A Clean Energy Pathway for New Jersey

Executive summary

Prepared for New Jersey Conservation Foundation as part of ReThink Energy NJ
by the Institute for Energy and Environmental Research and PSE Healthy Energy

September 2017

Lead authors

Elena Krieger, PhD | PSE Healthy Energy
Arjun Makhijani, PhD | IEER

Contributing authors

Boris Lukanov, PhD | PSE Healthy Energy
MV Ramana, PhD | University of British Columbia

About the Institute for Energy and Environmental Research

The Institute for Energy and Environmental Research (IEER) provides the public and policy-makers with thoughtful, clear, and sound scientific and technical studies on a wide range of issues. IEER's aim is to bring scientific excellence to public policy issues to promote the democratization of science and a healthier environment.

About PSE Healthy Energy

PSE Healthy Energy is a non-profit energy science and policy research institute dedicated to supplying evidence-based, scientific and technical information and resources on the public health, environmental and climate dimensions of energy production and use. The mission of PSE Healthy Energy is to bring scientific transparency and clarity to energy policy discussions, helping to level the playing field for citizens, advocacy groups, the media, agency staff, and elected officials by generating, translating, and disseminating scientific information.

Institute for Energy and Environmental Research (IEER)
6935 Laurel Ave., Suite 201
Takoma Park, Maryland, 20912
301-270-5500
www.ieer.org
info@ieer.org

PSE Healthy Energy
1440 Broadway, Suite 205
Oakland, CA 94612
510-330-5550
www.psehealthyenergy.org
info@psehealthyenergy.org

Acknowledgements

This is the final report of a project to develop a clean energy pathway for New Jersey with a focus on the year 2030, but in a manner compatible with deep decarbonization of the electricity sector by 2050. The project was commissioned by the New Jersey Conservation Foundation. Throughout the process we have benefited from careful, insightful, and thoughtful input from Barb Blumenthal, Research Coordinator, ReThink Energy NJ and the New Jersey Conservation Foundation. We also want to thank Tom Gilbert, Director for Energy, Climate & Natural Resources of the New Jersey Conservation Foundation and Campaign Director, ReThink Energy NJ; we have benefited greatly from his insights and also from his extraordinary ability to keep us all focused and moving towards the goal of completing the research and production of this report.

A number of others in New Jersey provided important comments and feedback. A special thank you to: Serpil Guran, Director of the Rutgers EcoComplex; Mary Barber, New Jersey Director, Clean Energy, EDF; Ferit Ucar, Senior Economist, EDF; Steve Isser, Ph.D., President, Energy Law & Economics, and Lyle Rawlings, Mid-Atlantic Solar Energy Industries Association. We would also like to thank Lois Chalmers, IEER's Librarian, who provided research support. We would also like to thank Ann Guy (PSE) for editing; Ana McPhail (PSE) and Teresa Dayrit (PSE/Stanford) for technical analysis at the start of this work; and Eliza Czolowski (PSE) for mapping expertise.

We would like to thank the Fund for New Jersey, which provided part of the funding for this work.

Our report is the better for all their comments and insights and experience; but as usual, the authors alone are responsible for the contents and conclusions.

Elena Krieger, PhD | **PSE Healthy Energy**

Arjun Makhijani, PhD | **IEER**

Executive Summary

We have developed a clean energy pathway that will enable the state of New Jersey to halve its electric power sector carbon dioxide emissions by 2030, a key component of a broader effort required to meet the 2050 greenhouse gas emission targets under the Global Warming Response Act (GWRA). We describe a Clean Energy Scenario that relies on the combination of three elements to achieve affordable emission reductions: greater energy efficiency, continuing New Jersey's historic levels of solar growth, and a new focus on offshore wind. In this Scenario, in-state renewable energy provides 33% of total generation needs by 2030. The cost is estimated to be comparable to a business-as-usual approach. Additional considerations include partial electrification of transportation and fossil fuel heating and a contingency for early nuclear power plant retirements. This latter analysis suggests that near-term procurement of renewable electricity imports to offset premature nuclear retirements may be a prudent and cost-effective way to ensure that emission reductions are maintained. Health and equity concerns will require specific actions to realize pollution reduction and clean energy benefits for everyone, particularly people living in vulnerable and overburdened communities. The Clean Energy Scenario will set the state on a course to develop the clean, equitable and resilient electric power system needed to achieve deep decarbonization across all sectors by 2050.

Overview of findings

Achieving the GWRA's 80% greenhouse gas emission reduction target from all energy sectors by 2050 is contingent upon decarbonizing the electric power sector and converting transportation, heating, cooling, and other fuel-using systems to run on renewable electricity. We analyze the potential for reasonable deployment rates of in-state resources including solar, offshore wind, and efficiency to replace fossil fuel power generation and evaluate the generation costs associated with deploying these resources from 2018-2030. We find the clean energy pathway to be:

- **Essential:** Investment in energy efficiency and expansion of in-state solar and offshore wind resources to provide 33% of electricity will enable New Jersey to cut power sector emissions in half by 2030, an important and urgent intermediate step to ensure growth of low-carbon power for the electrification of transportation and heating required to achieve the state's 2050 GWRA goals.
- **Achievable:** The clean energy pathway developed here is a conservative projection of what can be achieved by 2030. The efficiency target of 2% per year is a rate that has already been attained in several states in the Northeast. Solar targets continue the historic growth already realized in New Jersey. The development of 3,250 megwatts (MW) of the state's plentiful offshore wind resources is feasible and could be expanded further as costs decline.

