Clean Energy for New York

Replacement Energy and Capacity Resources for the Indian Point Energy Center Under New York Clean Energy Standard (CES)

Prepared for Riverkeeper and Natural Resources Defense Council

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1. INTRODUCTION AND SUMMARY FINDINGS

1.1. Introduction

Synapse Energy Economics (Synapse) was engaged by Riverkeeper and the Natural Resources Defense Council (NRDC) to analyze replacement energy and capacity resources associated with the retirement of the Indian Point Energy Center (IPEC). This report provides such analysis. Synapse utilized the National Renewable Energy Laboratory (NREL) ReEDS (Regional Energy Deployment System) modeling system[1] to estimate an economically optimal expansion of renewable energy resources in New York that would (i) meet Clean Energy Standard (CES) requirements; (ii) achieve required energy and capacity requirements with IPEC retired so as to maintain reliability, and (iii) track the energy production and capacity expansion costs of meeting all New York State requirements during the period 2016 to 2030.[2] Using ReEDS modeling results, we estimated the 2016–2030 trajectories of energy generation by type and the related carbon dioxide (CO_2) emissions in New York under IPEC retirement scenarios. We included energy and emissions both from in-state generation and from imports. We separately accounted for the costs of existing capacity resources and the levels of energy efficiency assumed to materialize in New York in the CES order.[3]

In early January 2017, the Governor and the Attorney General of New York State, along with Riverkeeper, announced an agreement with Entergy for the closure of the IPEC facility.[4] IPEC's retirement will occur during the transition to greater use of renewable electricity production in New York State, and during a period of expected increased efficiency of electricity use. Analysis of the electricity requirements in New York in the absence of Indian Point must directly account for this planned transition, which is described in the New York Public Service Commission's (NY PSC) orders and related documents on the Clean Energy Standard (upon which this report relies).

In our reference case retirement scenario, aligned with New York State's Clean Energy Standard, Indian Point Energy Center's 2016 level of output is fully displaced by clean energy resources by 2023.

More aggressive use of energy efficiency resources leads to lower costs and emissions than is seen in the reference scenario, and enables full displacement of IPEC's 2016 level of energy with clean energy resources by 2022, the first full year of IPEC retirement.

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[1] See Section 2.1 and the appendix for a description of the NREL ReEDS model.

[2] We modeled the period 2016–2020 at two-year intervals; thus we have annual results for 2016, 2018, 2020, etc. All interim period results are based on interpolation.

[3] The CES order assumes annual incremental savings through energy efficiency of roughly 1.5 percent of overall electric energy demand, resulting in a reduction from ~160k GWh in 2016 to ~146k GWh in 2030. However, the CES order does not include any mechanism to ensure that these levels of energy efficiency are achieved, in contrast to the binding and enforceable 50 percent by 2030 renewable energy target enacted by the CES order. Nor has the Public Service Commission enacted any other policies outside the scope of the CES order to ensure that the state achieves these levels of energy efficiency. Rather, existing policies (which consist primarily of Energy Efficiency Transition Implementation Plan (ETIP) targets and budgets for each of the state's investor-owned utilities) guarantee only a small fraction of this 1.5 percent annual incremental savings.

[4] NY.gov. 2017. "Governor Cuomo Announces 10th Proposal of the 2017 State of the State: Closure of the Indian Point Nuclear Power Plant by 2021." Press Release, January 9. Available at: https://www.governor.ny.gov/news/governor-cuomo-announces-10th-proposal-2017-state-state-closure-indian-point-nuclear-power.

This report contains summary findings, which follow this introductory section; a description of the methods, assumptions, and results of our energy modeling, which includes discussion of key retirement issues; a section on New York State reliability and capacity issues after IPEC retirement; and, lastly, our conclusions concerning this analysis.

1.2. Summary Findings

Our summary findings are listed below. The modeling results and discussion sections of this report contain further description, numerical tabulation, and explanation supporting these findings.

Replacement Energy

- Increases in the presence of distributed solar PV resources and assumed levels of energy efficiency under New York's Clean Energy Standard lead to continuing decreases in net load.[5] This results in a reduced need for grid-supplied (i.e., utility-scale) energy resources, either renewable or non-renewable, and sourced in-state or imported. Pursuant to the Clean Energy Standard's requirements, continuing increases in grid-supplied renewable energy combine with the lower net load to cause ongoing declines in the combined use of in-state fossil generation and imports sourced from PJM, Ontario, and New England ("non-Quebec imports").[6] This decline occurs in both our reference IPEC In-Service scenario and in all IPEC retirement scenarios.

- By 2022, the first full year of IPEC retirement, levels of energy efficiency assumed in the CES will provide 6 Terawatt-hours (TWh, or millions of megawatt-hours (MWh)). This is more than one-third of the output of the IPEC station. By 2030, those assumed increases in the efficient use of energy will lower demand by 91 percent (or 15 TWh) of IPEC output. Increases in renewable energy production, coupled with this more efficient use of energy, equates to 83 percent of IPEC's output by 2022. By 2023, assumed new energy efficiency and required new renewable energy provide as much output as IPEC would have produced.

- Under aggressive but cost-effective and potentially attainable increases in energy efficiency beyond the levels assumed in the Clean Energy Standard,[7] all of the consumption otherwise met with IPEC station output could be met by more efficient energy use alone by 2023. Actually locking in the CES's assumed levels of energy efficiency and going beyond those levels could result in efficiency gains that are more than double IPEC's energy output by 2030.

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[5] "Net load" as used in this report is the load net of energy efficiency resources and net of behind-the-meter solar PV resources.

[6] Imported energy from non-Quebec sources and in-state fossil energy represents the marginal energy source for New York.

[7] The Clean Energy Standard assumes a ramping up of energy efficiency provision in New York to attain the energy saving equivalent of an incremental 1.5%/year of retail sales by 2025 (2.2 TWh/year by 2025). The aggressive energy efficiency scenario modeled in our analysis ramps up to an incremental 3.0%/year of retail sales by 2021 (4.6 TWh/year by 2021, but declining in absolute terms thereafter as total state loads decrease).

- The completion of the Champlain Hudson Power Express (CHPE) provides one option for accelerated production of low-carbon energy beyond the Clean Energy Standard's requirements and could supply more than 40 percent of the output of the IPEC station.[8] A combination of CES-mandated increases in renewable energy, CHPE (or equivalent renewable production), and the CES's assumed levels of energy efficiency can supplant 1.5 times the full output of the IPEC station by 2024.

- Compared to a reference case with IPEC in service,[9] aggressive energy efficiency implementation and operation of CHPE together will fully make up the output from IPEC by 2026. If there were no changes to energy efficiency beyond assumed CES levels, CHPE would make up roughly 43 percent of IPEC's output. In this last case, in order to fully supplant the IPEC station output and avoid increases in non-Quebec imported energy or in-state fossil energy increases, additional renewables beyond the CES requirements would be needed and would cost more than an aggressive energy efficiency scenario.

Replacement Capacity

- The ReEDS modeling system adds renewable capacity to the New York system in every year (2016 through 2030) to account for the presence of the increasing renewable CES requirements. These additions of solar and wind energy serve to meet those CES energy needs, but they also provide a level of capacity in line with the capabilities of these resources to meet peak load: onshore wind provides roughly 15 percent of nameplate installed capability; offshore wind provides roughly 30 percent of nameplate installed capacity by 2030; and solar provides about 40 percent of installed capability. We also incorporate the addition of previously committed gas-fired generation in the region in 2018.[10]

- All IPEC retirement cases incorporate levels of energy efficiency at least equal to the levels assumed in the CES. This inclusion leads to lower year-over-year peak load levels

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[8] The Champlain Hudson Power Express is a proposed 1,000 MW HVDC cable connection between Queens, New York and Quebec that could provide on the order of up to 8 TWh per year, or roughly half of IPEC's annual output. We model it as providing 7 TWh, or roughly 43 percent, of IPEC's output in two of our retirement scenarios. While our accounting includes it as a zero-emitting resource, we do this only as a modeling convention. Its output does not contribute to renewable energy requirements under the CES 50 by '30 standard in our modeling and tabulations, though we do include it in aggregations of renewable energy in some tables.

[9] This reference case includes CES levels of energy efficiency, which are higher than current "status quo" levels of energy efficiency implementation in New York. In this regard, our baseline analysis already assumes an increased trajectory of energy efficiency gains in New York.

[10] Assumed gas-fired additions include the CPV Valley unit, at 650 MW; and a generic combustion turbine unit at 90 MW. Minor capacity additions, retirements, and upgrades occur and are considered in New York on a year-to-year basis; we do not attempt a detailed reconciliation of these variable factors, but instead fix in place a level of "new gas" to represent a reasonable proxy for overall system effects likely to be in place by 2018.

reflected in the model's resource trajectory for 2016–2030, and commensurate reduced need for incremental capacity resources.[11]

- As a result, our analysis anticipates no need for other new capacity resources beyond the resources noted above to meet New York State resource adequacy needs in either 2020 (the IPEC unit 2 retirement year) or 2021 (the IPEC unit 3 retirement year). The same holds for 2022, the first full year in which both IPEC units will be retired.[12] It is only when a significant portion of the older gas-fired capacity is estimated to retire in later years (due to age) that new gas-fired resources are deployed in the model. This occurs at a level dependent on the trajectory of peak load and the pace of retirement of older units. Under aggressive energy efficiency deployment scenarios, the need for new capacity resources after IPEC's retirement is less than seen in the reference CES-assumed EE level case and is limited to only the last year of the analysis, 2030. We note that under different sets of resource cost assumptions, especially including the comparative costs of gas-fired combustion turbines versus storage resources, actual resource scenarios could develop that would result in no additional new gas capacity builds in later years.[13]

- Local capacity requirements are different from the aggregate capacity requirements for New York State, but the current and near-term foreseen surplus of New York State capacity, both locational and system-wide in the New York Control Area (NYCA), provides a sufficient buffer such that no additional new capacity resources were added to our analysis other than the expansions resulting from the ReEDS modeling. Our analysis assumes retirement of both in-state coal resources (all by the end of 2020 as committed to by Governor Cuomo) and a number of older gas and oil steam resources over the course of the planning period (2016–2030). However, we note that if required under future local capacity requirements, some of these resources could be held in operation for longer periods than our analysis reflects.

Costs

The cost of supplying wholesale electricity in New York after IPEC retirement will depend on the mix of resources that will be in place in New York in the years after IPEC is out of service, the cost attributes of these resources, and the total load in the state. We have estimated these costs using three analytical mechanisms. First, we utilize the ReEDS modeling tool to estimate the total costs to build renewable capacity required to meet New York's CES (and, for scenario-years with new non-renewable additions,

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[11] If assumed levels of CES energy efficiency are not attained, longer retention of older, less-efficient fossil units and a possible need for nearer-term construction of new resources could result.

[12] Section 3 of this report provides additional discussion on capacity and reliability issues.

[13] We did not run an unlimited number of resource scenarios with different assumptions for renewable and storage resource costs, or the effect of public policies that may promote these alternatives to "new gas" resources. This is a critically important area that requires further research and analysis.

the costs of those resources).[14] ReEDS also estimates the fixed and variable production costs of meeting load.[15] Second, we estimate the program costs associated with increasing the level of energy efficiency to the level assumed in the CES, or to more aggressive levels. Third, we track the quantity of existing capacity resources that will continue to receive capacity market revenues through the New York Independent System Operator (NYISO) capacity market, and value that capacity using an estimate of the weighted average capacity price that those resources would attract. We track these costs across both our retirement and our IPEC In-Service scenarios.

Our cost comparison is not meant to be definitive in the absolute sense; rather we use a consistent framework across the different scenarios in order to ascertain relative cost patterns. We estimate a net present value (NPV) of total costs over the 2016–2030 timeframe to allow for direct comparison across scenarios (we acknowledge that we do not directly account for "end effects" in our cost tabulations - i.e., the ongoing effects past 2030 of resources installed during our modeling timeframe - but we do not think they would change the essence of our findings). These NPVs are seen in Table 1, below. Section 2 contains additional detail on the pattern of costs over time, and the different components of costs that make up our estimate.

The most cost-effective replacement resource scenario is an increase in the level of energy efficiency procurement in New York State above and beyond assumed CES levels, towards the most aggressive, achievable energy efficiency levels that NYSERDA and New York utilities can achieve. Increased levels of energy efficiency investment—and clear direction from the NY PSC to ensure those levels in fact materialize as they have for renewables in the CES—will reduce the cost of achieving the 50 percent by 2030 (50 by '30) CES requirement. These higher levels of energy efficiency, combined with energy from the proposed CHPE project, lead to slightly higher costs (above the reference CES-assumed energy efficiency case) than the scenario with only aggressive levels of energy efficiency, also seen in Table 1, below; but this scenario also results in steeper reductions in total emissions associated with imports to New York from non-Quebec sources, which are not directly valued (or costed out) in the ReEDS model runs.[16]

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[14] We do not attempt to map the recovery of these costs to the capacity market mechanism that exists in New York, but rather we presume that the total costs to build these resources will be recovered from New York load. ReEDS does not account for capacity market cost recovery from existing capacity resources.

[15] Our comparative analysis uses production costs from the ReEDS modeling package to gauge overall differences in energy costs between scenarios.

[16] Energy imported from non-RGGI (Regional Greenhouse Gas Initiative) states is not subject to the RGGI cap and therefore generators do not have to pay for allowances, consistent with current RGGI regulations.

Table 1. Comparison of NPV of total system costs by scenario, 2016$ millions

Scenario	NPV, $ millions, 2016–2030	Change in NPV (%)
Reference CES-Assumed EE IPEC In-Service	*102,724*	
Retire Reference CES-Assumed EE	103,393	0.7
Retire Reference CES-Assumed EE + CHPE	104,925	2.1
Retire High EE	102,892	0.2
Retire High EE + CHPE	104,496	1.7

Note: NPV at a 5 percent real discount rate. CHPE costs assumed to average $85/MWh (levelized cost, $2016). Emissions costs that could be attributed to non-Quebec import energy are not included. Post-2030 effects not included.

Table 1 shows that our high or aggressive energy efficiency scenario (with IPEC retired and energy efficiency implementation exceeding assumed CES levels) results in a 15-year net present value cost increase of 0.2 percent (for wholesale energy and capacity costs) [17] above a reference case with IPEC in service (and assumed CES energy efficiency levels).[18] With energy efficiency at CES-assumed implementation levels, the IPEC retired case leads to a 0.7 percent increase in wholesale energy and capacity costs.

Under scenarios where the CHPE project is assumed in service, at average costs of $85/MWh,[19] the total NPV cost increase is 1.7 percent if aggressive energy efficiency is implemented, and 2.1 percent with no change to CES-assumed energy efficiency levels. If CHPE low-carbon energy, or equivalent additional renewable resource energy, is available at lower costs, then this NPV cost increase would be lower.

CO_2 Emissions

Figure 1 below shows in-state CO_2 emissions for New York across the scenarios, including an estimate of the emissions associated with imports in a given year. In every scenario, emission reductions are driven

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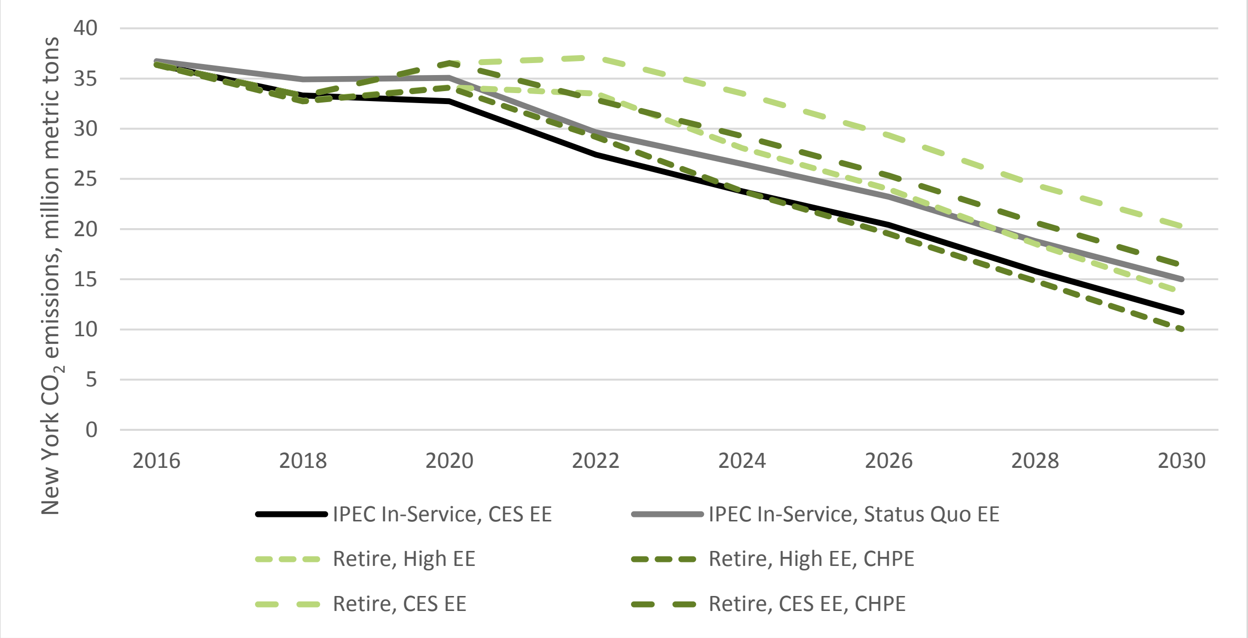
[17] These impacts are for wholesale energy and capacity. A customer’s total bill impact (beyond the scope of this study) over the modeled period would be on the order of one-half of these amounts, since other bill components (distribution, transmission, retail delivery) make up the other half of customers’ bills. As shown in Table 11 of this report, when comparing costs to “status quo” energy efficiency levels, both the CES-assumed EE scenario and the aggressive EE scenario (without CHPE) lead to net reductions in 15-year NPV costs.

