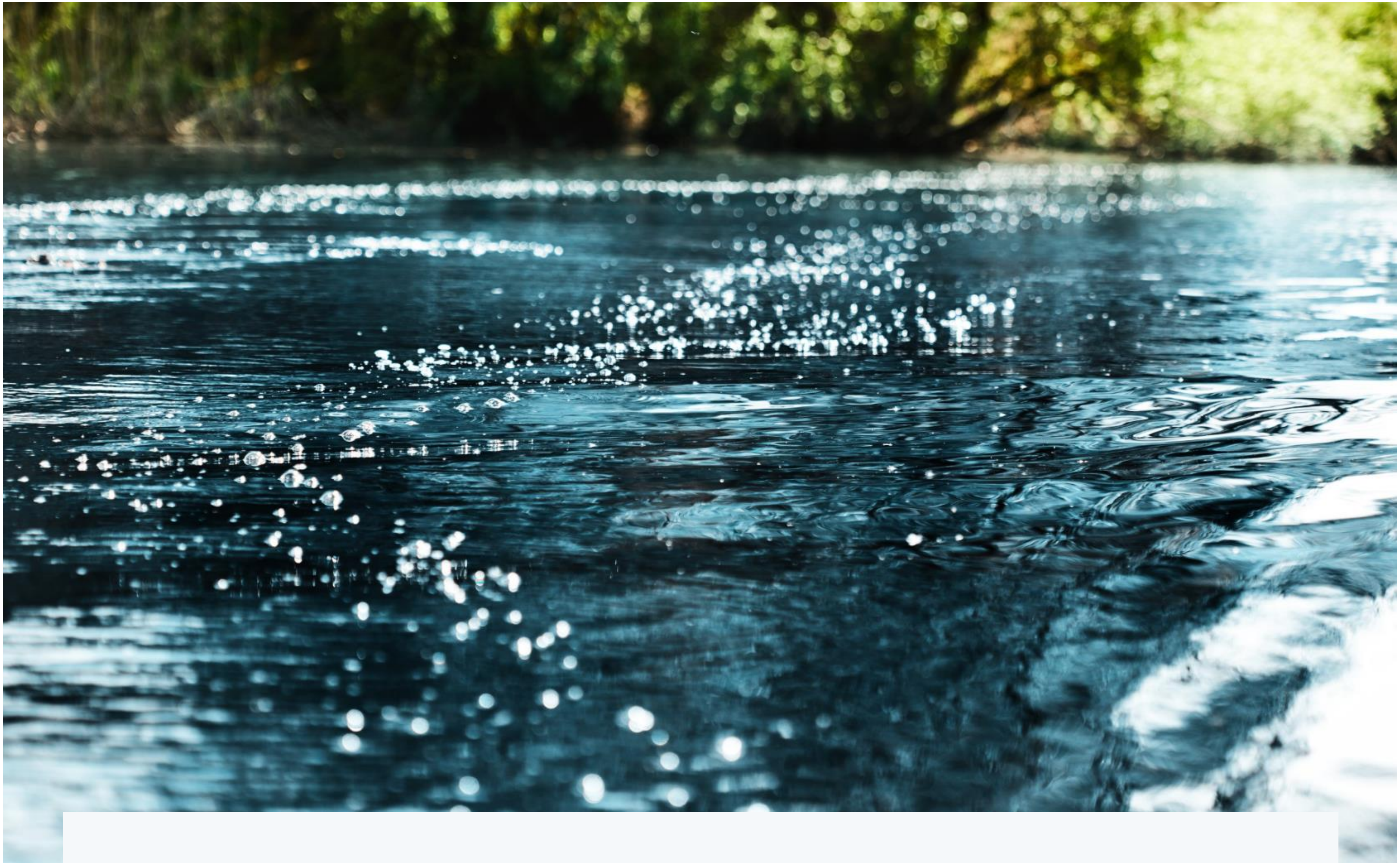

CHAMPLAIN HUDSON POWER EXPRESS

ANALYSIS OF ECONOMIC, ENVIRONMENTAL, RESILENCY AND RELIABILITY BENEFITS TO THE STATE OF NEW YORK

May 10, 2021

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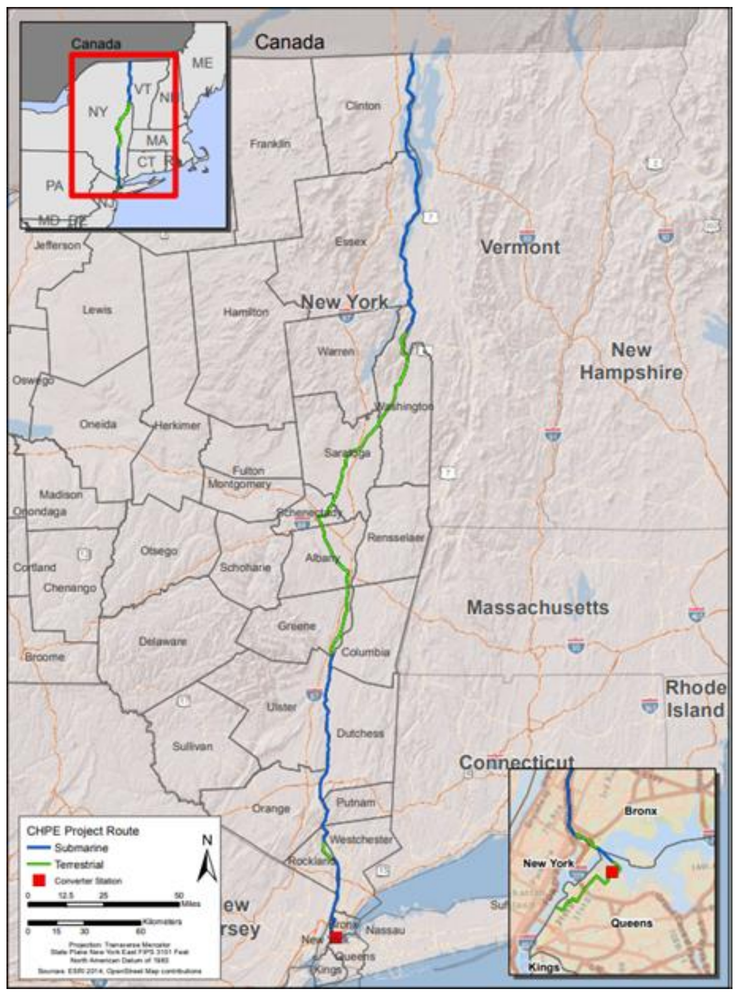
1 EXECUTIVE SUMMARY

This report has been prepared by PA Consulting Group ("PA") at the request of Transmission Developers, Inc. ("TDI") to analyze the economic, environmental, resiliency and reliability benefits from the Champlain Hudson Power Express project ("CHPE" or the "Project"). CHPE is a proposed electric transmission line that will run from the Canadian border to Queens, New York, which is within Zone J of the New York Independent System Operator ("NYISO") electricity system.