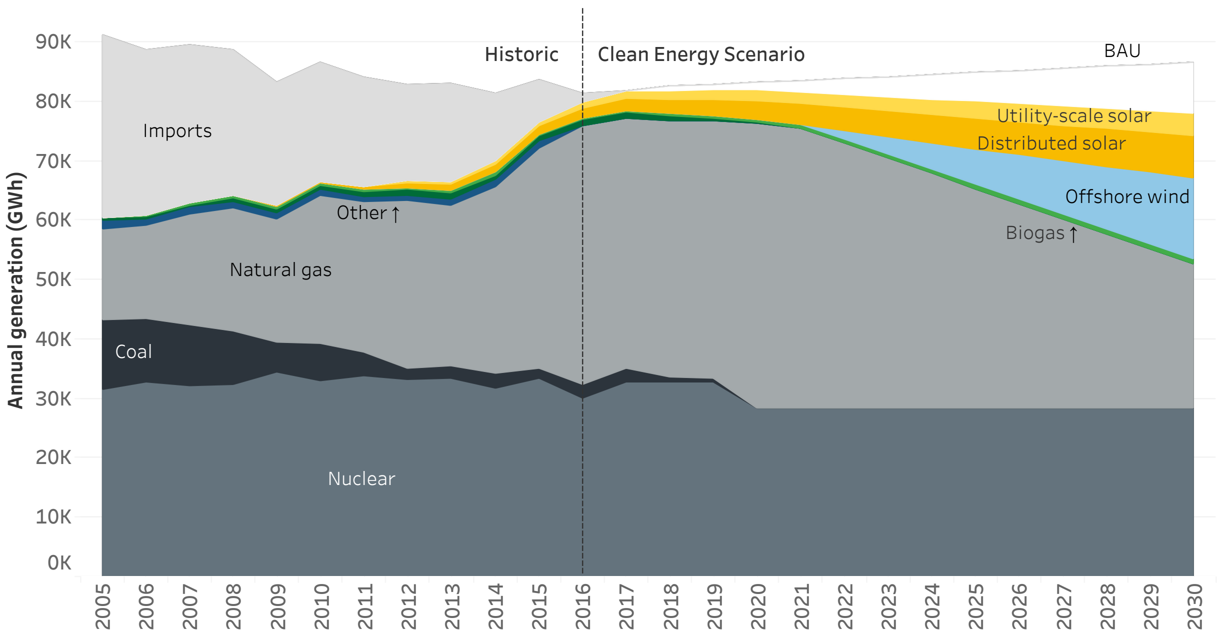

Figure E1: Electricity generation used to meet New Jersey's power sector needs, including the proposed Clean Energy Scenario to 2030. Expanded efficiency, offshore wind and solar resources displace coal and natural gas generation. Total generation in 2030 is lower than business-as-usual due to the growth of efficiency from 0.6% to 2%, even when accounting for initial electrification of vehicles and heating systems.

- **Affordable:** The proposed expansion of renewables is projected to moderately increase electricity generation costs, but overall costs of delivering electricity services to New Jersey consumers will be about the same due to efficiency savings.[1] Ongoing cost declines are expected to make renewables the most affordable energy generation resources after 2030. Additionally, wind and solar will provide a hedge against volatile or increasing natural gas prices. These cost projections do not include the significant health and environmental benefits of reducing harmful emissions.

We have developed a Clean Energy Scenario that incorporates these elements into an electricity system that can transition to deep decarbonization by the year 2050. New Jersey's historic nuclear and natural gas-dominated power generation mix and the proposed resources used to reduce emissions by 2030 are shown in **Figure E1**.

We also considered the Clean Energy Scenario cost impacts of two contingencies: 1) early nuclear power retirements, and 2) high natural gas prices. Important conclusions from these analyses are as follows:

- **Emissions can be reduced significantly, even if nuclear power retires early.** Given recent nuclear power plant retirements in Wisconsin, California, and elsewhere before their expiry dates, and plans for above-market payments to keep plants in New York and Illinois online, we considered the possibility that the Salem and Hope Creek Generating Stations would retire before 2030. If the retired nuclear plants are replaced by natural gas, power sector carbon emissions in 2030 would increase an estimated 5%

[1] The estimated difference in the year 2030 is that the cost of electricity in the Clean Energy Scenario will be about 1% more than business as usual. This is well within the uncertainty of the calculations and of the energy market. For instance, if the natural gas price rises faster than assumed, it would more than cancel out the cost increase (see below).

from 2015 levels even with the efficiency and renewable energy efforts outlined earlier, and spike significantly without such efforts. However, our analysis also suggests that policymakers can consider another option: building on the Clean Energy Scenario with about 500 MW of additional offshore wind and a significant expansion of low-cost renewable energy imports from PJM, the regional transmission operator (employing Virtual Power Purchase Agreements (VPPAs), for instance). This approach would allow New Jersey to meet the 50% emission reduction target from the electric sector by 2030 without any remaining nuclear plants at a cost comparable to the projected cost of above-market payments for nuclear, when analyzed from a generation cost standpoint. Additional reliability investment may be called for after required analysis by regulators. Ensuring grid reliability is the province of PJM.

