling drawn from that population. Sampling error should be adjusted to recognize the effect of weighting the data to better match the population. In this poll, the simple sampling error for 1,203 New Jersey adults is +/-2.8 percentage points at a 95 percent confidence interval. The design effect is 1.14, making the adjusted margin of error +/- 3.0 percentage points. Thus if 50 percent of New Jersey adults in this sample favor a particular position, we would be 95 percent sure that the true figure is between 47 and 53 percent (50 +/- 3.0) if all New Jersey adults had been interviewed, rather than just a sample.

Sampling error does not take into account other sources of variation inherent in public opinion studies, such as non-response, question wording, or context effects.

This Rutgers-Eagleton Poll was fielded by Braun Research, Inc. The questionnaire was developed and all data analyses were completed in house by the Eagleton Center for Public Interest Polling (ECPIP). Dr. Cliff Zukin, Professor Emeritus of Political Science and Public Policy and Senior Survey Advisor to ECPIP, assisted with this questionnaire and analysis. The Rutgers-Eagleton Poll is paid for and sponsored by the Eagleton Institute of Politics at Rutgers, The State University of New Jersey, a non-partisan academic center for the study of politics and the political process. Full questionnaires are available on request, and can also be accessed through our archives at eagletonpoll.rutgers.edu. For more information, please contact poll@eagleton.rutgers.edu.

Weighted Sample Characteristics
1,203 New Jersey Adults

Male	49%	**Democrat**	39%	**18-34**	27%	**HS or Less**	34%	**White**	59%
Female	51%	**Independent**	43%	**35-49**	24%	**Some College**	30%	**Black**	12%
		Republican	18%	**50-64**	30%	**College Grad**	22%	**Hispanic**	18%
				65+	20%	**Grad Work**	14%	**Other**	10%

[1] NCHS, National Health Interview Survey, 2011–2015; U.S. Census Bureau, American Community Survey, 2010–2014; and infoUSA.com consumer database, 2011–2015.
[2] Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, July–December 2014. National Center for Health Statistics. June 2015.
[3] Blumberg SJ, Luke JV. Wireless substitution: Early release of estimates from the National Health Interview Survey, July–December 2016. National Center for Health Statistics. May 2017.

William Mullen Testimony:

Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee – December 4, 2017

Good Morning/Afternoon.

My name is AJ Sabath and I am here on behalf of William Mullen, who is the President of the NJ State Building and Construction Trades Council.

- The NJ Building and Construction Trades Council.is responsible for coordinating activities with 15 affiliated trade unions in the construction industry. This represents 13 Local Building Trades Councils and more than 100 local unions, comprising over 150,000 men and women. The affiliated trades unions include: Electrical Workers, Iron Workers, Laborers, and Pipe Trades (such as Plumbers and Pipefitters, Sprinkler Fitters, and HVAC Service Technicians). We are proud to be over 100 years strong, having been founded in 1903. One of our missions is to opine on issues that affect working families, which is why I feel compelled to personally testify on the matter before us.

Nuclear energy is critical to the New Jersey economy and our labor unions, especially the number of jobs that Salem and Hope Creek units support. Thousands of the men and women in my trade unions work at the plant at one time or another during plant outages. They rely on that work to survive. If those plants were to follow Oyster Creek and close, there would be nowhere for these men and women to find work. Ultimately, they would have to uproot their families and move to another State where nuclear plants still run. This would be a tough blow for the State, but this would be a devastating blow to those South Jersey communities.

We can get an idea of the impact of the plant closing by looking at locations where nuclear plants have closed. In Vermont, the nuclear plant closing resulted in lost jobs, a collapse in the real estate market, small businesses shutting their doors and other businesses shedding jobs.

No one is in favor providing price support to nuclear unless it is needed. We expect that PSEG will be transparent about the financial condition of the plants and have to demonstrate the need. But once that is done, nothing should stop the State from taking the necessary steps to ensure that these valuable resources do not close.

NJ has always been a strong supporter of its labor community and we ask that the State continues to support the backbone of its labor force and protect these well paying jobs.

Thank you.

NEW JERSEY UTILITY SHAREHOLDERS ASSOCIATION

117 North Church Street • Moorestown, NJ 08057 • (856) 840-4187 • NJUSA.US

Statement of Karen D. Alexander
President, New Jersey Utility Shareholders Association
Before the Senate Environment and Energy Committee and the
Assembly Telecommunications and Utilities Committee on
Strategies to Prevent the Premature Retirement of Existing, Licensed, and Operating Nuclear Power Plants

December 4, 2017

Good morning, Chairman Smith, Chairman DeAngelo, members of both committees and the experts and interested parties attending today's hearing. I am Karen Alexander, president of the New Jersey Utility Shareholders Association. NJUSA is a not-for-profit association of New Jersey residents who are investors in one or more of the publicly traded entities that have a subsidiary providing utility service in New Jersey. Our members choose to join NJUSA to learn more about and advocate with other interested New Jersey utility investors on issues that can affect the value of their investments. Since they are not residents, institutional investors are not eligible to be NJUSA members.

NJUSA members are not a monolith. They come from different regions of the state, are of all races, creeds, ages and socioeconomic status. What our members have in common are these three things: 1) they are all New Jersey residents; 2) they are all utility ratepayers and 3) they are all investors in companies with New Jersey utility subsidiaries.

When NJUSA speaks on behalf of its members, we do so with respect to the potential impact of the public policy under consideration on all of our members, not with respect to the impact on any one member or group of members. NJUSA's concern is always with the overarching potential impact and precedent the policy underlying government actions could pose to our members. Consequently, I am here today to speak to the interests of all NJUSA members who, first and foremost, are New Jersey citizens and like all other New Jerseyans need safe, reliable and affordable electric power. As residents of the Garden State, our members want and deserve an energy future that is safe, reliable, affordable, characterized by diverse sources and environmentally responsible. To achieve those ends, New Jersey will continue to need nuclear power—a source that provides half of the state's electricity. We greatly appreciate the willingness of both committees to seek strategies to continue nuclear power as an integral part of New Jersey's energy future.

Those of you who know me know that I am not an expert in energy economics, so I am not able to offer a specific strategy to accomplish the goals articulated by the subject of this hearing. What I can offer, however, based on a career that has spanned 30+ years in the environmental and energy policy arena, are criteria to that I would urge you to consider as you evaluate proposed strategies.

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Suggested criteria for any proposed strategies:

1. ***They should include an alternatives analysis, i.e., "just say no" is not a realistic or helpful strategy.*** Those who would urge you to ignore the economic realities confronting existing nuclear plants across the U.S. and let New Jersey's plants close because they don't like nuclear and don't want the State to ensure ongoing future operations, but who don't offer realistic alternatives, are engaging in wishful thinking. The premature retirement of New Jersey's remaining nuclear facilities can have serious financial and environmental consequences that should not be ignored.

    - **Renewable energy is not a realistic substitute given the amount of baseload generating capacity that would be lost if the Salem and Hope Creek units are retired.** New Jersey is a high achiever with respect to renewable energy and there is more that can and should be done in that regard. But renewables cannot meet our reliability needs and they present their own financial challenges. It is simply not realistic to expect New Jersey to replace half of its electric generating capacity with renewable resources anytime soon.

    - **Reliance on out-of-state generation is neither environmentally nor financially sound.** Those who are willing to roll the dice and accept whatever decisions PJM might make regarding out of state resources that would need to be dispatched to fill the capacity deficit that will come from the premature retirements, are accepting the reality that under that scenario, New Jersey will be vulnerable to generation and transmission costs outside of its control. New Jersey would become increasingly reliant on out-of-state resources, possibly including coal-fired plants, to meet its energy needs. Continued operation of the Salem and Hope Creek plants will sustain New Jersey's energy independence and help the achieve the State's goal to reduce its carbon emissions.

2. ***They should recognize that the Salem and Hope Creek facilities are critically important New Jersey assets.***

    - **They have safely and reliably supplied needed electricity to New Jersey for over a generation.** While PSEG is the principal owner, these are facilities in which all New Jerseyans have a stake, and they are critical to the State's economy and its environment.

    - **They are the source of good paying, stable jobs in areas of the State where comparable jobs are not readily available.** The rest of the State may need the power, but the communities surrounding these plants need the power, the jobs and the ancillary benefits that accrue to the local economies. The economic burden that could result from the premature retirement of the facilities will negatively affect local families and businesses. Who would the retirements benefit? Certainly not the host communities or their residents. Neither would the rest of the state that has depended on these reliable sources of electricity for decades.

No one could have predicted the economic circumstances that now face half of America's nuclear power facilities. The decisions needed to address what could become a crisis here absent your intervention are not easy. It will be important to weigh the environmental and financial costs to New Jersey's residents and businesses from any of the strategies you evaluate as you endeavor to make certain that New Jersey's electric energy future is secure. On behalf of our members, thank you for your willingness to address this issue.

I appreciate the opportunity to share our views and would be glad to take any questions.