[18] Compared to a baseline associated with current energy efficiency policy (which reflects lower energy efficiency implementation than CES-assumed levels), the change in NPV associated with our High EE retirement scenario reflects a *decrease* in 15-year NPV wholesale costs of 0.7 percent. See Section 2.

[19] This is a Synapse estimate, for illustrative purposes. We have no specific knowledge of potential levelized costs of CHPE energy. The CHPE project is estimated to cost $2.2 billion (http://www.chpexpress.com/). Depending on assumptions about financing requirements, the price or cost of energy delivered over the line, and the annual utilization of the project, a range of average annual costs per unit of energy delivered can be computed. We use $85/MWh for illustration only, as it is within a range of possible costs.

by an assumed 2.5 percent per year reduction in region-wide RGGI caps as well as the 50 percent by 2030 renewable energy supply requirement of New York's CES. Generally, the difference in total emissions is driven in large part by the level of emissions from imported energy. Within New York, there is less variance across the scenarios. Section 2 explores this in more detail.

Figure 1. New York electric power sector CO2 emissions by scenario, including estimated emissions from imports



Source: ReEDS modeling results, plus Synapse estimate of emission characteristics of imports.

Reliability

All scenarios modeled a mix of resources sufficient to maintain a planning reserve capacity margin needed to meet New York State's energy system reliability requirements. The combination of increasing levels of energy efficiency in all retirement scenarios (which lower peak load in addition to lowering annual energy needs) and increasing levels of renewable energy capacity (which provide an incremental resource adequacy benefit) allows for assurance of sufficient capacity to support reliability requirements.[20] Section 3 contains additional discussion and explanation of the reliability aspects of IPEC retirement.

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[20] The modeling is limited to assessing resource adequacy, which the NYISO identified as the more severe reliability concern (NY ISO, 2016 Reliability Needs Assessment, page 45). Assessment of transmission security is beyond the scope of this review.

2. MODELING IPEC REPLACEMENT ENERGY AND CAPACITY

2.1. Modeling Methodology and Scenarios

Methodology

We used the NREL open-source expansion modeling package Regional Energy Deployment System (ReEDS) to anchor our analysis of the New York electric power system between 2016 and 2030. Appendix A contains additional detail on ReEDS.

We employed ReEDS primarily to estimate the mix, quantity, and cost of renewable energy resources added to New York's system to meet the 50 by '30 renewable requirements of the CES. We also used ReEDS to estimate production costs in New York State and the level of residual economic imported energy used to meet load. We specified a ramp-in rate for new solar and wind resources to meet 50 by 30, recognizing the existence of constraints to such deployment, and we assumed that offshore wind installations will occur by 2030 in concert with stated New York policy.[21] We used the output from ReEDS to estimate the trajectory of CO_2 emissions in New York, and the emissions associated with non-Quebec imported energy.[22]

We also directly incorporated the effect that the energy efficiency assumptions included in the NY CES will have on the trajectory of energy efficiency deployment, and thus net load, in New York. This estimation served as a critical input, since both renewable resource buildout, and remaining capacity build requirements (to maintain resource adequacy) depend on this assumption. We developed an estimate of aggressive but attainable levels of incremental energy efficiency implementation beyond assumed CES levels to inform our high energy efficiency retirement scenarios.

Based on the results of the ReEDS capacity expansion, we tracked the presence of existing capacity resources in New York State. Outside of the ReEDS environment, we estimated the ongoing costs of carrying this capacity, using an estimated weighted statewide capacity price applied to existing carried capacity.

We developed total system costs for wholesale energy production or purchase based on (i) the output from ReEDS (production costs plus capacity expansion costs), (ii) existing capacity costs, and (iii) energy efficiency deployment costs.

We developed six scenarios to assess the energy and capacity mix, cost, and emissions associated with IPEC retirement. Two are "reference" scenarios with IPEC in service, and four are retirement scenarios

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[21] NY.gov. 2017. "Governor Cuomo Presents 25th Proposal of 2017 State of the State: Nation's Largest Offshore Wind Energy Project Off Long Island Coast and Unprecedented Commitment to Develop up to 2.4 Gigawatts of Offshore Wind Power by 2030." Press release, January 10. Available at: https://www.governor.ny.gov/news/governor-cuomo-presents-25th-proposal-2017-state-state-nations-largest-offshore-wind-energy.

[22] We assume all energy imported from Quebec is emission–free for the purposes of our modeling tabulations.

with IPEC out of service in two steps—one unit in 2020 and one unit in 2021. This is consistent with the recent agreement between New York State, Riverkeeper, and Entergy. The scenarios are described below.

Scenarios

For this study, we modeled New York in conjunction with all six states in the New England ISO, and other RGGI states and adjoining regions for the period 2010 through 2030. We included a number of scenarios testing the effect of different levels of energy efficiency and different supply scenarios in order to determine the impact on in-state capacity expansion, annual energy generation, annual emissions, and total electric sector costs.

Importantly, energy efficiency is an exogenous input to the ReEDS model, and cannot be optimized within the model itself. As a result, the four retirement scenarios included two sets of nearly identical scenarios whose only difference is a pre-determined level of energy efficiency deployment. In this way, we could still determine the ability of efficiency programs to offset the need for energy previously provided by the IPEC units.

- **IPEC in-service status quo (Current EE):** This case uses the NYISO current forecast of load growth net of existing energy efficiency levels. It reflects lower levels of annual energy efficiency compared to CES-assumed levels, essentially leading to a slightly declining annual energy consumption profile (exclusive of behind-the-meter solar PV effects). Renewable resource build meets the 50 by ‘30 CES renewables standard. For this and all scenarios, a declining cap on carbon emissions is in place for the RGGI region (2.5 percent per year).[23] There is no IPEC retirement and no CHPE plant.

- **IPEC in-service reference (CES-Assumed EE):** This scenario models a future in which IPEC remains in service and New York complies with the CES, as well as RGGI with declining future emissions caps. This serves as our reference scenario. Energy efficiency levels are notably higher than in the status quo case, consistent with the assumed levels under the CES. See Table 2 for a description of additional relevant assumptions.

- **IPEC retirement (CES-Assumed EE):** This scenario models a future in which IPEC retires in two stages, in 2020 and 2021 as per the January 9, 2017 announced agreement. All other assumptions are consistent with the CES-Assumed EE reference case.

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[23] For modeling purpose, this analysis assumed a continuation of the current 2.5 percent per year cap decline. However, a RGGI Program Review that will ultimately determine what that post-2020 cap decline will be is still underway, and Governor Cuomo announced in his January 2017 State of the State that New York is committed to a cap decline equivalent to 3 percent per year after 2020 through 2030. https://www.governor.ny.gov/news/governor-cuomo-presents-14th-proposal-2017-state-state-lower-regional-greenhouse-gas-initiative.

- **IPEC retirement (high or aggressive levels of EE):** This scenario is the same as the above IPEC retirement scenario, with additional incremental energy efficiency significantly greater than the reference CES-Assumed EE policy case.
- **IPEC retirement (CES-assumed EE) and CHPE:** This scenario models a future in which CHPE is in service in 2022 and IPEC retires in two stages in 2020 and 2021. All other assumptions are consistent with the CES-Assumed EE reference case.
- **IPEC retirement (high or aggressive levels of EE) and CHPE:** This scenario models a future in which CHPE is in service in 2022, high levels of energy efficiency are assumed, and IPEC retires in two stages in 2020 and 2021. All other assumptions are consistent with the CES-Assumed EE reference case.

2.2. Modeling Assumptions

We incorporated New York State CES parameters into our projection of load and resource requirements. These parameters include CES-assumed increased levels of energy efficiency and meeting the 50 by '30 renewable energy requirement. We reflect New York's target of obtaining 2,400 MW of offshore wind energy by 2030 in all scenarios, staged to reflect 600/1200/1800/2400 MW attained by, respectively, 2024/2026/2028/2030.

Summary

Table 2 below contains the core ReEDS assumptions.

Table 2. ReEDS Reference case modeling assumptions

Modeling scope		
ReEDS version	ReEDS_v2016	
Timeframe	2010–2030	
Geographic scope	Nationwide	
Changes to load		
Electric retail sales before accounting for new energy efficiency measures	NY	2016 Gold Book extrapolated to 2030 (177 TWh in 2030)
	Others	AEO 2016, accounting for embedded EE
Energy efficiency levels	NY	Current Targets[24] (2.2 TWh annually, 35.6 TWh cumulative by 2030)

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[24] Synapse's targets are based on the Department of Public Service's assumptions in the CES White Paper, which were ultimately incorporated into the CES order. For the White Paper, Staff assumes collective statewide energy efficiency achievements for the utilities, NYSERDA, and the non-jurisdictional entities (NYPA, LIPA, and direct NYISO customers) on the basis of their share of statewide load (New York Department of Public Service 2016. Staff White Paper on Clean Energy

	Others	On-the-books EERS[25] for all states with them; otherwise use current savings levels
New units, other than economic		
Renewable policies	NY	CES—50% by 2030, including in-state hydro
	Others	Current RPS for all states with them
Prescribed new wind	NY	Any units listed as “under construction” in EIA 860 2015
	Others	Any units listed as “under construction” in EIA 860 2015, plus offshore wind in RI and MA
Prescribed new utility PV	NY	Any units listed as “under construction” in EIA 860 2015
	Others	Any units listed as “under construction” in EIA 860 2015
Prescribed new distributed PV	NY	Updated pre-2016 values, future forecast based on Sunshot projections
	Others	ReEDS based on Sunshot projections
Prescribed new hydro	NY	None
	Others	None
Natural gas and other fossil	NY	CPV and new GT
	Others	Any units listed as “under construction” in EIA 860 2015
Unit retirements		
Coal	NY	Synapse retirement database—all units out by 2022 model year
	Others	Synapse retirement database
Nuclear	NY	No retirements except IPEC per scenarios—all upstate plants assumed to remain throughout study period
	Others	Nuclear units retire after 60 years of operation
Natural Gas and other fossil	NY	Synapse retirement database
	Others	Synapse retirement database

Standard. Case 15-E-0302. Appendix B, pages 1-2.) We note that the Order Adopting a Clean Energy Standard uses a forecast of gross load (unadjusted for energy efficiency) that reaches 176.6 TWh in 2030 (CES Order, p. 79), whereas the Staff White Paper uses a forecast of gross energy need of 185.6 TWh in 2030 (New York Department of Public Service 2016. Staff White Paper on Clean Energy Standard. Case 15-E-0302. Appendix B, pages 1-2). Both sources, however, assume cumulative energy efficiency savings of 35.6 TWh as of that year.

[25] EERS refers to Energy Efficiency Resource Standard.

Unit retrofits		
Coal	NY	None
	Others	Synapse CAVT “Mid” case
Cost inputs (to ReEDS)		
Conventional generation O&M	NY	AEO 2016
	Others	AEO 2016
Natural gas price	NY	AEO 2016
	Others	AEO 2016
Wind	NY	Wind Vision Median Reduction
	Others	Wind Vision Median Reduction
Utility PV	NY	Sunshot 62.5% by 2020 and 75% by 2030
	Others	Sunshot 62.5% by 2020 and 75% by 2030
Cost inputs (outside ReEDS)		
Energy efficiency	NY	4.0 cents per kWh (levelized) per Synapse research
Distributed PV	NY	Sunshot 62.5% by 2020 and 75% by 2030
	Others	Sunshot 62.5% by 2020 and 75% by 2030
Incremental Transmission	NY	Upstate transmission improvements not explicitly costed
	Others	N/A
Existing Capacity		Per NYISO capacity market construct, estimated value as weighted price per kW-mo. ($8)
CHPE		Estimated at $85/MWh, $2016 levelized cost
Imports		All import energy costs estimated based on ReEDS marginal energy price for imports; average varies from ~$30/MWh to ~$37/MWh
Carbon Markets		
Caps	RGGI	RGGI 2.5% decline through 2030 (58.6MT in 2030)
	Others	None
Trading regions	RGGI	Free trading throughout RGGI
	Others	No Clean Power Plan
Transmission		
	NY	Upstate transmission improvements assumed in place, ReEDS considers upstate and NYC as one zone
	Others	No new transmission lines

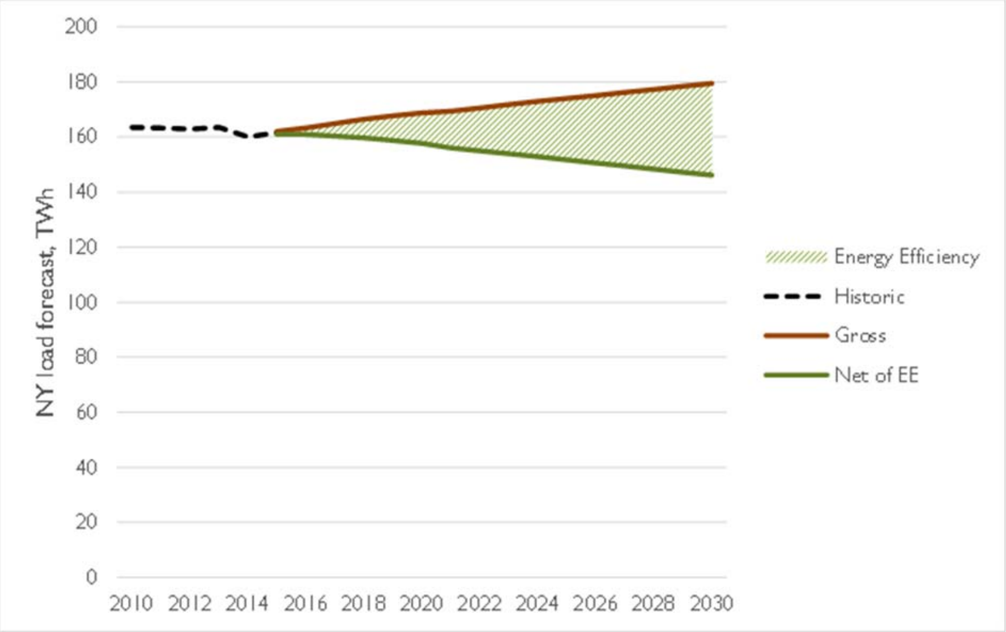
For the purpose of comparison, the IPEC In-Service reference case (with CES-assumed levels of energy efficiency) represents a “business-as-usual” base set of assumptions. It presents a world that complies with on-the-books regional environmental policies and state renewable energy policies, with no additional assumptions as to the future of the state's nuclear units, including IPEC. Table 2 outlines the input assumptions specific to both New York and the rest of New England for all scenarios. The "status quo" IPEC In-Service reference case is the same as the CES-Assumed EE reference case, except that lower—or status quo—levels of energy efficiency implementation are assumed, with corresponding increases in load relative to the CES-Assumed EE reference case. We used this case primarily as an alternative benchmark to the reference case, which assumes increases to energy efficiency that are not yet fully implemented.

Importantly, the Reference case (and all retirement cases) models a future in which the region-wide RGGI emission caps decline by 2.5 percent per year. While this particular policy is not currently on the books, there is a general expectation among interested parties that the RGGI program is heading in a direction that will result in *at least* that level of stringency. Considering Governor Cuomo's recent commitment to cap reduction equivalent to a 3 percent annual reduction post-2020, this assumption can reasonably be interpreted as conservative.[26]

Energy Efficiency

Figures 2 and 3 summarize the changes to modeled annual energy load reflecting the effect of energy efficiency implementation in New York State.

Figure 2. Reference case CES-Assumed load and energy efficiency assumptions



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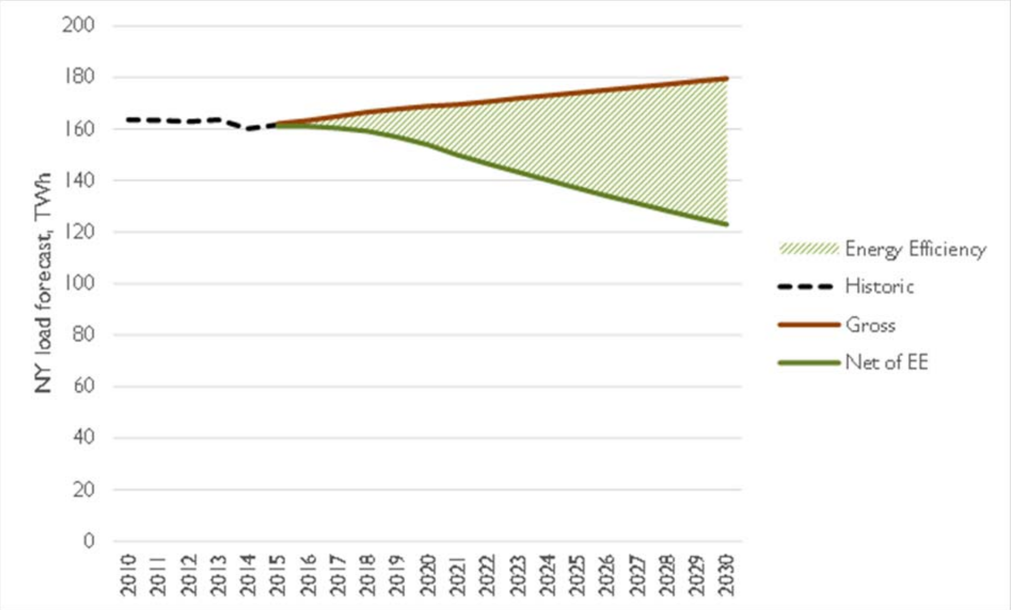
[26] While a review of RGGI program cap declines is currently in process, Governor Cuomo recently announced his support for a cap decline equivalent to 3 percent per year after 2020 through 2030. https://www.governor.ny.gov/news/governor-cuomo-presents-14th-proposal-2017-state-state-lower-regional-greenhouse-gas-initiative.