- **The Clean Energy Scenario would cost less than business as usual if natural gas prices increase more than the reference scenario considered here.** If natural gas prices are on the high end of the U.S. Energy Information Administration's projections for 2030, then the proposed renewable energy expansion would cumulatively save about $2.4 billion by 2030,[2] illustrating that renewables provide a hedge against fossil fuel price uncertainty. Renewables will also provide fuel diversity and can mitigate price spikes from overreliance on a single fuel like natural gas.

Other important considerations and findings in the report include:

- **The Clean Energy Scenario sets the stage for electrification of transportation and heating.** We assume initial electrification of 5% of vehicle miles traveled in New Jersey by 2030, and 10% additional electrification of heating by replacing 80% of residential heating systems that currently use fuel oil and propane with highly efficient electric heat pumps. This electrification reduces both greenhouse gas and health-harming criteria pollutant emissions, and begins the pathway towards nearly complete electrification of these sectors by 2050. The values here are used to evaluate power sector impacts of electrification, not to explicitly set transportation or heating targets, which must also include efforts such as building weatherization and fuel economy improvements. Our calculations indicate that widespread electrification needed for deep decarbonization would roughly double the electricity generation needs of New Jersey by 2050 compared to 2030.

- **Planning is needed to ensure an equitable, healthy, and just transition.** We find that communities living near New Jersey's fossil fuel power plants have 50% more minority residents and 75% more low-income residents than the state average. Meanwhile, average rooftop solar deployment per household is half the state average in the zip codes with incomes in the lowest 20%. The proposed clean energy pathway is projected to reduce health-harming criteria pollutant emissions, including approximately 75% reduction in nitrogen oxide emissions and a near-total elimination of sulfur dioxide emissions from the power sector. However, the above data also suggest the need to assess equity when comparing emission reduction policy strategies. This includes ensuring that criteria pollutant emissions are reduced in New Jersey overall as well as in vulnerable communities in particular, and that solar and energy efficiency access increases for low-income communities.

- **The clean energy transition can help increase the resilience of the electric grid.** We included 1,600 megawatt-hours (MWh) of energy storage by 2030, allocating half to renewable microgrids that can increase resilience, including backup during

[2]Discounted at 3% to present value.

outages. Permitting and encouraging distributed solar systems to operate both with and independently from the grid can allow residents to access electricity even in the case of grid outages. Fuel diversity also increases resilience in the face of fuel shortages. While we did not include investments in additional smart grid upgrades in our cost calculations, the deployment of smart grid technologies can both increase demand flexibility to help incorporate renewables and allow for rapid outage detection.

- **Reduced natural gas use will lower upstream methane emissions along with carbon dioxide emissions.** Our analysis describes primary targets based on combustion-related power sector grid emissions, but methane, a greenhouse gas 86 times more potent than carbon dioxide over 20 years, can leak throughout the natural gas system. Exact leakage values are uncertain, but a 3.5% fugitive emission rate for methane, for example, would nearly double New Jersey's direct power sector greenhouse gas emissions. Because New Jersey's current carbon dioxide emissions from the power sector are primarily from natural gas, our 2030 targets can be expected to cut upstream methane emissions nearly in half along with combustion-related carbon dioxide emissions. The methane leakage issue reinforces the need to switch directly from other fossil fuels such as coal or petroleum directly to renewable electricity rather than resorting to natural gas as a transitional step.
- **The benefits of the Clean Energy Scenario are much greater than direct costs indicate.** As mentioned above, the Clean Energy Scenario will reduce emissions of carbon dioxide, methane, and health-harming co-pollutants, as well as provide storage and distributed generation to increase grid resilience. Additional benefits include the creation of local jobs, the opportunity for New Jersey to become an industry leader in offshore wind, reduction of health care costs occasioned by co-pollutants, and reduction of water use for power plant cooling.

Research approach and generation cost analysis

This analysis takes a New Jersey-centric approach to reducing power plant emissions. New Jersey comprises roughly 10% of the PJM grid, which provides significant balancing and grid reliability to the state. Because New Jersey participates in this larger PJM market, specific plant dispatch and operation will depend on PJM-wide decisions beyond New Jersey's borders, which we do not model here. However, the state-specific framework is useful for assessing New Jersey's potential contributions to climate-protection efforts. The emissions reduction scenarios described in the body of the report ensure that New Jersey's net generation matches load requirements until 2030, and assume renewable deployment in the state will displace in-state fossil generation. This displacement, however, cannot be realized with a renewable energy target alone because gas plants in the state may continue to export outside of the New Jersey grid. Additional policy and regulatory tools may therefore be required to ensure in-state emission reductions.