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NEW JERSEY
MAIN STREET
alliance

Contact: Jerome Montes
(609) 540-9197
jerome@mainstreetalliance.org

Testimony of James Parker, New Jersey Main Street Alliance

Against a Nuclear Tax before a Joint State Committee

My name is James Parker and the I'm the owner of Riverview Studios, an independent video production studio in Bordentown. I'm also a Steering Committee member of the New Jersey Main Street Alliance. I'm here today to speak against any potential legislation that would raise power rates for small businesses in New Jersey without proper transparency and debate.

My video production company employs five people and is completely dependent on power for what we do, whether its filming editing or other activities. . It makes up an important part of my budget and even a modest change to my power bills could severely affect my bottom line. And like most small business owners, I have small margins. I can't afford to sustain losses over an extended period of time.

I don't have a problem paying for things that serve our community. Our state needs revenues to support things like public health, safety and education, things are that important to small businesses as well. But if PSEG needs public funding to keep its nuclear plants open then they do need to open their books to the public.

If a small business applies for a loan or a line of credit, or if we apply for an economic development grant, we are expected to provide transparency, to open our accounts to analysis. We ask that PSEG be held to the same standard. Thank you.

NEW JERSEY
MAIN STREET
alliance

Contact: Jerome Montes
(609) 540-9197
jerome@mainstreetalliance.org

Testimony of Jerome Montes, New Jersey Main Street Alliance

Against a Nuclear Tax before a Joint State Committee

My name is Jerome Montes and I'm the business representative of the New Jersey Main Street Alliance. I'm here today to speak against any potential legislation that would raise power rates for small businesses in New Jersey without proper transparency and debate.

We represent more than 1,600 small, independently owned businesses across the state, but the committee should keep in mind that some 1.7 million employees are employed by small businesses in New Jersey. For many of these businesses, especially those that manufacture or produce products, or keep extended hours, like restaurants, an even modest increase in power rates can be devastating. These businesses tend to have small margins and anything that negatively affects their bottom line could mean lights out from them.

When small businesses owners experience of run of losses they have to fold. They generally don't have bailouts available from the public. If a small business applies for a loan or a line of credit, or applies for an economic development grant, they are expected to provide transparency, to open their accounts to analysis. We ask that PSEG be held to the same standard. If PSEG needs public funding to keep its nuclear plants open then they do need to open their books to the public. Thank you.

NEW JERSEY
MAIN STREET
alliance

Contact: Jerome Montes
(609) 540-9197
jerome@mainstreetalliance.org

Testimony of Deirdre Ryan, New Jersey Main Street Alliance

Against a Nuclear Tax before a Joint State Committee

My name is Deirdre Ryan and I'm my own commercial photography business. My husband is a freelance film editor. I'm here because any energy tax that would increase expenses for small business owners would be a massive burden for us.

Like most small business owners and freelancers I don't make a massive profit and anything that negatively affects my bottom line means less money for other things. My husband and I both have high health expenses due to pre-existing conditions and like many New Jerseyans we struggle with property taxes. The US Senate just passed a bill that will make both healthcare and property taxes very expensive for residents in our state. We don't need another tax, especially if PSEG can't prove it's necessary.

I depend on customers having money to spend on money. A lot of New Jerseyans are struggling to make ends meet and they are probably going to struggle even more in the near future. If they have less money to spend then it's less likely they will be spending money on my services.

For the sake of all ratepayers and all business owners, we need to think carefully about this issue. No company should be allowed to tax the residents of this state without a proper accounting analysis. Thanks you.

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Before the New Jersey State
Joint Assembly Telecommunications & Utilities (ATU) and Senate Environment & Energy (E&E) Committees
Testimony of Dr. Paul Stockton
December 4, 2017

Summary

Good morning. My name is Paul Stockton, and I am the Managing Director of Sonecon LLC, a security and economic advisory firm in Washington, DC. I appreciate the opportunity to comment on the value of a diverse generation mix and the importance of existing nuclear power stations to the citizens of New Jersey.

I have spent much of my career working on issues related to the protection of critical public infrastructure, including the Bulk Power System. From June 2009 until January 2013, I served as the Assistant Secretary of Defense for Homeland Defense and Americas' Security Affairs. In that position, I was responsible for Defense Critical Infrastructure Protection and led the creation of the Department's Mission Assurance Strategy. I also served as the Domestic Crisis Manager for the Department of Defense (DOD) and was responsible for Defense continuity of operations. I was the principal civilian advisor to the Secretary of Defense for providing Defense support to the Federal Emergency Management Agency, the Department of Energy (DOE) and other Federal departments in Superstorm Sandy, Hurricane Irene, and other disasters. In addition, I was responsible for developing and overseeing the implementation of DOD security policy in the Western Hemisphere, including U.S.-Canada cooperation on Defense-related issues concerning energy sector resilience. From January 2012

until January 2017, I served as a Special Government Employee for the Department of Defense, and helped conduct studies to strengthen deterrence of cyberattacks, counter insider threats, and meet other infrastructure resilience challenges. I have also written extensively about the dangers that threaten energy sector resilience.[1]

I recommend maintaining the diverse mix of energy generation on which New Jersey has historically relied, including taking action to strengthening at-risk nuclear generation, which is one of the most dependable sources of baseload generation available today. Nuclear power plants can operate for many months between refueling operations, making them an invaluable element of grid resilience and, correspondingly, of national security. Indeed, in its August 2017 report, the Energy Futures Initiative found that existing nuclear power plants and their suppliers play a fundamental role in U.S. national security and that "meeting national security priorities requires a robust nuclear energy industry."[2]

Preserving energy diversity is critically important to mitigating extreme threats to the Bulk Power System. These threats are exacerbated by the growing dependence of the electric generation sector on a single fuel -- natural gas. In a December 2016 study, the North American Electric Reliability Corporation (NERC), pointed out that "reliance on a single fuel increases vulnerabilities, particularly

[1] In 2016, I authored *Superstorm Sondy: Implications for Designing a Post-Cyber Attack Power Restoration System*, published by Johns Hopkins University Applied Physics Laboratory; *Electric Grid Protection Handbook II, Volume 1: Resilient Fuel Resources for Power Generation in Black Sky Events,* published by the Electric Infrastructure Security Council; and co-authored the Homeland Security Advisory Council's *Final Report by the Cybersecurity Subcommittee: Incident Response.* I am also widely published on other issues of homeland security, national defense and infrastructure resilience, including *Resilience for Black Sky Days: Supplementing Reliability Metrics for Extraordinary and Hazardous Events*, prepared for the National Association of Regulatory Utility Commissioners.
[2] Energy Futures Initiative, Inc., The U.S. Nuclear Energy Enterprise: A Key National Security Enabler (August 2017).

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during extreme weather conditions[.]" New Jersey itself has experienced severe weather events in recent years, including Superstorm Sandy in 2012, and the 2014 Polar Vortex that crippled much of the northeast.[3] NERC emphasized the importance of fuel diversity in the Nation's electricity supply in its November 2017 report[4] which found "[t]his growing interdependence of the natural gas and electric infrastructure has resulted in new operational and planning reliability challenges," and recommends that regulators "consider fuel diversity as they evaluate electric system plans and establish energy policy objectives." Maintaining fuel diversity has been recommended by NERC.

Furthermore, the power grid and fuel supplies for power generation are potential targets for adversaries such as Russia, China and North Korea, which may seek to disrupt United States defense capabilities and our nation's economy by attacking the critical infrastructure on which the public and our military bases rely. For example, the DOD's Mission Assurance Strategy emphasizes that "The Department of Defense's ability to ensure the performance of its Mission-Essential Functions (MEFs) is at growing risk. Potential adversaries are seeking asymmetric means (*i.e.*, indirect means designed to avoid our own military strengths) to cripple our force projection, warfighting, and sustainment capabilities by targeting critical Defense and supporting civilian capabilities and assets -- within the United States and abroad -- on which our forces depend."[5]

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[3] In the wake of the 2014 Polar Vortex "[a]lmost all of the regions' nuclear power remained operational throughout the crisis. Hon. Tom Ridge, *Keeping Nuclear in the Nation's Energy Mix*, The Philadelphia Inquirer (Aug. 9, 2017).

[4] *"Special Reliability Assessment: Potential Bulk Power System Impacts Due to Severe Disruptions on the Natural Gas System"* The North American Electric Reliability Corporation, November 2017.

[5] Department of Defense, *Mission Assurance Strategy*, April 2012, p. 1, http://policy.defense.gov/Portals/11/Documents/MA_Strategy_Final_7May12.pdf.

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Preserving Nuclear Generation is Essential to State and National Security

In my work with DOD and DOE, it has become clear that preserving nuclear generation is a national security priority. This conclusion is supported by three leading authorities. First, the Energy Futures Initiative, a new group led by former Energy Secretary Ernie Moniz, released a report in August 2017 entitled "The U.S. Nuclear Energy Enterprise: A Key National Security Enabler."[6] Among the key findings of the report are that existing nuclear power plants and their suppliers play a fundamental role in U.S. national security. The report recommends that "state policies affecting the design of organized electricity markets . . . [should] appropriately value attributes of nuclear electricity including supply diversity." In addition, in a recent article,[7] former Governor of Pennsylvania and Secretary of Homeland Security, Tom Ridge urged that the United States "strengthen and preserve our nation's baseload nuclear fleet, thus protecting our national security while ensuring a diverse, resilient energy grid." Finally, retired Rear Admiral Michael Hewitt, recently called for policymakers to "....elevate the conversation to talk about nuclear power as an element of national power."[8] I agree with these security experts, and offer that the bill will help preserve an important element of New Jersey and national security.