CHPE will run along underwater and underground routes with a planned commercial online date of December 2025 and an expected economic life of 60-80 years. See Figure 1 below for a map of CHPE's proposed route. The transmission line will utilize high voltage direct current ("HVDC") technology, capable of transmitting 1,250 megawatts ("MW") of clean energy with an estimated capacity factor of 95% (equivalent to 10.4 TWh per year) and 1,250 MW of firm capacity sales.[1] The electricity shipped through CHPE will be sourced from a pool of 61 hydroelectric power plants located in Québec, with an installed capacity totaling over 36,500 MW, nearly three times greater than Zone J's highest recorded electricity demand (approximately 11,500 MW).

Figure 1: CHPE Route



The underwater portions of CHPE, approximately 197 miles in length, will be submerged in Lake Champlain, the Hudson River, the East River, and the Harlem River. The overland (terrestrial) portions of the transmission line, approximately 142 miles in length, will be buried underground beneath existing rights-of-way. The Canadian portion of the transmission line will begin at the Hertel converter station in the Province of Québec, Canada, and transmit electricity as described above across the international border, through upstate New York and to Queens, New York, where CHPE will tie into TDI's proposed CHPE Converter Station. The CHPE Converter Station will convert the electrical power from direct current ("DC") to alternating current ("AC") and then connect to the 345 kV Astoria Annex GIS Substation in Bronx County, New York that is owned by NYPA.

CHPE is construction-ready, having obtained a Certificate of Environmental Capability and Public Need from the New York State Public Service Commission ("NYPSC"), a Presidential Permit from the U.S. Department of Energy, and permits under Sections 10 and 404 of the Clean Water Act and Rivers and Harbors Act from the U.S. Army Corps of Engineers. CHPE currently holds NYISO Queue Positions 631 and 887 and is actively undergoing review by the NYISO. As a result of completing the Class Year processes in CY12, CY15, CY17 and CY19, PA understands that TDI is confident it has a robust interconnection point in Queens and that the associated upgrade costs are well understood. Once these upgrades are completed,

[1] Capacity factor for the CHPE HVDC transmission line is a measurement of the actual amount of electricity that is expected to flow over the line versus the potential amount of electricity that could flow over the line.

PA does not project congestion within Zone J to be significantly impacted due to CHPE's operations. On the contrary, PA expects that congestion across NYISO and into Zone J will be slightly reduced, assuming other conditions remain the same. In fact, as discussed in this report, CHPE is forecasted to increase the reliability of the New York electricity system by generating fast response and flexible clean energy delivered using proven HVDC technology that can safely and reliably meet the needs of the State of New York today and into the future.

With the passage of the Climate Leadership and Community Protection Act (CLCPA) in 2019, the state of New York formally recognized the ever-growing threat of climate change and committed the state to one of the most ambitious electric sector decarbonization targets in the U.S. By committing to a zero-carbon emission electric grid by 2040 New York has chosen a road seldom travelled, with none yet to reach the destination. And to reach its destination, New York will need every reliable clean energy megawatt hour that's available, and there are no more reliable, clean energy megawatts available to the state of New York than those provided by CHPE. (CHPE's 10.4 TWh of clean energy are sourced from a power supply pool of 176 TWh of annual generation.)

As outlined in this report, CHPE's 10.4 TWh of baseload, clean energy sourced from Québec hydroelectric power plants will help New York take a big step forward towards reaching its zero-carbon destination while simultaneously supporting the reliability and resiliency of the electric grid, providing economic and health benefits to New York's residents.

Notably, PA's analysis is not alone in its findings. There have been several reports recently that have either been directly authored or sponsored by NYISO, NYSERDA, and/or the New York Public Service Commission that all include ~1,000 MW of Québec-sourced hydroelectric generation interconnecting to New York City in their forecasts of New York's future power generation mix.[2] While the reports do not identify CHPE by name, CHPE is the only +1,000 MW HVDC transmission project between Québec and New York City that is active in the NYISO interconnection queue. This reinforces PA's analysis and its findings that CHPE is an integral part of New York's future power generation mix and uniquely positioned to make a difference in the fight against climate change and achieve the targets of the CLCPA.

The key findings of PA's analysis of CHPE are as follows:

Economic Benefits:

- CHPE is forecasted to decrease wholesale and capacity electricity costs for ratepayers across the State of New York by $17.3 billion in the first 25 years of operation, with $10.1 billion occurring in Zone J. This money will be available to spend in the New York economy, resulting in higher economic output for the state.
- CHPE will save low income households a total of $2.5 billion over its first 25 years of operation, due to the lower wholesale electricity costs. This will reduce the electricity portion of the median energy burden by 2.5% for the 2.3 million New Yorkers living in Disadvantaged Communities.[3]
- CHPE will significantly reduce CO2 emissions attributable to the State of New York and New York City. Over the first 25 years of operations, CO2 emissions in New York will be reduced by 97 million metric tons and the total economic benefit of those CO2 reductions is estimated to be $23.2 billion.[4]
- CHPE will create approximately 1,400 unique positions during construction.[5] CHPE will also support the creation of an average 40 direct, full-time jobs in the State of New York during the first 25 years of operations.

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[2] For example, the Zero-Emissions Electric Grid in New York by 2040 report states '*NYC Tx is a 1,250 MW one-way line that connects Québec to NYC and it is assumed to transfer 10,000 GWh per year*', and the 2019 CARIS report in its 70x30 scenario includes "*an assumed generic incremental HVDC connection of 1,310 MW between Hydro-Québec and New York City is included in these cases and also counts as RE towards the 70% target*".

[3] PA's calculation of the energy burden relief provided by CHPE excludes any potential costs associated with CHPE's Tier 4 RECs, since this cost was unknown at the time of PA's analysis.

[4] Based on the social cost of carbon value published by the New York Department of Environmental Conservation.

[5] Assumes CHPE's construction is from October 2021 through November 2025.

- CHPE will create $1.6 billion in economic output in the State of New York from the line's construction, and an additional $21.4 billion during its first 25 years of operations.
- CHPE will contribute $1.4 billion in property taxes in the first 25 years of operation, funding towns and school districts across the State of New York.
- CHPE will generate $49.5 billion in total economic benefits to the State of New York during its construction and first 25 years of operation. [6]

Environmental & Health Benefits:

- CHPE's impact on CO2 emissions will contribute 6% to achieving the State of New York's economy-wide GHG reduction target by 2030. [7] CHPE will also contribute 28% to achieving New York City's GHG reduction target by 2030. [8]
- CHPE will decrease local air pollutants (NOx, SO2, NH3, PM2.5 and VOC) by an average of 775 tons per year in the State of New York, with nearly 400 tons occurring in New York City. These reductions are forecasted to result in an average of 4 lives saved annually and total health benefits valued at $1.9 billion, primarily from avoided cases of heart attacks and premature deaths, over CHPE's first 25 years of operation.
- In its first full year of operation, 2026, CHPE is forecasted to decrease NOx emissions by 200 tons in Zone J, which is equivalent to the total NOx emissions from 15 of New York City's 16 peaker plants. [9] This will help improve the health and well-being of people living in Disadvantaged Communities, since most peaker plants in New York are located in or near Disadvantaged Communities.
- CHPE will decrease CO2 emissions attributed to the State of New York, specifically New York City, by an average of 3.9 million metric tons per year. [10] This is equivalent to removing 44% of the passenger vehicles from the streets of New York City [11].

