PSE Bringing science to energy policy

RESEARCH BRIEF: Evaluating the potential for renewables, storage, and energy efficiency to offset retiring nuclear power generation in New York

To meet climate targets, New York must rapidly deploy renewables and energy efficiency rather than expand gas infrastructure as Indian Point retires

Annelise Dillon
PSE Healthy Energy
April 2020

Executive Summary

The Indian Point nuclear power plant will retire its two reactors in 2020 and 2021, taking 2,000 MW of generating capacity offline in downstate New York. To mitigate climate impacts, New York must ensure that renewable energy and energy efficiency, rather than natural gas generation, replace the imminent loss of carbon-free[1] generation. This objective aligns with state goals: the build out of renewables, storage, and energy efficiency required to meet New York's 2025 clean energy targets will far exceed the loss in generation and capacity from Indian Point.

Introduction

After years of debate, the Indian Point nuclear power plant will retire its two units in 2020 and 2021, presenting a challenge for New York as it sets out to implement one of the most aggressive climate plans in the world to date. To mitigate climate impacts, New York must ensure that renewable energy and energy efficiency savings, rather than natural gas, replace the carbon-free generation from Indian Point. Rapidly deploying renewables to replace retiring capacity is particularly critical for New York, which last year passed accelerated climate targets calling for 70% renewables by 2030 and the reduction of economy-wide greenhouse gas emissions to 85% below 1990 levels by 2050. In spite of its climate objectives, New York is building new natural gas infrastructure. Two major gas generation facilities, Bayonne Energy Center and CPV Valley Energy Center, brought 800 MW of new capacity online in 2018; a third, Cricket Valley Energy Center, is scheduled to bring an additional 1,020 MW online this year.[2] Had these facilities not been constructed, renewables, storage, and energy efficiency

[1] We evaluate all resources in terms of operational greenhouse gas emissions throughout the brief, in line with how New York State structures its climate targets. We do not compare the full lifecycle emissions of each resource.
[2] NYISO. 2019. *2019 Load & Capacity Data Report (Gold Book)*. Available: https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/

alone could have feasibly met local capacity requirements following Indian Point's closure. As Indian Point and other nuclear and fossil fuel-based power plants retire across the state, New York will need to rapidly deploy renewables, storage, energy efficiency, and demand response rather than rely more heavily on gas generation. In addition to meeting the state's accelerated climate targets, these clean resources will bring valuable co-benefits such as improved local air quality, job creation, and resilience.

To evaluate the feasibility of replacing Indian Point with clean energy resources, we first compare the local capacity need resulting from the retirement to recent and projected deployment of renewable resources, energy efficiency, and storage in the local region. While the newly built gas capacity mentioned above will already fulfill the reliability need following Indian Point's closure, we evaluate whether clean resources could have met the reliability requirement in their absence. We then evaluate the potential for New York to avoid an increase in statewide emissions following the closure, by comparing the loss in carbon-free generation from Indian Point to recent and projected growth in renewable and energy efficiency deployment throughout the state.

Located in the Hudson Valley about 30 miles north of Manhattan, Indian Point has historically served as a key local resource in the transmission-constrained metropolitan area of New York City.[3] The facility contributes about 2,000 MW of generating capacity, meeting 15% of the region's local capacity requirement and about one-quarter of its annual electricity demand.[4] Although the nuclear facility supplies power consistently throughout the day and night, its closure will be particularly impactful to the grid during summer and winter peak demand, when local generation and transmission capacity are most constrained.[5] The capacity Indian Point provides to the grid during peak demand must in part be met by local resources, as congestion on the current transmission system limits energy upstate from reaching the densely populated load zone downstate. While statewide resources can replace Indian Point's non-peak generation, a portion of its local peaking capacity must be replaced with local resources or new transmission capacity.

Meeting local capacity needs with clean resources

In a 2017 assessment, the New York Independent System Operator (NYISO) evaluated the grid reliability need posed by Indian Point's deactivation. The report concludes that without the recent expansion of gas capacity discussed above —totalling 1,800 MW—at least 200 MW of capacity would need to be deployed in the local region[6] by 2023 and at least 600 MW would need to be deployed by 2027 in order to avoid a reliability violation after Indian Point's closure. Since the report's release in December 2017, the local region has already added enough energy efficiency to reduce summer peak