Threats to the Bulk Power System

I have identified three specific risks to the electric system: First, reliance on a single fuel creates the danger of "common-mode failures" where a lack of natural

[6] Energy Futures Initiative, Inc., *The U.S. Nuclear Energy Enterprise: A Key National Security Enabler* (August 2017).
[7] Id.
[8] Id.

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gas incapacitates multiple generators at the same time. Second, such failures could help create "black sky" power outages, which entail outages lasting a month or more over multiple regions of the United States.[9] Third, rising natural gas-electric interdependencies create dangers of mutually-reinforcing failures.

Increased dependence on a single type of fuel heightens the risks of common mode failures: that is, the danger that a single attack vector (especially via cyber means) could enable an adversary to disrupt fuel supplies for power generation across major portions of the United States. A significant interruption of the natural gas supply available for electric generation can dramatically reduce the supply of electricity available to serve load. For example, a large-scale disruption of a natural gas pipeline would prevent that pipeline from delivering natural gas to the generators it serves. It would also incapacitate any downstream pipelines dependent on it as a source of natural gas. Because natural gas is delivered close in time to its use as a fuel for electric generation, the system would have little time to respond to and compensate for the loss of a pipeline. Preserving a diverse generation mix that relies on multiple sources of fuel is essential to reducing the risk these potential common mode failures pose to the power grid.

Moreover, a black sky outage would inflict immense disruption on national security, the U.S. economy, and public health and safety. Many critical infrastructure systems and facilities have backup power generators and stored on-site fuel to keep them operating for a few days in a limited grid outage. However, the extensive length and scope of power outages in a black sky event

[9] Paul Stockton, *Resilience for Black Sky Days: Supplementing Reliability Metrics for Extraordinary and Hazardous Events*, at 3, National Association of Regulatory Utility Commissioners (2014).

would soon produce failures in emergency power assets and the infrastructure systems that rely on them. Blackouts of this severity would therefore cause cascading failures across multiple critical infrastructure sectors. As highlighted in recent hurricane events, generators will quickly break down through overuse. Demand for replacing them in a wide-area outage will rapidly outstrip available supplies, given the vast number of facilities that will require such replacements. Moreover, on-site fuel supplies for emergency generators will quickly be depleted. Massive, multi-sector requirements for fuel resupply will emerge. Contractors responsible for sustaining resupply operations will be unable to meet these requirements, as transportation systems, refinery operations, and other systems on which these contractors depend will also be disrupted in a black sky outage. Hospitals and other critical facilities and services would exhaust their ability to rely on backup power. Food manufacturing and distribution networks would cease to function. Other critical infrastructure sectors would also likely collapse. For example, water, wastewater, and cellular systems rely on a functioning power grid and are not currently prepared for such an event. Finally, national defense installations that depend on grid-supplied power would begin to fail. Domestic military facilities can operate without power for short periods of time, but most are not designed to be independent of the electric grid for extended durations.

Finally, as natural gas has become an increasingly important fuel for electric generation, natural gas pipelines have also come to rely on electricity to function. Key components of natural gas pipeline systems, including the compressors and industrial control systems that keep gas flowing to power generators and other

users, are increasingly reliant on electric power. Natural gas pipeline systems need compression pumps to sustain the flow of natural gas. Historically, these compressors were fueled with natural gas taken from the pipelines themselves. However, in many regions of the United States, these compressors are being replaced by variable speed electric-powered units to reduce onsite methane emissions and increase compressor efficiency. Black sky outages could interrupt the flow of electricity to these units, and (in a classic case of spiraling effects) magnify those outages by disrupting natural gas deliveries to power generators essential for power restoration.[10] These growing interdependencies create risks of cascading, mutually-reinforcing failures across both the electricity and oil and natural gas energy subsectors.[11]

Conclusion

Maintaining diversity across the electric generation fleet will help mitigate the substantial risks of natural and man-made disruption to the electric system that I have described. Maintaining nuclear power will help to make New Jersey and the nation more energy secure. Thank you for the opportunity to provide this testimony.

[10] Electric Infrastructure Protection (EPRO) Handbook II (Vol 1 – Fuel), July 18, 2016, at 24, http://www.eiscouncil.com/App_Data/Upload/149e7a61-5d8e-4af3-bdbf-68dce1b832b0.pdf.s
[11] Electric Infrastructure Protection (EPRO) Handbook II (Vol 1 – Fuel), July 18, 2016, at 21, http://www.eiscouncil.com/App_Data/Upload/149e7a61-5d8e-4af3-bdbf-68dce1b832b0.pdf.s

third way
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Before the New Jersey Senate Environment and Energy Committee and the Assembly Telecommunications and Utilities Committee

Ryan Fitzpatrick
Deputy Director for Clean Energy
rfitzpatrick@thirdway.org

December 4, 2017

Mr. Chairman, Members of the Committee, my name is Ryan Fitzpatrick, and I am the Deputy Director for Clean Energy at Third Way. Third Way is a nonpartisan public policy think tank based in Washington, D.C. that promotes pragmatic solutions to some of the nation's most complex challenges. My program focuses on the challenge posed by climate change, and the need for a number of clean energy tools to drastically cut emissions in time to avoid the most damaging impacts of rising temperatures.

I am pleased to appear before this Committee today to reinforce just how important nuclear energy is in this fight against climate change, and the need to ensure that existing nuclear plants are allowed to continue their contribution toward ambitious decarbonization goals.

Nuclear power plants across the country are facing economic headwinds and are at risk of closure, due mostly to cheap natural gas and the failure of markets and public policies to adequately reward nuclear plants for their many attributes. The loss of these important low-carbon assets threatens the foundations of America's clean energy progress. Taking action to stem these losses and maintain the nation's nuclear reactor fleet is among the lowest-cost clean energy options available today. Federal and state governments should take steps to ensure these plants continue to contribute to a low-carbon future, and should keep these facts in mind as they do:

- More than half the U.S. nuclear fleet may currently be at risk of closure.
- These at-risk reactors constitute America's largest source of clean energy, generating more electricity as all wind, solar, and hydroelectric power plants in the country combined.
- If existing reactors retire prematurely, they are likely to be replaced predominately by natural gas-fired power plants, which will cause emissions to rise.
- Today's power markets do not fully value the climate and grid benefits of America's nuclear fleet – something that state and federal policymakers should resolve, as they have for other important sources of clean energy like wind and solar.
- In addition to the climate and grid benefits, preserving these plants maintains thousands of jobs, protects air quality and public health, and supports billions of dollars in economic activity and federal and state tax revenue.

Recent analyses suggest that upwards of half of America's nuclear plants will be economically-challenged in the near future, putting them at risk of closure. And there is ample research and real-life examples to conclude that the vast majority of this carbon-free generation would be replaced by natural gas—and even coal in certain cases—pushing emissions up when we need to be ratcheting them down.

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To get a sense of the magnitude of the challenge, consider this: if we use the lower estimates and assume that half of the nation's plants (about 55,000 megawatts of nuclear power) are threatened by today's economic and policy landscape[1] and those plants are replaced by natural gas generation, CO_2 emissions could increase by roughly 156 million metric tons annually.[2] That would mean a 9% increase in overall U.S. power sector emissions.

Closure of New Jersey's nuclear reactors would contribute heavily to this backsliding on our climate efforts. Nuclear power plants produce the vast majority of New Jersey's carbon-free electricity, generating ten times the amount of power produced by all renewables in the State. If, hypothetically, the reactors operating at Salem and Hope Creek generating stations were taken offline in the near future, that generation would likely be replaced almost entirely by natural gas, given the availability of resources and cost projections in this region. Switching all of this carbon-free generation to gas would result in an increase of 9 million metric tons of carbon dioxide equivalent.[3] For comparison, that's roughly 9% of New Jersey's greenhouse gas emissions last year. Not just in the state's power sector. That's 9% of *all* of its emissions from power, transportation, industry, buildings, etc.[4]

The good news is that, despite today's economic challenges, preserving the existing U.S. nuclear fleet is one of the most affordable ways for America to decarbonize its electricity sector. In our 2016 analysis, Third Way found that, in all but the most remarkable situations, the costs associated with keeping an economically-challenged reactor online are actually less than the cost of building new wind, solar, or even natural gas generation to replace it.[5]

But this is about more than just the cost of preserving nuclear energy. It's also about the value we get from keeping these plants online. For instance, the CO2 emissions avoided by the nation's nuclear plants alone delivers an estimated public value of $6 to $54 per MWh.[6] The nation's nuclear fleet also helps avoid hundreds of thousands of tons of harmful air pollutants each year, including: particulate matter, which causes lung cancer, cardiovascular disease, and other devastating health impacts; sulfur dioxide, which causes acid rain; nitrogen oxides, a precursor to smog; and toxic

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[1] Bloomberg New Energy Finance, "Reactors in the red: financial health of the US nuclear fleet", July 2016.