Resiliency & Reliability Benefits:

- CHPE's 10.4 TWh of fully dispatchable, clean energy is sourced from a diversified pool of 61 hydroelectric power plants in Québec with a capacity of 36,500 MW and annual generation of 176 TWh.
- Québec's weather is distinct from New York's, and therefore CHPE's power supply is unlikely to be impacted by storm events affecting New York State. Moreover, since CHPE is comprised of 339 miles of buried cable, storm events are very unlikely to impact the line itself.
- PA estimates CHPE can help avoid offshore wind curtailment of 2.0 TWh to 5.4 TWh, with an associated value of $224 million to $588 million in 2040.
- Since CHPE will not be sourcing new renewable generation from upstate New York, like other competing Tier 4 projects, CHPE will not worsen the transmission congestion that already exists.

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[6] Totals may not equal sum of individual values due to rounding.

[7] In Executive Order No. 24, Governor David Patterson established a statewide goal to reduce GHG emissions to 80% below 1990 levels by 2050. The full text of Executive Order No. 24 can be found here: http://www.dec.ny.gov/energy/71394.html. Additionally, the New York State Climate Action Council released an Interim Climate Action Plan in 2010 that established a mid-term benchmark goal to reduce GHG emissions to 40% below 1990 levels by 2030. The full text of the plan can be found here: http://www.dec.ny.gov/docs/administration_pdf/irpart1.pdf

[8] In addition to New York City's established goal to reduce GHG emissions to 80% below 2005 levels by 2050, Mayor Bill de Blasio established an interim goal to reduce GHG emissions to 40% below 2005 levels by 2030. Mayor de Blasio's announcement can be found here: http://www1.nyc.gov/office-of-the-mayor/news/451-14/mayor-de-blasio-commits-80-percent-reduction-greenhouse-gas-emissions-2050-starting-with/#/0

[9] NOx emissions are based on 2019 values.

[10] CO_2 emission reductions are calculated using a consumption-based standard (discussed in Section 3.1).

[11] Assumes 1.9 million standard vehicles in NYC per 2018 registrations (https://dmv.ny.gov/statistic/2018reginforce-web.pdf) and an average CO2 emission of 4.6 metric tons/ year per the EPA (https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle)

The sum of the forecasted economic benefits from the 10.4 TWh per year of reliable, clean energy provided by CHPE are substantial, totaling $49.5 billion during its construction and initial 25 years of operation, as illustrated in Table 1. This equates to average annual benefits of nearly $1.7 billion per year.

These total forecasted benefits include the sum of the following unique benefits:

1. The direct economic output attributable to CHPE's expenditures during its construction and operations;
2. The secondary economic output attributable CHPE's expenditures during its construction, expenditures and property tax payments during operations, and wholesale electricity cost savings;
3. The property taxes that CHPE will pay to towns and school districts along the line's route; and
4. The value of power sector CO2 emission reductions attributable to CHPE;
5. The value of health benefits from avoided premature deaths and heart attacks, due to power sector local air pollutant emission reductions from CHPE.

Table 1: Benefits to the State of New York from CHPE ($ millions)

	Sum of Benefits (2021-2050)	Average Annual Benefits
(1) Direct Economic Output	**$1,780**	**$61**
(2) Indirect/Induced Economic Output (inc. 2a)	**$21,231**	**$732**
(2a) Wholesale Electricity Cost Savings	**$17,311**	**$597**
Energy Cost Savings	$10,882	$375
Capacity Cost Savings	$6,429	$222
(3) Property Tax Payments	**$1,441**	**$50**
(4) Value of CO2 Emission Reductions	**$23,159**	**$799**
(5) Value of Local Air Pollutant Emission Reductions	**$1,925**	**$66**
Total Economic Benefits [Sum of (1) to (5)]	**$49,536**	**$1,708**

2 ECONOMIC BENEFITS TO THE STATE OF NEW YORK

This section examines and quantifies the economic benefits (e.g., jobs created, compensation, increased economic output, and increased tax revenue) to the State of New York from CHPE's construction and operation. These economic benefits were calculated using IMPLAN, an Input-Output model, and categorized into (i) direct, and (ii) induced and indirect benefits. [12]

The key findings from this section of the report include the following:

CHPE Will Reduce Wholesale Electricity Costs for New York Ratepayers

- CHPE is forecasted to decrease wholesale and capacity electricity costs for ratepayers across the State of New York by $17.3 billion in the first 25 years of operation, with $10.1 billion occurring in Zone J. This money will be available to spend in the New York economy, resulting in higher economic output for the state.

CHPE Will Economically Benefit Disadvantaged Communities

- CHPE will save low income households a total of $2.5 billion over its first 25 years of operation, due to the lower wholesale electricity costs. This will reduce the electricity portion of the median energy burden by 2.5% for the 2.3 million New Yorkers living in Disadvantaged Communities. [13]

CHPE Will Create New Long-Term Jobs for New Yorkers

- CHPE will create an average of 485 direct full-time jobs during construction comprised of approximately 1,400 unique positions. CHPE will also support the creation of an average 40 direct, full-time jobs in the State of New York during the first 25 years of operations.

CHPE Will Increase Economic Output

- CHPE will create $1.6 billion in economic output in the State of New York from the line's construction, and an additional $21.4 billion during its first 25 years of operations.

CHPE Will Increase Local Tax Revenue

- CHPE will contribute $1.4 billion in property taxes in the first 25 years of operation, funding towns and school districts across the State of New York.

2.1 Overview

CHPE is forecasted to provide economic benefits to New York ratepayers during both its construction and operating periods. These economic benefits are expected to be realized from three primary areas:

- **Construction of the Project** – equipment, materials, and labor employed, as well as taxes, permitting fees, and other activities paid for during construction.
- **Operation of the Project** – fixed and variable costs associated with the materials and labor needed for project operation following construction.
- **Wholesale electricity cost savings from CHPE** – CHPE's entry will result in lower wholesale energy and capacity prices, thereby resulting in wholesale electricity cost savings to New York ratepayers.

The model that PA used in its economic impacts analysis is called IMPLAN – Impact Analysis for Planning. IMPLAN has been in use for more than 30 years and was originally commercialized by the Agricultural Department at the University of Minnesota. IMPLAN is used to assess economic impacts related to a wide variety of capital projects by federal and state agencies and private industry, including the U.S. Department of Agriculture, U.S. Department of Interior, U.S. Army Corps of Engineers, and U.S. Coast Guard. In

[12] As described in more detail in Appendix B, indirect benefits reflect supply chain impacts from CHPE's direct expenditures, whereas induced benefits reflect increased household income due to direct and indirect impacts.