[3] The transmission-constrained region served by Indian Point consists of Load Zones G, H, I, and J, collectively referred to as the "G-J Locality" or the "Lower Hudson Valley" by the New York Independent System Operator (NYISO Generator Deactivation Assessment Indian Point Energy Center, 2017).
[4] National Research Council. 2006. *Alternatives to the Indian Point Energy Center for Meeting New York Electric Power Needs*. Washington, DC: The National Academies Press. Available: https://doi.org/10.17226/11666
[5] National Research Council. 2006.
[6] NYISO Load Zones G, H, I, and J.

load by about 190 MW and winter peak load by about 140 MW.[7] In addition, the region has added roughly 215 MW in nameplate capacity of behind-the-meter solar, which can provide about 80 MW of summer peaking capacity and 2 MW of winter peaking capacity.[8] The summer peaking capacity of these local efficiency and solar resources has already exceeded the 200 MW required by 2023 to ensure reliability without relying on recently constructed gas capacity. Their winter peaking capacity, amounting to roughly 142 MW, is also approaching the 2023 requirement. If the local region continues to deploy solar and energy efficiency resources at this rate through 2027, it will far exceed the 600 MW of local capacity that would have been needed in the absence of newly built gas capacity. Local storage deployed to meet New York's statewide target of 1,500 MW by 2025 will provide flexibility to complement the intermittency of local solar generation. While hourly grid modeling would be needed to ensure these resources could adequately meet peak demand, our estimates indicate that local energy efficiency, storage, and solar resources could have fulfilled local capacity needs without the state's recent buildout of gas capacity.

Even if we exclude existing resources from our consideration, we estimate that new local resources deployed to meet New York's accelerated renewables targets will far exceed the local capacity required to meet grid reliability needs through 2027.

Last year's Climate Leadership and Community Protection Act (CLCPA) significantly accelerated New York State's renewables and emissions reductions targets, setting a 2040 carbon neutrality target—one of the most ambitious in the country. As part of an intermediary target to meet 70% of the state's electric load with renewables by 2030 (up from 28% in 2017[9]), CLCPA calls for 9,000 MW of offshore wind capacity by 2035, 6,000 MW of distributed solar capacity by 2025, and 3,000 MW of energy storage by 2030 with an incremental goal of 1,500 MW by 2025. The first two offshore wind projects in New York have already been awarded contracts, and are expected to bring 1,700 MW of renewable capacity off the coast of Long Island online in 2024. Governor Cuomo also increased the state's energy efficiency target in 2018, which now aims for annual savings of 3% of investor-owned utility electricity sales statewide by 2025.

If we allocate statewide renewables targets to the local downstate region[10] proportionally by peak demand,[11] and account for resources that have already been deployed, we estimate that the local region will need to deploy an additional 2,000 MW of distributed solar, 730 MW of storage, and 9,100 GWh of energy efficiency savings in order to make its proportional contribution to statewide 2025 deployment targets.[12] If we apply the same allocation methodology to New York's contracted offshore

[7] Estimated energy efficiency savings from 2018 and forecasted energy efficiency savings for 2019 for Load Zones G-J (NYISO Goldbook, 2019). We apply NYISO's forecasted ratios of summer and winter peak load reductions (MW) to annual energy savings (GWh) throughout 2019-2039, which are roughly 0.19 and 0.14, respectively (NYISO Goldbook, 2019).
[8] Historical behind-the-meter solar deployment in 2018 and forecasted deployment in 2019, in MW DC (NYISO Goldbook, 2019). To determine seasonal peaking capacity, we apply a summer capacity value of 37% and winter capacity value of 1% to nameplate capacity, using NYISO's values for fixed-tilt solar systems with a 180° azimuth and 20° tilt (NYISO Installed Capacity Manual, 2019).
[9] NYSERDA. 2019. *Clean Energy Standard Annual Progress Report: 2017 Compliance Year*.
[10] NYISO Load Zones G, H, I, and J.
[11] Peak demand in the transmission-constrained downstate region (G-J locality) is forecasted to remain roughly half that of statewide peak demand throughout 2019-2039 (NYISO Goldbook, 2019).
[12] We subtract historical deployment statewide from statewide targets to determine new deployment needed. We then allocate new deployment to the local region proportionally by peak demand. Statewide distributed solar deployment

wind capacity, we estimate an additional 850 MW[13] will serve the local region by 2024. This is likely an underestimate of supply, as 9,000 MW of offshore wind capacity will need to be deployed statewide by 2035 to meet New York's targets. Together, new deployment of local solar, energy efficiency, storage, and contracted offshore wind resources would provide approximately 3,500 MW of summer peaking capacity and approximately 2,300 MW of winter peaking capacity,[14] far exceeding the 600 MW of local capacity necessary to ensure reliability through 2027 without relying on the state's 1,800 MW of newly added gas capacity. The capacity provided by these renewable resources beyond the local reliability need could contribute to replacing the approximately 6,800 MW of steam and gas-turbine capacity that will near retirement age in New York by 2025. In addition to the deployment of local resources, two new transmission projects will be coming online in December 2023 to help relieve congestion between upstate resources and downstate load centers, together adding 1,250 MW of new transmission capacity that could be used to meet capacity needs following Indian Point's closure.