[2] Calculations assume 55 percent of annual U.S. nuclear electricity generation, or 438.5 million MWhs, is lost and replaced by new natural gas combined cycle power plants with a heat rate of 6.69 million Btus per MWh consuming natural gas with 117 pounds of CO2 per million Btus.

[3] Based on a combined total generation of 25,299,000 MWh from Salem and Hope Creek generating stations in 2016. This assumes a carbon dioxide emissions rate of 0.36 tons per MWh for a new combined cycle natural gas plant, based on heat rate data from the National Renewable Energy Laboratory and Energy Information Administration calculations of carbon dioxide emissions coefficients.

[4] New Jersey Department of Environmental Protection, "Greenhouse Gas Emissions in New Jersey," 2017. Available at http://www.nj.gov/dep/dsr/trends/pdfs/ghg.pdf.

[5] Third Way, "Preserving America's Clean Energy Foundation," December 2016. Available at: http://www.thirdway.org/report/preserving-americas-clean-energy-foundation.

[6] Estimated value of avoided CO2 emissions ranges from $12.77 to $65.00 per metric ton of CO2 in 2016 USD, based on social cost of CO2 from U.S. EPA (2015). EPA Fact Sheet: Social Cost of Carbon. U.S. Environmental Protection Agency, December 2015. Reported average social cost of CO2 for 2015 using 2.5, 3 and 5 percent discount rates inflated to 2016 USD using the Bureau of Labor Statistics Consumer Price Index Inflation Calculator. Public benefit per MWh of nuclear generation estimated using regional average marginal emissions rates ranging from 0.486 to 0.834 tons CO2 per MWh, as reported by Kyle Siler-Evans, Ines Azevedo, and M. Morgan, "Marginal Emissions Factors for the U.S. Electricity System", Environmental Science and Technology, 46(9): 4742–4748.

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mercury, which can cause birth defects in children. Given these clean air benefits, it is not an exaggeration to say the U.S. nuclear fleet saves thousands of American lives each year.

The nation's nuclear power plants are also an important component of a diverse and secure supply mix, providing a valuable hedge against volatility in natural gas prices. The value of fuel diversity is difficult to quantify, but if the nation's nuclear fleet was replaced by new natural gas plants, every $1 increase in the price per million Btus of natural gas would cost American consumers an extra $5.3 billion – or nearly $17 per person in the United States.

Public policy has recognized and monetized these valuable public benefits delivered by renewable energy – awarding renewable sources between $30 and more than $150 per MWh when state and federal incentives are combined.[7] These subsidies have helped two important resources, wind and solar, to thrive during an economically challenging period for U.S. power producers.

Nuclear power delivers the same benefits as renewable energy, including clean air, CO_2-free power, and increased fuel diversity, while operating around the clock. Therefore, policies to preserve the nuclear fleet would deliver similar and substantial net benefits to the public and should be explored by states with struggling nuclear facilities.

New York was the first state to adopt a policy that rewards the low-carbon benefits of nuclear energy. In August 2016, the New York Public Service Commission approved a Clean Energy Standard which includes zero emission energy credit for qualifying existing nuclear facilities. New York recognized that supporting the existing nuclear units is critical to meeting the state's emissions reduction goals – and to doing so more affordably. Reports have also shown that, by keeping these plants online, the State can avoid losing thousands of jobs in economically challenged areas and $720 million in tax revenue from these facilities.

Late last year, Illinois passed legislation that values the climate benefits of existing nuclear units via zero emission credits. The Future Energy Jobs Bill was designed to support the continued operation of the states' nuclear plants, several of which were slotted to retire. The six nuclear plants in the state represent 93% of Illinois' clean electricity generation and the Illinois Environmental Protection Agency found that the retirement of the plants would produce an additional 21.5 million metric tons of CO_2 per year, resulting in over $10 billion in costs to society. The Illinois Department of Commerce and Economic Opportunity analyzed the impact of nuclear plant retirements and found that the closure of the plants would result in the loss of 4,200 jobs and $1.2 billion in economic activity annually. The passing of this bill will ensure that Illinois will continue to reap these environmental and economic benefits, while at the same time supporting the ongoing development of renewables and energy efficiency in the state.

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[7] Federal ITC reduces overnight capital cost by 30 percent, lowering the levelized cost of solar projects by roughly $19 to $63 per MWh. Federal production tax credit delivers $23 per MWh (rising with inflation) for the first ten years of the project, reducing the levelized cost of electricity from wind projects by $14.76 per MWh. Benefits of a five-year modified accelerated depreciation schedule (MACRS) are compared to a 20-year straight-line depreciation schedule, resulting in a reduction in levelized cost ranging from roughly $5 to $14 per MWh for wind and $7 to $22 per MWh for solar projects, depending on capital cost assumptions. Renewable energy has received benefits from state renewable portfolio standards at a value generally ranging from $10 to $65 per MWh, according to the National Renewable Energy Laboratory.

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These two states serve as a model demonstrating how policies can recognize the benefits of both renewables and nuclear, and their approach should be considered by other states with nuclear units at risk.

Our existing nuclear fleet is the foundation on which clean energy progress can be built. If this foundation crumbles, so too will our national energy security, climate, and clean energy goals – taking thousands of jobs and substantial economic benefits with it.

The value of the public benefits to climate, public health, fuel diversity, and local economies far outweighs the cost of the policy supports that are needed to keep these units in operation. Therefore, we thank those leaders in the New Jersey legislature who are exploring opportunities for responsible policy solutions to allow valuable nuclear energy assets to continue contributing to the public well-being.

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NEW JERSEY STATE AFL-CIO

106 West State Street
Trenton, New Jersey 08608
(609) 989-8730
FAX (609) 989-8734
www.njaflcio.org

CHARLES WOWKANECH
PRESIDENT

LAUREL BRENNAN
SECRETARY-TREASURER

CHARLES H. MARCIANTE
PRESIDENT EMERITUS

December 4, 2017

Dear Members of the Assembly Telecommunications and Utilities and Senate Environment and Energy Committees:

RE: Support for PSEG Nuclear Energy Production Facilities

The New Jersey State AFL-CIO is here today to support our members employed at PSEG nuclear facilities and to support energy consumer's through New Jersey. In addition to seeing significant layoffs and spiking energy costs, if the current financial pressures on nuclear facilities are not addressed, we will see a significant negative impact on the regional economy, to the resiliency of our energy supply and to the diversity of our energy portfolio.

Of course, our primary concern are our members. The New Jersey State AFL-CIO and its affiliate, IBEW Local 94, has over 800 permanent workers employed at PSEG nuclear facilities. These are good, union, middle class, family sustaining jobs. These are the types of jobs that allow workers to raise a family, buy a home and contribute to the economic & societal development of their local communities. These are the type of jobs New Jersey needs more of. They include maintenance workers, mechanics, control operators, equipment operators, as well as dozens of special classes of workers, such as radiation monitors.

In addition to these 800 jobs, various building trade unions, including the Plumbers and Pipefitters, Iron Workers, Operating Engineers, Electricians, Laborers and other construction trades are employed by literally hundreds of union contractors that do regular business with PSEG at these facilities, as well as emergency work during outages. Twice a year facility wide maintenance and rehabilitation is performed, which includes the additional hiring of hundreds of skilled professionals from the building trades for temporary employment at the nuclear facilities. All of these jobs would be lost if the nuclear plants shutter due to financial stress.

The ancillary impact on aligned industries that also employ our members would be decimated in the south Jersey region if these facilities are prematurely shuttered. They include jobs in transportation, retail, security and the loss of jobs from the closing of small businesses.

- Over -

We will leave the discussion of the positive effects of these nuclear facilities on the environment and to consumers to other experts. Our focus is on jobs and economic development. And without these facilities, we would see both of these suffer dramatically. Thank you for taking our thoughts into consideration and we look forward to working with you on the issue in the future.

Sincerely,

Charles Wowkanech
President

Laurel Brennan
Secretary-Treasurer

CW:LB:jd
OPEIU:153

CORY A. BOOKER
NEW JERSEY

United States Senate

NEWARK OFFICE:
GATEWAY ONE
11-43 RAYMOND PLAZA WEST
SUITE 2300
NEWARK, NJ 07102

CAMDEN OFFICE:
ONE PORT CENTER
SUITE 505
2 RIVERSIDE DRIVE
CAMDEN, NJ 08101

December 4, 2017

Senator Bob Smith
Chair
New Jersey Senate
Energy and Environment Committee

Assemblyman Wayne DeAngelo
Chair
New Jersey General Assembly
Telecommunications and Utilities Committee

Chairman Smith, Chairman DeAngelo, and members of the Committees:

Meeting the rising global demand for energy while simultaneously slashing carbon emissions presents a critical challenge for our generation. The impacts of climate change on our nation and our state present an imminent danger, and despite false rhetoric from the Trump Administration, we know that these impacts are being caused by man-made emissions of carbon dioxide. As your Committees meet to discuss the future of energy production in the state of New Jersey, and the role of nuclear energy, I offer this testimony on the importance of carbon-free electricity generation.