The scenarios described here are meant to provide an achievable approach to reducing emissions, but are by no means the only pathways available. We have fixed growth rates for solar, offshore wind, and efficiency at ambitious but realistic rates that have been achieved within New Jersey or other locations, or validated by industry sources when available. Higher growth rates may be achievable, but in the contingency of early nuclear power plant retirements, we have opted to rely primarily on out-of-state renewable energy imports to replace this lost generation rather than expand in-state deployment (other than offshore wind) faster than in our Clean Energy Scenario. This option is not without challenges, and may, for example, increase transmission and congestion charges in New Jersey. Changing inputs—including the rate of cost declines for renewables, PJM market decisions, natural gas prices, unexpected plant retirements, vehicle electrification rates and policies—may all affect the speed and pathway by which New Jersey reduces its greenhouse gas emissions.

In our carbon-cutting Clean Energy Scenario for 2030, we expand solar at the maximum historic annual growth rates seen in New Jersey, increase efficiency to 2% annual savings, and set a target of 3,250 MW for offshore wind. In **Figure** E2 we compare the cumulative costs of this scenario to the costs of a business-as-usual pathway based on PJM load forecasts, existing solar targets, current efficiency levels of 0.6%, and Energy Information Administration and Environmental Protection Agency cost projections. Renewable energy, energy efficiency and other technology costs that are used to calculate the scenario total costs are derived from the National Renewable Energy Lab, Lawrence Berkeley National Laboratory, the NJ Clean Energy Program, offshore wind studies, and consultation with industry. These technology costs are expected to be conservative, although we do assume that policy changes will result in lower-priced renewable energy incentives than New Jersey's current solar renewable energy credits (SRECs). This comparison of the total delivered costs of electricity primarily highlights differences in the electricity production costs, because assumed non-generation costs were similar in each case, with the exception of some avoided costs due to efficiency savings and the expansion of transmission and energy storage in the Clean Energy Scenario.

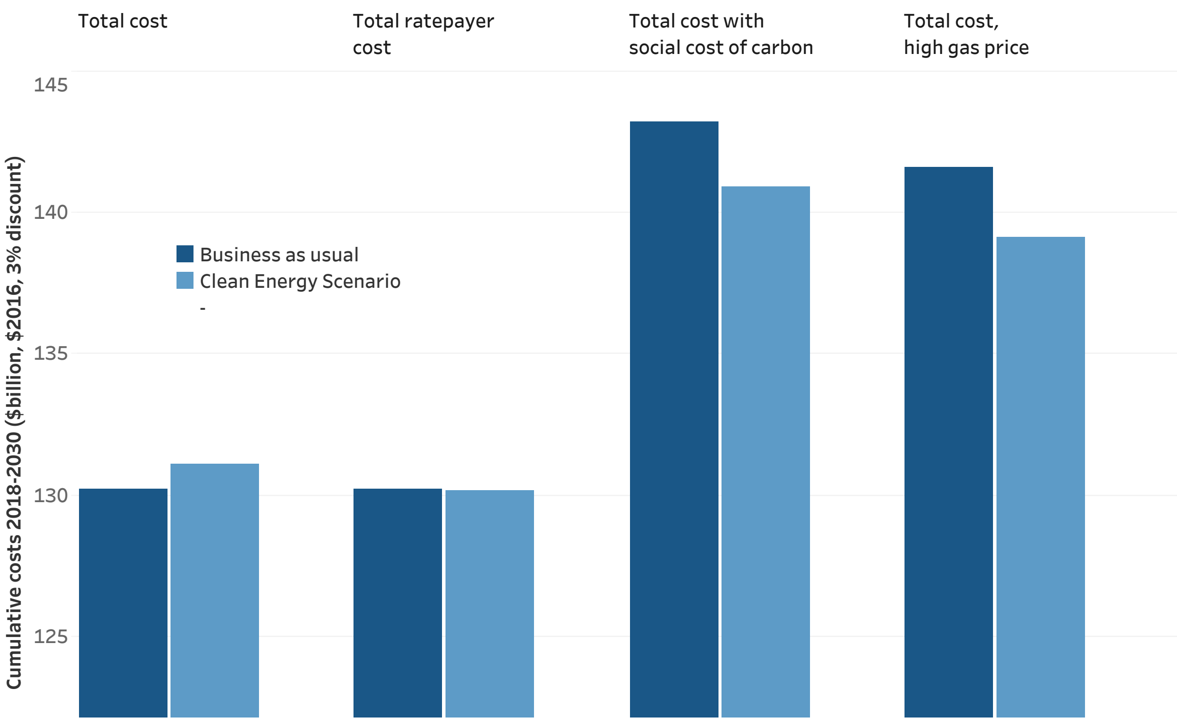

Figure E2: A comparison of the cumulative Clean Energy Scenario cost to the business-as-usual cost of electricity services from 2018-2030. Includes i) total costs (2016 dollars, 3% discount rate); ii) cumulative costs from the ratepayer perspective, excluding customer efficiency expenditures; iii) cumulative costs including the social cost of carbon; iv) cumulative costs in the case of high gas prices.