Replacing Indian Point's carbon-free generation with statewide resources

In addition to meeting local capacity needs, renewable generation and energy efficiency will need to replace Indian Point's carbon-free generation in order to avoid an emissions spike in New York following its closure. To evaluate this possibility, we compare Indian Point's retiring nuclear generation to New York's recent and projected growth in renewable generation and energy efficiency savings. It is important to note, however, that scenarios such as high load growth due to building electrification and electric vehicle adoption could affect the renewable deployment rate needed to decarbonize the grid within a certain time frame after Indian Point's closure.

Over the past two decades, gas and dual-fuel (oil and gas) facilities have made up an increasingly large percentage of New York's overall generating capability, rising from 47% in 2000 to 59% in 2019. While New York continues to build new gas infrastructure —in spite of its greenhouse gas emissions reduction targets—the state has also made progress over the past couple of years in terms of energy efficiency deployment and investment in renewables. Since Indian Point's closure was announced in January 2017, annual renewable generation and energy efficiency savings have increased roughly

---

reached 2,000 MW in December 2019 (NYSERDA). Statewide storage deployment is estimated to be roughly 44 MW (NYISO Goldbook, 2019). Energy efficiency savings are cumulative, relative to 2019. We assume annual energy efficiency savings increase at a constant rate from NYISO's estimate of 1% in 2019 to the target of 3% in 2025 (NYISO Goldbook, 2019). We estimate projected statewide load prior to energy efficiency impacts from 2020-2025 by adding NYISO's projected energy efficiency savings for each year to NYISO's projected statewide load in that year (NYISO Goldbook, 2019). We allocate the estimated statewide cumulative energy efficiency savings to the local region proportionally by annual load, which is about 45% of statewide annual load (NYISO Goldbook, 2019).

[13] Offshore wind will be located off the coast of Long Island, but new transmission lines could allow the capacity to serve the transmission-constrained G-J locality (NYSERDA Offshore Wind 2018 Solicitation Results).

[14] Summer peaking capacity includes roughly 1,800 MW from wind, solar, and storage, and roughly 1,700 MW from energy efficiency peak load reductions. Winter peaking capacity includes roughly 1,070 MW from wind, solar, and storage, and roughly 1,270 MW from energy efficiency peak load reductions. We assume a 37% summer capacity value and 1% winter capacity value for solar, using NYISO's values for fixed-tilt solar systems with a 180°azimuth and 20° tilt (NYISO Installed Capacity Manual, 2019). We assume a 38% summer and winter capacity value for offshore wind (NYISO Installed Capacity Manual, 2019). We apply NYISO's forecasted ratios of summer and winter peak load reductions (MW) to annual energy savings (GWh) throughout 2019-2039, which are roughly 0.19 and 0.14, respectively, to the estimated cumulative energy savings in 2025 relative to 2019 based on a 3% annual savings target (NYISO Goldbook, 2019).

6,550 GWh statewide, equivalent to almost half of Indian Point's generation in 2018.[15] This includes an increase in annual generation of roughly 430 GWh from utility-scale solar, 970 GWh from small-scale distributed solar, 450 GWh from onshore wind, and about 4,700 GWh in cumulative energy efficiency savings relative to 2016.[16] In this same timeframe, New York has also invested $2.9 billion in 46 large-scale land-based wind, solar, and hydro projects, which will bring an additional 2,744 MW of capacity online by 2023, generating about 4,500 GWh annually[17]. In addition, New York awarded contracts for its first offshore wind projects in 2018, which will bring 1,700 MW online by 2024 and will generate roughly 7,400 GWh annually. As of December 2019, an additional 1,262 MW of distributed solar was under development statewide, which will contribute roughly 1,550 GWh annually.[18] In total, clean resources that have recently been deployed or are under development will contribute roughly 20,000 GWh annually by 2024, exceeding Indian Point's annual generation of 16,334 GWh in 2018.[19] This is a conservative estimate, as it does not include large-scale renewable projects under development outside of NYSERDA's 2017 and 2018 solicitations. Beyond the 20,000 GWh estimate, an additional 3,400 GWh of solar generation and 20,200 GWh of cumulative energy efficiency savings relative to 2019 will be deployed by 2025 if New York meets its CLCPA targets for distributed solar and energy efficiency.[20] See Figure 1 (below) for a comparison of New York's recent and planned deployment of renewable generation and efficiency savings to the retiring generation from Indian Point.