[13] PA's calculation of the energy burden relief provided by CHPE excludes any potential costs associated with CHPE's Tier 4 RECs, since this cost was unknown at the time of PA's analysis.

addition to being used to assess the economic impacts of transmission lines and power plants, IMPLAN has also been used to assess impacts from baseball stadiums, forestry, factories, and other projects.

IMPLAN is an Input-Output model, explained in greater detail in Appendix B, which analyzes relationships among industries and how spending in industry A impacts industries B, C, D, etc. By analyzing and quantifying these inter-relationships and impacts, IMPLAN produces a forecast of economic benefits (both direct and indirect and induced) for regional economies for (i) jobs created; (ii) compensation; (iii) economic output growth, and (iv) local tax revenue.

2.1.1 Methodology

PA calculated the economic impacts to New York ratepayers resulting from (1) CHPE's direct expenditures in New York (e.g., design, engineering, environmental services, and construction projected to be provided by firms in New York), (2) CHPE's property taxes paid in New York and (3) lower wholesale costs from CHPE's operations. CHPE's direct and indirect expenditures in New York and outside New York, respectively, were calculated based on inputs provided by TDI related to the development, construction, and operation of CHPE.

PA's analysis found that wholesale electricity prices would decrease as a result of CHPE's operations, and that these decreases would lead to lower wholesale electricity costs for New York ratepayers. As a result, the energy burden on ratepayers is reduced so they would have more disposable income to spend in the economy, since they would be spending less of their household income on electricity. This results in higher economic output for New York's economy and directly benefits members of disadvantaged communities by reducing their utility costs, resulting in a lower energy burden for them.

2.2 Findings

CHPE is forecasted to provide significant economic benefits to New York ratepayers. These benefits will come in the form of (a) job creation during construction and operation, which will result in more compensation, (b) increased disposable income stemming from reductions in electricity costs and compensation increases – creating (c) economic stimulus and more economic output within the state. In addition, CHPE's property tax payments will lead to (d) increased local tax revenue throughout the state. The jobs and compensation are expected to be stimulated by CHPE's expenditures within the State of New York during construction and operations years and the wholesale electricity cost savings to New York ratepayers from CHPE's operations.

The cumulative benefits that CHPE is forecasted to provide to New York ratepayers during its construction period (through the end of 2025) and first 25 years of commercial operation (through the end of 2050) are summarized in Table 2.

Table 2: CHPE Cumulative Economic Benefits in New York State

Benefit	Construction Period (2021-2025)	Operation Period (2026-2050)
New Direct Jobs (Annual Avg.)	485	40
New Secondary Jobs (Annual Avg.	3,186	3,219
Increased Compensation	$0.6 billion	$7.3 billion
More Economic Output	$1.6 billion	$21.4 billion

2.2.1 CHPE Will Reduce Wholesale Electricity Costs for New York Ratepayers

An additional benefit of the 10.4 TWh per year that CHPE is forecasted to deliver to the New York electric grid is that CHPE is forecasted to decrease wholesale electricity costs for residential, commercial, and industrial users of electricity. Wholesale electricity costs are primarily comprised of costs for energy and capacity. Energy costs are the payments made to power plants for the actual electricity they produce when they are needed, which is effectively a variable production charge. Capacity costs are the payments made to power plants to ensure they are available to operate when needed, which is effectively a reservation charge paid to power plants. CHPE is forecasted to reduce both categories of costs for New York ratepayers.

In NYISO, power is sourced from lowest cost producer first, adding generated power from producers in order of increasing price until total system demand is met. The energy price paid to all power producers is equal and set by the production cost of the most expensive source so removing the highest priced source will reduce the energy price for all power producers. Since CHPE will source its electricity from Québec's pool of hydroelectric power plants, CHPE's production costs will be lower than almost all the existing power plants in the State of New York and Zone J. By providing low cost electricity, CHPE will operate ahead of (i.e., displace) the more expensive power plants that New York ratepayers would have otherwise relied on for their electricity needs. As a result, CHPE will decrease the wholesale electricity market's use of expensive natural gas and fuel oil-fired power plants, thus reducing energy prices and the energy component of wholesale electricity costs.

Similar to energy costs, CHPE is forecasted to lower capacity costs by increasing the amount of low-cost capacity available to New York ratepayers. More specifically, capacity costs in New York are calculated based on the ICAP auction, which purchases capacity on behalf of electricity users to meet the New York system's peak electricity demand. All else equal, the more low-cost capacity that is available in the auction, the lower the total cost of purchasing capacity. This is because low cost capacity will be purchased before higher cost capacity. As a result, New York ratepayers will pay less for capacity and realize the associated cost savings.

Overall, based on CHPE's forecasted impacts to New York's energy and capacity markets, PA's analysis forecasts CHPE to lower wholesale electricity costs (made up of energy and capacity) by $17.3 billion in the State of New York over the first 25 years of operation, with $10.1 billion of those savings accruing in Zone J. These cost savings are reflected in the economic benefits outlined in Section 2.2.3 and 2.2.4.

2.2.2 CHPE Will Economically Benefit Disadvantaged Communities

As described in Section 2.2.1, construction of CHPE will lead to a reduction in wholesale electricity prices and both energy and capacity costs across multiple zones in NYISO, and as a result, will lead to a reduction in retail electricity rates. The reduction in retail rates will benefit all New York residents including residential, commercial, and industrial entities. However, since low-income and disadvantaged communities pay a higher share of their income on energy, the reduction in electricity costs will benefit these communities to a greater extent than others and will help alleviate their energy burden. Energy burden is defined as the "percentage of gross income that a household devotes towards energy bills" [14] .

In 2016, the State of New York set a target that New York residents should pay no more than 6% of their income on energy bills. An energy burden above 6% is considered high, and above 10% is considered a severe energy burden. Lower income households are disproportionally impacted – data shows that the energy burden for a low-income family in New York City is 9.3% which is almost triple that of a median income household. [15]

Multiple efforts are underway in New York to address the energy burden issue. In 2019, the NYC Mayor's Office of Sustainability and the Mayor's Office for Economic Opportunity published a joint report recommending solutions to alleviate energy burdens in NYC.[16] Increasing access to low-cost renewable

[14] According to US Office of Energy Efficiency and Renewable Energy (https://www.energy.gov/eere/slsc/low-income-community-energy-solutions#:~:text=Energy%20burden%20is%20defined%20as,income%20spent%20on%20energy%20costs)

[15] Low income energy burden in NYC is found to be 9.3% compared to 2.9% in a median income home based on information from the US Census Bureau's American Housing Survey (AHS) according to a 2020 ACEEE report (located here: https://www.aceee.org/sites/default/files/pdfs/aceee-01_energy_burden_-_new_york_city.pdf). Discussion on effects of high energy burden are discussed in more detail in a 2016 ACEEE report (located here: https://www.aceee.org/sites/default/files/publications/researchreports/u1602.pdf).