Figure 3. High EE case load and energy efficiency assumptions



In the reference cases, New York experiences a decline in overall load from 160 TWh in 2016 to 146 TWh in 2030. In the high energy efficiency cases, load declines to around 123 TWh in 2030.

The Clean Energy Standard Staff White Paper and CES order assume annual incremental energy efficiency savings of 2,227 gigawatt-hours (GWh) statewide through 2030. These assumptions, however, have yet to be backed up by enforceable requirements that would provide certainty in the manner that 50 by 30 has provided certainty for renewable energy.[27] We used the CES's energy savings assumption in the reference cases and applied it to the gross load forecast from the 2016 NY Gold Book, extrapolated through 2030. This level of savings translates into 1.4 to 1.5 percent annual savings as a percent of sales throughout the period of analysis. In comparison, actual savings in New York were 1.0 percent in 2015.[28]

The high energy efficiency cases assume that New York State pursues aggressive energy efficiency policies. Utilities in Massachusetts and Rhode Island have achieved even higher energy savings levels than assumed by the CES, which have been enabled by those states' aggressive regulatory policies and

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[27] Staff extrapolates the PSC-authorized annualized NYSERDA goal and annual utility targets to NYPA, LIPA, and direct access customers to come up with 2,227 GWh annual savings. (NY DPS Staff white paper on Clean Energy Standard. Case 15-E-0302, Jan. 25, 2016, Appendix B, p. 2.)

[28] Based on EIA 861 data on incremental annual energy savings for all New York State utilities (1597.8 GWh), compared with total load in 2015 (161,572 GWh) per the 2016 Gold Book.

savings targets.[29] Leading program administrators, including National Grid, have been able to establish strong program delivery infrastructure, which in turn enables them to ramp up energy savings rapidly.[30]

In the high energy efficiency cases, efficiency savings start at the CES-assumed level of 2,227 GWh. Starting in 2018, savings begin to ramp up at a rate of 0.4 percent per year, up to a maximum savings level of 3.0 percent of retail sales in 2021. Three percent of retail sales per year reflects recent electric efficiency savings achievements of multiple New England states.[31] From 2008 to 2015, the utilities such as National Grid in Massachusetts and Rhode Island were able to increase their annual incremental efficiency savings on average by roughly 0.4 percent of retail sales each year. Given New York's history with energy efficiency, we assume that it too can ramp up by 0.4 percent per year.[32]

For both the Reference and High EE case, we assumed a levelized total cost of 4 cents per lifetime kWh saved, representing program administrator costs only, for the cost of energy efficiency resources. This figure was based on our calculation of the cost of saved electricity for the Energy Efficiency Portfolio Standard (EEPS) II programs statewide—3.4 cents/kWh levelized—using data from the NY DPS EEPS Electric Performance Summary website.[33] We rounded the 3.4 cents up to 4.0 cents and applied this level throughout the study period. We used the higher level to recognize the potential for program costs to go up somewhat as administrators increasingly target more comprehensive retrofits, continue or increase efforts to include harder-to-reach customers such as low-income and small business customers, and shift investment to new technologies. Even so, the cost-of-saved-energy assumption is intended to be conservative, because the economies achieved when programs are delivered on a larger scale counter these upward pressures on costs.[34] Four cents per kWh is 23 percent higher than the results of

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[29] Such polices include establishing aggressive energy efficiency targets, effective shareholder performance incentive mechanisms, adopting "all cost-effective EE" requirements, and adopting recommendations of active, inclusive energy efficiency advisory committees.

[30] Internal program delivery infrastructure includes the labor and resources necessary for program design, reporting, implementation, and evaluation. External infrastructure includes contractors and program delivery network necessary for program implementation. (Baatz, B., A. Gilleo, and T. Barigye. 2016. *Big Savers: Experiences and Recent History of Program Administrators Achieving High Levels of Electric Savings*. American Council for an Energy-Efficient Economy, p. 21).

[31] In 2015, the utilities in Massachusetts and Rhode Island, including National Grid, achieved efficiency savings of roughly 3.0 percent of retail sales, and have targets for future years on the order of 2.5 to 3.0 percent of retail sales.

[32] These rates of increase in annual savings were supported by a recent national analysis of annual energy savings increases conducted by U.S. Environmental Protection Agency (EPA). EPA found the average ramp-rate for 26 program administrators that achieved a maximum first-year savings level of 1.5 to 3 percent was 0.38 percent of sales per year based on the Energy Information Administration's Form EIA-861 on energy efficiency program electricity savings. In contrast, jurisdictions with limited program activity have been able to expand program savings by about 0.2 percent of sales per year. (EPA. 2015. "Clean Power Plan Final Rule: Demand-Side Energy Efficiency Technical Support Document." https://www.epa.gov/sites/production/files/2015-11/documents/tsd-cpp-demand-side-ee.pdf.)

[33] For the calculation of the historical cost of saved energy, we use a discount rate of 5 percent and assume an average measure life of 12 years. 3.4 cents is calculated using expenditures, including an assumed 5 percent adder for evaluation costs, and net first-year electricity savings for the EEPS II programs from inception through the end of 2014, for NYSERDA and the investor-owned utilities. No decay in savings was assumed.

[34] In a recent national study, LBNL considered the cost of saved energy (COSE) for all program administrators in its dataset, versus PAs with larger, more mature portfolios. The average cost of saved energy for all programs combined starts at

a 2014 LBNL study, which found a levelized cost of saved energy of about 3.2 to 3.3 cents/kWh (2012$) for New York State based on savings data from 2009 to 2011 (adjusted to be gross) and a 6 percent real discount rate.[35] Furthermore, we note that the assumption that the cost of saved energy begins at 4.0 cents per kWh and stays at that level throughout the study period is conservative.

The costs of saved energy for Massachusetts and Rhode Island are presented here for comparison purposes because, as mentioned above, they are achieving savings as a percent of sales in the range of the High EE level recommended for New York. In Massachusetts, the levelized cost of saved energy for the 2013 through 2015 programs has been between 4.0 and 4.6 cents per lifetime-kWh assuming a 5 percent discount rate, while achieving savings of between 2.3 and 3.0 percent of sales. Rhode Island has seen roughly similar cost and savings levels in recent years.[36] Costs in both states have not displayed an upward trend, even as these states climbed to high savings levels during the first half of the decade.

2.3. Key Modeling Results

Energy

IPEC's annual energy production of roughly 16 TWh will be displaced by a combination of clean energy resources such as increased levels of energy efficiency and renewable energy sourced from onshore wind, solar photovoltaics (PV), and eventually offshore wind production.[37] Canadian hydro resources might also make up a portion—potentially a very substantial portion—of the replacement energy and capacity required after IPEC's closure, if the Champlain Hudson Power Express project is initiated and completed. We ran two modeling scenarios to develop an annual energy balance including the CHPE.

$0.044/kWh in 2009, decreases to 0.023/kWh in 2011, and rebounds a little to $0.028/kWh in 2013). LBNL found a different trend among administrators with larger, more mature portfolios, reflected by the savings-weighted COSE. This savings-weighted metric increased slightly from $0.020/kWh in 2009 to $0.023/kWh in 2013. The difference between the non-weighted and the savings-weighted COSEs suggests that the COSE for the portfolios with lower savings levels has pulled up the average for the dataset as a whole. See also Synapse's analysis of average costs based on EIA data, pointing to lower costs for larger programs. (Ackerman, F., P. Knight, B. Biewald. 2016. *Estimating the Cost of Saved Energy: The EIA 861 Database*. Synapse Energy Economics. http://www.synapse-energy.com/sites/default/files/COSE-EIA-861-Database-66-017.pdf.)

[35] Billingsley, Megan, Ian Hoffman, Elizabeth Stuart, Steven Schiller, Charles Goldman, and Kristina LaCommar. 2014. *The Program Administrator Cost of Saved Energy for Utility Customer-Funded Energy Efficiency Programs*. LBNL. p. 37.

[36] Malone, E. and J. Kallay. 2016. *Rhode Island and Massachusetts Eclipse Efficiency Targets.* Synapse Energy Economics. http://www.synapse-energy.com/about-us/blog/rhode-island-and-massachusetts-eclipse-efficiency-targets.

[37] Additional renewable portfolio standard (RPS) eligible resources, such as increased levels of biomass, may also make up a small portion of IPEC replacement energy.

Depending on the exact timing and scale of the buildout of renewable wind and solar PV resources, increases in energy efficiency investment,[38] and the potential construction of the CHPE, temporary increases in the use of imported energy and/or natural gas-fired generation from New York sources may be seen in the period immediately after IPEC's retirement. However, absolute TWh levels of these resources are likely to be roughly equal to or lower than that seen in 2016. This is due to modeled increases in energy efficiency and associated reductions in net energy requirements in New York between 2016 and 2022 (the first year of full IPEC retirement), and continued renewable energy installations between now and 2022.

We modeled the annual energy balance for New York for each of the six defined scenarios described above in Section 2.1. Tables 3 and 4 below show the aggregate generation and import levels for the two IPEC In-Service cases, one assuming a status quo level of energy efficiency implementation, and one assuming the CES-assumed trajectory is attained for energy efficiency resources.

Table 3. Status Quo EE Scenario—IPEC in-service energy balances by resource type, 2016–2030

TWh (millions of MWH) by Resource	2016	2018	2020	2022	2024	2026	2028	2030	2016 share	2030 share
Status Quo - IPEC In-Service, No Change to EE Policy										
Nuclear	43	43	43	43	43	43	43	43	26%	27%
In-State Fossil Resources (Existing + New)	72	70	65	57	51	46	40	35	44%	22%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	45	46	52	59	65	72	78	27%	50%
All Other Imports (PJM/NE/Ontario)	4	5	8	8	7	5	4	2	2%	1%
Total Load - TWh	162	162	162	160	160	159	158	158	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		0.1%	-0.2%	-0.4%	-0.2%	-0.2%	-0.2%	-0.2%		

Source: Synapse ReEDS modeling results, aggregated by resource type group.

Table 4. CES-Assumed EE Reference Scenario—IPEC in-service energy balances by resource type, 2016–2030

TWh (millions of MWH) by Resource	2016	2018	2020	2022	2024	2026	2028	2030	2016 share	2030 share
Reference - IPEC In-Service, CES-Assumed EE Policy Implementation										
Nuclear	43	43	43	43	43	43	43	43	26%	29%
In-State Fossil Resources (Existing + New)	72	68	63	55	49	45	38	34	45%	23%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	44	46	51	56	62	67	72	27%	49%
All Other Imports (PJM/NE/Ontario)	4	4	6	6	4	1	1	-2	2%	-2%
Total Load - TWh	161	160	158	155	153	151	148	146	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		-0.4%	-0.7%	-0.9%	-0.7%	-0.7%	-0.8%	-0.8%		

Source: Synapse ReEDS modeling results, aggregated by resource type group.

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[38] Clean Energy Standard implementation policies will influence the rate of such investment in energy efficiency and solar and wind resources.

As seen above, the share of New York annual energy load served by different resource types varies under the reference case and status quo case, as increasing levels of energy efficiency implementation lead to a reduction in the need for additional imported energy from the adjacent regions. In both cases, the steadily increasing buildout of renewable resources arising from the presence of the 50 by 30 renewables requirement leads to increasing levels of energy share by renewable resources.

Table 5 below shows results of our modeling for the four retirement scenarios analyzed, using the same IPEC retirement path (one unit in 2020 and one unit in 2021). But in this case we used two different levels of energy efficiency implementation, both with and without the presence of the CHPE resource coming into service in 2022—the first full year of IPEC absence.

The appendix includes tables with the full breakout of energy generation by individual resource type (nuclear, coal, existing gas, new gas, hydro, wind, solar, biomass, oil/gas steam, and imports).

Table 5. IPEC retirement scenarios, energy balances by resource type, 2016–2030

TWh (millions of MWH) by Resource	2016	2018	2020	2022	2024	2026	2028	2030	2016 share	2030 share
Retirement Case, CES-Assumed EE Policy Implementation										
Nuclear	43	43	37	26	26	26	26	26	26%	18%
In-State Fossil Resources (Existing + New)	72	68	66	60	53	49	44	39	45%	27%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	44	46	51	56	62	67	72	27%	49%
All Other Imports (PJM/NE/Ontario)	4	4	10	18	17	13	11	9	2%	6%
Total Load - TWh	161	160	158	155	153	151	148	146	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		-0.4%	-0.7%	-0.9%	-0.7%	-0.7%	-0.8%	-0.8%		
Retirement Case, High EE Policy Implementation										
Nuclear	43	43	37	26	26	26	26	26	26%	21%
In-State Fossil Resources (Existing + New)	72	68	64	58	52	47	41	35	45%	29%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	44	46	48	52	55	58	61	27%	50%
All Other Imports (PJM/NE/Ontario)	4	4	7	14	10	5	3	0	2%	0%
Total Load - TWh	161	159	154	146	140	134	128	123	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		-0.6%	-1.7%	-2.4%	-2.2%	-2.2%	-2.2%	-2.1%		
Retirement Case, CES-Assumed EE Policy Implementation + CHPE										
Nuclear	43	43	37	26	26	26	26	26	26%	18%
In-State Fossil Resources (Existing + New)	72	68	65	58	52	49	42	37	44%	26%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	44	46	58	63	69	74	79	27%	54%
All Other Imports (PJM/NE/Ontario)	4	4	10	13	12	7	6	3	2%	2%
Total Load - TWh	161	160	158	155	153	151	148	146	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		-0.4%	-0.7%	-0.9%	-0.7%	-0.7%	-0.8%	-0.8%		
Retirement Case, High EE Policy Implementation + CHPE										
Nuclear	43	43	37	26	26	26	26	26	26%	21%
In-State Fossil Resources (Existing + New)	72	68	64	57	52	47	38	34	44%	28%
All Renewables (Hydro, QB imports, Wind, Solar, Bio)	43	44	46	55	59	62	65	68	27%	55%
All Other Imports (PJM/NE/Ontario)	4	4	7	8	3	-1	-1	-5	2%	-4%
Total Load - TWh	161	159	154	146	140	134	128	123	100%	100%
Annual Growth Rate of Load (CAGR over 2 years)		-0.6%	-1.7%	-2.4%	-2.2%	-2.2%	-2.2%	-2.1%		

Source: Synapse Energy Economics. ReEDS modeling results, aggregated by resource type group.

The level of energy from renewable resources varies across the scenarios, reflecting different renewable buildout patterns tied to energy load levels, and the presence or absence of the CHPE resource. We included CHPE as a renewable resource in this tabulation, and its inclusion leads to “all renewables” shares greater than 50% by 2030.[39] Lower total load arising from energy efficiency resources in turn leads to lower renewable buildout requirements to meet the 50 by ‘30 mandate. As seen in the table, the lowest level of total renewable energy is seen in the scenario with the highest level of energy efficiency and the absence of the CHPE resources. The highest level of renewable energy production is

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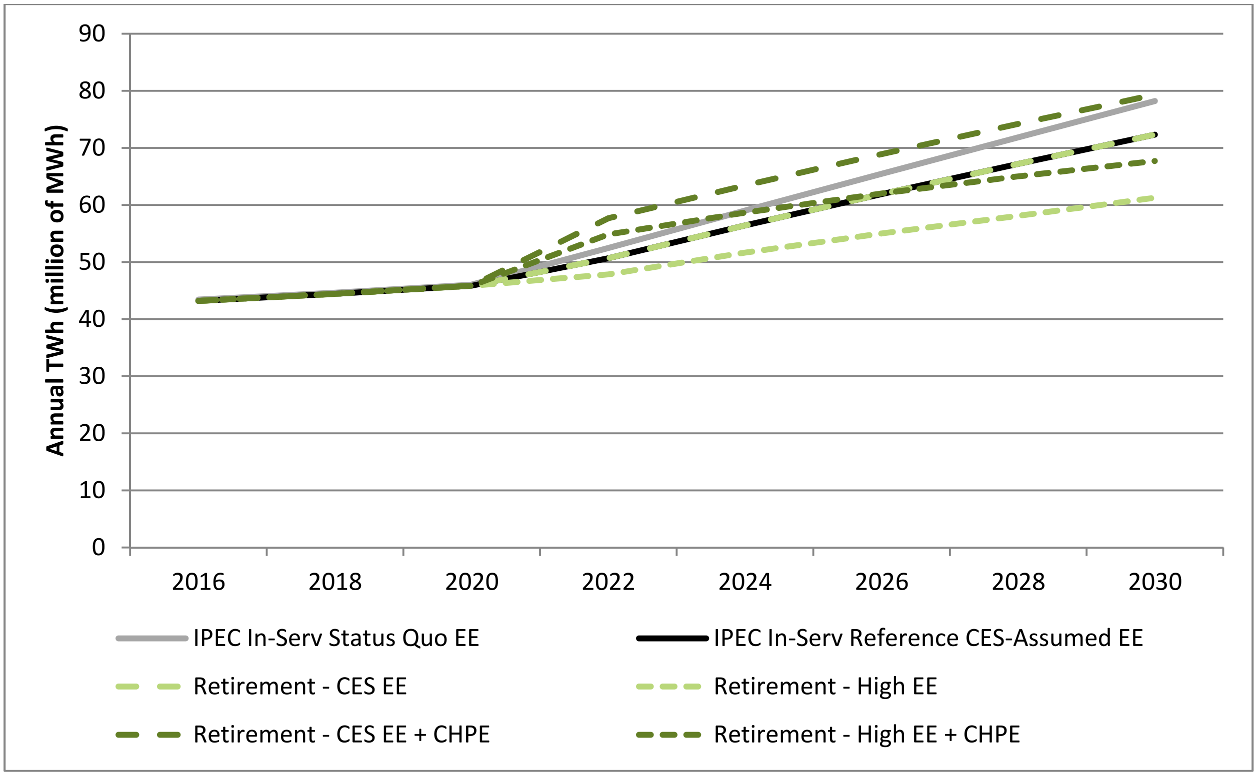
[39] The ReEDS modeling does not count the CHPE resource as contributing to New York’s renewable resource requirement.

seen in the CHPE scenario with relatively lower levels of energy efficiency implementation (i.e., the CES-assumed level of energy efficiency). Figure 4 below shows the pattern of renewable resource energy production by retirement scenario, and for the two non-retirement scenarios, for 2016 through 2030.