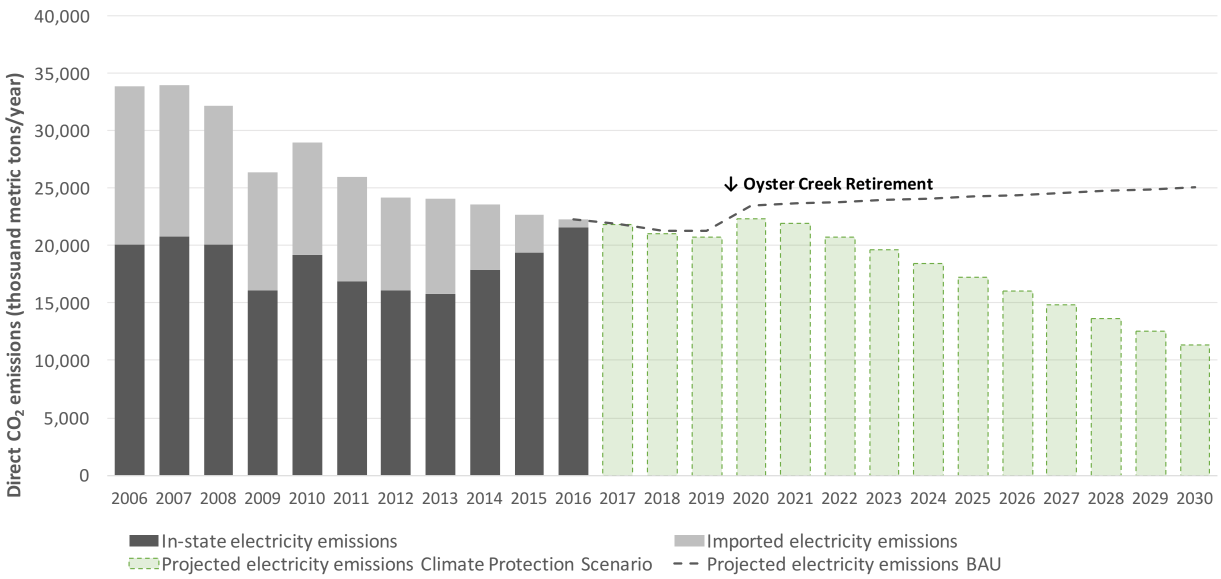

Figure E3: Historic and projected direct carbon dioxide emissions from in-state and imported electricity in New Jersey, comparing business-as-usual to the Clean Energy Scenario. Fugitive methane emissions (not shown) increase total emissions but are expected to fall in a similar proportion to direct carbon dioxide reductions.

With the caveat that future cost projections include significant uncertainties, our results suggest that New Jersey can cut electricity sector carbon emissions in half by 2030 without a significant cost penalty. The Clean Energy Scenario reduces cumulative power emissions from 2018 to 2030 by 85 million metric tons of carbon dioxide. The direct carbon dioxide emissions of the Clean Energy Scenario by year as compared to the business-as-usual scenario are given in **Figure** E3.

There are two principal reasons that the costs of the Clean Energy Scenario are comparable to business as usual, despite higher generation costs per megawatt-hour.

First, in the near term, greater efficiency reduces the need for electricity generation, including expensive peaking resources. For instance, we estimate that the need for peaking gas turbine generation would be 54% less than business as usual by 2030—a value in line with or conservative compared to PJM estimates. Peaking generation costs would be about $17 million lower in 2020, growing to almost $400 million lower by 2030 in the Clean Energy Scenario compared to business as usual (undiscounted). The overall avoided generation and related costs due to efficiency would grow over time, totaling more than $600 million in 2030.

The second reason for cost neutrality is fundamental to the current and projected economics of clean energy. Well before 2030, projections show that New Jersey utility-scale solar should be competitive with natural gas without subsidies; offshore wind costs are expected to decline rapidly. Utility-scale solar is already the cheapest source of electricity in some parts of the country, and the cost comparison comes out in favor of renewables in an ever-expanding set of regions when the social and environmental costs of carbon are considered. While New Jersey is unlikely to ever have the lowest cost solar in PJM due to its higher land values and land-use goals, costs within New Jersey are still expected to decline.

Table 1: Summary of costs and carbon reductions for business-as-usual and Clean Energy Scenarios. Values do not include electric vehicle (EV) and heating (HVAC) electrification unless otherwise indicated.

	Base case, no ZECs	**Base case with ZECs**	**Early nuclear shutdown**	**Staggered nuclear shutdown**	**Business-as-usual**
Cumulative generation, GWh	1,008,737	1,008,737	1,008,737	1,008,737	1,088,196
Cumulative generation with EV/HVAC, GWh	*1,037,473*	*1,037,473*	*1,037,473*	*1,037,473*	*1,088,196*
Cumulative CO_2 emissions, mil. mt	224	224	224	224	310
Cumulative cost 2018-2030, mil.$	$131,100	$136,300	$136,900	$135,300	$130,200
Cumulative cost increase relative to BAU, mil.$	$900	$6,100	$6,700	$5,100	NA
Cost increase per mt CO_2 reduction, $/mt	$11	$71	$78	$60	NA
Average cost increase per MWh, $/MWh	$1	$6	$7	$5	NA

In **Figure E2** we have taken a total-cost-of-energy-services approach to comparing the Clean Energy Scenario with business as usual. This means that consumer costs, such as payments for owning distributed solar behind the meter and for purchasing more efficient appliances, are included in the total cost for the Clean Energy Scenario. However, it is relatively straightforward to estimate and separate the consumer payments for energy efficiency and estimate the ratepayer perspective on efficiency, all other things being equal.[3] This calculation is shown in **Figure E2** (ii), illustrating that the average ratepayer cost in this case is actually slightly lower than business as usual. **Figure E2** (i) implies slightly higher total costs for energy services; **Figure E2** (ii) shows slightly lower average ratepayer costs when the consumer expenditures on efficient appliances are excluded to obtain a ratepayer perspective. However, it is not assured that everyone would benefit equally, in particular low-income households and renters which may lack access to efficiency upgrades without suitable policy efforts.