[16] Understanding and Alleviating Energy Cost Burden in New York City, August 2019 (https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/EnergyCost.pdf)

energy is one of the main policy recommendations. The report acknowledged the additional challenge of increasing access to low-cost renewable energy (e.g., rooftop solar) for low-income households as these residents may not have direct control over their roof space. In 2020, Governor Cuomo announced a $1 billion initiative to promote energy efficiency in New York, benefiting over 350,000 low-to-moderate income households, with the primary goal of reducing energy burden on low income households.

There are typically very few options for low income families to reduce their energy costs – they are more likely to live in older, inefficient homes and they use less efficient appliances which result in higher energy cost per square foot. Additionally, they often lack the money to perform upgrades, and are more impacted by fixed fees on utility bills. Residents in these communities often seek to reduce their energy costs by minimizing power usage, which can result in inadequate heating or cooling during severe weather conditions, leading to discomfort and health hazards. They also choose to forgo food or medicine to be able to keep their home's utilities running, which has negative physical and mental health impacts in low income households.

While there are programs to assist with paying power bills and subsidizing energy efficiency upgrades for those in disadvantaged communities, they usually lack the scale needed to address energy burden for all low-income households in New York. According to NY Public Service Commission, there are 2.3 million residents who live in disadvantaged communities. [17]. Alternatively, a reduction in wholesale electricity costs can reduce the energy burden on all households, including low income and disadvantaged communities.

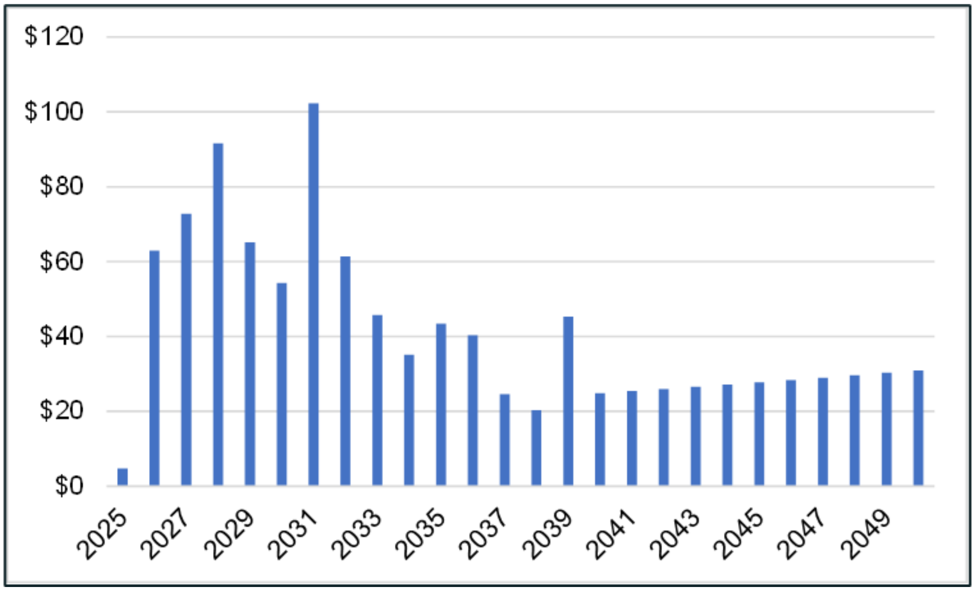
PA estimates that as a result of CHPE's operations, and the associated impact on lowering wholesale electricity costs, will save low income households on average $40 per year, totalling $2.5 billion over the first 25 years of CHPE's operation. [18] This will reduce the electricity portion of the median energy burden by 2.5% for the 2.3 million New Yorkers living in Disadvantaged Communities. The money saved on electricity bills by residents would be available to spend on other expenses such as food, medicine, education, etc. and will impact the broader New York economy, resulting in higher economic output. [19]

[17] Understanding and Alleviating Energy Cost Burden in New York City, August 2019 (https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/EnergyCost.pdf)

[18] This figure does not account for the cost of CHPE's Tier 4 REC contracts, since this value is unknown at the time of PA's analysis.

[19] This economic impact is captured in the values provided in Table 2.

Figure 2: Average Annual Reduction Low-Income Ratepayer Electricity Costs (2025-2050)



2.2.3 CHPE Will Create New Long-Term Jobs and Compensation for New Yorkers

CHPE is a 339-mile underground HVDC transmission line that extends from the Canadian border to New York City. The extent of this construction spans the state of New York and is expected to take 4 years, with operations beginning in December 2025. CHPE's planning is at a very mature stage, with permits already received and the grid interconnection process advanced, so job creation from construction is expected to begin as soon as this year.

During the construction period of 2021-2025, CHPE will create an annual average of 485 direct, full-time jobs across the state.

CHPE will also contribute a total of $426 million in compensation to New York State through the direct jobs required to build the line, such as design, engineering, construction and other skilled labor. CHPE's construction is complex and will require a wide variety of tradespeople with job numbers in each field peaking in different parts of the installation. For example, transporting cables will occur earlier in the project than final grading, but neither of these is expected to continue across the full duration of construction. As a result of this variety of jobs, there are expected to be as many as 1,400 unique jobs during CHPE's construction.

Other jobs are also developed as a result of the construction, including providing goods and services needed to support the line (indirect secondary jobs) as well as jobs created through the increased spending and sales from the line (induced secondary jobs). PA estimates CHPE will contribute $197 million in other compensation for a total compensation contribution during construction of $623 million.

Upon completion, CHPE will require workers for operation, maintenance, and other support functions to maintain operation of the line. In turn, CHPE is expected to create an average of 40 direct annual, full-time jobs within the state of New York during the first 25 years of operation. As a result of these direct jobs and from secondary jobs, once operational, CHPE is forecast to create $7.6 billion in compensation in New York during its first 25 years in operation.

Table 3: Annual Average Direct and Secondary Jobs Created from CHPE Operations (2026-2050)

Location	Direct Jobs	Secondary Jobs
New York State	40	3,219

2.2.4 CHPE Will Increase Economic Output In New York State

Based on the jobs created and compensation paid by those jobs, CHPE is forecasted to create approximately $1.6 billion in total (direct and secondary) economic output to New York's economy during its construction (2021-2025). Furthermore, during the first 25 years of operations (2026-2050), CHPE is forecasted to create approximately $21.4 billion in total economic output. The increased economic output during the operations period is driven primarily by the $17.3 billion in wholesale electricity cost savings, discussed in Section 2.2.1, as these savings increase disposable income that can be spent in the economy. Therefore, the economic output created during CHPE's operations incorporates the benefits from these wholesale cost savings, and the net economic output from CHPE's operations is $4.1 billion.

2.2.5 CHPE Will Increase Local Tax Revenue

CHPE will contribute significant local taxes to towns and school districts along its 339-mile route. CHPE, considered to be a significant asset for the purposes of property tax assessments, will be assessed based on its cost or value and the applicable mill rate for each town or school district. The $1.4 billion of expected property tax payments over the first 25 years of operations will be paid directly local governments, contributing to economic development and public facility improvement.