Figure 4. Renewable resource energy by scenario, 2016–2030



Source: Synapse Energy Economics. ReEDS modeling results.

The retirement scenario results show significantly declining use of in-state fossil resources in all cases, reflecting the presence of increased renewable resources, retirement of coal units,[40] reduced levels of energy from older gas and oil units (both steam and combined-cycle units), and the effect of the declining RGGI regional cap on total CO_2 emissions. Of the remaining levels of energy produced by in-state fossil resources, most of it is generated by natural gas combined-cycle units.

The level of imported energy from non-Quebec sources also varies across the scenarios. Essentially, in-state fossil and non-Quebec imports serve as the marginal energy sources for all of the scenarios. With higher levels of energy efficiency deployment, there is less of a need for this marginal energy. The lowest level of imported energy is seen in the scenario with the highest level of energy efficiency and with the CHPE resource; in that scenario, New York is actually a net exporter of energy by 2026 (1 TWh

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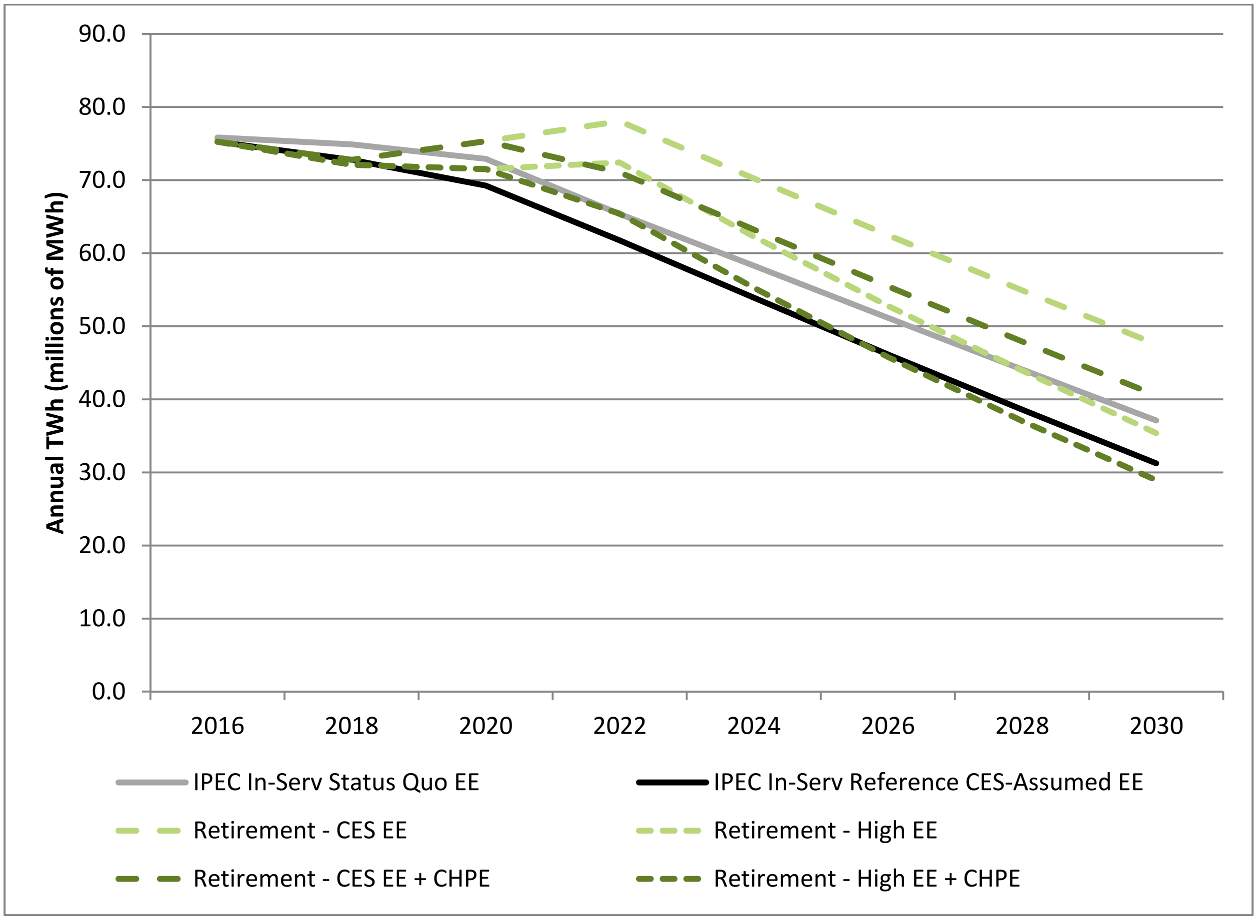
[40] Synapse assumption. Our understanding is that Governor Cuomo has also committed to coal retirement by this date.

of net exports in 2026, rising to 5 TWh of net export by 2030). Figure 5 shows the pattern of declining New York fossil plus imported energy between 2016 and 2030, for each scenario.

Figure 5. Fossil + non-Quebec import energy by scenario, 2016–2030



Source: Synapse Energy Economics. ReEDS modeling results.

Figures 6 and 7 below summarize the energy balance findings from our analysis for our reference (CES-Assumed EE) retirement scenario. They indicate the source and type of energy resource from 2022–2030 (in two-year steps) relative to energy provision in 2016, reflecting the CES-assumed increases in energy efficiency between now and 2030 as well as the CES 50 by ‘30 renewable energy requirement.[41] The figures show IPEC’s reduction of 16.3 TWh is made up by increased energy efficiency and increased

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[41] The CES assumes (but not include specific binding requirements for) continuing increases in the level of achieved energy efficiency improvement in New York, ramping up to obtaining roughly 1.5%/year of retail energy sales quantities through energy efficiency implementation by 2030. Each year, the incrementally obtained energy efficiency continues to provide energy savings for subsequent years. Existing Canadian hydro imports are included as part of RPS requirements, but new Canadian imports are not (see CES order Appendix A on eligibility of resources for renewable accounting).

renewable energy provision, and continuing reduction (after 2022) of the combination of in-state fossil and imported energy.

Figure 6. Reference Case (CES-Assumed EE) IPEC Retirement—Replacement energy source in 2022–2030 (Absolute TWh) – change from 2016 output

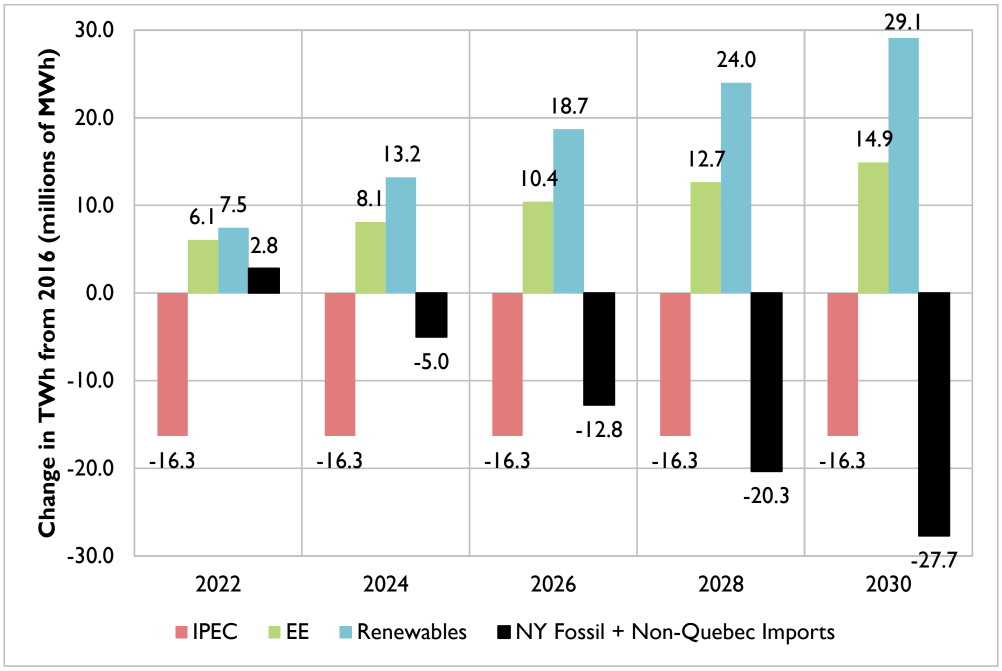
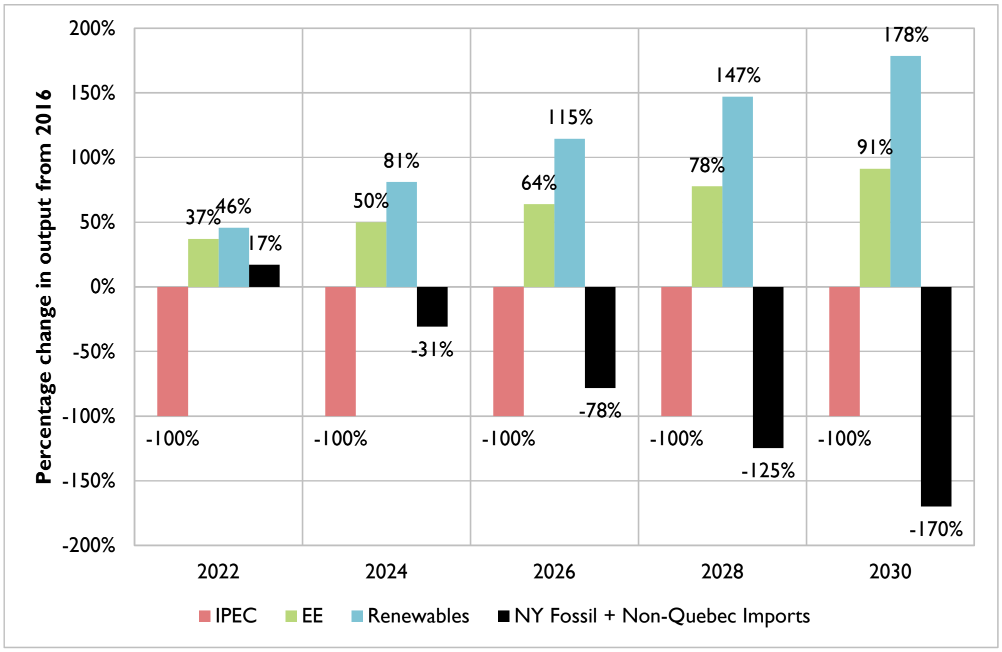


Figure 7. Reference Case (CES-Assumed EE) IPEC Retirement—Replacement energy source in 2022–2030 – percentage of IPEC's 2016 output



Sources for Figures 6 and 7: Synapse tabulation from ReEDS modeling outputs.

Figures 8 and 9 below show the same information as seen in Figures 6 and 7, but for the high energy efficiency retirement scenario.

Figure 8. IPEC Retirement Case (High Energy Efficiency)—Replacement energy source in 2022–2030 (Absolute TWh) – change from 2016 output

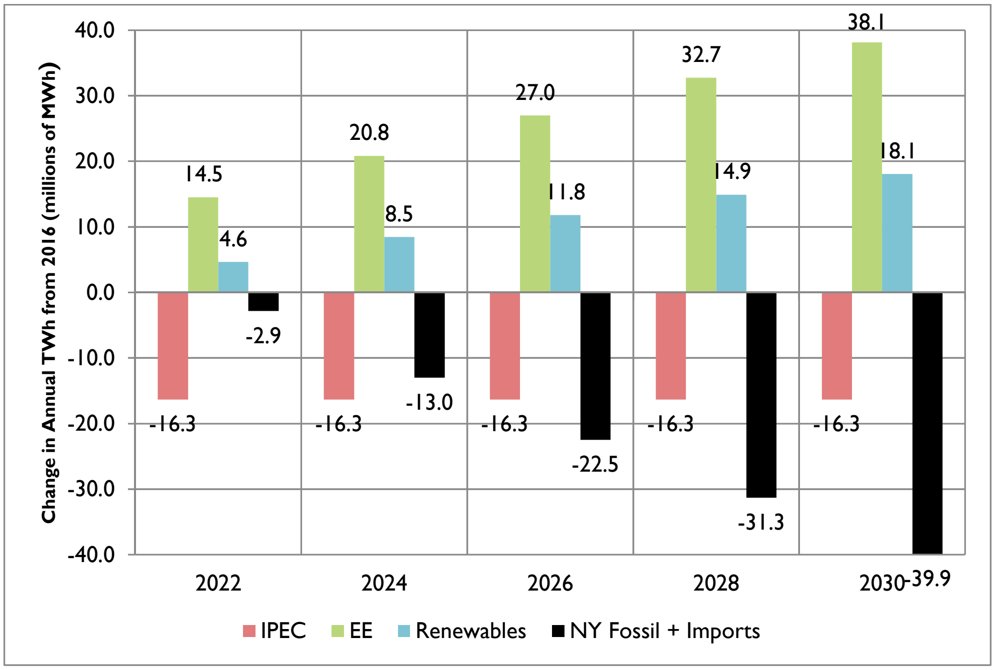
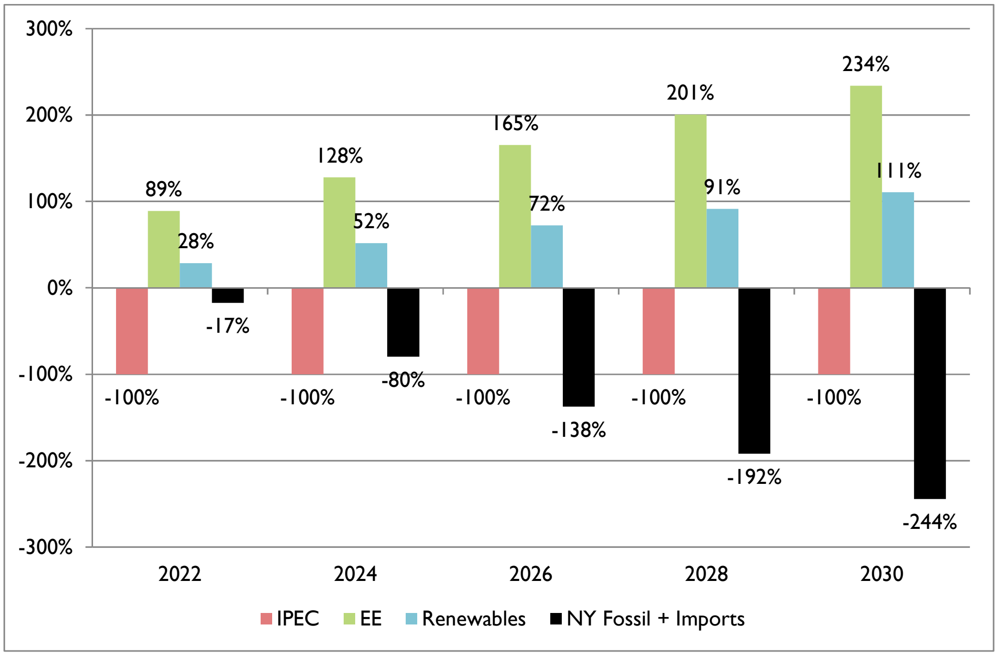


Figure 9. IPEC Retirement Case (High Energy Efficiency)—Replacement energy source in 2022–2030 – percentage of IPEC's 2016 output



Sources for Figures 8 and 9: Synapse tabulation from ReEDS modeling outputs.

Figures 10 and 11 below show the same information as seen in the earlier graphs (Figures 6 through 9), but for the CES-assumed retirement scenario including the presence of the CHPE project.