Climate change is causing our sea levels to rise, leading to more extreme and intense weather events, and is negatively impacting the health and well-being of vulnerable populations in New Jersey, the United States and around the world. While legislatures and governments around the globe work to implement the historic Paris climate agreement, which sets an ambitious target to limit global warming to 1.5°C above pre-industrial levels, scientists agree that even if all countries meet their commitments under the plan, we will still not be on track to meet that target.

The United States and the state of New Jersey must aggressively pursue a comprehensive approach to advancing the development of renewable energy – which is why I have fought vigorously for the extension of renewable energy tax credits for solar and wind. Policies to encourage and incentivize energy efficiency and conservation must be explored and implemented to ensure that once generated, energy is transmitted and utilized as effectively and efficiently as possible. But from a national and a global perspective, we are in a race against climate change, and in order to avert the worst consequences I believe nuclear energy must be part of the solution.

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President Trump's decision to withdraw the U.S. from the Paris agreement has made states' responsibilities in reducing carbon emissions that much more important. Just as the United States should take a decisive approach to reducing carbon emissions as quickly as possible, states must as well. That approach, particularly in states like New Jersey, should include nuclear energy.

Nuclear energy, which provides critical and reliable baseload power, currently comprises 20% of total U.S. electricity generation and more than 60% of our nation's carbon free electricity generation. According to the Energy Information Association, last year in New Jersey those numbers were closer to 39% and 97% respectively. And while fossil fuel power plants cause emissions that lead to negative health impacts and increasing asthma rates, nuclear generation emits no greenhouse gases or other air pollutants.

The nuclear energy industry provides long-term, high-paying jobs for trades ranging from electricians and machinists to electrical and nuclear engineers, reactor operators and more. Because of pending worker retirements, nationally, the industry expects to hire 25,000 new workers over the next several years – if the existing fleet of reactors stays on line.

As you know, several existing reactors have recently been shut down prematurely, and many more are at risk. In order for the United States to meet short and medium-term emissions reduction goals, we need sound, long-term government policies that will maintain the existing fleet of nuclear reactors.

I appreciate your attention to this matter and the opportunity to provide testimony. Should you have any additional questions or concerns, please do not hesitate to reach out to me or my staff at 973-639-8700.

Sincerely,

Cory A. Booker
United States Senator

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DONALD NORCROSS
FIRST DISTRICT NEW JERSEY

website:
www.house.gov/norcross

Congress of the United States
House of Representatives
Washington, DC 20515-3001

PLEASE REPLY TO:

☐ 1531 LONGWORTH BUILDING
WASHINGTON, DC 20515
(202) 225-6501

☐ 10 MELROSE AVE
SUITE 210
CHERRY HILL, NJ 08003
(856) 427-7000

Written Testimony Submitted to the
New Jersey Assembly Telecommunications and Utilities Committee
and the New Jersey Senate Environment and Energy Committee
Congressman Donald Norcross (NJ-01)

Thank you for holding today's hearing on strategies to prevent the premature retirement of existing, licensed, and operating nuclear power plants. This hearing comes at a critical time for our country, as states and communities evaluate options to fuel their electrical grids in ways that are both safe and economically sound. As you consider possible solutions to solve our electrical needs, I urge you to remain open-minded to the many different sources of energy available in our state, especially those sources that have proven to be low-carbon, sustainable, and reliable. Maintaining a diverse energy portfolio will also ensure there is no single point of failure for the whole of the grid, and with that, provide stability and predictability for both the energy market and the consumer. I hope you will join me in supporting a comprehensive and diverse energy portfolio for the State of New Jersey.

As an electrician by trade, I spent years installing and restoring power for New Jersey homes, businesses and industrial sites. Thanks to my first-hand experience with the energy sector, I understand the importance of a stable and secure energy grid. A reliable and affordable energy system is not overly-reliant on one source. A 2014 study by IHS Energy found a diversified portfolio is the most cost-effective tool available to manage the inherent production cost risk involved in transforming primary energy fuels into electricity. In addition, a diverse power generation technology mix is essential to cost-effectively integrate intermittent renewable power resources into the power supply mix.[1]

My colleagues in Congress and I are pursuing an "all of the above" approach on energy production at the federal level which incorporates the best of clean energy

[1] Makovich, L., Marks, A. and Martin, L. (2014)." The Value of US Power Supply Diversity". [PDF]. Retrieved from https://www.nei.org/CorporateSite/media/filefolder/Backgrounders/Reports-Studies/IHS-Fuel-Diversity-Study-18-July-2014.pdf?ext=.pdf

standards, guidelines for safe maintenance and production, and economic feasibility. After sharing perspectives with other Members of Congress, I have learned that finding the right mix energy sources is problem not just in New Jersey, but in states across the country. For example, California, Vermont, and Maine saw increased air emissions and adverse economic effects after closing nuclear power plants in recent years. Closing nuclear plants in New Jersey would trigger similar adverse effects, and come at a cost to energy production. Nuclear energy powers nearly half the state, or approximately 3.8 million homes. In order to maintain stable energy production, these existing power plants would need to be replaced with another type of energy plant. This would be an additional expense for our already heavily-burdened taxpayers. Estimates project that replacements could increase costs by as much as $400 million per year statewide.

The long-term well-being of New Jersey residents is paramount, and I am extremely concerned that whatever energy sources we employ are able to produce electricity in a safe, sustainable, and secure fashion. To me, safe energy means production that is carbon-free and helps reduce greenhouse gas emissions. Safe energy also means physical and cyber security, as well as plans for preparedness in the case of attack or natural disaster. Last but not least, safe energy means responsible end-of-production maintenance so that our environment does not pay the price for our energy consumption. Right now in my Congressional district, Holtec International is building supplies and equipment to manage the back-end of the nuclear power cycle for commercial nuclear power plants, contributing to the safe and secure maintenance of nuclear products. I believe this will play a positive role in the long-term safety of energy production.

To conclude, a stable, secure and reliable energy portfolio will ensure a bright future for New Jersey. Maintaining diversity in our state's energy supply creates confidence that we are keeping our energy portfolio clean, secure, and economically viable. Keeping nuclear power in our energy supply will be the key to achieving these objectives. I sincerely hope you will consider these points as you debate long-term energy policy in our great state. Thank you.

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243x

FRANK A. LoBIONDO
2ND DISTRICT, NEW JERSEY

TRANSPORTATION
AND INFRASTRUCTURE
CHAIRMAN,
AVIATION
COAST GUARD AND MARITIME
TRANSPORTATION
HIGHWAYS AND TRANSIT

ARMED SERVICES
TACTICAL AIR AND LAND FORCES
EMERGING THREATS AND CAPABILITIES

HOUSE PERMANENT SELECT
COMMITTEE ON INTELLIGENCE
CHAIRMAN,
CIA
EMERGING THREATS

Congress of the United States
House of Representatives
Washington, DC 20515–3002

November 30, 2017

The Honorable Stephen Sweeney
New Jersey Senate
935 Kings Highway, Suite 400
West Deptford, NJ 08086

The Honorable Thomas H. Kean Jr.
New Jersey Senate
425 North Ave. East, Suite C
Westfield, NJ 07090

The Honorable Vincent Prieto
New Jersey General Assembly
1 Harmon Plaza, Suite 205
Secaucus, NJ 07094

The Honorable Jon Bramnick
New Jersey General Assembly
251 North Ave West, 2nd Floor
Westfield, NJ 07090

Dear Senate President Sweeney, Speaker Prieto, Leader Kean Jr., and Leader Bramnick,

I am writing to express my strong support for nuclear power as part of a diverse energy generation portfolio in New Jersey and the important role it plays in providing for a reliable and resilient electric grid. Without action, nuclear power could be forced into early retirement if the valuable attributes of the power assets are not properly valued in wholesale competitive markets. The early retirements of our assets would significantly impact grid reliability and negatively impact New Jersey both economically and environmentally.

Nuclear power is responsible for 47 percent of the power generated within New Jersey. That is enough power to provide electricity to 2.7 million homes on a round-the-clock basis while contributing 90 percent of the state's air emissions-free electricity. The closing of nuclear plants will result in a large increase in emissions and pollutants in New Jersey and negatively impact air quality and public health for residents.

Specific to my congressional district, the nuclear power plants in Salem County are an important economic driver for the county, South Jersey, and the state at large. These nuclear plants are economic engines that employ 1,600 permanent, high wage jobs with an annual payroll of $175 million. Further another 1,000 outage jobs and 1,600 jobs in the local community add to the economic health and wellbeing of Salem County. The economic benefits also include $30 million in state and local taxes paid and $60 million purchased in New Jersey goods and services. Cumulatively, the nuclear power plants provide $265 million to help fund schools, roads and other vital community services throughout the state.

Recognizing the important role the state government plays in this area, I encourage the elected officials in Trenton to focus on the importance of nuclear energy and help address the current market flaws in the wholesale electricity markets. This will help ensure that the nuclear power plants in Salem County remain an important resource for grid reliability, fuel resiliency, and practice sound economic and environmental policies.