Table 4: CHPE Property Tax Payments (2026-2050)

Average Property Tax Payments ($millions)	Total Property Tax Payments ($millions)
$57.6	$1,441

The taxes paid to local governments will be injected into these local economies by supporting town, school and county budgets and may go towards spending for upkeep of roads, salaries to teachers and advertising for tourism in the area. It's also possible that the funding from these taxes could be used to pay down county debt incurred from previous capital projects or budget shortfalls.

An example of the impact these taxes could have on local economies can be seen with Washington County which is located on the border of Vermont in upstate New York and ranks in the bottom 25% of counties in New York for per capita income. [20].. Like most counties in the U.S., Washington County's budget was hard hit by shortfalls due to COVID-19, resulting in difficult budget cuts such as postponing replacement of the roof on a local school. [21] Washington County's budget in 2021 requires $35 million be raised through taxes. Should the budget be similar in CHPE's first year of operation, CHPE could account for a measurable portion of the necessary taxes, allowing the county to reliably be able to plan for capital improvements like needed maintenance on school buildings without needing to incur new debt.

[20] From 2010 US Census data (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_DP03&prodType=table)

[21] Washington County 2021 Budget Message (https://washingtoncountyny.gov/DocumentCenter/View/15990/2021-Budget-Message-Oct-28-20)

3 ENVIRONMENTAL AND HEALTH BENEFITS TO THE STATE AND CITY OF NEW YORK

This section examines and quantifies the environmental and health benefits to the State of New York and New York City that result from CHPE's operations and the progress towards the State of New York and New York City's individual emission reduction targets. The emission reductions, in GHGs and local air pollutants, were calculated using the AURORA electricity market model, which simulated the operation of the NYISO electricity system and adjacent markets (e.g., Hydro-Québec, Ontario, New England, PJM) and the power plants and transmission lines within them. Health benefits from local air pollutant emission reductions were quantified using the EPA's CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA).

The key findings from this section of the report include the following:

CHPE Will Decrease CO2 Emissions in the State of New York and New York City

- CHPE will decrease CO2 emissions attributed to the State of New York, specifically New York City, by an average of 3.9 million metric tons per year. [22] This is equivalent to removing 44% of the passenger vehicles from the streets of New York City. [23.] .

CHPE Will Help the State of New York Meet Its 2050 GHG Reduction Target

- CHPE's impact on CO2 emissions will contribute 6% to achieving the State of New York's economy-wide GHG reduction target by 2030. [24] CHPE will also contribute 28% to achieving New York City's GHG reduction target by 2030. [25]

CHPE Will Help Save Lives and Provide Significant Value in Health Benefits

- CHPE will decrease local air pollutants (NOx, SO2, NH3, PM2.5 and VOC) by an average of 775 tons per year in the State of New York, with nearly 400 tons occurring in New York City. These reductions are forecasted to result in an average of 4 lives saved annually and total health benefits valued at $1.9 billion, primarily from avoided cases of heart attacks and premature deaths, over CHPE's first 25 years of operation.

CHPE Improve the Health and Wellbeing of People Living in Disadvantage Communities

- In its first full year of operation, 2026, CHPE is forecasted to decrease NOx emissions by 200 tons in Zone J, which is equivalent to the total NOx emissions from 15 of New York City's 16 peaker plants. [26] This will help improve the health and well-being of people living in Disadvantaged Communities, since most peaker plants in New York are located in or near Disadvantaged Communities.

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[22] CO_2 emission reductions are calculated using a consumption-based standard (discussed in Section 3.1).

[23] Assumes 1.9 million standard vehicles in NYC per 2018 registrations (https://dmv.ny.gov/statistic/2018reginforce-web.pdf) and an average CO2 emission of 4.6 metric tons/ year per the EPA (https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle)

[24] In Executive Order No. 24, Governor David Patterson established a statewide goal to reduce GHG emissions to 80% below 1990 levels by 2050. The full text of Executive Order No. 24 can be found here: http://www.dec.ny.gov/energy/71394.html. Additionally, the New York State Climate Action Council released an Interim Climate Action Plan in 2010 that established a mid-term benchmark goal to reduce GHG emissions to 40% below 1990 levels by 2030. The full text of the plan can be found here: http://www.dec.ny.gov/docs/administration_pdf/irpart1.pdf

[25] In addition to New York City's established goal to reduce GHG emissions to 80% below 2005 levels by 2050, Mayor Bill de Blasio established an interim goal to reduce GHG emissions to 40% below 2005 levels by 2030. Mayor de Blasio's announcement can be found here: http://www1.nyc.gov/office-of-the-mayor/news/451-14/mayor-de-blasio-commits-80-percent-reduction-greenhouse-gas-emissions-2050-starting-with/#/0

[26] NOx emissions are based on 2019 values.

3.1 Overview

Access to electric power in the last 150 years has resulted in technologic innovation and has improved the efficiency of the modern world through electrification and automation of manual tasks. While power generation in New York has transitioned away from coal-fired power plants, the last coal power plant (Somerset) retired in March 2020, a large amount of New York's power generation still relies on burning natural gas. This results in GHGs (including indirect GHGs like NOx and SO2), and fine particulates (PM2.5), NH3, and VOCs being released into the regional and local air. While several types of gasses are classified as GHGs, the most common GHG emitted by the electric power sector is CO2, and this analysis focuses specifically on the CO2 emission reductions associated with CHPE.

When CO2 and other GHGs are released, they remain trapped in the atmosphere where they reflect radiation back to the surface. Similar to a greenhouse, this results in increased temperatures and as the production of CO2 from humans has increased since the Industrial Revolution, these GHGs have been the main driver of global warming and climate change.

In addition to contributing to climate change, local air pollutants such as NOx, SO2, NH3, PM2.5 and VOCs from industrial facilities like power plants negatively impact New York's residents by being linked to increases in respiratory diseases, heart attacks and even premature death. [27] The effects from chronic exposure to these pollutants burdens the health system and has a negative impact on the overall economy. Without significant reductions in GHGs and local air pollutants, these negative impacts are only expected to worsen over time.

3.1.1 CO2

Order No. 24, signed in 2009 by Governor Patterson, established a goal for the State of New York to reduce its GHG emissions from all sources to at least 80% below 1990 levels by 2050 (80 x 50). [28] Following this Order, the CLCPA was signed in 2019 by Governor Cuomo, directing the Department of Environmental Conservation to establish state-wide emissions limits which were then adopted via 6 NYCRR Part 496 (Statewide Greenhouse Gas Emissions Limits), becoming effective on December 30, 2020. Part 496 establishes goals for the State of New York to reduce its GHG emissions from all sources to at least 40% below 1990 levels by 2030 (40 x 30) and to at least 85% below 1990 levels by 2050 (85 x 50).