Figure 10. IPEC Retirement (CES-Assumed EE + CHPE) —Replacement energy source in 2022–2030 (Absolute TWh) – change from 2016 output

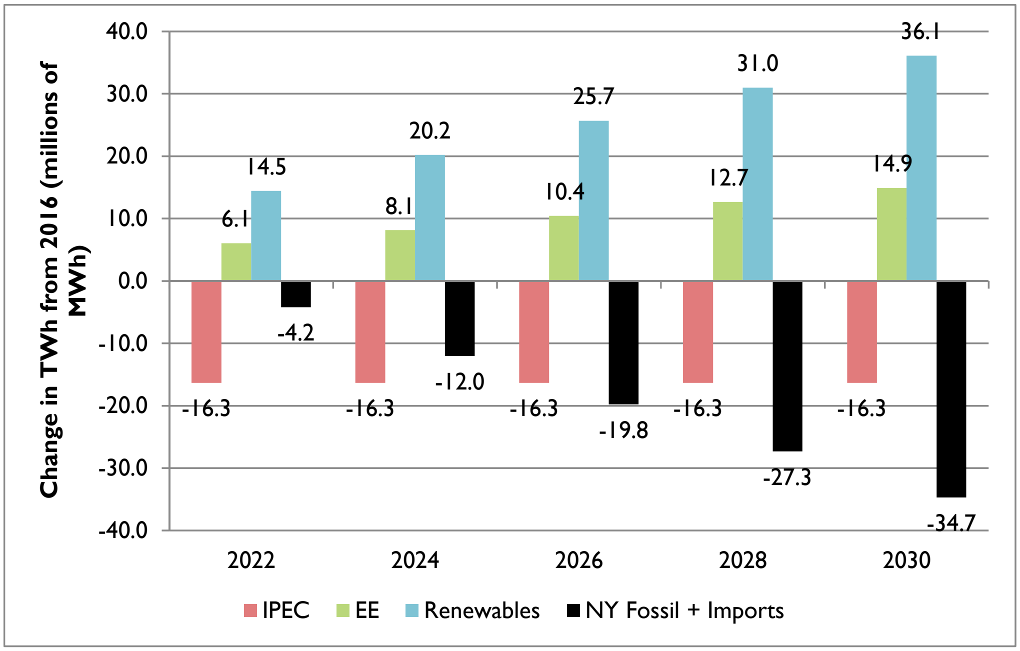
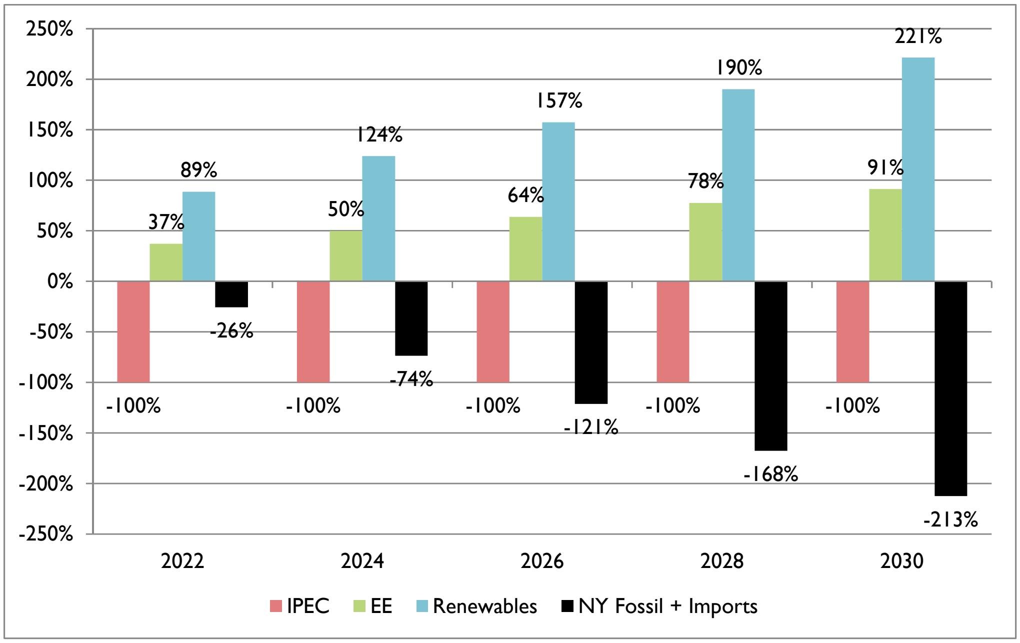


Figure 11. IPEC Retirement (CES-Assumed EE + CHPE)—Replacement energy source in 2022–2030 – percentage of IPEC's 2016 output



Sources for Figures 10 and 11: Synapse tabulation from ReEDS modeling outputs.

Figures 6 and 7 illustrate that as energy efficiency resources ramp up over time, they offset a greater portion of IPEC energy, reaching 91 percent of the 2016 output of IPEC by 2030. Critically, they also show that the combined effect of increasing efficiency of electric use and installation of renewable energy sources to meet the CES 50 by '30 renewable requirement leads to declining levels of in-state fossil fuel and non-Quebec-based imported energy relative to 2016 levels. The absolute quantities of fossil fuel use and non-Quebec-based imported energy also declines after 2022, as is shown in Table 5 of the report. Figures 8 through 11 show the same effect, but for the retirement scenario with aggressive levels of energy efficiency (Figures 8 and 9) and the scenario with CES-assumed levels of EE, but with inclusion of the CHPE project (Figures 10 and 11).

Table 6 below provides summary information on the key output parameters associated with our reference case (CES-Assumed EE) retirement scenario, and the three others: aggressive energy efficiency, inclusion of the CHPE under reference case energy efficiency provision, and a final scenario with both aggressive energy efficiency and inclusion of CHPE. As shown in Table 6, higher levels of energy efficiency enable lower levels of required renewable energy infrastructure to meet the 50 by '30 renewables CES requirement. As also shown, the presence of higher levels of energy efficiency and/or the CHPE project leads to lower levels of electricity from either in-state fossil resources (coal, gas and oil) or imported non-Quebec energy (PJM, Ontario, and New England) by the later part of the modeling period. These latter resources generally compete with in-state fossil energy to be the marginal fuel for New York. This is the case for all years for all scenarios except for the first full year of IPEC retirement, 2022, in the reference scenario, in which a small increase in imports (relative to 2016) is reflected in the table (2.8 TWh).

Table 6. IPEC retirement replacement energy by source and by scenario for 2022 and 2030

TWh from replacement resource relative to 2016	**2022**			**2030**		
Scenario	EE	Renewables Including CHPE	NY Fossil / Imports	EE	Renewables Including CHPE	NY Fossil / Imports
Reference Scenario	6.1	7.5	2.8	14.9	29.1	(27.7)
High EE Scenario	14.5	4.6	(2.9)	38.1	18.1	(39.9)
Reference Scenario + CHPE	6.1	14.5	(4.2)	14.9	36.1	(34.7)
High EE Scenario + CHPE	14.5	11.6	(9.9)	38.1	24.5	(46.3)

Note: IPEC output is modeled as 16.3 TWh per year. New York State net energy demand in 2016 is estimated at 161 TWh. In 2015, total New York fossil energy plus non-Quebec imports equaled roughly 76 TWh.

Retirement Scenarios Compared to IPEC In-Service Cases

Tables 7 and 8 illustrate the energy balance impact of IPEC's retirement compared to scenarios where the nuclear plant remains in service in future years. Table 7 compares retirement scenarios against a scenario in which IPEC remains in service and CES-assumed energy efficiency levels are attained. Table 8 compares retirement scenarios against a case in which IPEC remains in service and energy efficiency continues at the status quo.

Table 7. Replacement energy balance compared to reference (CES-Assumed EE) IPEC In-Service scenario

TWh Changes from IPEC In-Service Case - CES EE	2022			2030		
Scenario	EE	Renewables Including CHPE	NY New + Existing Fossil / Imports	EE	Renewables Including CHPE	NY New + Existing Fossil / Imports
High EE Retirement Scenario	8.5	(2.8)	10.7	23.2	(11.1)	4.1
High EE + CHPE Retirement Scenario	8.5	4.2	3.7	23.2	(4.6)	(2.3)
Reference (CES-assumed EE) + CHPE Retirement Scenario	0.0	7.0	9.3	0.0	7.0	9.3
Reference (CES-assumed EE) Retirement Scenario	0.0	0.0	16.3	0.0	0.0	16.3

Table 8. Replacement energy balance compared to Status Quo (lower EE) IPEC In-Service scenario

TWh Changes from IPEC In-Service Case - Status Quo EE	2022			2030		
Scenario	EE	Renewables Including CHPE	NY New + Existing Fossil / Imports	EE	Renewables Including CHPE	NY New + Existing Fossil / Imports
High EE Retirement Scenario	13.9	(4.6)	7.1	35.0	(16.9)	(1.7)
High EE + CHPE Retirement Scenario	13.9	2.4	0.1	35.0	(10.5)	(8.2)
Reference (CES-Assumed EE) + CHPE Retirement Scenario	5.4	5.2	5.7	11.8	1.1	3.4
Reference (CES-Assumed EE) Retirement Scenario	5.4	(1.8)	12.7	11.8	(5.9)	10.4

Sources for Tables 7 and 8: Synapse tabulation of ReEDS modeling output.

The first row of Table 7 shows the considerable impact of incremental energy efficiency gains if New York were to move from CES-assumed levels to more aggressive levels of energy efficiency—namely, lower levels of fossil or imported resources in 2030 (the breakeven point is 2027) even after accounting for IPEC's retirement and without any additional renewable energy from CHPE. The second row shows that the presence of CHPE further reduces any need for incremental fossil or imported energy (the breakeven point is 2023). The last two rows of Table 7 show that when comparing IPEC In-Service (with CES-Assumed EE levels) to IPEC retirement scenarios with the same level of energy efficiency (and a resulting CES buildout that is tied to the same level of load), the only change seen is in the remaining sources of energy – fossil and imported energy. The presence of CHPE reduces, but does not eliminate, the need for additional fossil or imported energy.

Table 8 shows that if the framework for comparison is today's trajectory of CES-assumed energy efficiency gains, aggressive energy efficiency levels coupled with the CHPE project will lead to net declines in fossil plus imported energy by 2022 even with the IPEC station retirement (second row). Under less aggressive energy efficiency implementation—i.e., CES-assumed energy efficiency levels (last two rows)—fossil generation use by 2030 will still be higher than it otherwise would be with IPEC in service, though CHPE output mitigates against such increases.

Capacity

The ReEDS modeling system broadly accounts for capacity resources required to maintain reliability in New York. The model applies a planning reserve requirement to reflect resource adequacy needs that are greater than peak load;[42] those loads are lower because of the peak-reducing effects of energy efficiency resources. Renewable resource capacity buildout within the ReEDS model occurs in proportion to the annual energy requirements and the 50 by '30 CES factors for each year out to 2030.[43] After accounting for the effect of energy efficiency and including the capacity contribution of newly built renewable resources, the model gauges whether or not new capacity additions—either gas-fired (combustion turbine or combined cycle) or storage—are required. If new additions are found to be necessary, the model then economically "builds" those resources in the required years.

All scenarios modeled included the planned operation of new gas resources in 2018, mainly the CPV plant;[44] accounted for the capacity value of existing Canadian (Quebec) imports;[45] assumed the retirement of remaining coal-fired resources in New York by the end of 2020; and included an estimate of retirement of a substantial amount of older gas and oil-fired resources over the planning period.

Table 9 shows the aggregate generation installed capacity levels for the two IPEC In-Service cases. One assumes a status quo level of energy efficiency implementation, and one assumes the CES-assumed trajectory is attained for energy efficiency resources. As seen below, the share of New York installed capacity served by different resource types varies under the two difference reference cases. Increasing levels of energy efficiency implementation lead to a different pattern of renewable capacity buildout and result in a different pattern of new gas or storage buildout needs in the latter years of the analysis.

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[42] The actual planning reserve margin in New York is on the order of 118% of peak load.

[43] In our analysis we fixed the level of offshore wind build in the model; and ReEDS incorporated a fixed level of distributed generation build out (solar PV). The remaining wind and solar build out's proceeded to ramp up from 2016 to 2030 to meet the 50% target. Outside of ReEDS, Synapse limited the near-year buildout of wind (through 2020) to reflect planned increases in transmission between upstate and downstate by no earlier than model year 2022.

[44] CPV Valley is 650 MW. Modeling was completed prior to determining the status of the Cricket Valley planned gas-fired facility. We estimate that the broad conclusions in this report would be unchanged if the Cricket Valley plant were included; it would contribute more energy to the NY system and non-Quebec import energy would be lower.

[45] At 1,100 MW.

Table 9. Status Quo EE and CES-Assumed EE Reference scenario – IPEC In-Service capacity balances by resource type, 2016–2030

MW Installed Capacity by Resource Type	2016	2018	2020	2022	2024	2026	2028	2030
Status Quo - IPEC In-Service, No Change to EE Policy								
Nuclear	5,383	5,383	5,383	5,383	5,383	5,383	5,383	5,383
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	822	822	822	1,750	2,144	4,628
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,414	11,269	12,367	14,998	16,875	19,211	23,407	26,346
Installed Capacity, MW	38,942	38,905	37,738	39,658	40,203	42,934	45,657	48,586
Reference - IPEC In-Service, CES-Assumed EE Policy Implementation								
Nuclear	5,383	5,383	5,383	5,383	5,383	5,383	5,383	5,383
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	747	747	747	1,347	1,426	3,212
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,282	11,138	12,235	14,429	16,083	17,672	21,236	23,643
Installed Capacity, MW	38,810	38,773	37,531	39,013	39,336	40,993	42,768	44,466

Source: ReEDS modeling results, aggregated by resource type.

Notably, even in the "status quo" scenario with a lower level of energy efficiency implementation, there is minimal need for additional capacity until the later years of analysis.[46]

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[46] ReEDS builds to maintain resource adequacy, not to address local needs. ReEDS retires older resources, but if those resources were needed to meet local needs, the renewable buildout effects would not be any different from what is seen here, and the energy effects would likely not vary materially since the older resources contribute lesser amounts to energy requirements in the middle and later years of the analysis.

Table 10. IPEC retirement scenarios, installed capacity by resource type, 2016–2030

MW Installed Capacity by Resource Type	2016	2018	2020	2022	2024	2026	2028	2030
Retirement Case, CES-Assumed EE Policy Implementation								
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	747	747	883	1,534	1,896	3,910
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,282	11,138	12,235	14,428	16,079	18,083	21,336	23,498
Installed Capacity, MW	38,810	38,773	36,766	36,949	37,403	39,526	41,273	42,955
Retirement Case, High EE Policy Implementation								
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	747	747	747	747	747	2,304
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,282	11,138	12,235	13,723	14,816	15,790	17,181	18,025
Installed Capacity, MW	38,810	38,773	36,766	36,243	36,004	36,447	35,970	35,877
Retirement Case, CES-Assumed EE Policy Implementation + CHPE								
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	747	747	747	1,416	1,854	3,712
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,282	11,138	12,235	15,428	17,078	18,652	21,804	24,133
Installed Capacity, MW	38,810	38,773	36,766	37,949	38,266	39,978	41,700	43,392
Retirement Case, High EE Policy Implementation + CHPE								
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
In-State Fossil Resources (Existing Coal, Gas, Oil)	23,138	21,506	19,166	18,455	17,123	16,591	14,723	12,228
In-State Fossil Resources - New Gas	7	747	747	747	747	747	756	2,386
All Renewables (Hydro, Quebec imports, Wind, Solar, Biomass)	10,282	11,138	12,235	14,723	15,815	16,788	17,662	18,378
Installed Capacity, MW	38,810	38,773	36,766	37,243	37,004	37,445	36,460	36,312

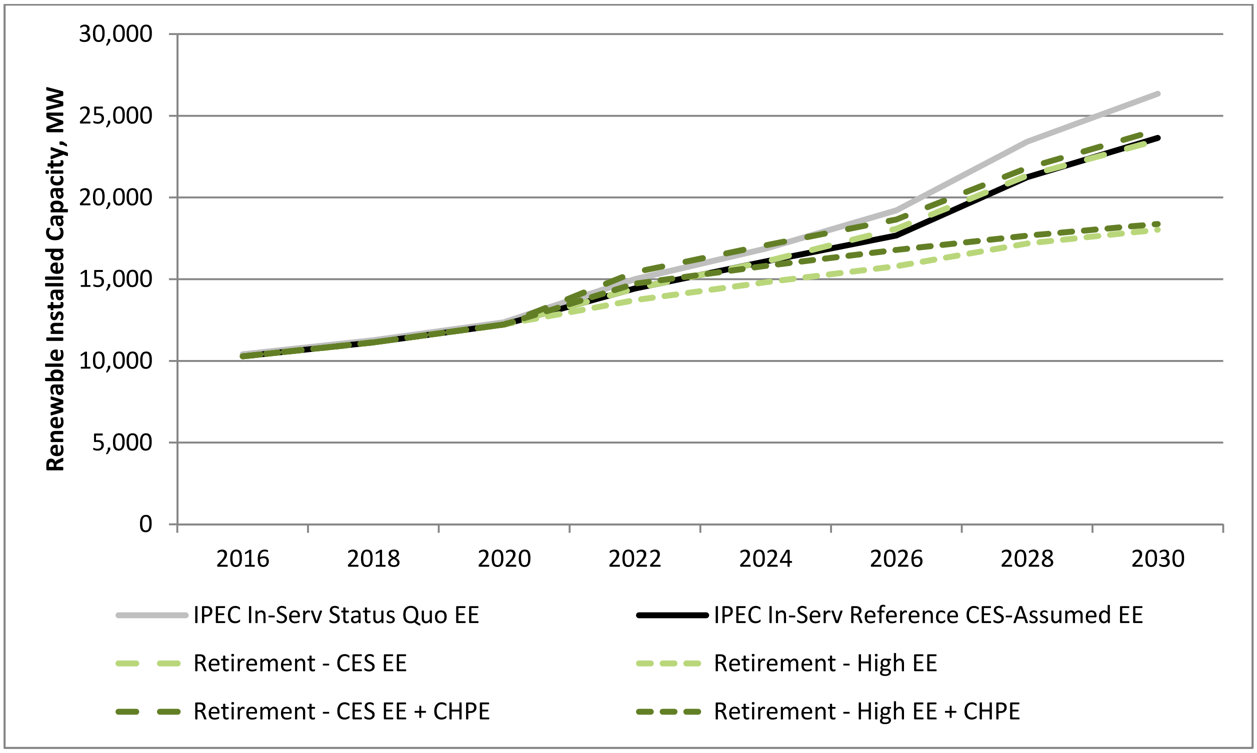
Source: Synapse Energy Economics. ReEDS modeling results.

Table 10 above shows results of our modeling of the four retirement scenarios analyzed, using the same IPEC retirement path (one unit in 2020 and one unit in 2021). They differ in the levels of energy efficiency implementation, and also in regard to the presence of the CHPE resource coming into service in 2022, the first full year of IPEC absence.

The table illustrates a varying level of renewable capacity buildout, and later-year new gas buildouts. This is further illustrated by Figures 12 and 13 below.

