Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

Running Behind: New York State's Renewable Transformation

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Applied Economics Clinic

Prepared on behalf of Earthjustice

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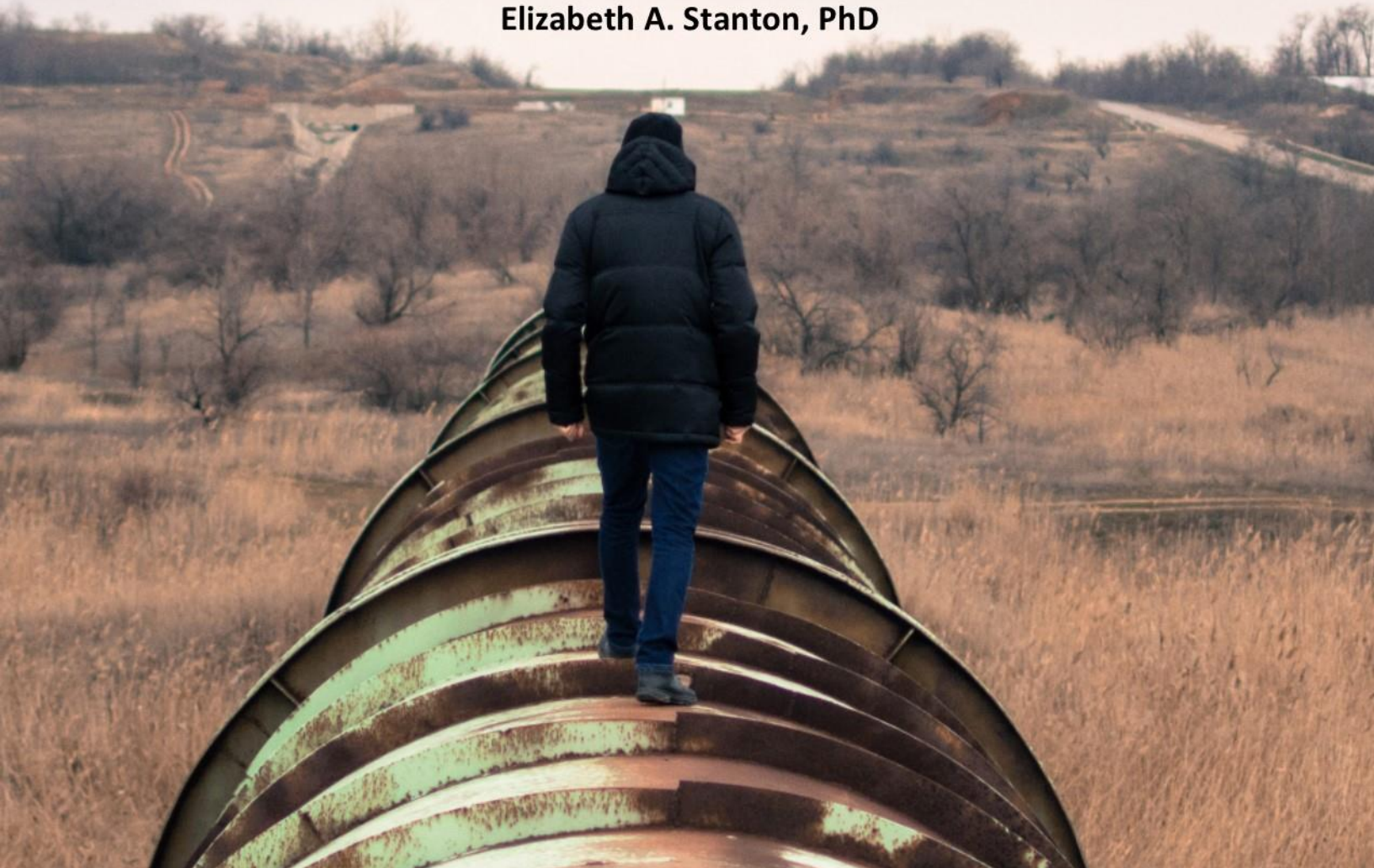

Executive summary

This Applied Economics Clinic report reviews New York State's past progress in the context of its new climate law, as it applies to the electric sector. We find that the state has its work cut out for it in meeting its ambitious targets regarding: renewable energy development, energy efficiency, and greenhouse gas emissions reductions. Given historical trends in these areas, New York will need to dramatically scale up its efforts, beginning immediately, to be able to reach its goals (see Table ES-1 below). Importantly, we also find that solar, wind and solar plus storage technologies are feasible and immediately available and that currently planned gas capacity is at odds with the state's renewable energy and emission reduction goals and will, therefore, impose unnecessary costs on New York consumers.

Table ES-1. New York State progress to date on its CLCPA climate goals

Category	Goal	Expected	Status
Renewables	Supply 70% of electricity generation by 2030 and 100% by 2040	32% in 2030 26% in 2040	Behind
Rooftop Solar	Install 6 GW by 2025	2.8 GW in 2025	Behind
Offshore Wind	Install 9 GW by 2035	4.8 GW in 2035	Behind
Battery	Install 3 GW by 2030	0.013 GW in 2030	Behind
Energy Efficiency	Increase cumulative savings to reach 23% of 2030 total demand by 2030	15.2% in 2030	Behind
Statewide Emissions	Reduce: ▪40% from 1990 levels by 2030 ▪85% from 1990 levels by 2050	39% in 2030 77% in 2050	On track for 2030 Behind for 2050

New York State instituted new climate goals in 2019—and it's already running behind. Success will depend on the state's ability to quickly ramp down emissions from gas and other fossil fuel generation.

Over the last fifteen years, New York has replaced most of its coal and oil electric generation with gas-fired plants. In retrospect, this choice put the state behind schedule on its new Climate Leadership and Community Protection Act (CLCPA) climate goals. The state will need to speed up its buildout of immediately available wind and solar, battery storage and energy efficiency measures to reach its climate targets.

All gas plants (and all other fossil fuel-powered plants) will need to close before 2040 to meet New York State's clean energy targets.

Given New York's ambitious goal of 100 percent renewable energy by 2040, we find that the state cannot build any more gas capacity, effective immediately. Moreover, 27 percent (or $1.5 billion) of the total equipment costs of New York's currently planned gas-fired generation capacity will be stranded on January 1, 2040. These are costs that fall to the business in question, though at least some of these costs will get passed along to ratepayers in one way or another, without receiving the value of gas generators that will be shut down by 2040.

The stringency of New York State's climate targets, the fact that the state is behind schedule on most its climate targets, and the dependence on the electric sector for emissions reductions preclude the use of gas as a bridge fuel in the state.

To meet its clean energy goals, New York State cannot build any new fossil fuel capacity beyond what is already planned, and must choose between: (1) foregoing currently planned gas capacity, (2) retiring it before the end of its lifetime, or (3) accepting stranded assets totaling $1.5 billion.

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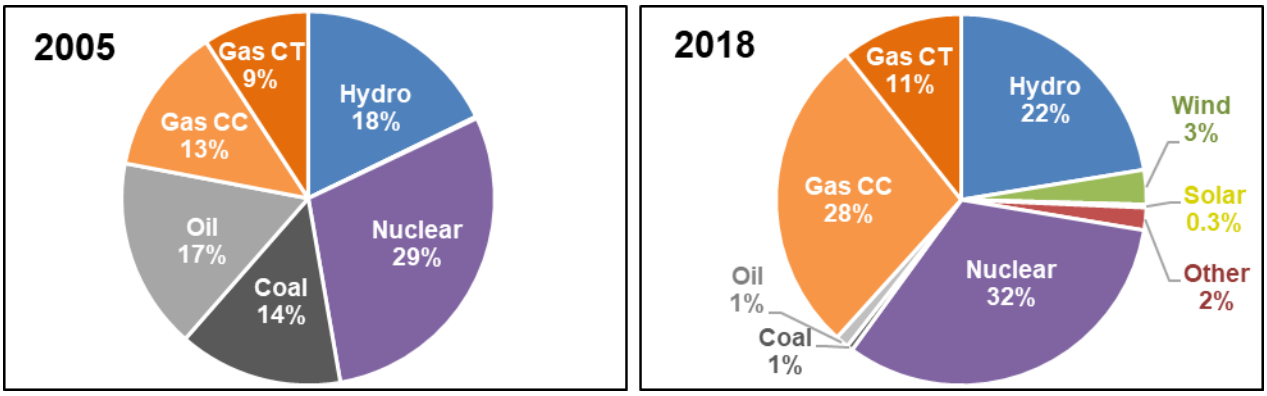
1. Introduction

In June 2019, New York's Governor Andrew Cuomo signed the Climate Leadership and Community Protection Act (CLCPA) into law.[1] Passed in the New York Assembly with 41 Senators voting in favor (out of 62 total), the CLCPA sets the tone for the next 30 years of the state's energy development by mandating 100 percent renewable electric supply by 2040, 100 percent reduction in statewide greenhouse gas emissions by 2050 (where 15 percent of these emission reductions may be achieved via emission offset projects, meaning that the state need only achieve an 85 percent emission reduction by 2050), and increased levels of energy efficiency This Applied Economics Clinic report, on behalf of Earthjustice, assesses the performance to date of New York State's electric sector relative to its climate goals. We find that New York is behind schedule and must speed up its renewable energy deployment and fossil fuel retirements and increase its energy efficiency in order to reach its goals.

Today, New York State generates most of its electricity using gas (39 percent in 2018), nuclear (32 percent) and hydro (22 percent). The state's dependence on coal and oil have decreased substantially since 2005, however, this supply has been replaced largely with gas-fired generation rather than renewable energy. Nevertheless, renewable wind and solar have increased their share of total generation to 3 and 0.3 percent, respectively (see Figure 1). In 2018, New York State had 44.3 gigawatts (GW) of total installed generating capacity producing approximately 132,500 gigawatt-hours (GWh) of electricity.