When accounting for GHG emissions from the New York power sector (to determine progress toward the 40 x 30 and 85 x 50 targets), the state currently uses a consumption-based accounting method. This method is used because New York imports and exports electricity from and to neighboring states and provinces, and the GHG emissions associated with producing the electricity that is consumed in New York are not necessarily emitted within the state.

In addition to the State of New York's 40 x 30 and 85 x 50 targets, New York City has adopted its own GHG reduction goal. In the first PlaNYC report issued in 2007, Mayor Michael Bloomberg's administration called for a reduction in GHG emissions of at least 30% below 2005 levels by 2030. However, in September 2014, Mayor Bill de Blasio issued a public commitment to reduce the city's GHG emissions to at least 80% below 2005 levels by 2050 with an interim target of 40% below 2005 levels by 2030, a commitment that has been upheld in the City's Roadmap to 80 x 50 plan. [29] Similar to NYSERDA, New York City uses a consumption-based approach to account for GHG emissions from the power sector in order to capture the GHG emissions associated with imported electricity. [30]

Therefore, because both the State of New York and New York City have individual GHG emission reduction targets, and because both use a consumption-based approach to account for GHG emissions from the power sector, CO2 emission reductions and their associated benefits are presented in this analysis using a consumption-based standard. Additionally, using a consumption-based standard and assuming that all

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[27] Per the American Lung Association (https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution)

[28] The full text of Order No. 24 can be found here: http://www.dec.ny.gov/energy/71394.html

[29] Source: The City of New York, New York City's Roadmap to 80 x 50, September 2016.

[30] Source: The City of New York, New York City's Roadmap to 80 x 50, September 2016.

energy delivered by CHPE directly into New York City is consumed within Zone J, all system-wide CO2 emission reductions associated with CHPE's entry into the market are attributable to New York City.

3.1.2 Local Air Pollutants

As a result of power plant emissions reductions attributable to CHPE's operations, there are measurable health benefits from the cleaner air. Pollutants such as NOx and particulate matter smaller than 2.5 microns (PM2.5) have been directly linked to increases in respiratory health issues, heart attacks and premature death in exposed populations. The estimated local air pollutant emission impacts focused on five major pollutants, each having adverse environmental and/or health effects:

- Nitrogen Oxides (NOx) are highly reactive gases that can contribute to the development of respiratory diseases such as asthma. [31]
- Sulfur Dioxide (SO2) exposure leads to breathing difficulties and contributes to acid rain. [32]
- Ammonia (NH3) reacts with water in the body to produce ammonium hydroxide which can damage body cells. [33].
- Particulate Matter (PM2.5) are ultra-fine particles (less than 2.5 µm) that can travel deep into the respiratory tract and affect lung function. [34]. Long-term exposure can lead to or worsen asthma and heart disease and can cause chronic bronchitis, and, in some cases, may cause lung cancer.
- Volatile Organic Compounds (VOCs) are a variety of chemicals that can cause eye and throat irritation, and may lead to liver, kidney, and central nervous system damage[35]..

PA estimated the health impacts the local air pollutant emission reductions using the EPA's COBRA model. COBRA provides estimations of how changes in air pollution particulate matter can result in various health effects, which are then translated to the economic results of these health outcomes. COBRA was first developed in 2002 and has been updated with increased functionality over several years. The model's technical peer review concluded that COBRA is a "valuable model that produces a screening tool that can contribute to policy analysis and public dialogue.".

3.2 Methodology

PA determined the annual emission reductions attributable to CHPE by simulating the New York electric grid with and without CHPE. The analysis was performed using PA's proprietary electricity market model process, which simulates the operations of power plants and transmission lines within New York and adjacent power markets (e.g., PJM) using AURORA, and calculates the emissions of the individual power plants with and without CHPE. This modeling process is described in greater detail in Appendix B. The emission reductions attributable to CHPE were calculated using a consumption-based standard for CO2 and a generation-based standard for local air pollutants, consistent with the accounting standard used by both the State of New York and New York City.

3.2.1 CO2

To quantify the value of the environmental benefit to the State of New York and New York City associated with the CO2 emission reductions attributable to CHPE, PA assumed that the value of avoiding one metric ton of CO2 emissions is equal to the New York DEC's Social Cost of Carbon calculation. The Social Cost of Carbon is a monetized estimate of the societal damages, (e.g., agricultural productivity, human health impacts, property damages caused by flooding, and changes to ecosystem services) attributable to increases in carbon-based emissions and associated climate change. It is the predominant tool for valuing the social, environmental, and human health costs associated with GHG emissions, as well as the benefits

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[31] Source: EPA, "Nitrogen Dioxide (NOx) Pollution", Basic Information about NO_2

[32] Source: EPA, "Sulfur Dioxide (SO_2) Pollution", Sulfur Dioxide Basics

[33] Source: NY Department of Health, Emergency Preparedness and Response, "The Facts about Ammonia",

[34] Source: NY Department of Health, Air Quality, "Fine Particles ($PM_{2.5}$) Questions and Answers"

[35] Source: EPA. "Indoor Air Quality", Volatile Organic Compounds' Impacts on Indoor Air Quality

associated with reducing those emissions. The use of the Social Cost of Carbon calculation to assessprojects based on monetarily quantified benefits from CO_2 emission reductions has been established within New York regulatory processes.[36]

This analysis focuses primarily on the CO_2 emission reductions associated with CHPE but when accounting for emissions of non-CO_2 GHGs from various economic sectors, which have different global warming impacts per amount of mass, a common metric is carbon dioxide equivalent ("CO_2e"). This unit standardizes measurement of GHGs based on their estimated global warming impact. Therefore, when assessing the impact that CHPE would have on state-wide and New York City GHG emissions and progress towards specified targets, emissions are reported on a CO_2e basis.

3.2.2 Local Air Pollutants

To estimate local air pollutant impacts, PA calculated the emission impacts from CHPE's operations across five different pollutant categories: NO_x, SO_2, NH_3, $PM_{2.5}$, and VOC. COBRA evaluates how the changes in these pollutants affect 'health endpoints', selected health conditions affecting the population that have societal cost such as premature mortality, nonfatal heart attacks, and general hospital admissions.

The COBRA model functions in three stages: reading in emission changes and population by county, calculating the health effects which results from those emission changes, and outputting estimates of the dollar value implications of those adverse health effects. The model accepts changes in different county-level emissions categories, using a Source-Receptor matrix (S-R Matrix) to translate emission changes into spatial variation in ambient particulate matter. This matrix is constructed based on air quality models that simulate particle dispersion and reflects the relationships between the locations of pollution emitters and a single receptor in the center of each county. Based on the differences in particle concentrations that COBRA estimates from emission changes, the model estimates the changes in different health risks. For each health risk, COBRA employs a unique 'health endpoint function' that quantifies how much change in one adverse health effect can be expected due to a change in the concentration of pollution in the air.

Each health effect is also associated with a health impact economic valuation that considers the age of the population affected, the adverse health condition, and the discount rate selected in the model. These economic valuations assign 'unit values' to health conditions which reflect the cost of willingness-to-pay to avoid illness, treatment/effect mitigation of the health effect, or of lost wages. Further information about the COBRA model methodology is found in Appendix B.