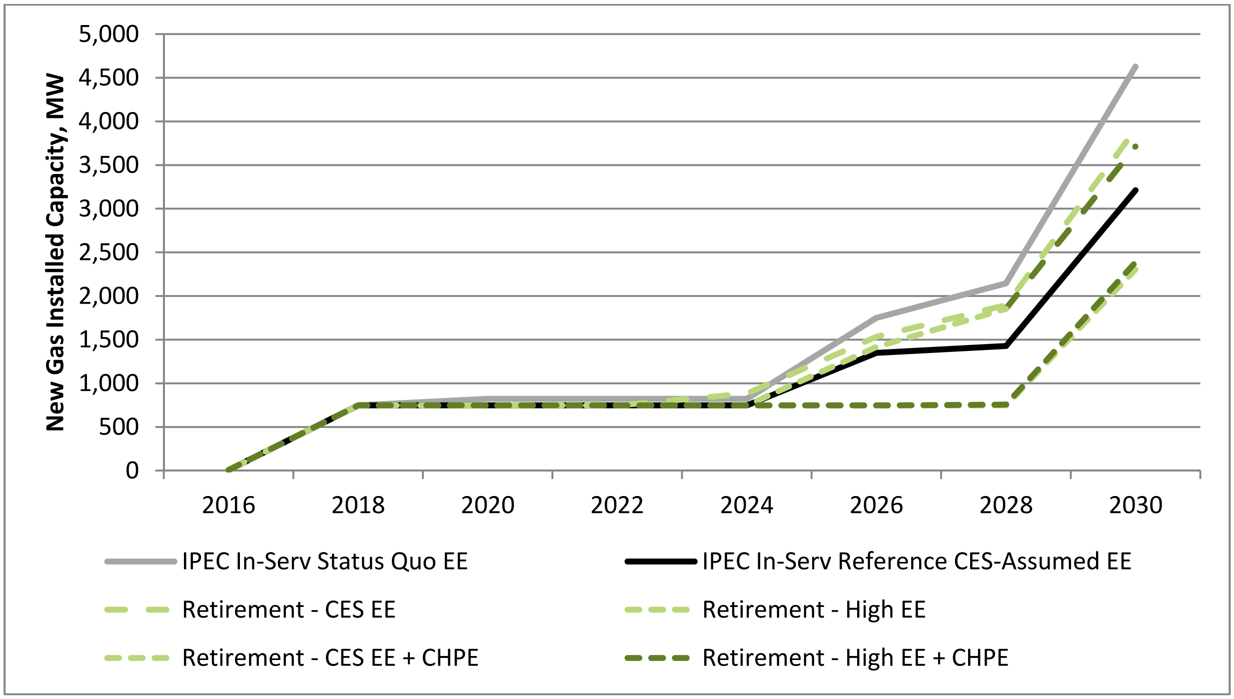
For further information, the appendix includes tables with the full breakout of installed capacity by individual resource type (nuclear, coal, existing gas, new gas, hydro, wind, solar, biomass, oil/gas steam, and imports).

Figure 12. Renewable installed capacity—existing and buildout—by scenario



Source: Synapse Energy Economics, ReEDS modeling.

Figure 13. New gas build outs by scenario



Note: High EE scenarios reflect combined cycle gas buildout in 2030 only, beyond committed gas units. Other scenarios reflect a combination of combined cycle and gas CT units. New gas buildout includes CPV. Source: Synapse Energy Economics. ReEDS modeling results.

Costs

New York State wholesale market costs are roughly $9–10 billion annually.[47] These costs consist broadly of energy, capacity and ancillary service, and uplift costs, but are dominated by energy and capacity costs. Total electric sector costs to deliver electricity to end-use consumers include transmission and distribution and related retail delivery charges. Together, these costs amounted to total New York electric sector costs of more than $20 billion in 2015.[48] Indian Point is an energy and capacity provider in the wholesale marketplace. The cost impact of the retirement of IPEC ultimately realized by consumers will depend largely on the costs associated with how electricity markets respond to the replacement energy and capacity that will be necessitated by IPEC's retirement in 2020 and 2021. This market response will include growth in renewable energy sources, which are being brought online in response to New York's CES renewable resource requirements; declining net load over time due to growth in energy efficiency and distributed solar resources; the effect of surplus capacity that now exists on the New York system; and planned transmission improvements that will allow greater transfers of energy and capacity between upstate and downstate New York.

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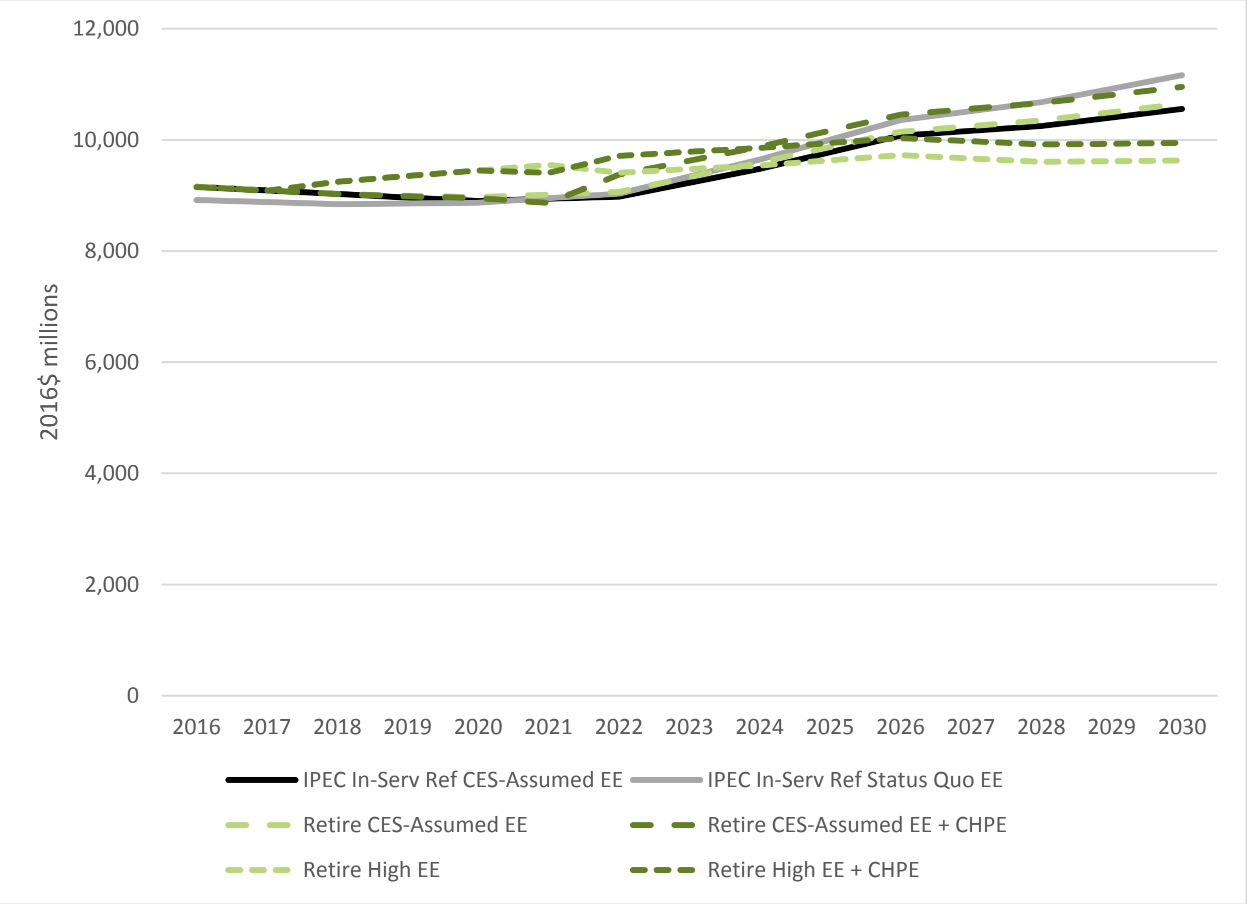
[47] Potomac Economics, *2015 State of the Market Report*, Page 3. Available at https://www.potomaceconomics.com/wp-content/uploads/2017/02/NYISO-2015-SOM-Report.pdf.

[48] EIA http://www.eia.gov/electricity/state/NewYork/.

In every scenario modeled, the future total system costs to operate NYISO's electric system increase from 2016 levels. As seen in Figure 14, the magnitude and timing of those increases in system costs vary by scenario, with the two high energy efficiency scenarios incurring higher system costs in early years before leveling out and finishing the study period well below the baseline efficiency scenarios. A comparison of the 15-year NPVs of each scenario is presented in Table 11.

Figure 14. Total system costs in New York by scenario



Source: Synapse Energy Economics. ReEDS modeling results plus Synapse estimates of non-ReEDS costs.

Table 11. Net Present Value of total New York system costs by scenario, 2016$ millions

		Change in NPV	
	NPV, $ millions, 2016-2030	Vs. Ref. CES EE	Vs. Status Quo
Status Quo EE IPEC In-Service	*103,585*		
Reference CES-Assumed EE IPEC In-Service	*102,724*		
Retire Ref CES-Assumed EE	103,393	0.7	-0.2%
Retire Ref CES -Assumed EE + CHPE	104,925	2.1	1.3%
Retire High EE	102,892	0.2	-0.7%
Retire High EE + CHPE	104,496	1.7	0.9%

Note: NPV at a 5 percent real discount rate. CHPE costs assumed to average $85/MWh (levelized cost, $2016). Emissions costs that could be attributed to non-Quebec imported energy are not included. Post-2030 effects not included.

The table above shows that the NPV of costs for IPEC retirement scenarios are lowest in the High EE scenario. In absolute terms, the NPV is 0.2 percent more costly than the reference CES-Assumed EE scenario, and that same retirement scenario is actually *less costly* than a scenario that assumes the status quo for energy efficiency resource implementation and IPEC in service. The table also shows the cost impacts of the other retirement scenarios.

Total system costs broken out by component are included in the appendix for all scenarios. Below, we show this breakout for the reference case IPEC In-Service scenario (CES-Assumed EE levels), and the scenario that assumes a high level of energy efficiency and the presence of the CHPE project.

Table 12. IPEC In-Service Reference (CES-Assumed EE) scenario, annual costs ($ millions)

	2016	2018	2020	2022	2024	2026	2028	2030
Stream of capital costs	150	278	327	635	1,318	2,007	2,649	3,417
Stream of fuel costs	2,495	2,407	2,422	2,250	2,140	2,092	1,780	1,631
Stream of FOM costs	1,801	1,761	1,698	1,680	1,783	1,916	1,955	1,999
Existing capacity costs	3,514	3,358	3,133	3,065	2,937	2,886	2,706	2,467
Canadian hydro	243	248	270	280	291	298	289	275
Imports	123	145	220	239	180	48	38	-61
Energy efficiency	829	829	829	829	829	829	829	829
Total costs	9,156	9,025	8,900	8,979	9,478	10,076	10,248	10,557

Table 13. High EE + CHPE retirement case, annual costs ($millions)

	2016	2018	2020	2022	2024	2026	2028	2030
Stream of capital costs	151	278	328	419	957	1,407	1,883	2,486
Stream of fuel costs	2,486	2,387	2,400	2,157	2,069	1,995	1,625	1,477
Stream of FOM costs	1,800	1,760	1,617	1,409	1,472	1,559	1,578	1,606
Existing capacity costs	3,514	3,358	3,059	2,866	2,739	2,688	2,508	2,269
Canadian hydro	243	248	270	875	886	893	884	870
Imports	127	140	258	312	132	-43	-23	-162
Energy efficiency	829	1,074	1,518	1,674	1,601	1,531	1,464	1,402
Total	9,151	9,245	9,450	9,712	9,856	10,030	9,919	9,946

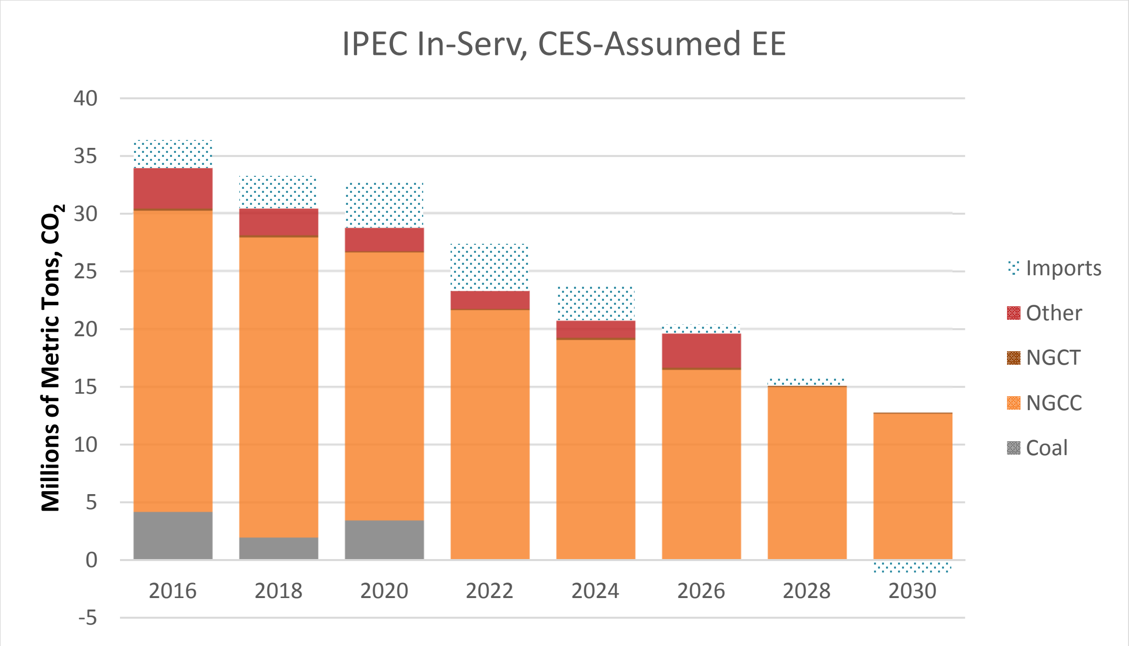
As shown in the above tables, the costs for energy efficiency and Canadian hydro (which includes CHPE) are higher in the retirement scenario with higher energy efficiency and CHPE. Compared to the In-Service case, fuel and fixed O&M costs decline over time. The stream of capital costs declines in the retirement case because lower load (through energy efficiency effects) leads to a lower requirement in CES resource buildout. The cost of non-Quebec imports rises in the immediate year of and just after IPEC retirement (relative to the In-Service case), but drops below the In-Service case by 2024, reflecting the cumulative effects of energy efficiency and the annual output of CHPE energy provision being greater than IPEC output by then.

CO_2 Emissions

As shown in Figures 15 and 16 below, in-state New York emissions decline from 2016 levels in both the reference scenario (IPEC In-Service, CES-Assumed EE levels) and the High EE, CHPE scenario.

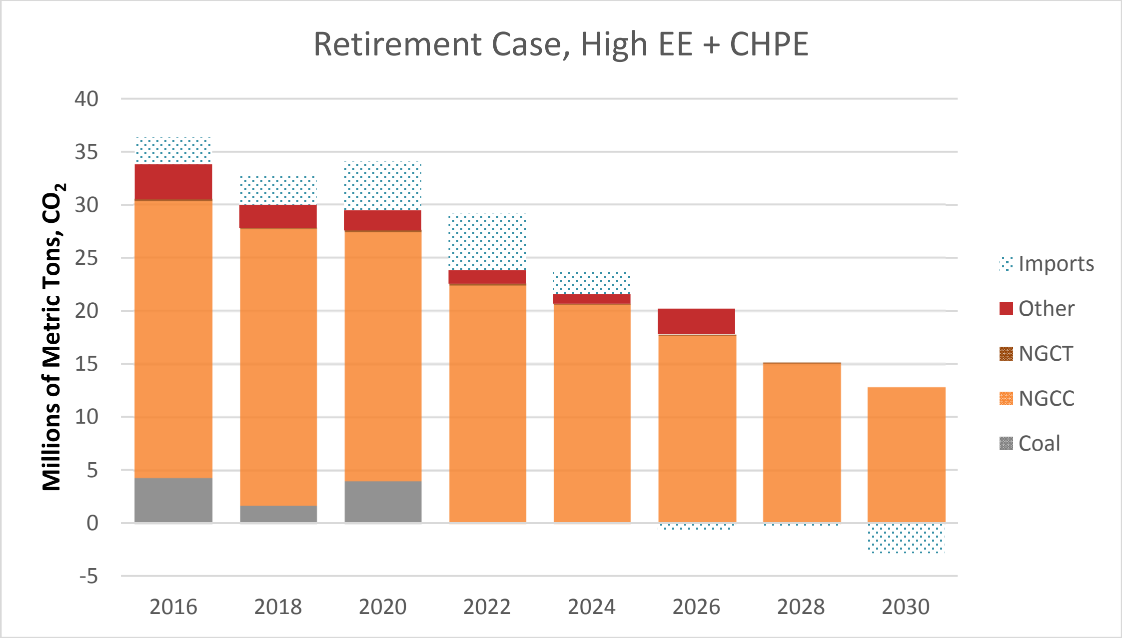
Figure 17 illustrates that in order to maximize emissions reduction, including those associated with imported energy, aggressive levels of energy efficiency and the production of additional renewable energy (modeled in this case as the energy associated with the CHPE project) is required.

Figure 15. Reference case CO_2 emissions – IPEC In-Service, CES-Assumed EE



Source: Synapse Energy Economics. ReEDS modeling results.