Figure 1. New York State share of annual electric generation by resource type



Note: "Other" includes hydro pumped storage, municipal solid waste and landfill gas.
Data source: U.S. Energy Information Administration (EIA). 2005 and 2018. Form EIA-923. Available at: https://www.eia.gov/electricity/data/eia923/.

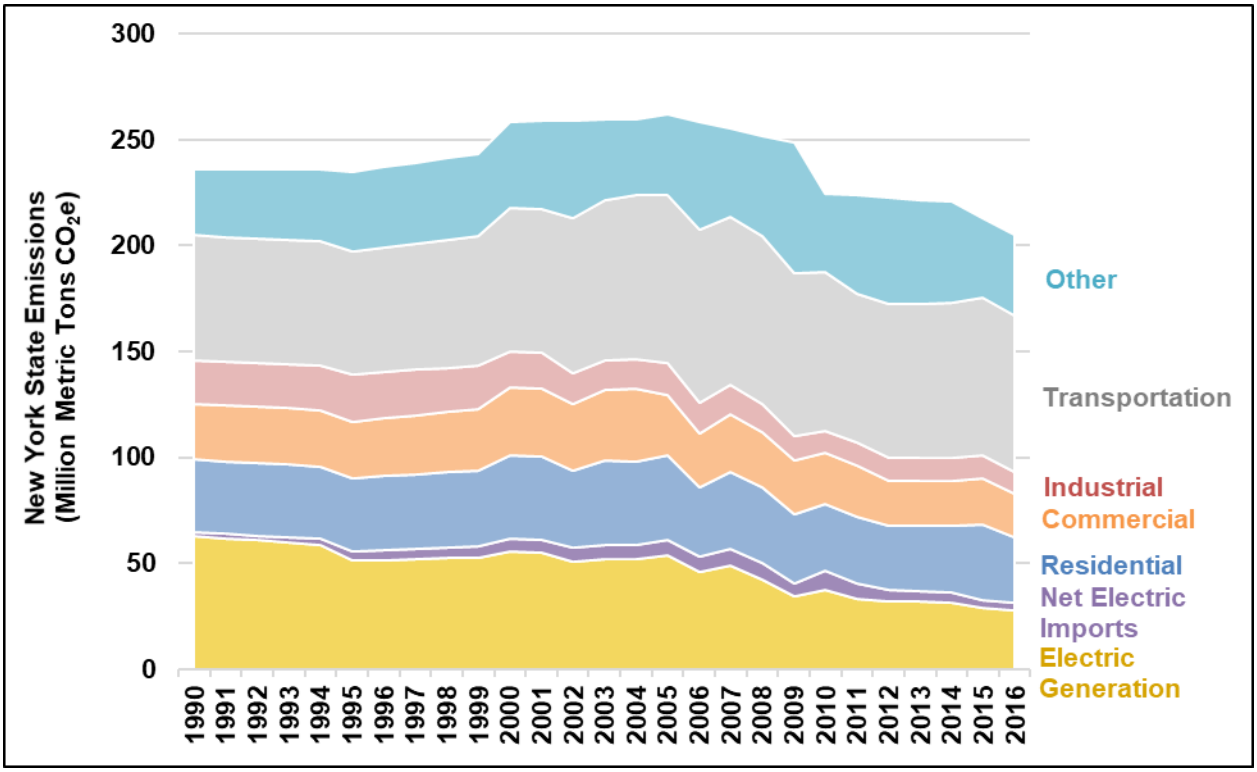
[1] The New York State Senate. 2019-2020 Legislative Session. Senate Bill S6599. New York state climate leadership and community protection act. Available at: https://www.nysenate.gov/legislation/bills/2019/s6599.

Between 2005 and 2018:

- Combined solar and wind generation grew by more than 4,000 percent;
- Combined coal and oil generation fell by 95 percent;
- Gas generation grew by 59 percent; and
- Both nuclear and hydro generation remained relatively constant but became slightly greater shares of the whole as total generation declined (see Figure 1 above).

Between 1990 and 2016[2], New York State's total greenhouse gas emissions fell by 13 percent—from 236 million metric tons (MMT) carbon dioxide equivalent (CO_2e) to 205 MMT (see Figure 2).[3] Emissions from the electric sector (including electric imports) have fallen 51 percent—from 65 MMT in 1990 to 32 MMT in 2016.

Figure 2. New York State greenhouse gas emissions by sector (MMT CO_2e), 1990-2016



Data source: New York State Energy Research and Development Authority. January 2019. Patterns and Trends: New York State Energy Profiles 2002-2016. Table A-1. Available at: https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Energy-Statistics.

This report reviews New York State's progress towards achieving each of the seven requirements of the 2019 CLCPA. Section 2 provides a background of New York's climate laws and introduces the CLCPA

[2] 2016 is the latest year for which greenhouse gas emissions data are available.
[3] New York State Energy Research and Development Authority (NYSERDA). July 2019. *New York State Greenhouse Gas Inventory 1990-2016*. Table B-1. In collaboration with New York State Department of Environmental Conservation. Available at: https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Energy-Statistics.

goals. Section 3 presents New York's progress toward meeting the CLCPA goals. Section 4 addresses the conflict between planned gas capacity and the CLCPA targets, and Section 5 presents the methods and data utilized in our analysis.

2. New York State's History of Climate Leadership

New York State's long history of climate leadership includes, in 2009, joining eight neighboring states to launch the United States' first mandatory cap-and-trade program to limit emissions from the power sector—the Regional Greenhouse Gas Initiative (RGGI). Since RGGI began, New York's total reported emissions from power plants subject to RGGI compliance has fallen by more than half: from 35 MMT CO_2e in 2009 to 23 MMT in 2017. Since 2009, New York State also:

- initiated a Clean Energy Standard to achieve 50 percent[4] renewable electric supply by 2030;
- established Reforming the Energy Vision (REV) and a State Energy Plan to achieve a 40 percent reduction in statewide greenhouse gas emissions from 1990 levels by 2030; and
- established energy efficiency targets that included increasing energy efficiency to 19 percent of projected 2025 electric sales.[5]

In June 2019, New York went still further by passing the Climate Leadership and Community Protection Act (CLCPA)[6] to "address and mitigate the effects of climate change by drastically cutting greenhouse gases, diverting the state's energy reliance to renewable sources, and creating green jobs to promote environmental justice across New York State."[7] The CLCPA sets the following statewide targets for its electric sector (surpassing and replacing early targets, see Table 1 below).

[4] New York State. 2019. "Clean Energy Standard." Available at: https://static1.squarespace.com/static/576aad8437c5810820465107/t/5b43ab7570a6ad28d506172e/1531161461418/CES-ov-fs-1-v4.pdf.

[5] In 2025, incremental energy efficiency savings are expected to be 3 percent (2,957 GWh of energy efficiency out of 98,568 GWh of electricity sales). Source: New York PSC. December 13, 2018. Order adopting accelerated energy efficiency targets. Case 18-M-0084. Appendix D – Table 1. Available at: http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?Mattercaseno=18-M-0084.

[6] State of New York, S. 6599/A. 8429. June 18, 2019. An act to amend the environmental conservation law, the public service law, the public authorities law, the labor law and the community risk and resiliency act, in relation to establishing the New York state climate leadership and community protection act. Submitted by Todd Kaminsky (D). p.9. Available at: https://www.nysenate.gov/legislation/bills/2019/s6599.

[7] Heppner, J. 2019. "Senate Democratic Majority Passes Historic Climate Leadership And Community Protection Act (CLCPA)." New York State Democratic Majority. Available at: https://www.nysenate.gov/sites/default/files/press-release/attachment/06.19.19_CLCPA_release.pdf.

Table 1. New York State CLCPA electric sector targets

a. Supply 70 percent of electricity generation from renewables by 2030 and 100 percent by 2040
b. Install 6 GW of distributed solar energy capacity by 2025
c. Install 9 GW of offshore wind capacity by 2035
d. Install 3 GW of battery storage capacity by 2030
e. Increase cumulative energy efficiency savings to reach 23 percent of 2030 total demand by 2030
f. Reduce statewide greenhouse gas emissions by 40 percent from 1990 levels in 2030, and by 85 percent by 2050

With the passage of the CLCPA, New York's carbon-neutral-by-2050 emissions reduction target is the most stringent of the 23 states that have set greenhouse gas standards (with the exception of the District of Columbia, which aims to reduce its emissions by 100 percent by 2050 from 2006 levels)[8]. By the end of 2021, the New York State Climate Action Council will prepare a scoping plan outlining its recommendations to achieve New York's climate and energy targets.

3. Status Report of the CLCPA Goals

New York State is behind schedule on most of its new climate goals (see Table 2 below). While the CLCPA targets were only announced this past June, New York will need to undertake a much quicker replacement of fossil fuel generation with renewable energy than it has done in the past to meet its ambitious climate goals and avoid creating stranded fossil fuel generation assets.

[8] Carbon Neutral Cities Alliance. No Date. "Washington, DC." Available at: https://carbonneutralcities.org/cities/washington-dc/.

Table 2. New York State's progress to date on its CLCPA climate goals

Category	Goal	Expected	Status
Renewables	Supply 70% of electricity generation by 2030 and 100% by 2040	32% in 2030 26% in 2040	Behind
Rooftop Solar	Install 6 GW by 2025	2.8 GW in 2025	Behind
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Note: "Expected" amounts of renewable energy, rooftop solar, energy efficiency and emissions reductions were calculated by applying the rate of increase or decrease over the past five years to future years. Offshore wind and battery storage data were not available for the past five years; their rate of increase was derived from the available historical data.