Sincerely,

Frank A. LoBiondo

Frank A. LoBiondo
Member of Congress

MAYS LANDING OFFICE:
5914 MAIN STREET, SUITE 103
MAYS LANDING, NJ 08330-1746
PHONE: (609) 625-5008
PHONE: (800) 471-4450
FAX: (609) 625-5071

WASHINGTON OFFICE:
2427 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-3002
PHONE: (202) 225-6572
FAX: (202) 225-3318
www.lobiondo.house.gov

244x

LEONARD LANCE
SEVENTH DISTRICT, NEW JERSEY

COMMITTEE:
ENERGY AND COMMERCE

SUBCOMMITTEES:
VICE CHAIR
COMMUNICATIONS AND TECHNOLOGY

HEALTH

DIGITAL COMMERCE AND CONSUMER PROTECTION

COMMITTEE:
ETHICS

Congress of the United States
House of Representatives

2352 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515
PHONE: 202-225-5361
FAX: 202-225-9460

425 NORTH AVENUE, EAST
WESTFIELD, N.J. 07090
PHONE: 908-518-7733
FAX: 908-518-7751

361 ROUTE 31, UNIT 1400
FLEMINGTON, N.J. 08822
PHONE: 908-788-6900
FAX: 908-788-2869

December 4, 2017

The Honorable Stephen Sweeney
New Jersey Senate
935 Kings Highway, Suite 400
West Deptford, NJ 08086

The Honorable Thomas H. Kean Jr.
New Jersey Senate
425 North Ave. East, Suite C
Westfield, NJ 07090

The Honorable Vincent Prieto
New Jersey General Assembly
1 Harmon Plaza, Suite 205
Secaucus, NJ 07094

The Honorable Jon Bramnick
New Jersey General Assembly
251 North Ave. West, 2nd Floor
Westfield, NJ 07090

Dear Senate President Sweeney, Speaker Prieto, Leader Kean Jr., and Leader Bramnick,

I am writing to inform you of my support for nuclear generation as part of a diverse energy generation portfolio and the role it plays in providing for a reliable and resilient electric grid in the state of New Jersey.

As you know, nuclear power is responsible for nearly fifty percent of the power generated within New Jersey—enough to provide electricity to 3.8 million homes on a round-the-clock basis while contributing 90 percent of the state's air emissions-free electricity. Closing nuclear plants will result in a large increase in emissions and pollutants for New Jersey and negatively impact air quality and public health for New Jersey residents.

Specific to the Seventh Congressional District, which I represent, nuclear power generation helps avert the need for costlier infrastructure that may lead to the potential loss and degradation of open space, damage sensitive and protected environmental areas, and infringe on my constituents' private property rights. Replacing New Jersey's existing nuclear plants would increase energy costs by $400 million per year.

As a member of the U.S. House Energy and Commerce Committee I understand the economic challenges facing nuclear power plants in New Jersey and across the country. Recognizing the important role the state government plays in this area, I encourage the elected officials in Trenton to focus on the importance of nuclear energy and help address the current market flaws in the wholesale electricity markets. This will help ensure that New Jersey's nuclear power plants remain an important resource for grid reliability, fuel resiliency, and New Jersey practices sound economic and environmental policies.

Sincerely,

Leonard Lance

Leonard Lance
Member of Congress

345x

Peterson, Matthew

From: Patrizia Zita <PZita@kzgrp.com>
Sent: Friday, December 01, 2017 12:09 PM
To: Peterson, Matthew
Subject: PSEG Press Release Warning Energy Tax to Subsidize Power Plants Will Cost New Jersey Residents & Businesses
Attachments: PSEG Press Release.pdf

TO: **Members, Senate Environment and Energy Committee**
Members, Assembly Telecommunications and Utilities Committee

FROM: **Patrizia Zita**

RE: **PSEG Press Release, January 2011**

Please review the attached document prior to the Joint Committee hearing on Monday, December 4th.

In January of 2011, PSEG released the attached document in opposition to a proposed bill (A-3442) which would have subsidized the construction of new power plants through guaranteed long-term payments.

I look forward to seeing you on Monday and if you have any questions or would like to discuss this issue, please feel free to contact me at 609-530-1234.

Thank you.

Trish
Patrizia A. Zita
Principal

KAUFMAN ZITA GROUP

The Offices at Trenton Junction
400 Sullivan Way
West Trenton, NJ 08628
609-530-1234 / 609-530-0110 FAX
609-462-0562 cell
www.kaufmanzitagroup.com

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PSEG Warns Energy Tax to Subsidize Power Plants Will Cost New Jersey Residents & Businesses

In January of 2011, PSEG released the following in opposition to a proposed bill (A-3442) which would have subsidized the construction of new power plants through guaranteed long-term payments:

PSEG Warns Energy Tax to Subsidize Power Plants (A3442)
Will Cost New Jersey Residents & Businesses

Will lead state down a road of proven failure, result in lost jobs,
new customer surcharges and undermine efforts to conserve energy

TRENTON, N.J., Jan. 6, 2011 / PRNewswire / -- PSEG today announced its strong opposition to legislation (A3442) that will subsidize the construction of new power plants through guaranteed long-term payments.

"This is essentially an energy tax that will cost New Jersey residential and business customers more than a billion dollars," said Anne Hoskins, Senior Vice President, Public Affairs and Sustainability, PSEG.

"Customers have been put through this before with disastrous results for customers," Hoskins warned. In the 1970's, government required New Jersey's utilities to enter into long-term contracts with power generators and set prices and production targets for the energy industry. That resulted in billions of dollars in excess payments by consumers. Over the next six years, PSE&G customers alone will pay more than $1 billion for the remaining costs of these long-term contracts. Atlantic City Electric recently received approval to raise its customers' bills by roughly five percent to recover the costs of its out-of-market contracts.

"The resulting customer surcharges will have long-term impacts," Hoskins said. "Subsidies are a slippery slope and will drive away other non-subsidized private investment in New Jersey."

"This bill is trying to fix a problem that does not exist," added Hoskins. Since 2007, New Jersey's wholesale electric markets have spurred significant investment in new generation, environmental retrofits, upgrades on existing generation, and investments to reduce electric usage through demand response.

"These investments totaled billions of dollars -- all made at the risk of private investors, not customers. PSEG alone has invested approximately $1.5 billion in generating plants in New Jersey since 2007," Hoskins said.

"It is best when investors, not government, determine when new generation is needed, where it is built, what technology to use and what price to pay for it," said Hoskins.

"Supporters of A3442 hope to create jobs, but real jobs will be lost in the process," said Hoskins. "Subsidized generation will replace non-subsidized generation and threaten hundreds of existing jobs."

SOURCE: Public Service Enterprise Group (PSEG)
LINK: http://prn.to/2BE4T9Z

Dr. Edward H. Salmon
Chairman, New Jersey Energy Coalition
Senate Environment and Energy Committee and
Assembly Telecommunications and Utilities Committee
December 4, 2017

Thank you. I am Dr. Edward H. Salmon, chairman of the New Jersey Energy Coalition.

I have had the honor and privilege to serve for 26 years in public office as a Mayor, Freeholder-Director, State Legislator, and as a member of the Governor's Cabinet as President of the Board of Public Utilities. For the past 27 years I have been working closely with the National Association of Regulatory Utility Commissioners (NARUC) and currently serving as President of NARUC Commissioner Emeritus.

In August 2007, we established the New Jersey Energy Coalition, an organization founded to raise public awareness of the value of clean, affordable and reliable energy for our state.

I'm here today to talk about preserving New Jersey's nuclear power plants, which are facing an uncertain future. I am concerned, as are many of us here today, that economic conditions could force PSEG's Salem and Hope Creek plants into early retirement unless action is taken.

New Jersey's nuclear plants are a critical source of clean, reliable baseload energy. They provide almost half of the electricity generated in our state. New Jersey's nuclear reactors work around-the-clock, even when faced with the most severe weather conditions – whether hurricane, superstorm or polar vortex.

One of nuclear's most important contributions is the need for fuel diversity. Let me explain what I mean by that: In New Jersey, we generate power using a number of fuels – nuclear and natural gas are the largest by far, combining to make the largest contribution to Grid Security. However, we also buy electricity from coal plants and solar farms, and even small amounts of hydroelectric power and methane collected from landfills. This diversity of different fuels helps keep New Jersey's energy supply reliable, resilient and affordable. It also protects ratepayers from sudden shifts in the price of any one fuel.

Now take nuclear out of the mix: New Jersey would be dependent on natural gas for more than 90 percent of its electricity. That's extremely risky. To understand why, let's go back to the polar vortex in January 2014. Faced with continual sub-freezing temperatures, PSE&G and other utilities were required to divert, or curtail, critically needed gas away from power plants due to firm pipeline capacity constraints to make sure enough remained available to heat people's homes.

should not have to make that choice. To combat such vulnerability in the future, NERC recommended that regulators reflect the importance of fuel diversity in energy policy. Preserving nuclear for New Jersey and the region does just that.

We all value the safe, clean, reliable and affordable energy our nuclear plants provide. But unless state policies do the same, our nuclear plants may disappear. Lawmakers in New York, Connecticut and Illinois already have enacted policies to support their struggling nuclear plants. New Jersey lawmakers would be wise to follow suit. I urge the state's policymakers to protect the state's electric customers from higher bills and increased air pollution by throwing our nuclear plants a crucial safety net. New Jersey's nuclear plants are worth saving.