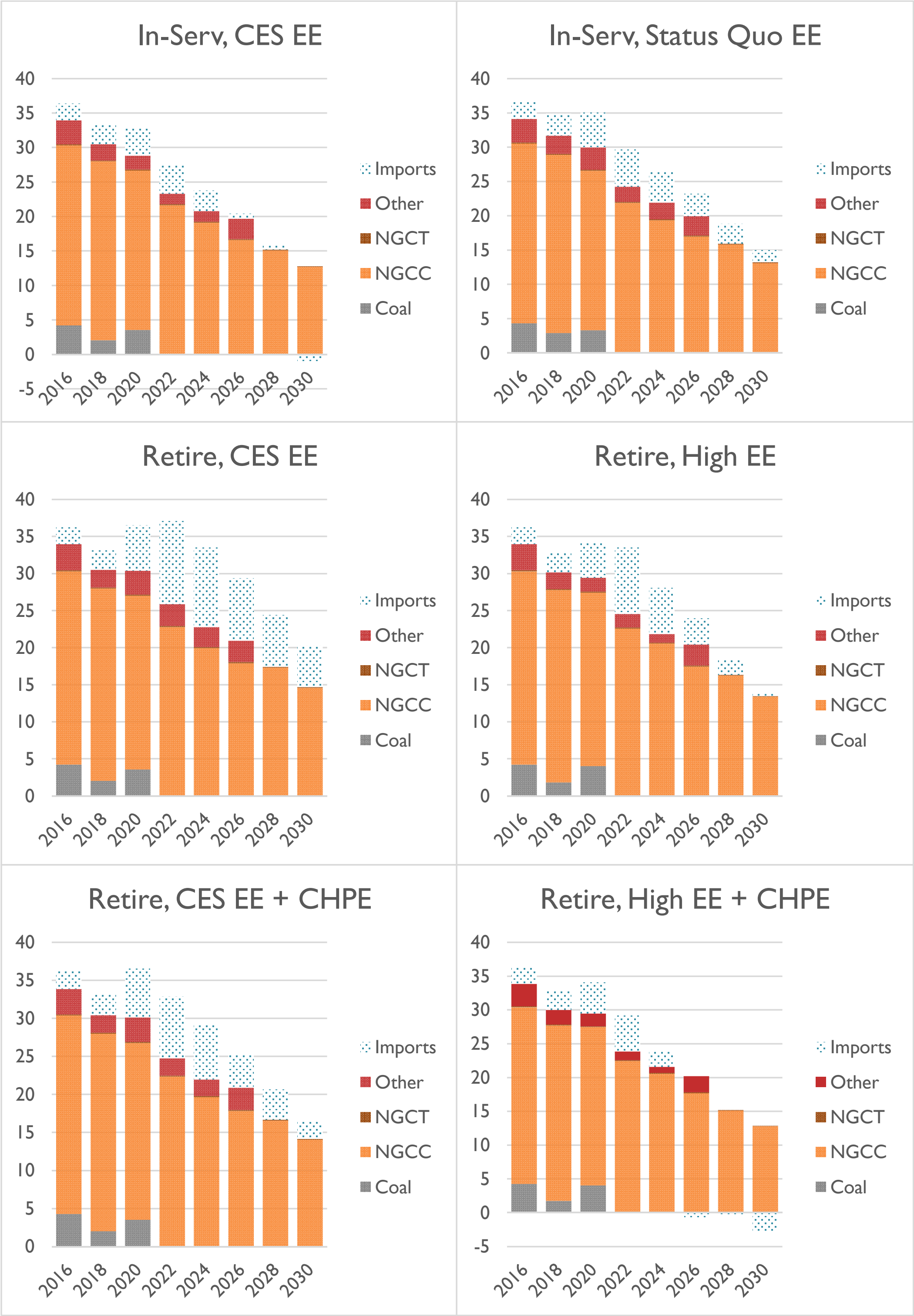
Figure 16. High EE and CHPE Retirement scenario CO_2 emissions



Source for Figures 16 and 17: ReEDS modeling output and Synapse estimation of emissions associated with non-Quebec imports.

As shown in Figure 17, below, which allows for an all-scenario high-level view of CO_2 emission patterns over time, in-state New York emissions decline substantially in every scenario modeled, and emissions associated with imports vary across scenarios. This decline is largely driven by the in-state requirement to meet half of load with renewables by 2030 in addition to the declining RGGI cap.

Figure 17. In-state New York CO_2 emissions by scenario, million metric tons



3. CAPACITY AND RELIABILITY

New York currently projects surplus installed capacity through 2026 relative to the New York ISO's required reserve margin.[49] With IPEC out of service in 2022, this surplus is eroded; however, there is no need to fully replace the 2,060 MW IPEC station with an equivalent amount of new capacity. Roughly 1,150 MW of New York's current surplus (more than the output of one of IPEC's units) could disappear from the lower Hudson Valley this year and reliability would still be maintained.[50] By 2022, the first full year of IPEC retirement, peak load projections in New York state will have continued to decline,[51] new resources will be online—both under-construction gas-fired resources and new renewable resources—and additional transmission support between upstate and downstate New York will likely be in place.[52] All told, these factors mitigate against reliability concerns that might otherwise arise with the loss of such a large source of capacity. In short, peak load reductions through energy efficiency, continuing development and deployment of distributed solar PV generation, deployment of larger-scale renewable resources, and transmission system reinforcement all point to no additional need for large-scale gas-fired generation or storage resource requirements to replace IPEC until later in the decade of the 2020s when older oil and gas steam units are likely to retire. Our ReEDS modeling reflects this.

Reliability is assessed by the New York ISO regularly, and the NYISO issues a formal report, the Reliability Need Assessment (RNA), every two years. In October 2016, the NYISO released its latest findings, which indicated an increase in surplus capacity in New York State in 2016 compared to its findings in the previous 2014 report.[53] This change that occurred from 2014 to 2016 is notable because it arises primarily from a finding that the peak load forecast for New York has declined considerably—by 2,300 MW for 2021—compared to the analysis performed in 2014. This change is attributed to the deployment of two critical resources—energy efficiency improvements and installation of distributed "behind-the-meter" solar PV resources. These findings show that, after accounting for these resources, the net peak load forecast for New York State is now in a declining, year-over-year pattern. This means that the aggregate level of energy required from all other resources on the grid—wind, nuclear, gas, hydro, imports, oil, large scale solar—will be lower over time, relative to 2016.

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[49] New York ISO 2016 Gold Book, Table V-2a: NYCA Load and Capacity Schedule—Summer Capability Period, "Installed Reserve Percent", Page 78.

[50] New York ISO, 2016 Reliability Needs Assessment, zonal capacity at risk (page 44).

[51] For example, at the end of 2016, NYISO's projection for peak load in New York in 2017 was already lower than was indicated in the 2016 Gold Book. Increases in New York State efficiency programs pursuant to the CES, and continuing installation of small-scale behind-the-meter solar PV will drive NYISO net peak load reductions—for any given year in the future—to lower levels than the current forecast vintage indicates.

[52] Pursuant to the so-called "AC Proceedings" at the New York Public Service Commission, where an increase in upstate to downstate transfer capacity of roughly 1,000 MW is planned for the 2020-2021 timeframe.

[53] New York ISO, 2016 Reliability Needs Assessment. October 18, 2016. http://www.nyiso.com/public/webdocs/media_room/press_releases/2016/Child_2016_RNA/2016RNA_Final_Oct18_2016.pdf.

The NYISO also analyzed a scenario with IPEC retired. It found, not surprisingly, that if both units at IPEC were retired (essentially immediately) *with no additional supply or demand-side resource considerations*, there would be a reliability violation. It is important to note that the violation for the year of retirement was only half of what it was in its 2014 study, and as with all such resource adequacy studies it only indicated an elevated statistical chance of a resource shortage rather than a guaranteed shortfall of needed capacity. However, IPEC retirement will not occur in a vacuum. We now have three years lead time for just the first half of its retirement; and many resources are available to make up any shortfall in requirements, in line with the structure and intent of the NYISO capacity market construct. The selection of the specific resources to meet any needs will depend on market forces and the time available between an announced retirement and the actual retirement.

In 2017, NYISO will complete its Comprehensive Reliability Plan (CRP) to determine what level of new capacity is needed to ensure a reliable level of resources upon IPEC retirement in 2020/2021. In the 2014 study, the amount of downstate resource required in 2016 for a 2016 shortfall due to full IPEC retirement was 500 MW, although updated load forecasts effectively reduced this amount to 134 MW. 134 MW of shortfall capacity would have been attainable through the market in a very short timeframe, certainly less than one year, if not sooner. The amount of resource requirement for a 2017 retirement would have been lower than 500 MW because the reliability violation indicated in the 2016 RNA was substantially less than what was seen in the 2014 report. Already, in 2017, the load forecast information that the NYISO used to conduct the 2016 RNA is outdated, as the 2017 peak load forecast is 180 MW lower than it was for 2017 when the RNA was conducted.[54]

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[54] NYISO, 2017 ICAP Load Forecast, December 2016. Available at: http://www.nyiso.com/public/webdocs/markets_operations/committees/bic_icapwg_lftf/meeting_materials/2016-12-20/2017_ICAP_Final.pdf. As compared to 2016 Gold Book peak load forecast for 2017, page 11 of the Gold Book. Available at http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2016_Load__Capacity_Data_Report.pdf.

4. CONCLUSIONS

Retirement of the Indian Point nuclear facility will occur during New York State's sweeping transition to use of cleaner electricity generation sources and, with appropriate policy mechanisms, increasing efficiency of electricity use. Our analysis of replacement energy and capacity resources necessarily accounts for this transition; and it demonstrates the critical importance of energy efficiency improvements to effectively displace increasing proportions of IPEC's output during the next decade. New York will require an aggressive energy efficiency policy framework in order to secure the improvements needed to obtain either the "CES-assumed" or the "high efficiency" scenarios we model in this analysis.

Critically, such a policy framework is not currently in place in New York for attaining the levels of energy efficiency contemplated in five of the six scenarios considered in this analysis. Only the IPEC in-service status quo EE case is likely to reach its assumed levels of energy efficiency without further regulatory support. The levels of energy efficiency assumed in the CES order have no binding mechanisms, other than the ETIPs approved for each of the utilities. These ETIPs require only a small fraction of the 2,227 GWh annual incremental savings that are assumed by the CES order and reflected in the CES-assumed efficiency scenarios modeled herein. No such enforceable mechanism exists for NYSERDA or for the non-jurisdictional entities (NYPA, LIPA, and direct NYISO customers). And while even higher levels of energy efficiency are possible, consistent with our High EE scenarios, New York must implement immediate and vigorous policy measures in order to reach them. Relying on market-based initiatives and third-party developers to animate markets for energy efficiency, as has been the NY Commission's stated preference, is unlikely to result in these high efficiency levels on its own. Proven program and procurement methods must also be used. Policies to support higher energy efficiency levels could include, for example, setting higher energy efficiency savings targets and establishing effective shareholder performance incentive mechanisms.

The effect of the 50 by '30 renewable energy policy initiatives is seen in our modeling through the buildout of increasing amounts of solar and wind energy through 2030, including our "hard-wired" provision of the State's offshore wind goals for 2030. The effect of this buildout is to increase New York's reliance on renewable energy (inclusive of in-State hydro and existing Quebec imports) to upwards of 70 million MWh per year by 2030 in the CES-assumed EE scenarios, with the ultimate level of renewable energy deployed in our modeling exercise dependent on the total load in the state. The less costly buildout scenario is the one where the most aggressive levels of energy efficiency are first implemented. The impact of such renewable energy increases is seen in the generally continuing decline in fossil-fuel generated electricity, and declining CO2 emissions, in all of our retirement scenarios.

We have modeled the amount of renewables in alignment with New York CES policy, but accelerated production of renewable energy above the levels considered by the 50 by '30 policy could be achieved with additional effort. Two retirement scenarios we modeled included the presence of a roughly 7 million MWh/year CHPE project, which serves to demonstrate a scenario with that specific project but can also be considered a proxy scenario for increases in low-carbon energy beyond that called for in the

CES 50 x ’30 requirement. New York could choose to more rapidly expand its production of renewable solar and wind energy beyond what the 50 by ’30 trajectory calls for. Our modeling, using the CHPE project as a proxy, shows that such scenarios would incur only modest cost increases beyond what would otherwise occur with the current trajectory to meet 2030 renewable requirements.

The overall cost impact (as measured by the NPV of wholesale costs over 15 years) of retiring the IPEC facility is minimal, and if New York can successfully attain best practices in utility program energy efficiency implementation, IPEC retirement scenarios would be less costly that what would be seen under current, status quo levels of energy efficiency implementation. Using a CES-assumed level of energy efficiency improvement as a baseline, the overall wholesale costs of a retirement scenario that deploys aggressive levels of energy efficiency is only 0.2% higher than that baseline, based on a 15-year NPV assessment. Even under assumptions that only a CES-assumed level of EE improvement could be attained, IPEC retirement costs (15-year wholesale NPV) are only 0.7% above the reference in-service scenario.

New York State carbon emissions can continue on their downward trajectory without IPEC. The combined effect of aggressive energy efficiency and 50 x ’30 renewables deployment modeled in our retirement scenarios is ongoing decreases in the use of fossil fuels to generate electricity in New York and the need for energy imports from nearby fossil-intensive regions like PJM. We have shown that New York can easily exceed its electric sector greenhouse gas emission reduction goals by 2030 by deployment of energy efficiency and renewable energy in place of the IPEC facility.

Appendix

The ReEDS Model

ReEDS is a long-term capacity expansion and dispatch model of the electric power system in the lower 48 states. It has a high level of renewable energy resource detail with many wind and solar resource regions, each with availability by resource class and unique grid connection costs. Model outputs include generation, capacity, transmission expansion, capital and operating costs, and emissions of CO_2, SO_2, NO_X, and mercury.[55] The model operates through 2050 in two-year steps, with each two-year period divided into 17 time slices. These time slices represent morning, afternoon, evening, and night in each of the four seasons, plus an additional summer peak time slice representing the 40 highest demand hours of the summer. The time slices represent the windows of 10 p.m. to 6 a.m., 6 a.m. to 1 p.m., 1 p.m. to 5 p.m., and 5 p.m. to 10 p.m. in each season. ReEDS includes data on the existing fossil fuel facilities in each of the model's 134 Power Control Areas (PCAs). New York State is represented by two PCAs.

ReEDS benefits from NREL's detailed data sets on renewable resource potentials and constraints across the country, providing a higher level of resolution than similar industry models. Wind resources are modeled in 356 regions of the United States (with 10 in New York), based on high-resolution wind speed modeling and taking into account environmental and land-use exclusions. Biomass, geothermal, solar PV, and hydropower plants are built at the resolution of the model's 134 PCAs.

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[55] Short et al. 2010. Regional Energy Deployment System (ReEDS). Available at: http://www.nrel.gov/docs/fy12osti/46534.pdf.

New York’s Clean Energy Standard

On August 1, 2016, the Public Service Commission of New York passed an Order adopting a state-wide Clean Energy Standard in order to achieve the State Energy Plan’s goal of generating 50 percent of the state’s electricity demand from renewables by 2030. Citing the impacts of climate change already felt by the state of New York and the numerous quantifiable and unquantifiable benefits associated with shifting towards zero-emission sources of generation, the Commission’s order is strong and unwavering, marking a firm commitment to these policies.

The order adopting the CES calls for a ramp-up period towards the 2030 requirement. During the early years of the policy, in-state Load Serving Entities are required to procure incremental new renewable generation to cover from 0.6 percent of retail load in 2017 to 4.8 percent of retail load in 2021. These are values of required *incremental* new renewable generation to be procured, not *total* renewable generation required by year. From 2022 through 2030, the Commission plans to establish more substantial annual targets with an upward sloping trajectory.

In order to be eligible to count toward the 50 by ‘30 requirement, a renewable resource must deliver into NYISO. Accordingly, resources can help achieve compliance with the CES only if they are procured or currently exist in-state, or are located in adjacent control areas to New York (i.e., PJM or ISO-NE) and possess a documented contract path for delivery of that energy specifically to New York. This exemption for resources from adjacent control areas does not apply to imported hydro energy. Further, compliance can be achieved by a wide variety of resources: utility and distributed solar, onshore and offshore wind, biogas, biomass, liquid biofuels, fuel cells, and tidal/ocean energy are all eligible resources.[56] In our modeling of the CES, however, we focus specifically on utility and distributed PV in addition to onshore and offshore wind for compliance. The reason for this is that they are the resources that currently have the best economics and are the most likely to be procured in New York. While we include scenarios with the Champlain Hudson Power Express project, we do not count that project’s output as contributing to meeting the CES order requirements for renewable energy.

Notably, the CES does not afford special status to energy efficiency, electric vehicles, storage resources or heat pumps at this time. The only way in which efficiency can contribute towards CES compliance is by reducing in-state, or LSE-specific annual load. When load is reduced, the overall requirement for producing renewable generation is lowered, as the percent targets are mapped to lower future net loads.

Further, while nuclear resources cannot contribute to the 50 by ‘30 renewables mandate, their ability to provide zero emission energy is recognized through the Zero Energy Credit (ZEC) program passed within the CES. The ZEC obligation is an additive program designed specifically to reduce emissions beyond the impact of the renewable energy portion of the CES. The prices of ZECs are pre-established and guaranteed between 2017 and 2022, but will be up for review at that point for the remainder of the CES.

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[56] See Appendix A to the CES order for resource eligibility.

As a result of this provision, we model a reference case in which all upstate nuclear units remain online through 2030.