To assess New York's progress towards its climate goals, we collected historical data on electric capacity, generation and emissions and projected all three variables into the future (see the Methods section below for more details about our approach). Underlying assumptions include:

- All currently planned[9] capacity additions come online; this includes 7.6 GW of gas, 8.3 GW of wind, 1.8 GW of solar and 1.0 GW of other technologies, including hydro, battery storage and municipal solid waste;
- All existing and proposed plants retire at their announced retirement date or (where no date has been announced) at the end of their expected useful lifetime;[10]
- New York's future demand is consistent with New York Independent System Operator (NYISO)'s 2019 Gold Book projection;[11]
- Maximum allowable energy imports are the share of total demand imports accounted for in

[9] Planned capacity additions are defined as any capacity additions listed in EIA 860 data or NYISO data. Sources: 1) Source: U.S. EIA. 2018. Form EIA-860. Available at: https://www.eia.gov/electricity/data/eia860/; 2) NYISO. 2019. 2019 Load & Capacity Data. Available at: https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/

[10] Resources that should have retired already (given their expected useful lifetime) were assumed to retire over the next 10 years, with one-tenth of this total capacity retiring in each year.

[11] NYISO. 2019. *Gold Book Forecast Tables*: *NYCA Baseline Energy and Demand Forecasts*. Table I-1a. Available at: https://www.nyiso.com/documents/20142/6284426/2019-Gold-Book-Forecast-Tables.xlsx/4d14c1a2-84c2-c95e-ea57-8d181618732a?version=1.0&t=1556215454749.

2018;[12]

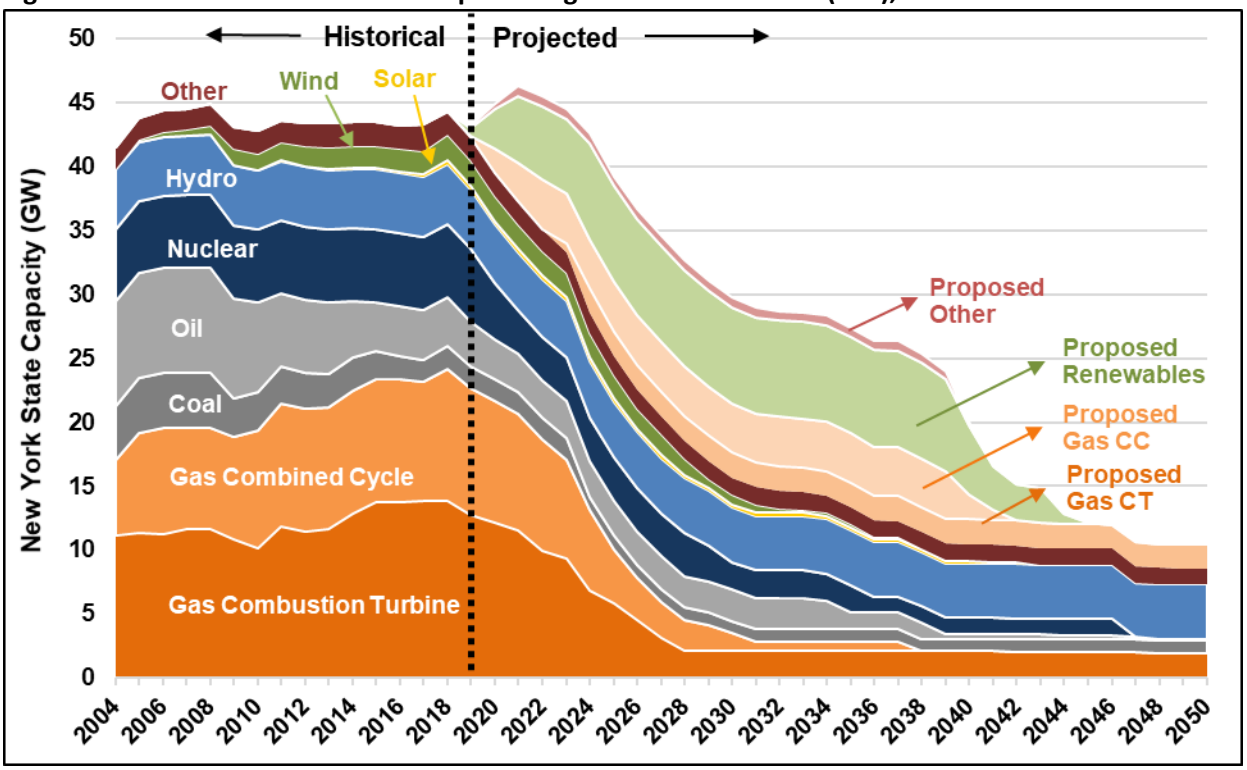
- When energy supply (less energy efficiency) is less than demand in the future (as resources) retire at the end of their useful lifetimes), this "missing" generation is assumed to come from renewable energy sources per the CLCPA definition, which includes solar, wind, hydro, geothermal, and tidal and wave energy;[13]
- Generation is calculated as capacity times the 5-year historical average capacity factor by technology;
- New York achieves its energy efficiency goal of cumulative energy efficiency savings reaching 23 percent of 2030 total demand and maintaining this same level of savings thereafter; and
- Energy efficiency measures have an assumed lifetime of 10 years.

Our capacity forecast indicates that New York's planned capacity additions are dominated by renewable wind and solar (with planned additions totaling 10.1 GW by 2025) and gas combustion turbines and combined cycles (with planned additions totaling 7.6 GW by 2025) (see Figure 3 below). Other proposed capacity includes battery storage (0.95 GW by 2022); municipal solid waste (0.02 GW by 2022); and other waste biomass (0.02 GW by 2022). By 2050, New York should expect all of its existing oil and nuclear capacity to have retired, and all of its existing (and planned) gas combined cycle capacity to have retired as well.

[12] Assuming fixed imports is a common energy modeling assumption because imports are very hard to predict or forecast. Energy imports accounted for 18 percent of total demand in 2018—which is typical of the 2003 to 2018 period (where imports as a share of demand averaged 16 percent).

[13] The CLCPA states "'renewable energy systems' means systems that generate electricity or thermal energy through use of the following technologies: solar thermal, photovoltaics, on land and offshore wind, hydroelectric, geothermal electric, geothermal ground source heat, tidal energy, wave energy, ocean thermal, and fuel cells which do not utilize a fossil fuel resource in the process of generating electricity." p.17.

Figure 3. New York State current and planned generation resources (GW), 2004-2050



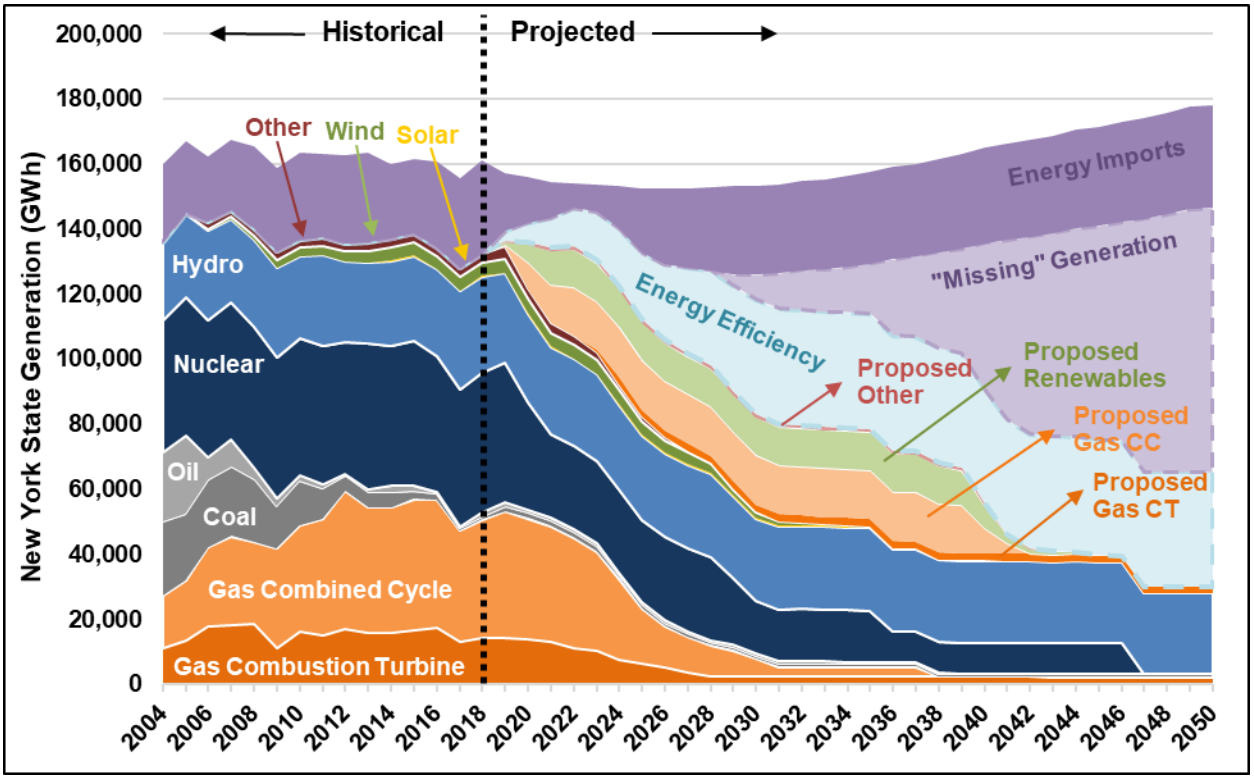
Source: U.S. EIA. 2004 to 2018. Form EIA-860. Available at: https://www.eia.gov/electricity/data/eia860/. Note: Planned capacity additions used here are any capacity additions currently listed in EIA 860 data or NYISO data. We assume that all capacity retires on its announced retirement date or at the end of its useful lifetime. See Section 5: Methods for more detail. Planned capacity sources: 1) Source: U.S. EIA. 2018. Form EIA-860. Available at: https://www.eia.gov/electricity/data/eia860/; 2) NYISO. 2019. 2019 Load & Capacity Data. Available at: https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/.