Depending on the fraction of planned large-scale and distributed renewable projects that come online by the time Indian Point's units retire in 2020 and 2021, it is possible that a portion of the plant's generation might temporarily be replaced with gas generation rather than renewables. A short-term demand for gas generation could likely be met by existing plants, however, without the need to build new gas infrastructure.

While renewable generation and energy efficiency savings added between 2017-19 and planned for 2020-2024 will exceed the loss in annual carbon-free generation from Indian Point, several factors are important to consider when drawing conclusions from this comparison. Renewable generation is intermittent, in contrast to the consistent power provided by nuclear day and night. Sufficient storage must be added to allow renewable generation, rather than gas, to meet daily fluctuations in demand. Hourly grid modeling will be necessary to determine the optimal siting and operation of storage to allow renewable resources to replace the consistent power provided by Indian Point and other

---

[15] Indian Point's annual net generation in 2018 was 16,334 GWh (NYISO Goldbook, 2019).
[16] We compare annual net generation of utility-scale solar, small-scale solar, and onshore wind in 2019 to annual generation in 2016 (EIA Electricity Data Browser, 2020). Assumes generation level in December 2019 for each resource is the same as generation level in 2018. Cumulative energy efficiency savings are estimated using NYISO Goldbook 2019's historical electricity savings in 2017 and 2018, and forecasted electricity savings for 2019.
[17] Assumes 26% capacity factor for onshore wind, 14% capacity factor for solar, and 78% capacity factor for hydro (NYISO Power Trends, 2019).
[18] Assumes 14% capacity factor for solar (NYISO Power Trends, 2019).
[19] NYISO Goldbook, 2019.
[20] Existing and planned distributed solar capacity is estimated to be 3,262 MW, as of December 2019 (NYSERDA, 2019). We estimate generation from the additional 2,738 MW solar required to meet the 6,000 MW state target, using a 14% capacity factor. We assume annual energy efficiency savings increase at a constant rate from NYISO's estimate of 1% in 2019 to the target of 3% in 2025 (NYISO Goldbook, 2019). We estimate projected statewide load prior to energy efficiency impacts from 2020-2025 by adding NYISO's projected energy efficiency savings for each year to NYISO's projected statewide load in that year (NYISO Goldbook, 2019).

nuclear facilities. Another important consideration is the possibility of high demand growth due to electric vehicle adoption and building electrification, which could create the need for additional generating capacity. Incentivizing off-peak charging schedules will be necessary to mitigate peak load growth in this scenario, but the overall increase in electricity demand could affect the rate of renewables deployment needed to expand generating capacity while reducing grid emissions. If the demand for electricity increases due to electrification, the *total* GWh of renewable generation will need to increase to meet the 2030 target of 70% of statewide load from renewables. Tightening ozone and fuel oil regulations might also lead to earlier retirements for certain power plants in New York—particularly those meeting peak demand[21]— which could likewise create the need for additional generating capacity. These possibilities are important to take into account, as they might affect the feasible timeline and relative cost of decarbonizing the grid following Indian Point's closure.