Detailed Modeling Results – Additional Tables

Energy/Generation

Table A1. Reference case (CES EE) IPEC in-service generation, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6
Coal	4.3	2.1	3.6	0.0	0.0	0.0	0.0	0.0
Gas	61.4	56.7	50.3	46.8	40.8	34.6	31.0	15.2
New Gas	0.0	5.1	5.1	5.1	5.1	5.5	5.5	17.0
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	8.2	13.6	18.8	21.8	23.9
Solar	0.3	0.3	0.3	0.3	0.3	0.3	2.5	5.2
DG PV	1.2	2.3	3.7	5.6	5.9	6.1	6.3	6.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	6.0	4.6	4.1	3.5	3.5	5.3	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Load	161.0	159.8	157.7	155.0	152.9	150.6	148.3	146.1

Table A2. Status Quo EE IPEC in-service reference case generation, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	42.6	42.6	42.6	42.6	42.6	42.6
Coal	4.4	2.9	3.4	0.0	0.0	0.0	0.0	0.0
Gas	61.6	56.9	50.6	47.4	41.4	34.7	31.9	13.7
New Gas	0.0	5.1	5.1	5.2	5.2	6.4	6.5	19.7
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	9.7	16.0	20.8	23.9	26.8
Solar	0.5	0.5	0.5	0.5	0.5	1.9	5.0	8.3
DG PV	1.2	2.3	3.7	5.6	5.9	6.1	6.3	6.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	5.9	4.9	5.7	4.4	4.7	5.1	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Load	161.8	162.1	161.5	160.4	159.9	159.2	158.5	157.9

Table A3. Retire scenario, reference CES EE, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	36.5	26.2	26.2	26.2	26.2	26.2
Coal	4.3	2.1	3.6	0.0	0.0	0.0	0.0	0.0
Gas	61.4	56.7	51.1	49.5	42.8	33.5	32.0	14.2
New Gas	0.0	5.1	5.1	5.1	5.2	10.3	10.3	23.1
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	8.2	13.6	17.6	21.0	23.7
Solar	0.3	0.3	0.3	0.3	0.3	1.5	3.3	5.4
DG PV	1.2	2.3	3.7	5.6	5.9	6.1	6.3	6.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	6.0	4.6	5.7	5.3	5.0	5.3	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Load	161.0	159.8	157.7	155.0	152.9	150.6	148.3	146.1

Table A4. Retire scenario, High EE, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	36.5	26.2	26.2	26.2	26.2	26.2
Coal	4.3	1.9	4.1	0.0	0.0	0.0	0.0	0.0
Gas	61.4	56.7	50.9	49.0	44.3	36.9	34.0	16.4
New Gas	0.0	5.1	5.1	5.1	5.1	5.1	5.1	17.4
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	5.3	8.8	11.9	14.8	17.8
Solar	0.2	1.1	2.6	4.4	4.7	5.0	5.2	5.4
DG PV	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	6.0	4.4	3.9	3.9	3.0	5.2	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Load	161.0	159.1	153.9	146.5	140.2	134.0	128.3	122.9

Table A5. Retire scenario, CHPE, reference EE, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	36.5	26.2	26.2	26.2	26.2	26.2
Coal	4.4	2.1	3.6	0.0	0.0	0.0	0.0	0.0
Gas	61.5	56.7	50.6	48.5	42.1	35.7	32.7	14.8
New Gas	0.0	5.1	5.1	5.1	5.1	7.6	7.6	21.0
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	8.2	13.6	18.8	22.0	24.3
Solar	0.3	0.3	0.3	0.3	0.3	0.3	2.2	4.8
DG PV	1.2	2.3	3.7	5.6	5.9	6.1	6.3	6.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	5.7	4.5	5.7	4.4	4.3	5.3	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	7.0	7.0	7.0	7.0	7.0
Load	161.0	159.8	157.7	155.0	152.9	150.6	148.3	146.1

Table A6. Retire scenario, CHPE, High EE, TWh

	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	42.6	42.6	36.5	26.2	26.2	26.2	26.2	26.2
Coal	4.4	1.8	4.1	0.0	0.0	0.0	0.0	0.0
Gas	61.5	56.7	51.0	48.7	44.3	37.5	31.4	14.6
New Gas	0.0	5.1	5.1	5.1	5.1	5.1	5.1	17.9
Hydro	27.4	27.4	27.4	27.4	27.4	27.4	27.4	27.4
Wind	5.0	5.2	5.2	5.3	8.8	11.9	14.7	17.2
Solar	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
DG PV	1.2	2.3	3.7	5.6	5.9	6.1	6.3	6.5
Biopower	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oil-Gas-Steam	5.7	4.3	3.9	3.1	2.6	4.6	1.5	1.5
Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canadian Hydro	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
CHPE	0.0	0.0	0.0	7.0	7.0	7.0	7.0	7.0
Load	161.0	159.1	153.9	146.5	140.2	134.0	128.3	122.9

Capacity

Table A7. Reference Case (CES EE) IPEC In-Service, ICAP Capacity, MW

Reference	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	5,383	5,383	5,383	5,383	5,383	5,383
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	747	747	747	1,347	1,426	3,212
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	2,566	3,930	5,282	5,985	6,420
Solar	200	200	200	200	200	200	1,550	3,287
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	2,727	2,727
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	0	0	0	0	0
ICAP Total	38,810	38,773	37,531	39,013	39,336	40,993	42,768	44,466

Notes: 2020 nuclear capacity reflects a proportionate derating associated with the first unit retirement in April. Canadian hydro capacity level based on external import capacity value. The wind category reflects hard-wiring of offshore wind resources in the model based on 2,400 MW by 2030, starting with 600 MW in 2024, increasing to 1200 MW by 2026 and 1800 MW by 2028.

Table A8. Reference case Status Qou EE, IPEC in-service, ICAP capacity, MW

Reference, Low EE	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	5,383	5,383	5,383	5,383	5,383	5,383
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	822	822	822	1,750	2,144	4,628
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	3,003	4,590	5,825	6,566	7,207
Solar	331	331	331	331	331	1,195	3,139	5,203
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	2,727	2,727
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	0	0	0	0	0
ICAP Total	38,942	38,905	37,738	39,658	40,203	42,934	45,657	48,586

Table A9. Retirement scenario, reference load (CES EE) ICAP capacity, MW

Retire, Ref Load	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	747	747	883	1,534	1,896	3,910
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	2,565	3,926	4,937	5,770	6,336
Solar	200	200	200	200	200	956	2,044	3,406
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	2,546	2,546
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	0	0	0	0	0
ICAP Total	38,810	38,773	36,766	36,949	37,403	39,526	41,273	42,955

Table A10. Retirement scenario, high energy efficiency, ICAP capacity, MW

Retire, High EE	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	747	747	747	747	747	2,304
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	1,860	2,663	3,401	4,102	4,710
Solar	200	200	200	200	200	200	200	200
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	1,905	1,905
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	0	0	0	0	0
ICAP Total	38,810	38,773	36,766	36,243	36,004	36,447	35,970	35,877

Table A11. Retirement scenario, CHPE, reference load (CES EE) ICAP capacity, MW

Retire, CHPE, Ref	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	747	747	747	1,416	1,854	3,712
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	2,565	3,925	5,263	6,055	6,490
Solar	200	200	200	200	200	200	1,371	3,030
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	2,403	2,403
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	1,000	1,000	1,000	1,000	1,000
ICAP Total	38,810	38,773	36,766	37,949	38,266	39,978	41,700	43,392

Table A12. Retirement scenario, CHPE, high energy efficiency ICAP capacity, MW

Retire, CHPE, EE	2016	2018	2020	2022	2024	2026	2028	2030
Nuclear	5,383	5,383	4,618	3,319	3,319	3,319	3,319	3,319
Coal	925	925	232	0	0	0	0	0
Gas	12,890	12,355	12,069	12,001	11,578	11,048	10,334	9,816
New Gas	7	747	747	747	747	747	756	2,386
Hydro	4,682	4,682	4,682	4,682	4,682	4,682	4,682	4,682
Wind	1,782	1,824	1,824	1,860	2,662	3,398	4,081	4,562
Solar	200	200	200	200	200	200	200	200
DG PV	948	1,761	2,859	4,311	4,601	4,838	5,029	5,265
Biopower	164	164	164	164	164	164	164	164
Oil-Gas-Steam	9,324	8,226	6,865	6,454	5,545	5,543	4,388	2,412
Storage	1,407	1,407	1,407	1,407	1,407	1,407	1,407	1,407
Canadian Hydro	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
CHPE	0	0	0	1,000	1,000	1,000	1,000	1,000
ICAP Total	38,810	38,773	36,766	37,243	37,004	37,445	36,460	36,312

Imports

Table A13. Imports/Exports (Non-Quebec), TWh

Imports/Exports (+ is import into NY)

	2016	2018	2020	2022	2024	2026	2028	2030
Reference IPEC In-Service (CES EE)	4.0	4.7	6.5	6.8	4.9	1.3	1.1	-1.8
Reference IPEC In-Service Status Quo EE	4.4	5.4	8.5	9.0	7.6	5.5	4.8	3.0
Retire Ref CES EE	4.0	4.7	10.2	18.7	17.9	14.0	11.7	9.4
Retire High EE	4.0	4.4	7.8	14.9	10.4	5.9	3.6	0.5
Retire Ref CES EE + CHPE	4.2	4.8	10.7	13.6	12.2	7.4	6.6	3.8
Retire High EE + CHPE	4.2	4.5	7.7	8.9	3.6	-1.1	-0.6	-4.7

Costs

Table A14. Costs by Cost Category - $2016 millions

Reference CES EE	**IPEC In Service**														
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**9,156**	**9,090**	**9,025**	**8,961**	**8,900**	**8,939**	**8,979**	**9,229**	**9,478**	**9,777**	**10,076**	**10,162**	**10,248**	**10,401**	**10,557**
Stream of capital costs	150	214	278	303	327	481	635	976	1,318	1,662	2,007	2,328	2,649	3,033	3,417
Stream of fuel costs	2,495	2,451	2,407	2,414	2,422	2,336	2,250	2,195	2,140	2,116	2,092	1,936	1,780	1,706	1,631
Stream of FOM costs	1,801	1,781	1,761	1,730	1,698	1,689	1,680	1,732	1,783	1,849	1,916	1,935	1,955	1,977	1,999
Existing capacity costs	3,514	3,436	3,358	3,245	3,133	3,099	3,065	3,001	2,937	2,911	2,886	2,796	2,706	2,587	2,467
Canadian hydro	243	246	248	259	270	275	280	286	291	295	298	294	289	282	275
Imports	123	134	145	181	220	230	239	210	180	115	48	43	38	-13	-61
Energy efficiency	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829
Status Quo EE	**IPEC In Service**														
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**8,917**	**8,880**	**8,842**	**8,854**	**8,868**	**8,951**	**9,032**	**9,339**	**9,646**	**10,001**	**10,356**	**10,517**	**10,678**	**10,920**	**11,163**
Stream of capital costs	177	240	304	359	414	603	791	1,162	1,534	1,934	2,335	2,715	3,095	3,556	4,016
Stream of fuel costs	2,501	2,475	2,450	2,479	2,507	2,412	2,316	2,271	2,226	2,174	2,122	1,986	1,851	1,763	1,675
Stream of FOM costs	1,804	1,785	1,767	1,738	1,710	1,715	1,720	1,780	1,839	1,905	1,972	1,999	2,027	2,060	2,094
Existing capacity costs	3,519	3,441	3,363	3,250	3,138	3,104	3,070	3,006	2,942	2,916	2,891	2,801	2,711	2,592	2,472
Canadian hydro	243	246	248	259	270	275	280	286	291	295	298	294	289	282	275

Imports	132	150	168	225	287	301	316	297	277	241	204	188	173	137	102
Energy efficiency	541	542	543	543	542	541	538	537	537	536	534	533	532	531	530
RetireRef															
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**9,156**	**9,090**	**9,025**	**8,995**	**8,971**	**9,015**	**9,065**	**9,329**	**9,592**	**9,870**	**10,145**	**10,247**	**10,351**	**10,499**	**10,650**
Stream of capital costs	150	214	278	322	367	509	651	1,000	1,350	1,701	2,052	2,389	2,725	3,115	3,505
Stream of fuel costs	2,495	2,451	2,407	2,441	2,475	2,392	2,309	2,233	2,157	2,110	2,064	1,946	1,828	1,740	1,652
Stream of FOM costs	1,801	1,781	1,761	1,694	1,626	1,550	1,474	1,524	1,575	1,635	1,694	1,721	1,749	1,774	1,799
Existing capacity costs	3,514	3,436	3,358	3,208	3,059	2,963	2,866	2,803	2,739	2,713	2,688	2,598	2,508	2,388	2,269
Canadian hydro	243	246	248	259	270	275	280	286	291	295	298	294	289	282	275
Imports	123	134	145	241	345	498	656	654	652	587	521	471	422	370	322
Energy efficiency	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829
RetireRefCHPE															
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**9,151**	**9,087**	**9,023**	**8,984**	**8,953**	**8,865**	**9,374**	**9,625**	**9,876**	**10,166**	**10,454**	**10,558**	**10,663**	**10,807**	**10,953**
Stream of capital costs	151	214	278	314	350	497	643	983	1,322	1,668	2,014	2,353	2,691	3,075	3,460
Stream of fuel costs	2,486	2,444	2,401	2,430	2,458	2,338	2,219	2,154	2,090	2,071	2,051	1,906	1,760	1,680	1,600
Stream of FOM costs	1,800	1,780	1,761	1,693	1,624	1,545	1,466	1,516	1,566	1,634	1,703	1,727	1,751	1,774	1,796
Existing capacity costs	3,514	3,436	3,358	3,208	3,059	2,963	2,866	2,803	2,739	2,713	2,688	2,598	2,508	2,388	2,269

Canadian hydro	243	246	248	259	270	275	875	881	886	890	893	889	884	877	870
Imports	127	138	148	251	362	418	475	460	444	361	276	258	239	183	129
Energy efficiency	829	829	829	829	829	829	829	829	829	829	829	829	829	829	829
RetireHighEE															
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**9,156**	**9,089**	**9,247**	**9,353**	**9,450**	**9,550**	**9,409**	**9,474**	**9,539**	**9,633**	**9,726**	**9,665**	**9,606**	**9,617**	**9,632**
Stream of capital costs	150	214	278	303	327	384	441	702	964	1,191	1,418	1,657	1,895	2,206	2,517
Stream of fuel costs	2,495	2,445	2,394	2,395	2,396	2,303	2,211	2,151	2,091	2,051	2,012	1,870	1,729	1,631	1,533
Stream of FOM costs	1,801	1,781	1,760	1,688	1,616	1,516	1,415	1,445	1,475	1,518	1,561	1,574	1,588	1,605	1,621
Existing capacity costs	3,514	3,436	3,358	3,208	3,059	2,963	2,866	2,803	2,739	2,713	2,688	2,598	2,508	2,388	2,269
Canadian hydro	243	246	248	259	270	275	280	286	291	295	298	294	289	282	275
Imports	123	129	135	196	263	390	522	451	377	299	220	175	132	72	16
Energy efficiency	829	839	1,074	1,303	1,518	1,718	1,674	1,636	1,601	1,566	1,531	1,497	1,464	1,433	1,402
RetireHighEECHPE															
NY Total	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total costs	**9,151**	**9,085**	**9,245**	**9,352**	**9,450**	**9,406**	**9,712**	**9,785**	**9,856**	**9,944**	**10,030**	**9,974**	**9,919**	**9,930**	**9,946**
Stream of capital costs	151	214	278	303	328	373	419	688	957	1,182	1,407	1,645	1,883	2,184	2,486
Stream of fuel costs	2,486	2,437	2,387	2,394	2,400	2,279	2,157	2,113	2,069	2,032	1,995	1,810	1,625	1,551	1,477
Stream of FOM costs	1,800	1,780	1,760	1,688	1,617	1,513	1,409	1,441	1,472	1,515	1,559	1,568	1,578	1,592	1,606

Existing capacity costs	3,514	3,436	3,358	3,208	3,059	2,963	2,866	2,803	2,739	2,713	2,688	2,598	2,508	2,388	2,269
Canadian hydro	243	246	248	259	270	275	875	881	886	890	893	889	884	877	870
Imports	127	134	140	197	258	285	312	224	132	46	-43	-33	-23	-95	-162
Energy efficiency	829	839	1,074	1,303	1,518	1,718	1,674	1,636	1,601	1,566	1,531	1,497	1,464	1,433	1,402
Total	**9,151**	**9,085**	**9,245**	**9,352**	**9,450**	**9,406**	**9,712**	**9,785**	**9,856**	**9,944**	**10,030**	**9,974**	**9,919**	**9,930**	**9,946**

Table A15. Price Schedules for Costing Outside of ReEDS

	Price/cost schedules	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
$/kW-month	Capacity price schedule	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
$/MWh	Price of HQ imports	30.4	30.7	31.0	32.4	33.7	34.4	35.0	35.7	36.4	36.8	37.3	36.7	36.1	35.2	34.3
$/MWh	Cost of CHPE							85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
$/MWh	Price of imports	30.4	30.7	31.0	32.4	33.7	34.4	35.0	35.7	36.4	36.8	37.3	36.7	36.1	35.2	34.3

Table A16. Marginal Energy Prices – ReEDS - $/MWh

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
IPEC In-Service CES-Assumed EE (Reference)	$30.4	$30.7	$31.0	$32.1	$33.3	$33.8	$34.3	$35.1	$35.9	$36.4	$36.9	$36.4	$35.9	$35.0	$34.1
IPEC In-service Status Quo EE	$30.4	$30.8	$31.1	$32.4	$33.7	$34.1	$34.5	$35.3	$36.1	$36.6	$37.1	$36.4	$35.8	$34.9	$34.1
Retire CES-EE	$30.4	$30.7	$31.0	$32.4	$33.8	$34.7	$35.6	$36.2	$36.8	$37.1	$37.4	$36.8	$36.2	$35.3	$34.4
Retire High EE	$30.4	$30.7	$31.0	$32.3	$33.6	$34.3	$34.9	$35.6	$36.3	$36.8	$37.3	$36.8	$36.3	$35.3	$34.4
Retire CES-EE + CHPE	$30.4	$30.7	$31.0	$32.4	$33.8	$34.3	$34.8	$35.6	$36.3	$36.8	$37.2	$36.6	$36.1	$35.2	$34.3
Retire High EE + CHPE	$30.4	$30.7	$31.0	$32.3	$33.7	$34.2	$34.8	$35.4	$36.1	$36.6	$37.2	$36.6	$36.1	$35.2	$34.2