We also develop two contingency scenarios in which the nuclear reactors at the Salem and Hope Creek plants either retire at the end of 2021 or are phased out in stages between the end of 2021 and the end of 2025. In these contingency scenarios, we explored a policy option in which the lost generation is replaced with roughly 500 MW of offshore wind, with the rest being secured by wind and solar imports from across PJM. We have also included some costs for replacing lost tax revenues in communities where nuclear or fossil plants may close to prevent or at least significantly mitigate economic distress.

Importantly, total carbon dioxide emissions from 2018 to 2030 in the contingency scenarios are capped at the same level as in the base-case Clean Energy Scenario. By creating an artificial cap, we can ensure that any spikes in gas use after nuclear retirements are compensated for at other times.

For comparison, we also consider the option that nuclear power plants are subsidized with zero emission credits (ZECs) to continue operation past 2022, as is currently planned in

[3] In effect, this calculation assumes that all other costs except the consumer costs for efficiency are in the electricity bill. This "bill" represents the cost of energy services per month using a ratepayer perspective on efficiency. This calculation is meant to illustrate the impact of each scenario on average bills, but not to predict actual bills, which will depend on rate structure and other decisions beyond our scope.

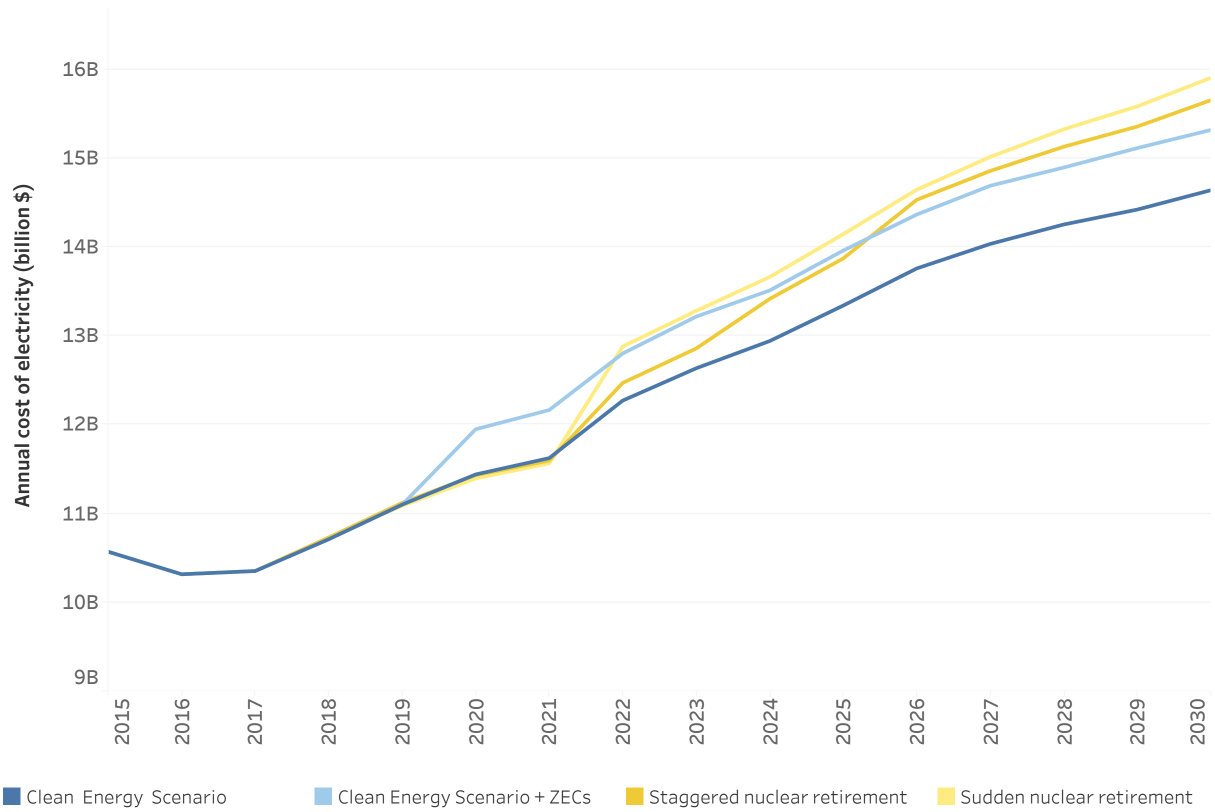

Figure E4: A comparison of four scenarios with the same constraints on carbon emissions: the Clean Energy Scenario with and without above-market payments to keep nuclear plants online (called "Zero Emission Credits," or ZECs) and early nuclear retirement with higher offshore wind and renewable imports. These costs include additional electrification of vehicles and heating systems, which are excluded from our business-as-usual scenario comparisons.