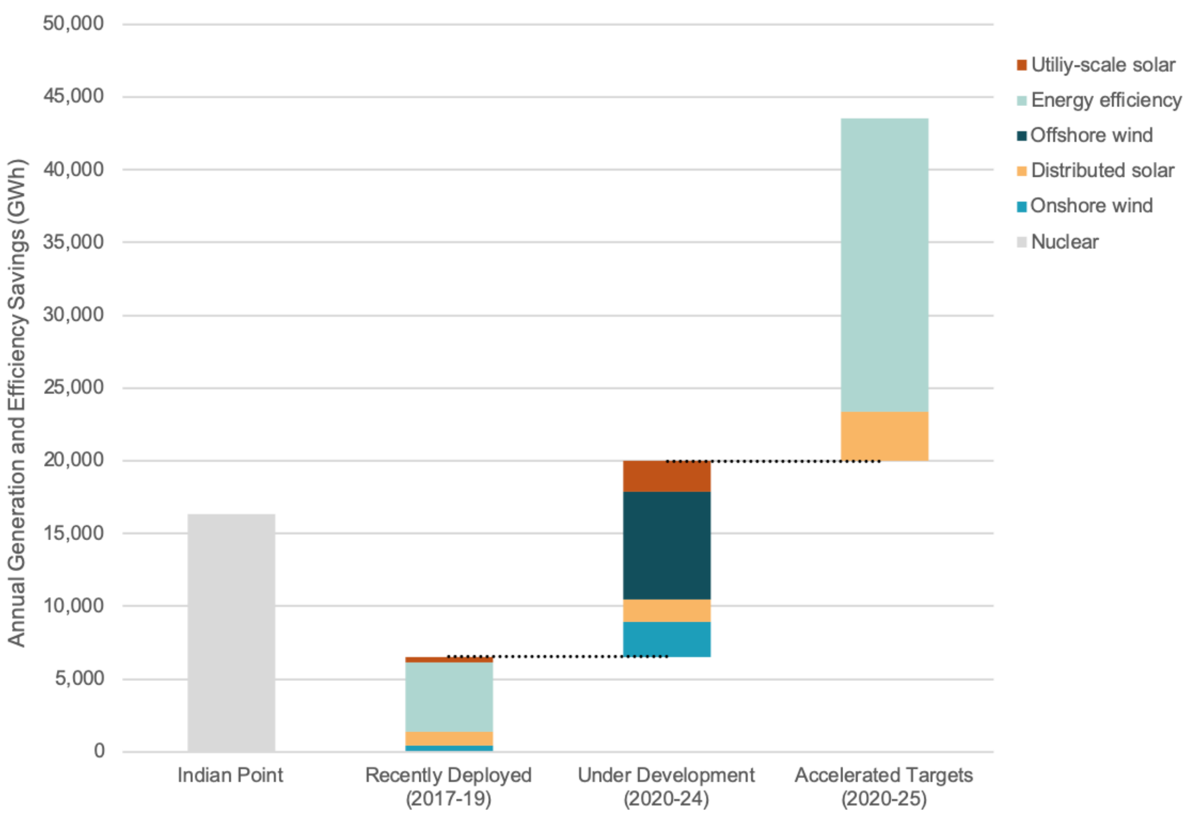

Figure 1: Recent and planned additions of renewable generation and efficiency in New York since the announcement of Indian Point's closure in January 2017. Includes renewable generation and energy efficiency savings deployed in 2017-19, distributed solar and NYSERDA large-scale renewable projects coming online by 2024, and additional resources needed to meet New York's accelerated energy efficiency and CLCPA targets by 2025. Excludes utility-scale projects under development outside of NYSERDA's 2017 and 2018 large-scale renewables solicitations, as well as future awardees of NYSERDA's third solicitation, which will support an additional 1,500 GWh of renewable generation. Data from U.S. Energy Information Administration's

[21] New York Department of Environmental Conservation. *Adopted Subpart 227-3: Ozone Season Oxides of Nitrogen (NOx) Emission Limits for Simple Cycle and Regenerative Combustion Turbines*. Available: https://www.dec.ny.gov/regulations/116131.html

Electricity Data Browser, New York State Energy Research and Development Authority 2019 Announcements, and New York Independent System Operator's 2019 Load & Capacity Data Report (Gold Book).

Conclusion

Our estimates suggest that renewables, storage, and energy efficiency growth in line with New York's targets could provide sufficient generation and local capacity following Indian Point's closure, avoiding the need for a sustained increase in gas generation. Expanding gas infrastructure not only threatens to undermine New York's climate goals, but also risks creating stranded assets and risks exposing the grid to natural gas supply constraints during winter months.[22] Using a portfolio of clean resources instead of gas to replace retiring generating capacity of other nuclear and fossil-fuel based power plants in New York will be critical to meeting the state's climate targets. Along with emissions reductions, these resources could bring co-benefits like improved local air quality from the reduction of criteria air pollutants emitted by natural gas plants and enhanced grid resiliency in the case of natural disasters or other emergencies.

[22] National Research Council. 2006. *Alternatives to the Indian Point Energy Center for Meeting New York Electric Power Needs*. Washington, DC: The National Academies Press. Available: https://doi.org/10.17226/11666.