Pocino Testimony

Good Morning/Afternoon.

My name is:

- Raymond Pocino and I am Vice President & Eastern Regional Manager of the Laborers' International Union of North America & NJ Laborers.

I'm here today to testify about the importance of nuclear energy to the labor community. But first, a little background about my organization:

- Founded in 1903, our union has grown to more than 20,000 members strong. We support a variety of industries for over 1,000 employers in New Jersey, such as: building construction, environmental remediation and energy conservation/green technologies. My union members live in every county and every community in New Jersey. We are committed to creating partnerships and working collaboratively with stakeholders and policymakers alike. This includes promoting the union construction industry and encouraging economic development, which is why I feel compelled to personally testify on the matter before us.

Nuclear energy is critical to the New Jersey economy, including the number of jobs that it supports.

The Salem and Hope Creek units support nearly 6,000 well paid jobs. This not only includes direct jobs such as plant operators, but also includes supporting jobs like refueling, repair and remediation. Moreover, the plants pump over $800M into the NJ economy each year such as payroll, taxes, goods and services.

The sudden and premature retirement of the plants will have an instant ripple effect – once PSEG announces closure, there is no turning back and these jobs will be gone forever. This not only impacts the plant operator, but the repairman who fixes the equipment and ultimately the local mom-and-pop shop that feeds both during lunch hour.

My people can't afford to have this happen – not when there are 20-30 years of life left in these plants. It provides a safety net for NJ's energy future – and for the thousands of families who support that effort every single day.

NJ has a proud history of nuclear energy and a strong labor community. We have an opportunity to preserve both. Let's not waste it.

Thank you.

John O'Conner, Executive Director
South Jersey Mechanical Contractors Association

Testimony Before The Senate Environment and Energy Committee and Assembly Telecommunications and Utilities Committee

Dec. 4, 2017

I am John O'Connor, Executive Director of the South Jersey Mechanical Contractors Association (SJMCA). The SJMCA membership is comprised of both large and small mechanical and plumbing contractors. The SJMCA promotes the advantages of union construction throughout South Jersey and represents contractors in Washington and Trenton.

I am pleased to be here today to talk before this joint committee on the value of nuclear power and the need to preserve the South Jersey nuclear plants. These plants are critical contributors to the health and vitality of the South Jersey economy. The owners of the three plants are not just committed to being strong members of the community, they are also strongly committed to safe operations of the plants and utilizing a union workforce.

I cannot overstate how important these plants are to the wellbeing and continued economic prosperity of the region.

Many of our members have done work for the plants – or have done work for businesses that are dependent on the plants for their economic viability. Closing these plants would have a severe negative impact on many of my members.

When nuclear plants have closed in other locations, it has had significant negative impacts on the surrounding economy. Yes, the 1,600 jobs at the plant are lost – which is is significant in itself. But it has a much greater impact as well. If those plants close, the loss of wages and purchases made for the plant will result in thousands of additional jobs going away.

Let's be real – the impact on South Jersey would be devastating, but the rest of New Jersey would be impacted as well. The cost to New Jersey in lost jobs, taxes, and economic activity and overall impacted lives would be great.

I urge the legislature to find a way to preserve nuclear for New Jersey.

COVANTA
Powering Today. Protecting Tomorrow.

Scott Henderson
Senior Director, Government Relations
Covanta
Tel 862-485-8649
Email Shenderson@covanta.com
Website www.covanta.com

December 4, 2017

The Honorable Bob Smith
Chairman, Senate Environment and Energy Committee
New Jersey Senate
216 Stelton Rd., Suite E-5
Piscataway, NJ 08854

The Honorable Wayne P. DeAngelo
Chairman, Assembly Telecommunications and Utilities Committee
4621A Nottingham Way
Hamilton, NJ 08690

Dear Chairmen Smith and DeAngelo:

Thank you for the opportunity to comment on strategies to prevent the premature retirement of existing nuclear power plants. As New Jersey moves to lower its greenhouse gas emissions to help prevent the most serious impacts of climate change, the loss of existing zero to low emitting sources of baseload power is very concerning. Covanta, therefore supports legislation that will support existing electric generating technologies that have zero or below zero net impact on the climate.

Covanta, headquartered in Morristown, NJ, is a national leader in developing, owning and operating facilities that convert municipal solid waste ("MSW") into renewable energy in specially designed waste-to-energy (WTE) facilities. We operate four such facilities in New Jersey, in Union, Camden, Warren and Essex counties. Statewide, the five WTE facilities generate 170 MW of renewable electricity, recognized as Tier II in the state's RPS, close to load centers and act as critical community infrastructure processing approximately 2 million tons of MSW annually, or roughly 20% of the State's total annual MSW generation.

On average, the U.S. EPA has determined that EfW facilities reduce GHG emissions by one ton of CO_2 equivalents (CO_2e) for every ton of MSW diverted from landfill and processed.[1] EfW facilities reduce GHG emissions, even after consideration of stack emissions from combustion, by:

1. Generating steam and/or electricity that would otherwise would likely be generated by fossil-fueled facilities;
2. Diverting solid waste from landfills where it would have emitted the potent greenhouse gas methane, even with consideration of landfill gas collection systems in place; and
3. Recovering metals for recycling, thereby saving the GHGs and energy associated with the production of products and materials from virgin inputs.

By reducing emissions that would have otherwise occurred at landfills, EfW is the only major source of electricity that actually reduces GHG emissions.

The GHG benefits of WTE relative to landfilling are well recognized by scientists and policymakers alike, including by CalRecycle,[2] CARB,[3] the Center for American Progress,[4] Third Way,[5] a 2016 report from the Berkeley Law Center for Law, Energy & the Environment,[6] U.S. EPA,[7] U.S. EPA scientists,[8] the Intergovernmental Panel on Climate Change ("IPCC"),[9] the World Economic Forum,[10] the European Union,[11,12] and other researchers.[13] WTE facilities were not covered under the EPA's new Clean Power Plan.[14] In fact, WTE facilities were considered zero carbon power under the CPP's accounting structure and new WTE facilities were eligible to generate Emission Rate Credits (ERCs).[15]

Despite the benefits they confer, similar to nuclear facilities, WTE facilities face long term financial risks. The wholesale electricity price in New Jersey has collapsed in the past ten years because of the low price of natural gas. While the steep decline in the wholesale electricity price is hurting all existing generation facilities, we believe the State should be increasingly concerned about the facilities like nuclear and WTE that have zero or below zero net impact on the climate. Whereas the State's RPS could act as a hedge against falling wholesale prices, the program has been flooded with RECs from across the PJM Market. These excess RECs have collapsed the Class I and Class II REC prices in the state as well. This lost revenue falls particularly hard on WTE facilities which face significant ongoing operation and maintenance costs relative to other renewables.

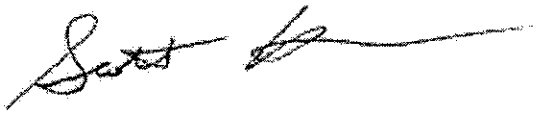
The power provided by WTE facilities offers additional benefits as well. In contrast to many other renewable energy technologies, WTE facilities generate baseload renewable energy typically located next to load centers. As our electrical grid becomes increasingly dependent on intermittent renewable power sources, baseload sources like WTE will help aid in grid stability and resiliency, fuel diversity and reliability, and will reduce long distance transmission burden and associated costs. WTE facilities typically operate with availabilities above 90%.

The five WTE facilities in NJ provide critical local sustainable waste management infrastructure. In addition to providing day to day service, these facilities can help make the communities more resilient as well. In fact, when weather and other natural events disrupt the grid, WTE facilities often remain operational, managing both routine waste and the resulting debris from those events, regardless of whether the grid is able to receive the power it can generate. In addition, there is a further potential to integrate WTE into community microgrids, currently under study in Camden. Reliable power generated by local WTE facilities could help communities ensure an energy supply to wastewater treatment plants, emergency services, prisons, and other necessary community services.

Given its benefits, we hope we can work with you to ensure that this legislation protects this critical infrastructure with zero or below zero impact on the climate. We ask that you consider including existing WTE facilities that achieve net lifecycle GHG reductions as demonstrated through an accepted waste management lifecycle assessment tool, like the EPA's MSW Decision

Support Tool (MSW-DST) alongside nuclear in the committee's efforts to prevent the premature retirement of energy sources that provide low carbon energy.