In 2018, 3 percent of New York State's total electric generation came from renewable wind and solar resources; 22 percent came from hydro; 38 percent came from gas; 32 percent came from nuclear; and the remaining 4 percent came from coal, oil and other sources like landfill gas and municipal solid waste (see Figure 4 below). After allowing for maximum energy imports that are set as the share of total demand imports accounted for in 2018, our generation forecast indicates that New York has sufficient capacity to meet projected demand (assuming energy efficiency gains consistent with the CLCPA target) until 2029—at which point planned and end-of-life retirements result in a gap between supply and demand—"missing" generation.

As a share of total demand (less energy efficiency), "missing" generation grows from 3 percent in 2029 to 57 percent in 2050 (see Figure 4 below). Solar, wind, and solar plus storage technologies are feasible and immediately available, as evidenced by, for example: Northern Indiana Public Service Company's all-source request for proposals and subsequent 2018 Integrated Resource Plan identified the company's plans to retire all its coal-fired capacity by 2028 and replace it with "more economic resources" including

solar, wind and solar plus storage.[14] In addition, Lazard's most recent Levelized Cost of Energy and Levelized Cost of Storage assessment showed that utility-scale wind and solar are less expensive on a per MWh basis than fossil fuel alternatives and that wholesale solar plus storage is less expensive than new gas peaker plants (per MWh).[15]

Figure 4. New York State electric generation (GWh), 2004-2050



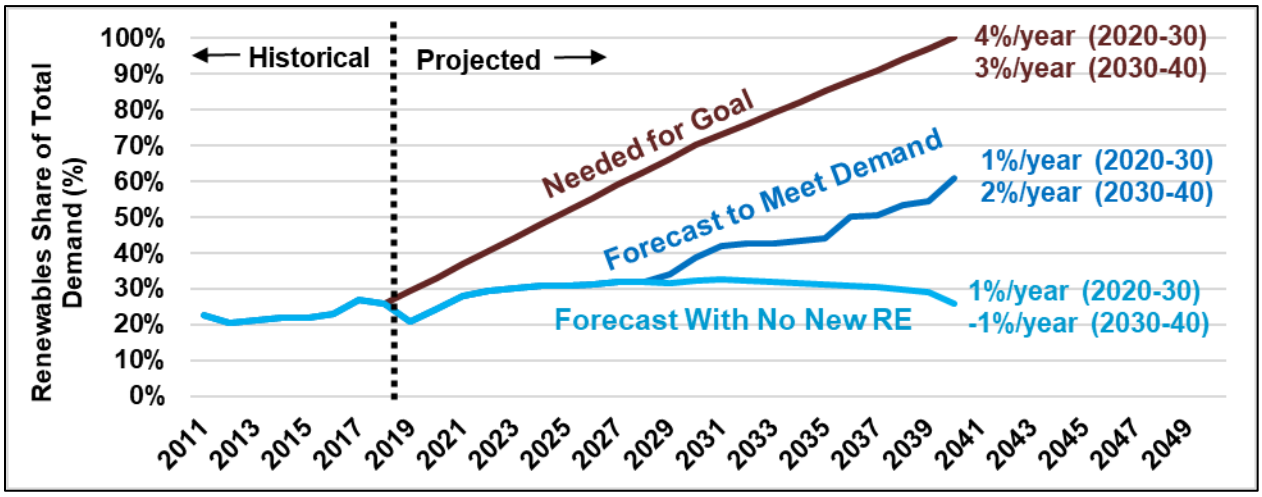
Note: Total demand is assumed to follow NYISO's 2019 forecast. This energy efficiency forecast is "business-as-usual" given existing policy, i.e. it is assumed to increase until it reaches 23 percent of 2030 total demand in 2030 and then remain constant. Maximum allowable energy imports are set as the share of total demand imports accounted for in 2018. When generation (less energy efficiency) is lower than demand, "missing" generation is assumed to come from renewable energy sources per the CLCPA definition.
Source: U.S. EIA. 2005, 2010, 2015 and 2018. Form EIA-923. Available at: https://www.eia.gov/electricity/data/eia923/.

[14] Gheorghiu, J. October 9, 2019. "NIPSCO to replace coal with 2.3 GW of solar, storage in latest RFP". *UtilityDive.* Available at: https://www.utilitydive.com/news/nipsco-to-replace-coal-with-23-gw-of-solar-storage-in-latest-rfp/564427/.
[15] Lazard. November 7, 2019. *Levelized Cost of Energy and Levilized Cost of Storage 2019.* Lazard. Available at: https://www.lazard.com/perspective/lcoe2019.

a. Renewables: Supply 70 percent of electric generation from renewables by 2030 and 100 percent by 2040

Status: To achieve the CLCPA goal, forecasted renewable generation will need to increase by approximately 44,000 GWh by 2030 (equal to 37 percent of total 2030 demand) and approximately 97,000 GWh by 2040 (equal to 75 percent of total 2040 demand).

Figure 5. New York State renewable share of total demand (2030 goal = 70%, 2040 goal = 100%)



Note: Hydro, solar and wind resources are treated as renewable, per the CLCPA definition. Annual percentage growth rates to meet the CLCPA goal are calculated as a linear increase between current (2019) renewable generation and the 2030 and 2040 targets. Annual percentage growth rates for the two forecasts are calculated as the average annual percent change over the period in question. The growth rates are different between 2020 and 2030 than they are between 2030 and 2040 because of the different targets in those years.

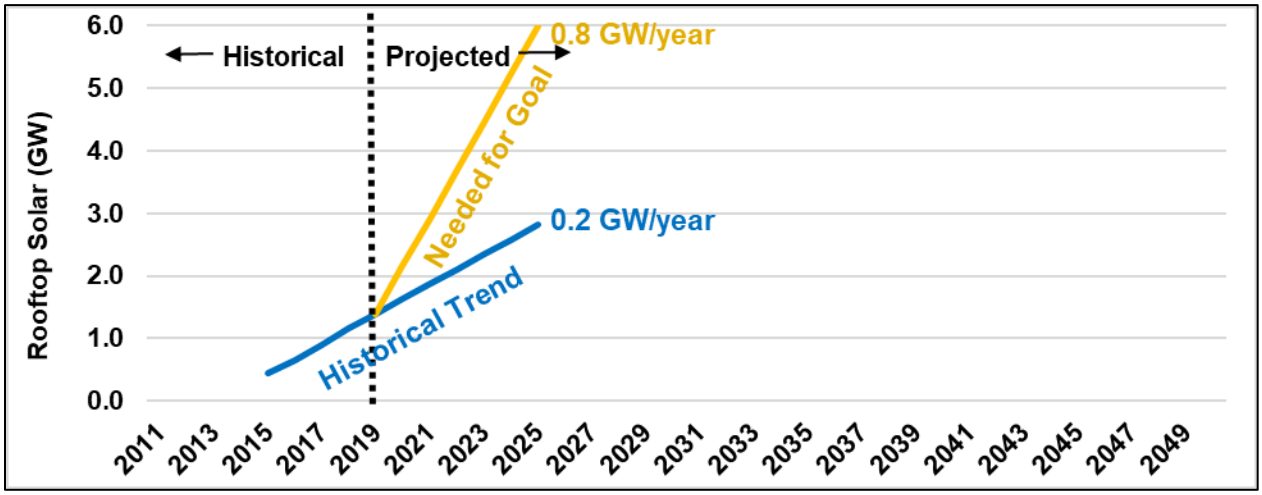
Our generation forecast finds that—assuming all planned renewable capacity additions come online—renewable energy will account for 33 percent of total generation in 2030 (37 percentage points short of the 70 percent target) and 25 percent in 2040 (75 percentage points short of its 100 percent target) (See "Forecast With No New RE" in Figure 5). In 2030, in order to reach the state target, renewable generation would need to increase by approximately 44,000 GWh, and by about 97,000 GWh in 2040.

Even if we assume that any "missing" generation (needed to meet forecasted demand) is served by renewable sources, renewables still fall short of the CLCPA targets: accounting for 39 percent of total demand in 2030 and 60 percent in 2040 (see "Forecast to Meet Demand" in Figure 5).

b. Rooftop Solar: Install 6 GW of rooftop solar energy capacity by 2025

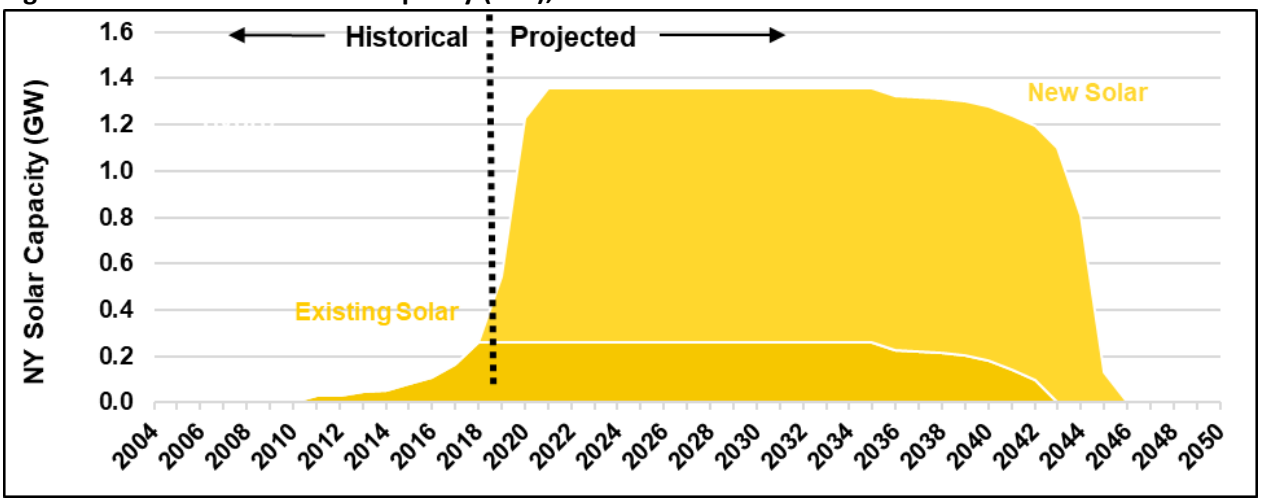
Status: To achieve the CLCPA goal, New York State will need to install an additional 4.6 GW of rooftop solar by the end of 2025 (up from the 1.4 GW currently installed).