New York and Illinois. These costs are compared in **Figure E4**. If ZECs are priced at the same levels as proposed in New York State, then a ZEC subsidy offers no savings up to 2030 over retiring the nuclear power plants in New Jersey and importing renewable electricity from across PJM by utilizing VPPAs from the standpoint of electricity generation costs, although we do not analyze in-state reliability upgrades that may be needed in the case of retirements. Our analysis is indicative; further work will be needed to evaluate the risks and benefits of the two approaches (including financial risks), reliability needs, and costs in the post-2030 timeframe when the licenses of the nuclear plants are due to expire.

A summary of the costs of each scenario and emission reductions is presented in **Table 1**. The cost of reducing carbon emissions varies across these scenarios from $11 per metric ton in the base case of the Clean Energy Scenario to $78 per metric ton for sudden early nuclear retirement and $60 per metric ton in case of staggered nuclear retirement (at a 3% discount)[4]—all of which are close to or lower than the social cost of carbon, which is above $40 per metric ton, growing to $50 per ton in 2030 [1].

Our projections here are based on the best available data, but significant uncertainties remain, particularly regarding future costs of fuel and conventionally generated electricity. However, we do not expect the 33% renewable energy target to provide substantial reliability

[4]The cost in case of abrupt shutdown is higher because we assume that renewable energy would begin to be imported starting in 2019, even though shutdown is assumed at the end of 2021. Later acquisition of larger amounts of solar and wind would reduce these costs, while keeping cumulative emissions in 2018-2030 the same. Our assumption was made to indicate the potential for early action and its cost.

concerns, given that PJM recently modeled the impact of 30% renewables across PJM and found no significant reliability concerns [2], and New Jersey load accounts for only one tenth of PJM. However, in the case of nuclear retirements, PJM is required to conduct reliability analysis and could request that transmission upgrades be completed to ensure reliability prior to agreeing to such shutdowns.

Policy considerations

Our charge in this report was to illuminate policy options and their technical and economic implications, rather than to make specific policy recommendations. We have done so in certain key areas, mainly connected with an energy transition in which the role of efficiency and solar and wind energy is much greater than the present New Jersey trajectory. In this context, we have also addressed certain equity and community transition issues. Achieving emissions reductions in New Jersey will depend on a combination of policies designed to tilt market-based decisions away from fossil fuel generation. The emissions from individual plants will depend on market dispatch within PJM. Requiring high levels of in-state renewables may be one of the most direct ways to influence in-state fossil fuel generation levels, and energy efficiency investments can also impact demand for local generation. However, both market- and nonmarket-based policies should be considered to ensure real emissions reductions are achieved in state, particularly in communities that are most affected by health-harming co-pollutant emissions.

Efficiency: The expansion of efficiency from the present 0.6% per year to about 2% per year is at the core of ensuring the affordability of a Clean Energy Scenario to 2030. Efficiency program spending will need to increase to appropriate levels to ensure effective and successful results. Special policy measures will have to be adopted to guarantee that low- and moderate-income households, particularly renters, receive sufficient efficiency investments to lower their energy consumption and improve energy affordability.

Renewable energy targets: In our scenario, emission reductions of 50% assume a 2030 target of 33% in-state renewable energy. New Jersey's current renewable energy targets include 4.1% in-state solar generation by 2028 and 20.38% additional renewable energy credits for electricity generated somewhere within the PJM region. To ensure that in-state solar and offshore wind ramp up at the rates described here, several policy options are available, such as rebates for distributed solar and competitive capacity bidding for offshore wind—an approach that has led to steady cost declines elsewhere. A procurement process, such as the one newly adopted in Massachusetts, would enable New Jersey to use competitive bidding and Power Purchase Agreements (PPAs) to acquire between 3,250 and 3,800 MW of offshore wind energy by 2030.

Solar energy incentives: New Jersey's current solar incentives, the Solar Renewable Energy Credits (SRECs), have historically played a key role in catalyzing solar deployment but have not fallen in proportion to declining solar cost. Direct rebates per watt of installed capacity for distributed solar, such as that used in New York's "Megawatt Block" program, can help ensure that solar projects can obtain financing at lower cost based on a certain, though much smaller, incentive.

Planning for nuclear retirement contingencies: Without planning, an early retirement of Salem and Hope Creek nuclear plants is likely to result in a persistent rise in natural gas use and increased carbon emissions. A proactive strategy would substantially reduce the risk of increased emissions in case of such retirements. One approach is the acquisition of out-of-state renewable energy, such as through long-term VPPAs, beyond the in-state deployment rates described. Such procurement could begin as early as 2019, locking in low guaranteed prices for renewable energy generation past 2030 to help meet the demand for low-carbon electricity to electrify transportation and other sectors. Another option, adopted by New York's Public Service Commission in 2016, is to provide above-market payments for nuclear energy in the form of Zero Emission Credits (ZECs) to prevent premature shutdown. The costs of these approaches are broadly comparable up to 2030, as illustrated in Figure E3. However, it is important to note that investing in renewables in the near term rather than paying for ZECs will lower future replacement costs beyond 2030 and will help New Jersey maintain its carbon reduction goals whenever the nuclear plants do retire.