Sincerely,



Scott Henderson
Senior Director, Government Relations

Cc: Senate Environment and Energy Committee
Assembly Telecommunications and Utilities Committee

---

[1] See U.S. EPA Office of Solid Waste, *Air Emissions from MSW Combustion Facilities*, https://archive.epa.gov/epawaste/nonhaz/municipal/web/html/airem.html and Center for American Progress (2013) *Energy from Waste Con Help Curb Greenhouse Gas Emissions* https://cdn.americanprogress.org/wp-content/uploads/2013/04/EnergyFromWaste-PDF1.pdf

[2] CalRecycle (2012) CalRecycle Review of Waste-to-Energy and Avoided Landfill Methane Emissions. http://www.calrecycle.ca.gov/Actions/PublicNoticeDetail.aspx?id=73S&aiid=689

[3] See Table S of California Air Resources Board (2014) *Proposed First Update to the Climate Chonge Scoping Plan: Building on the Framework, Appendix C – Focus Group Working Papers, Municipal Solid Waste Thermal Technologies*

[4] Center for American Progress (2013) Energy from Waste Can Help Curb Greenhouse Gas Emissions http://www.americanprogress.org/wp-content/uploads/2013/04/EnergyFromWaste-PDF1.pdf

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[6] Berkeley Law Center for Law, Energy & the Environment (2016) *Wasting Opportunities: How to Secure Environmental & Clean Energy Benefits from Municipal Solid Waste Energy Recovery*. https://www.law.berkeley.edu/research/clee/research/climate/waste-to-energy/

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[9] EfW identified as a "key mitigation measure" in IPCC, "Climate Change 2007: Synthesis Report. Contribution of Work Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change" [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

[10] EfW identified as a key technology for a future low carbon energy system in World Economic Forum. *Green Investing: Towards a Clean Energy Infrastructure.* January 2009. Available at: http://www.weforum.org/pdf/climate/Green.pdf

[11] EU policies promoting EfW as part of an integrated waste management strategy have been an overwhelming success, reducing GHG emissions over 72 million metric tonnes per year, see European Environment Agency, *Greenhouse gas emission trends and projections in Europe 2009: Tracking progress towards Kyoto targets http://www.eea.europa.eu/publicotions/eea_report_2009_9*

[12] European Environmental Agency (2008) Better management of municipal waste will reduce greenhouse gas emissions. Available at: http://www.eea.europa.eu/publications/briefing_2008_1/EN_Briefing_01-2008.pdf

[13] The Joint Institute for Strategic Energy Analysis (JISEA) is operated on behalf of the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), the University of Colorado-Boulder, the Colorado School of Mines, the Colorado State University, the Massachusetts Institute of Technology, and Stanford University.

[14] 40 CFR 60.5845

[15] 40 CFR 60.5800

Scott Judge for the record

EPSA

1401 New York Avenue, NW
Suite 950
Washington, DC 20005-2100

(202) 628-8200

December 5, 2017

Honorable Bob Smith
New Jersey State Senate
Trenton, New Jersey
(via email)

Dear Chairman Smith:

Thanks for chatting with me briefly yesterday following the hearing on the nuclear power plant issue. You said I should write to you on behalf of the Electric Power Supply Association (EPSA) without waiting too long if we had anything to convey, hence this letter promptly today. I am always available to discuss further.

As I mentioned, we actually welcome the discussion of these issues and only regret time did not permit us to testify. As the national association for independent power producers, whose members once included PSEG and Exelon, we have been both with them on issues over the years, but more recently on the opposite side of what they are up to in states such as New Jersey after they left EPSA at the end of 2016.

Since time is of the essence, let me start by simply saying if I had to reduce what you should know to a single tweet it would be this: "when told to hurry, you really ought to worry." Please allow me to summarize below why this is the case here based on what I heard yesterday as informed by EPSA's expertise on what you correctly termed yesterday are very complex aspects of wholesale electricity markets.

Point #1: Then and Now

I last testified before you on December 9, 2010, almost exactly seven years ago, on LCAAP, largely at the behest of PSEG and Exelon when they were both members of EPSA. The price of wholesale electric energy was then around $45 per megawatt hour (MWh) and nuclear plants were printing money. Then, they had me tell you (correctly) that "this is markets at work" and consumers cannot toggle between the *lower* of cost-based and market-based rates. Now, when prices are down to around $30 per MWh and consumers are getting the benefits of competition, PSEG tells you and your colleagues that the same markets are not working. Mr. Izzo said it is your job to "fix" flawed wholesale markets, but only for them, by requiring New Jersey consumers to buy them a "safety net" to protect their higher expected above-market profits (sort of a minimum wage for nuclear plant operators) without divulging the costs (putting aside how and why a state should fix a perceived flaw in a federally-regulated wholesale market).

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Point #2: Nuclear Plants Are Not Alone In Facing Challenges

The historically low wholesale prices that Mr. Izzo complained about yesterday are negatively impacting *all* wholesale power producers, not just nuclear. Last Friday's *Wall Street Journal* had an excellent front page story summarizing why, citing flat demand for power, inexpensive natural gas, increasingly cheaper renewables, and other factors. Thus, a discriminatory "safety net" for nuclear as PSEG seeks actually does not reduce the risk of premature retirement of power plants, it merely shifts it to the non-nuclear plants that supply a majority of New Jersey's needs and that of the PJM regional grid. As a result, plants that are less expensive than nuclear plants will be forced to retire prematurely or seek similar "safety net" treatment by states, the regional grid and FERC. The end result is an irreversible unwinding of New Jersey's restructuring law that has successfully shifted the risks of new and existing power plants from consumers to investors.

Point #3: No Need to Rush Now

As you heard from several witnesses, including those without a commercial interest in the outcome, there is no need to rush to judgment any time soon. In fact you heard that from Mr. Izzo. As he has told his shareholders, the plants are currently profitable. He only testified that he may "seriously consider" closing them in two years if certain conditions come to pass in the future that may or may not actually obtain. In fact, the output from the two nuclear plants is already legally committed to PJM through May 31, 2021 pursuant to the May 2017 capacity auction that runs three years forward. The capacity price for PSEG actually went up about 50 percent from the prior year based on bids PSEG voluntarily made this year when it cleared the PJM capacity auction.

Among other things, the Legislature should carefully probe several assertions that Mr. Izzo made only in passing, preferably with the benefit of an independent consultant. For example, in suggesting why there might be a problem in two years, he mentioned using currently available forward commodity curves for what future prices will be. That was a very loaded statement because the forward curves are widely known in the industry to be lightly traded and usually are priced today well below the actual wholesale prices when the forward years are reached (at least Exelon if not PSEG said so publicly on an earnings call this year).

Mr. Izzo also told you that a factor to consider is the misnamed and misused catchall phrase "fuel diversity" which the nuclear and coal industries are throwing around together in Washington, DC in support of the Trump Administration's plan to subsidize so-called "base load" resources. (As you heard during yesterday's hearing, PSEG is one of only a few utilities supporting this plan, which is strongly opposed by environmental groups for increasing carbon emissions.) PJM will confirm that the PJM supply mix is now more fuel diverse than ever. Mr. Izzo tells you not to rely too much on one fuel, natural gas, when PSEG is building three new natural gas-fired power plants including one in New Jersey.

Finally, Mr. Izzo testified that "things can change" and indeed they can. With all due respect, the Legislature should not "seriously consider" the skeletal "safety net" we heard about publicly for the first time yesterday until you have a better read on the many changes being debated on a regional and national level that could very well obviate the need for what PSEG is seeking.

Point #4: Devil is in the Details, Whatever Happens Please Do Not Overpay

What would amount to a $4-5 billion "safety net" over a decade was only described by PSEG in three short bullets so we need more detail to better evaluate it. It was ominous that Mr. Izzo cited Illinois and New York, where the subsidy is around $17 per MWh or over 50 percent above current wholesale market prices for electric energy. That will raise consumer bills, not lower them.

There is a big financial disconnect between the amount consumers should have to pay to prevent "premature" retirement and what it sounds like they are seeking. We would oppose any such payment, but please do not let them recover more than needed. Any independent economist worth their Ph.D. will tell you that the proper measure of the amount needed to avoid retirement is only "going forward" costs, which are a fraction of what nuclear plants are seeking. *If* there is going to be a "safety net," *then* limiting it to "going forward" costs partially protects consumers. Otherwise, the plants are fully protected on the downside at consumer expense while PSEG keeps all the upside.

Finally, please make them open their books *before* legislation is enacted. In Connecticut, Dominion Energy, the owner of the state's sole nuclear plant, sought a long-term above-market contract but refused to open its books. Governor Malloy issued an executive order requiring state regulators to consider the company's claims. The consultant concluded that Millstone is profitable through 2035. (While Governor Malloy signed a bill allowing Millstone to apply for the contract, he said the review shows that it is not justified at this time.)

Thank you for the opportunity to speak "from the heart" as you asked of witnesses yesterday. I have been working on these issues since 1981 and especially after having testified seven years ago, I feel a special obligation to give you the complete picture as best I can describe it, given the many adverse consequences of a rush to act.

Sincerely,

John E. Shelk
President & CEO
Electric Power Supply Association
Email: jshelk@epsa.org and Mobile: 703-909-4226

ADDITIONAL APPENDIX MATERIALS
SUBMITTED TO THE

SENATE ENVIRONMENT AND ENERGY COMMITTEE
and
ASSEMBLY TELECOMMUNICATIONS AND UTILITIES COMMITTEE

for the
December 4, 2017 Meeting

Submitted by Senate Environment and Energy Committee:

Daniel Shen, Kristy Hartman, "State Options to Keep Nuclear in the Energy Mix," *National Conference of State Legislatures,* January 2017.