Figure 6. New York State rooftop solar (Goal = 6 GW by 2025)



In 2018, U.S. EIA reported that New York State had approximately 1.4 GW of rooftop solar (see Figure 7 below).[16] Also in 2018, New York had 0.3 GW of larger "utility-scale" solar[17] (see Figure 7, and note that rooftop solar is not included).[18] Our solar capacity forecast indicates that, in 2025, utility-scale solar capacity will total approximately 1.4 GW (assuming that all planned solar additions come online, see Figure 6 above).

Figure 7. New York State solar capacity (GW), 2004-2050



Data source: U.S. EIA. 2004 to 2018. Form EIA-860. Available at: https://www.eia.gov/electricity/data/eia860/.

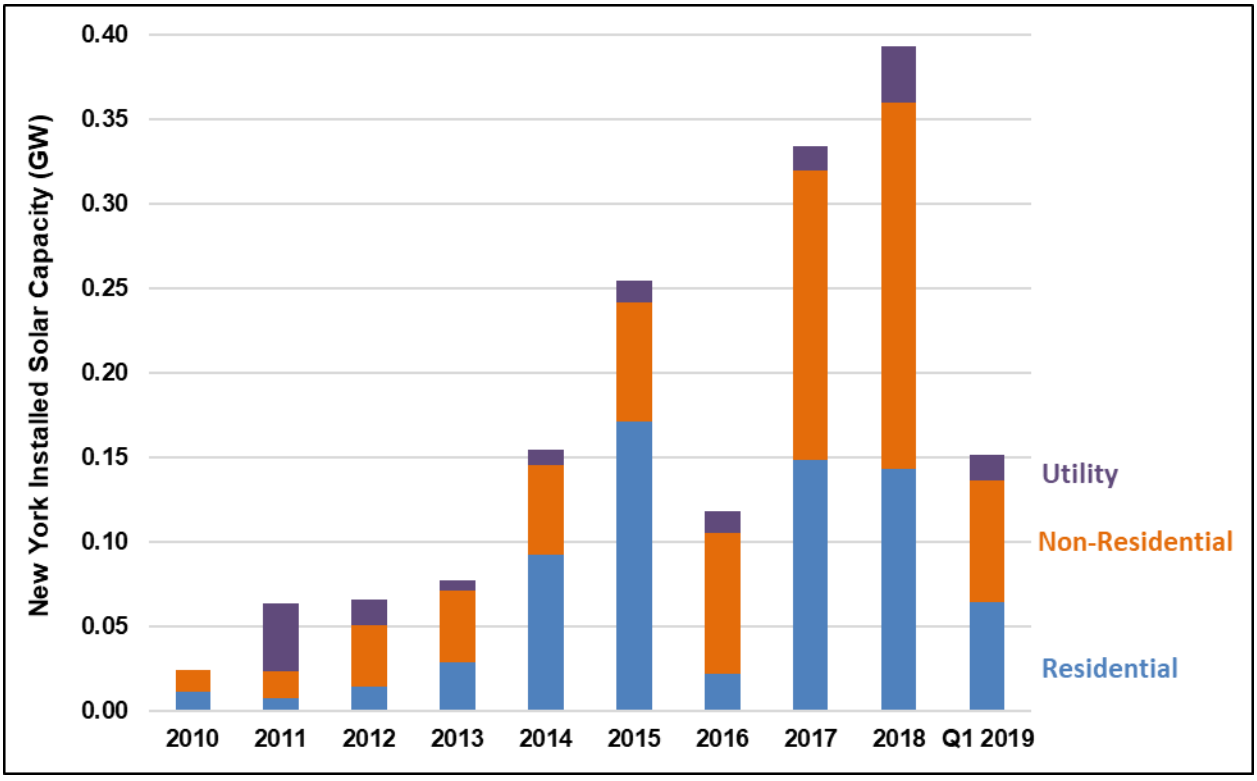
[16] U.S. EIA. 2019. *Electric Power Monthly with Data for September 2019*. Table 6.2.B. Available at: https://www.eia.gov/electricity/monthly/current_month/epm.pdf.

[17] U.S. EIA. 2018. "Form EIA-860". Available at: https://www.eia.gov/electricity/data/eia860/.

[18] Distributed or "behind-the-meter" solar is typically included in modeling and forecasting as a reduction in demand (like energy efficiency) rather than as a type of generation. Source: U.S. EIA. 2019. *Electric Power Monthly with Data for August 2019*. Table 6.2.B. Available at: https://www.eia.gov/electricity/monthly/current_month/epm.pdf.

The Solar Energy Industries Association (SEIA) predicts that New York will add 3.3 GW of solar capacity (utility and rooftop) by 2025[19]—a much more rapid pace of solar growth than the state has experienced in the previous five years (see Figure 8).

Figure 8. SEIA projected New York State annual solar installations (GW), 2010-Q1 2019



Source: Recreated from Solar Energy Industries Association. June 2019. Solar Spotlight – New York. Available online: https://www.seia.org/sites/default/files/2019-09/Factsheet_New%20York.pdf.

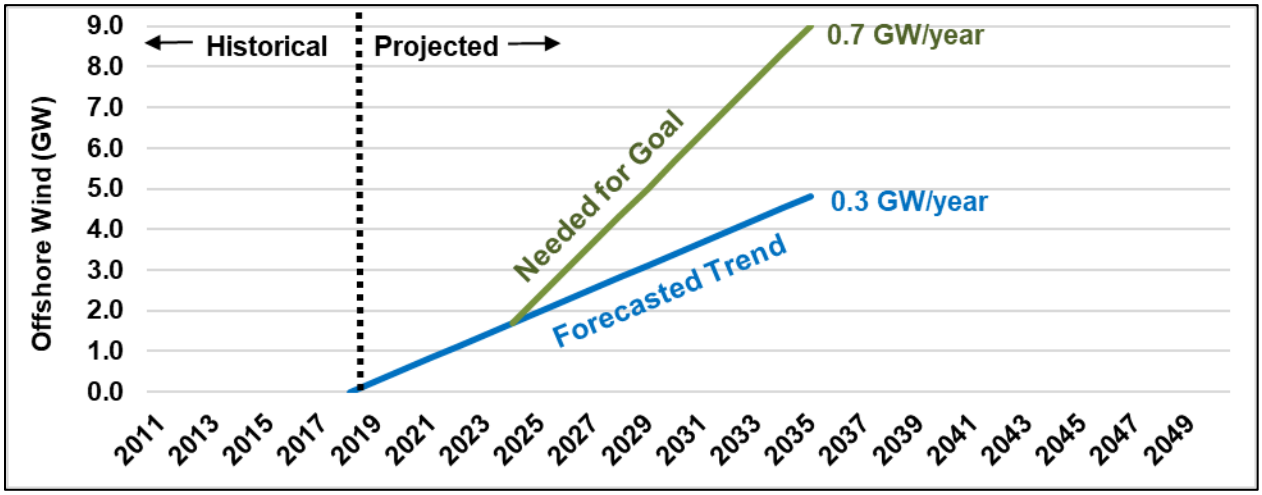
However, even if this rapid growth were to come to pass and all 3.3 GW of new capacity were rooftop solar, New York would still fall short of its 2025 target. In order to reach its goal of 6 GW of rooftop solar by 2025, New York State will need to increase the amount of projected rooftop solar in 2025 by 3.2 GW (see Figure 8 above).

c. Offshore Wind: Install 9 GW of offshore wind capacity by 2035

Status: To achieve the CLCPA goal, New York's currently planned offshore wind projects must come online in 2024, and the state must build a minimum of 1.3 GW of offshore wind capacity every three years between 2024 and 2035.

[19] SEIA. June 2019. *Solar Spotlight – New York*. Available at: https://www.seia.org/sites/default/files/2019-09/Factsheet_New%20York.pdf.

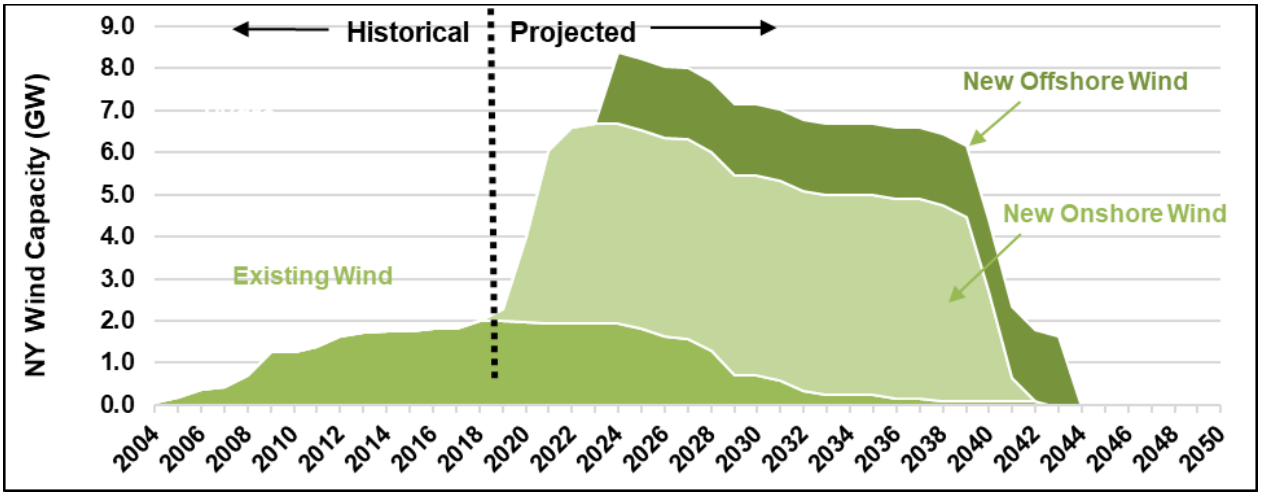
Figure 9. New York State offshore wind (Goal = 9 GW by 2035)



Note: Forecasted trend takes the 1.7 GW of offshore wind contracts planned to be operational in 2024 and spreads it equally over the six-year period from 2019 to 2024.