Impact on rates and bills: All other things (such as the impact of distributed solar installations and rate structure) being equal, the average ratepayer electricity bill is likely to decrease under a Clean Energy Scenario compared to the business-as-usual scenario. However, it is not assured that everyone would benefit equally. In particular, given that low-income renters have little leverage over efficiency investments, some households may see bill increases without specific measures to obviate this outcome, such as policies to ensure that a minimal level of efficiency improvements are implemented across the board. Currently, all New Jersey ratepayers pay to ensure that low-income households pay no more than 6% of income on energy bills. As a result, efficiency measures targeted at low-income households would also benefit non-low-income households by reducing these assistance expenses.

Equity and pollution reduction: We expect that overall air pollution and carbon emissions will decline as a result of increasing solar and offshore wind in tandem with efficiency increases. However, a reduction of pollution in the disproportionately impacted low-income communities is not a guaranteed outcome. Because New Jersey is part of the larger PJM grid, deployment of solar and wind may still allow fossil fuel plants to operate and export electricity to other parts of PJM. Specific policies may be needed to restrict emissions from individual plants, including in vulnerable communities. This can be accomplished in a variety of ways, including strategically deployed electricity storage and microgrids. We have included the costs of 1,600 MWh of battery storage to be used for peaking generation (800 MWh) and for microgrids (800 MWh); however, we have not done a siting analysis beyond a demographic analysis of communities near existing plants.

Community and worker protection: In addition to the potential early closure of Salem and Hope Creek nuclear plants, the energy transition may put some of New Jersey's fossil fuel plants at risk for closure. The negative impact of premature closures on communities and workers is a matter for the people of the state at large, well beyond any shareholder concerns. We have included $20 million per year in the early nuclear retirement scenarios to replace the various tax revenues that such retirements would entail; we have also included a provision of $40 million per year for communities that host fossil fuel plants that may close.

Preparing for 2050: Electrification of transportation on a large scale and conversion of fossil fuel heating to efficient electric systems will be essential for New Jersey to achieve its goal of 80% reduction in greenhouse gas emissions by 2050. This transition will roughly double today's electric load, but this electricity generation must be low-carbon to achieve deep decarbonization. Assuming that all nuclear generation has retired by 2050 and 90 to 100% of electricity would be provided by renewables, the deployment rate of renewables from 2030 to 2050 will have to be approximately triple the average annual deployment rate from 2020 to 2030 to meet growing demand. Renewables are expected to be the lowest-cost generation sources after 2030, but this scale of infrastructure expansion is not trivial. Pre-2030 contracts for out-of-state renewables can ease the required post-2030 growth. New Jersey can also lay the foundation for this transition by providing incentives, for example for conversion of fossil fuel space and water heating and vehicle electrification; electrification beyond the levels assumed here would similarly reduce the speed of infrastructure development required later. The transition to deep decarbonization using solar and wind as principal energy sources will require profound changes in other arenas as well, including the creation of a smart grid that would accommodate a refined demand-response system and millions of distributed generation sources, a new business model for utilities, and new approaches to rates.

Additional research needs: To help realize a clean energy transition by 2030, additional research would be useful to support planning, including: 1) identification of optimal land for solar deployment, with a focus on marginalized lands and brownfields; 2) analysis of reliability and renewable capacity attribution under nuclear retirement scenarios; 3) strategies to reduce peak demand; 4) projections of impact on energy market prices; 5) employment impacts; 6) amount and locations of deployment of storage and microgrids for resilience; 7) grid modernization strategies that enhance reliability and flexibility; (8) comparison of the risks of renewable energy imports using VPPAs with those of making above-market payments to keep nuclear plants operating both in the pre-2030 and post-2030 period.

In summary, we find that a 50% reduction in power sector emissions is necessary, achievable, and affordable with the deployment of 33% in-state renewables by 2030. With careful planning this transition can provide additional resilience, health, equity, economic, and environmental benefits. Our calculations indicate that the cost will be comparable to a business-as-usual approach even without including the benefits of pollutant emission reductions, health improvements, and the hedging value of fuel-free solar and wind energy against natural gas price volatility. Further, it appears advisable for New Jersey to prepare now for nuclear plant retirements through initiating VPPAs for renewable imports and through more vigorous development of offshore wind. These efforts will set the state on a path to achieve deep decarbonization by 2050.

For the full report please visit:
https://www.psehealthyenergy.org/our-work/publications/archive/clean-energy-pathways-for-nj/

Bibliography

[1] U.S. Environmental Protection Agency, *EPA fact sheet: social cost of carbon*, 2016. [Online]. Available: www.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf

[2] GE Energy, *PJM renewable integration study*, Prepared for PJM Interconnection, LLC, 2014. [Online]. Available: www.pjm.com/committees-and-groups/subcommittees/irs/pris.aspx