In 2018, New York had 2.0 GW of onshore wind capacity ranging in age from 0 to 18 years. Assuming a 20-year economic life for onshore wind turbines[20] and that all planned onshore wind (6.6 GW by 2024) and offshore wind (1.7 GW by 2025) come online successfully, in 2035, New York's onshore wind capacity will reach 6.7 GW (see Figure 10).

Figure 10. New York State wind capacity (GW), 2004-2050



At present, New York State has no offshore wind, but two large offshore wind projects totaling 1.7 GW of capacity are planned. In July 2019, the New York State Energy Research and Development Authority (NYSERDA) awarded two offshore wind contracts: the first to Norwegian firm Equinor for the 0.82 GW Empire Wind facility to be located southeast of Long Island, and the second to Orsted and Eversource's

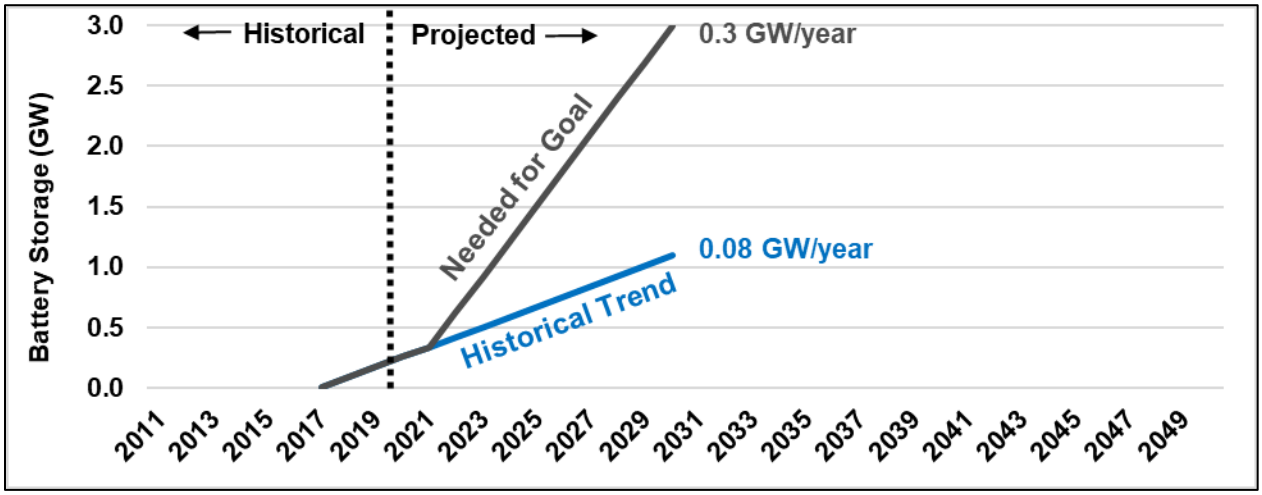
[20] Source: Lazard. 2018. *Levelized Cost of Energy*. Version 12.0. Available at: https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf.

joint Sunrise Wind project, an 0.9 GW project to be built east of Long Island.[21] Assuming this offshore wind is operational by 2024 (as planned), the State will still need to build at least an additional 1.3 GW (see Figure 9 above).

d. Batteries: Install 3 GW of Electric Battery Storage Capacity by 2030

Status: To achieve the CLCPA goal, New York State must install 3 GW of battery storage by 2030.

Figure 11. New York State battery storage (Goal = 3 GW by 2030)



Note: The historical trend is based on the 0.001 GW currently installed plus the planned 0.02 GW Key Capture Energy project and 0.32 GW Ravenswood project (scheduled to come online in 2019 and 2021 respectively).

In 2017, NYSERDA announced a $15.5 million[22]19 Retail Energy Storage Incentive Program that "provides financial incentives for new grid- connected energy storage systems."[23] At that time (and through the end of 2018), the state had 0.001 GW of installed battery storage capacity. In 2019, Key Capture Energy's 0.02 GW battery storage project near Albany became the first project completed under the NYSERDA program and the State's largest storage system online.[24] Also in 2019, New York's utility regulator approved plans for the Ravenswood 0.32 GW storage system in New York City—if completed by the end of 2021 as planned, it will replace sixteen 50-year old combustion turbines at Ravenswood Generating Station.[25]

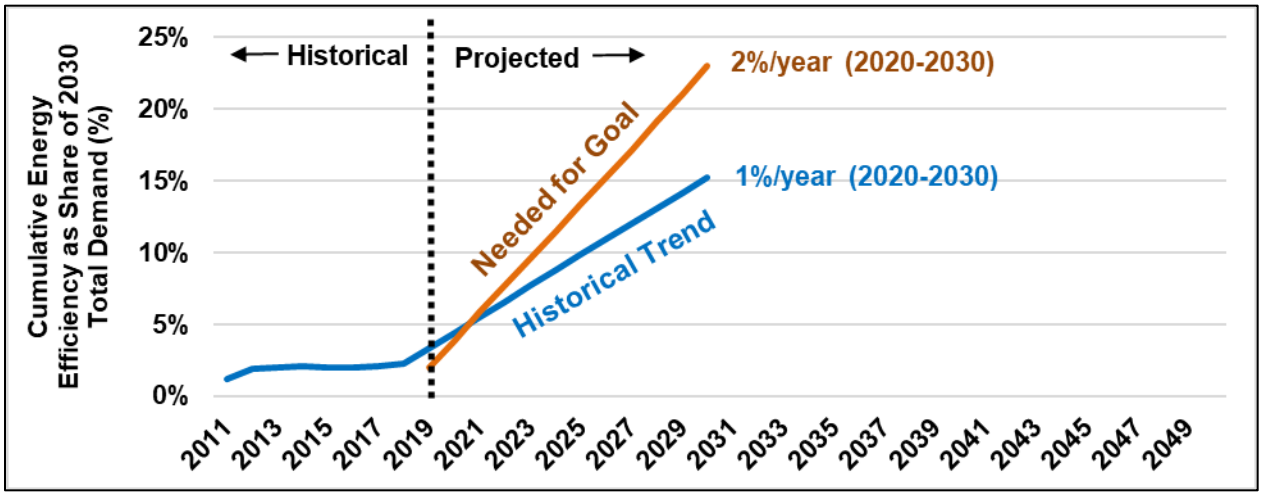
[21] Frangoul, A. July 19, 2019. "New York gives green light for two huge offshore wind projects in waters off Long Island". CNBC. Available at: https://www.cnbc.com/2019/07/19/new-york-gives-green-light-for-two-huge-offshore-wind-projects.html.
[22] Editors of Power Engineering. 2017. "New York State Offers Funding for Energy Storage Projects." Power Engineering. Available at: https://www.power-eng.com/2017/04/26/new-york-state-offers-funding-for-energy-storage-projects/.
[23] New York State. n.d. "Retail Energy Storage Incentive Program." PON 4112. Available at: https://portal.nyserda.ny.gov/CORE_Solicitation_Detail_Page?SolicitationId=a0rt000000ZmYWWAA3.
[24] Editors of Power Engineering. 2019. "NY's largest energy storage system completed in Albany region." Power Engineering. Available at: https://www.power-eng.com/2019/09/18/nys-largest-energy-storage-system-completed-in-albany-region/#gref.
[25] Spector, J. 2019. "New York Approves 316MW Battery Plant for Peak Power, First of Its Kind in Region." Greentech Media. Available at: https://www.greentechmedia.com/articles/read/new-york-approves-316-mw-battery-plant-for-peak-power.

Even if we account for the Key Capture Energy and Ravenswood battery projects coming online by the end of 2021, New York is still expected to fall 1.9 GW short of its 2030 storage target in 2030 (see Figure 11 above). In order to reach its battery storage goal, the State will need to install a minimum of 0.3 GW of battery storage per year.

e. Energy Efficiency: Increase cumulative energy efficiency savings to reach 23 percent of total demand by 2030

Status: To achieve the CLCPA goal, cumulative energy efficiency levels will need to be approximately 12,000 GWh higher in 2030 than projected.

Figure 12. New York State cumulative energy efficiency savings (Goal = 23% of total demand by 2030)



Note: The historical trend takes the average annual energy efficiency savings from the last three years (2016-2018) and adds that amount each year.

In 2018, New York's cumulative energy efficiency savings (since 2010) totaled 3,507 GWh, or 2.3 percent of projected 2030 demand.[26] If the average annual energy efficiency savings from the last three years (2016-2018) continues each year into the future, New York's cumulative energy efficiency savings will reach 23,315 GWh in 2030, or 15.2 percent of 2030 total demand. In order to reach the CLCPA goal, New York will need to increase its energy efficiency savings by nearly 12,000 GWh in 2030 (see Figure 12).

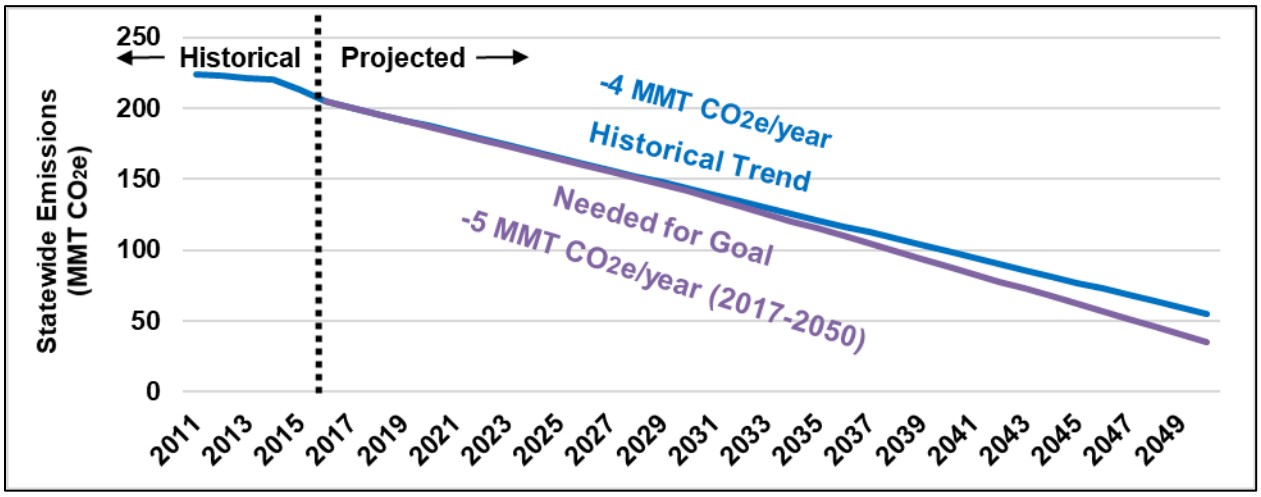
It is important to note that our analysis of progress towards all CLCPA goals (other than this one) assumes that New York State's energy efficiency goal is met. Even more progress would be needed to meet New York's other CLCPA goals if the state fails to achieve its 23 percent by 2030 energy efficiency goal.

[26] U.S. EIA. 2017. "Form-861 detailed data files – Energy Efficiency and Sales to Ultimate Customers". Available at: https://www.eia.gov/electricity/data/eia861/.

f. Emissions: Reduce greenhouse gas emissions by 40 percent from 1990 levels by 2030, and 85 percent by 2050

Status: If the historical trend continues, New York State will almost meet its 2030 emissions target—falling short by just 1.5 MMT. The state's 2050 projected emissions, however, must be 20 MMT lower to meet the CLCPA target.

Figure 13. New York State greenhouse gas emissions (Goal = 40% reduction from 1990 levels by 2030, 85% reduction by 2050)

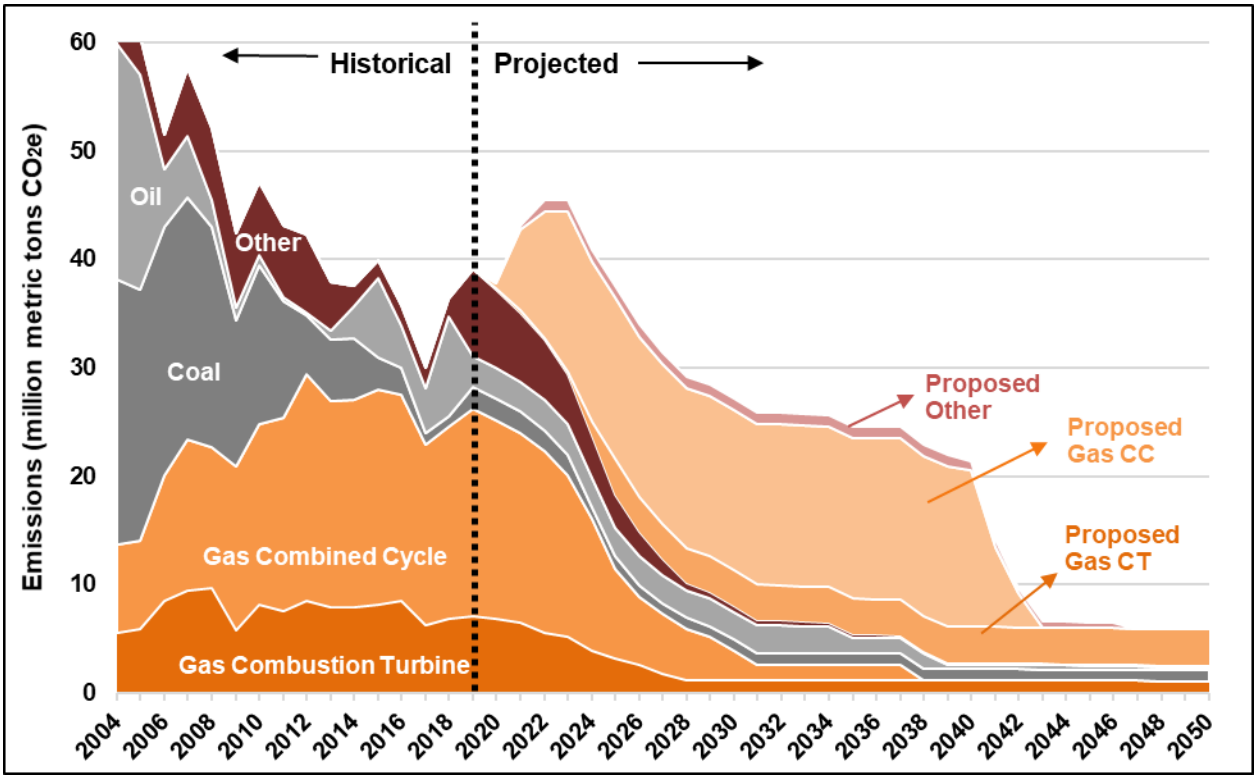


Note: The "needed for goal" trend begins in 2017 because the most recent emissions data available is from 2016.

In 2016 (the most recent data year available), New York State's emissions totaled 205 MMT CO_2e—which is a 13 percent reduction from 1990 levels (236 MMT). New York State's 2016 electric sector emissions totaled 32 MMT—a 51 percent reduction from its 1990 levels (see Figure 13).[27] Compare this to the state's emission reduction target for all sectors of just 40 percent in 2030—the electric sector is already ahead of schedule. In 2050, however, our projection of electric sector emissions shows 5.9 MMT remaining (see Figure 14 below). Unlike transportation, building and industrial emissions, New York's electric sector cannot use offsets to meet the 2050 net zero goal. This means that 2050 electric emissions must be zero MMT.

[27] Electric sector emissions include those from electricity imports. New York State Energy Research and Development Authority (NYSERDA). 2018. *New York State Greenhouse Gas Inventory: 1990-2015*. Table S-2. Available at: https://www.nyserda.ny.gov/About/Publications/EA-Reports-and-Studies/Energy- Statistics.

Figure 14. New York State electric sector emissions (MMT CO_2e), 2004-2050



For New York to reach its emission reduction targets in 2030 and 2050, statewide emissions must be reduced by at least 5 MMT CO_2e each year between 2030 and 2050 (see Figure 13 above). If the historical emission reduction trend continues, the state will come very close to meeting its 2030 target—falling short by just 1.5 MMT—but will miss its 2050 target by 20 MMT.

This illustrates a critical point: even if the state meets its 2030 emission reduction goal, the 2050 emissions target requires that the state drastically ramp up its emissions reductions—precluding the possibility to use gas-fired resources as a bridge to greater renewable penetration (see Figure 14).

4. Stranded Gas Assets and Ratepayer Costs

Only 30 percent of New York State's electric generation can originate from fossil fuel plants in 2030. By 2040, all electric generation must come from renewable sources. To meet the state's clean energy targets, all fossil fuel-fired power plants will need to close by December 31, 2039. At present, there is no

existing technology able to render fossil fuel power plants carbon neutral: carbon capture and storage technologies have been found to be prohibitively expensive and to have little impact on net emissions.[28]

All but one of New York's ten currently proposed gas plants will still be online in 2040, based on their expected useful lifetimes (see Table 3). In deregulated electric markets like New York, companies are on the hook for their capital (equipment) costs plus a rate of return for their investors. In 2040, New York State's owners of electric generation will still have many years of capital costs remaining on their gas plants planned for construction in the next few years. When energy assets become stranded, there are a variety of options available including: filing for bankruptcy, government bailouts, ratepayer-backed bonds, or securitization. While we cannot know which path New York will take—some portion of these costs will likely fall to New York's electric customers.

Table 3. New York's stranded gas capacity assuming 100 percent renewable energy by 2040

Plant Name	Capacity (GW)	Year Online	Technology	Plant Lifetime (Years)	End-of-Life Year	Years Stranded	Stranded Capital Cost (billions $)
Cricket Valley Energy	1.3	2020	Combined Cycle	20	2040	1	$0.07
NISA Electric Generation Project	0.1	2022	Combined Cycle	20	2042	3	$0.01
Berrians East Replacement	0.6	2023	Combustion Turbine	56	2079	40	$0.38
Ogdensburg	0.1	2019	Combined Cycle	20	2039	0	$0.00
Renovo Energy Center	0.5	2020	Combined Cycle	20	2040	1	$0.03
NYC Energy	0.1	2019	Combustion Turbine	56	2075	36	$0.05
Tioga County Power	0.6	2021	Combined Cycle	20	2041	2	$0.06
Luyster Creek Energy	0.4	2021	Combined Cycle	20	2041	2	$0.04
Bowline Gen. Station Unit #3	0.7	2022	Combined Cycle	20	2042	3	$0.11
North Bergen Liberty Gen. Alt.	1.2	2024	Combustion Turbine	56	2080	41	$0.72
TOTAL	**5.8**	--	--	--	--	**129**	**$1.5**

Sources: 1) Form EIA-860. Available at: https://www.eia.gov/electricity/data/eia860/. 2) Lazard's Levelized Cost of Energy Analysis—Version 13.0. November 2019. Available at: https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf.

[28] Woods, B and Stanton, L. PhD. 2019. *Technosilvicultural Reclamation for Environmental Emission Sequestration.* Applied Economics Clinic. Prepared for Home Energy Efficiency Team (HEET) and Speak for the Trees (SFTT). Available at: https://aeclinic.org/publicationpages/2019/11/20/technosilvicultural-reclamation-for-environmental-emission-sequestration.

To determine the dollar value of New York's stranded (that is, unpaid for) assets in 2040, we took the average capital cost[29] per GW of each type of gas plant (gas-fired combined cycle and gas-fired combustion turbine), divided that amount by the standard lifetime of that plant type, and multiplied the annualized capital costs by the number of years of the plant's lifetime that will be stranded in 2040 (given the year the plant is built and its expected lifetime). The result was $1.5 billion of costs still left to pay for gas plants that will be shuttered by 2040.

In order to avoid stranding $1.5 billion of gas capacity assets on January 1, 2040 (an amount equal to 27 percent of the total capital costs of these plants), New York will either need to forego building these plants, or recoup their capital costs over a shorter lifetime than these plants' expected useful time in service. To recoup the full capital costs of these plants by 2040, New York would need to speed up the rate at which these costs are recouped, which would increase customer bills by 23 percent on average if these costs were passed through onto ratepayers.

The case to forego building new gas plants in New York State is made more urgent by the electric sector's role to date as the driving force behind the state's emission reductions (see Table 4). In 1990, emissions from electric generation totaled 65 MMT CO_2e; by 2016, electric emissions had fallen to 32 MMT—a 51 percent reduction—surpassing the 2030 emission reduction target for the electric sector. The industrial sector has also achieved its 2030 target ahead of schedule, but the remaining sectors either have had slower progress—like the residential and commercial sectors—or have seen emissions increases since 1990—like the transportation sector.

Table 4. Emissions changes by sector from 1990 levels, MMT CO_2e

Sector	1990	2016	% change
Residential	34	31	-10%
Commercial	27	21	-22%
Industrial	20	10	-49%
Transportation	59	73	24%
Electricity	65	32	-51%
Other	31	38	23%
TOTAL	236	205	-13%

Note: Electric sector emissions include emissions from electricity imports.

Ultimately, the electric sector may need to do more than its "fair share," given the challenge of reducing emissions from transport and direct fuel use in the residential and commercial sectors. In fact, the CLCPA accepts this reality by disallowing the use of emission offsets for the electric sector to meet its emission reduction goals.[30] For example, in its roadmap to reach 80 percent emission reductions by 2050, New York City acknowledged that "the biggest driver of GHG emission reductions in New York

[29] Lazard. November 2019. "Lazard's Levelized Cost of Energy—Version 13.0." Available at: https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf.
[30] The CLCPA legislation states "sources in the electric generation sector shall not be eligible to participate in such mechanism." p.13.

City, to date, has been changes to our electricity supply" while emissions reductions in other sectors like transportation and industrial direct fuel use have been more modest and difficult to achieve.[31]

Three factors preclude the use of gas as a bridge to greater renewable penetration in New York State:

- The stringency of New York's climate targets;
- The urgency of action (above and beyond historical trends) to achieve the CLCPA climate goals; and
- The challenge of achieving emissions reductions in non-electric sectors like transport and direct fuel use in buildings.

If all currently planned gas plants come into service, New York State will find itself in a position in which it must (1) retire the plants ahead of schedule and recoup the costs of those plants over a shorter period of time, (2) risk stranding those assets, or (3) fail to comply with its legally-binding climate goals. Under all three of these paths new gas means additional, unnecessary costs for New York ratepayers.

5. Methods

a. Capacity

EIA-860 data[32] were used for nameplate capacity (GW), additions and retirements from 2004 through 2018. EIA-860 addition and retirement data were merged with NYISO addition[33] and retirement[34] data. To organize the data by resource, plants were aggregated by their prime mover and energy source to create the initial resource groupings.[35] For the projected capacity values, official additions, retirements, and end-of-life projections are accounted for in addition to 2018 capacity. For plants that should have retired, or were expected to reach the end of their useful lifetime between 2004 and 2018, their total capacity is dispersed evenly across 10 years (2019-2028) to reflect gradual retirements in the

[31] The City of New York. September 2016. "New York City's Roadmap to 80 X 50." p. 8. Available at: https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/New%20York%20City's%20Roadmap%20to%2080%20x%2050_Final.pdf.
[32] Form EIA-860. 2004-2018. Detailed data with previous form data - Generator. Available at: https://www.eia.gov/electricity/data/eia860/.
[33] NYISO. 2019. 2019 Load & Capacity Report. Table IV-1: Proposed Generator Additions & CRIS Requests. Available at: https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/.
[34] NYISO. 2019. "Generator Status Update 08-12-2019". Available at: https://www.nyiso.com/ny-power-system-information-outlook.
[35] Technologies were obtained by matching the prime mover and fuel source codes within the most recent capacity data to their corresponding technology. If a prime mover/fuel source combination was not within the capacity data set, code definitions from the EPA's eGrid Technical Support Document were used. Source: EPA. The Emissions & Generation Resource Integrated Database Technical Support Document for 2016. Available at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

future.[36]Expected facilities lifetimes by resource were taken from Lazard's most recent Levelized Cost of Energy report. If resource lifetime information was unavailable in Lazard, AEC generated its own assumptions. See Table 5 (below) for assumed lifetimes.

Table 5. Resource lifetime assumptions

Resource Type	Average Lifetime (years)	Source
All Other	25	Lazard
Batteries	20	Lazard
Coal Fired Combined Cycle	50	Lazard
Coal-Derived Synthetic Gas Fired Combined Cycle	50	Lazard
Conventional Hydroelectric	25	AEC
Conventional Steam Coal	40	Lazard
Conventional Steam Coal	40	Lazard
Flywheels	25	AEC
Hydroelectric Pumped Storage	25	AEC
Landfill gas	25	AEC
Municipal Solid Waste	25	AEC
Natural Gas Fired Combined Cycle	20	Lazard
Natural Gas Fired Combustion Turbine	56	Lazard
Natural Gas Internal Combustion Engine	50	AEC
Natural Gas Steam Turbine	50	AEC
Onshore Wind Turbine	20	Lazard
Offshore Wind Turbine	20	Lazard
Other Natural Gas	44	Lazard
Other Waste Biomass	25	Lazard
Petroleum Liquids	45	Lazard
Petroleum Liquids (ST-RFO)	60	Lazard
Solar Photovoltaic	25	Lazard
Wood/Wood Waste Biomass	25	AEC

Note: No lifetime assumption was required for nuclear resources since the analysis utilized license expiry dates for all of New York's operating nuclear plants.
Sources: 1) Lazard. 2018. "Levelized Cost of Energy Version 12.0". Available at: https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf. 2) Lazard. 2018. "Levelized Cost of Storage Analysis Version 4.0". Available at: https://www.lazard.com/media/450774/lazards-levelized-cost-of-storage-version-40-vfinal.pdf. 3) AEC assumptions.

[36] For operating nuclear power plants in New York, expected lifetimes were calculated using license issue dates and their respective expiration dates from the U.S. Nuclear Regulatory Commission. Source: United States Nuclear Regulatory Commission. N.d. "Operating Nuclear Power Reactors by Location or Name". Available at: https://www.nrc.gov/info-finder/reactors/.

b. Generation

EIA-923 data[37] were used for generation (GWh) from 2004 through 2013. Average capacity factors (taken from years 2013 through 2018) were applied to projected capacity to calculate expected generation. Capacity factors were calculated for aggregated categories of resource types as a five-year average from 2013 to 2018. As in the capacity forecast, the generation forecast accounted for all planned capacity additions, planned retirements and end-of-lifetime retirements. New York's future demand was assumed to be consistent with NYISO's 2019 Gold Book projection.[38] When future generation (less imports—which are limited to no more than the share of total demand they accounted for in 2018—and energy efficiency—which is assumed to increase in order to meet New York State's goal) is insufficient to meet total demand, we assume "missing" generation is met with renewable sources, per the CLCPA definition.[39]

c. Emissions

EPA plant-level emissions data[40] were used to estimate historical emission rates by resource type. For years in which emissions data were not available, emissions were interpolated between previous and successive years, and were extrapolated for years 2017 and 2018. Future emissions were determined using emission rates for aggregated categories of resource types averaged from 2012 to 2016.

[37] Form EIA 923. 2004-2018. Detailed data with previous form data: Electricity. U.S. EIA. Available at: https://www.eia.gov/electricity/data/eia923/.

[38] NYISO. 2019. *Gold Book Forecast Tables*: *NYCA Baseline Energy and Demand Forecasts*. Table I-1a. Available at: https://www.nyiso.com/documents/20142/6284426/2019-Gold-Book-Forecast-Tables.xlsx/4d14c1a2-84c2-c95e-ea57-8d181618732a?version=1.0&t=1556215454749.

[39] The CLCPA states that "'renewable energy systems' means systems that generate electricity or thermal energy through use of the following technologies: solar thermal, photovoltaics, on land and offshore wind, hydroelectric, geothermal electric, geothermal ground source heat, tidal energy, wave energy, ocean thermal, and fuel cells which do not utilize a fossil fuel resource in the process of generating electricity." p.17.

[40] eGrid. 2004-2016. Emissions & Generation Resource Integrated Database. U.S. Environmental Protection Agency. Available at: https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.