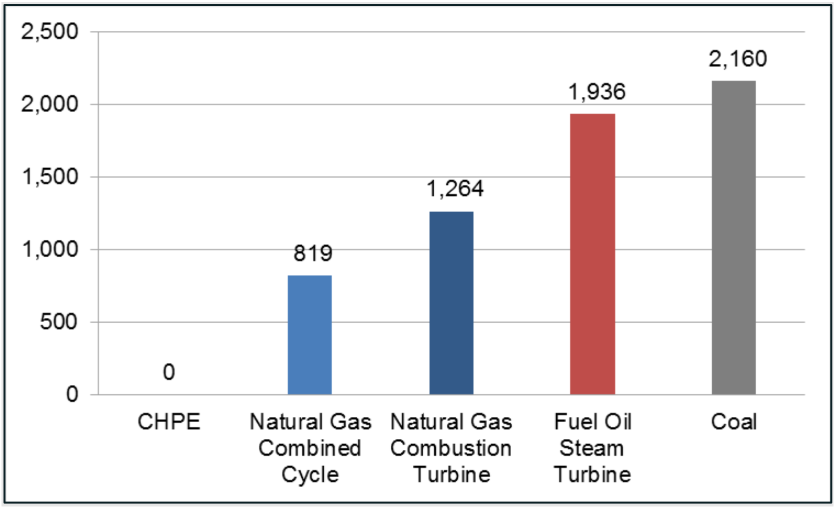
3.3 Findings

Since CHPE will source electricity from Québec hydroelectric power plants, which have lower production costs than power plants that emit CO_2 (e.g., fuel oil and natural gas), CHPE will operate ahead of (i.e., displace) these power plants.

See Figure 3 for a comparison of the CO_2 emissions associated with different fuels used to generate electricity. By displacing these CO_2-emitting power plants, emissions from the power sector will decrease in New York. This includes lower emissions from power plants within New York City, across the State of New York, and in adjacent markets that export power into New York. As a result, CHPE will help the State of New York and New York City meet their respective GHG emission reduction targets and will positively impact the health of New York residents.

[36] PA used the Social Cost of Carbon value calculated using a 2% social discount rate which is consistent with the NY Department of Environmental Conservation's discount rate recommendation for decision making by state entities. PA used the SCC values published by the NY DEC in the October 2020 Value of Carbon Guidance documents (https://www.dec.ny.gov/regulations/56552.html). Note that on February 26, 2021, President Joe Biden signed an executive order reinstating the Obama administration's SCC figures adjusted for inflation and called for a comprehensive update of the SCC by January 2022.

Figure 3: CO_2 Emission Rate by Power Plant Fuel Type (pounds/MWh)[37,38]



3.3.1 CHPE Will Help the State of New York and New York City Meet Their GHG Reduction Targets

The emission reductions attributable to CHPE's operations are substantial. Average annual reductions of CO2 are approximately 3.9 million metric tons across the state of New York using a consumption-based standard over the first 25 years of CHPE's operation. Because all electricity delivered by CHPE is assumed to be consumed within Zone J, the average annual CO2 emission reductions for Zone J are attributable to New York City.

With an average vehicle emitting 4.6 tons [39] of CO2 per year, the reductions in CO2 attributable to CHPE are equivalent to removing 44% of the passenger vehicles from New York City. [40].

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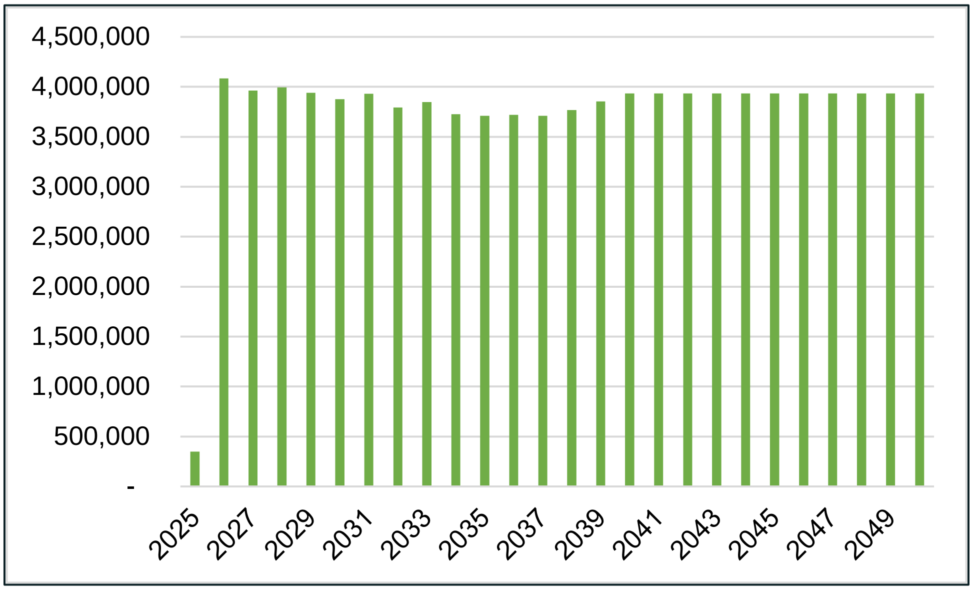
[37] CO_2 emissions data by fuel type was sourced from the U.S. Energy Information Administration. This analysis assumes a heat rate of 7,000 Btu/kilowatt-hour ("kWh") for a natural gas combined cycle power plant, 10,800 Btu/kWh for a natural gas combustion turbine power plant, 12,000 Btu/kWh for an oil power plant, and 10,500 Btu/kWh for a coal power plant.

[38] Because the electricity delivered through CHPE will be sourced from Québec's existing pool of hydro power plants, CHPE is not expected to create additional GHG emission through new storage impoundments. Additionally, the lifecycle emissions from these existing hydropower resources are negligible, and thus are not included in this analysis.

[39] An average CO2 emission of 4.6 metric tons/year per the EPA (https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle).

[40] 1.9 million standard vehicles registered in NYC in 2018 (https://dmv.ny.gov/statistic/2018reginforce-web.pdf)

Figure 4: Power Sector CO_2 Emission Reductions from CHPE Operations (Metric Tons)



The emission reductions associated with CHPE will also contribute substantially towards GHG reduction targets under Order No. 24. Based on the NYSERDA New York State Greenhouse Gas Inventory report, baseline emissions in 1990 were 236 MMtCO2e[41] and as of 2016, according to the most recent inventory report, [42] economy-wide emissions had reduced to approximately 206 million metric tons of CO2e.

In order to meet its emission reduction targets, as shown in Table 5, the State of New York would need to reduce its economy-wide emissions to approximately 142 million metric tons of CO2e to reach 40% reduction by 2030 and would need to reduce economy-wide emissions to 35 million metric tons to reach 85% reduction by 2050.

Table 5: New York Economy-Wide GHG Emission Targets

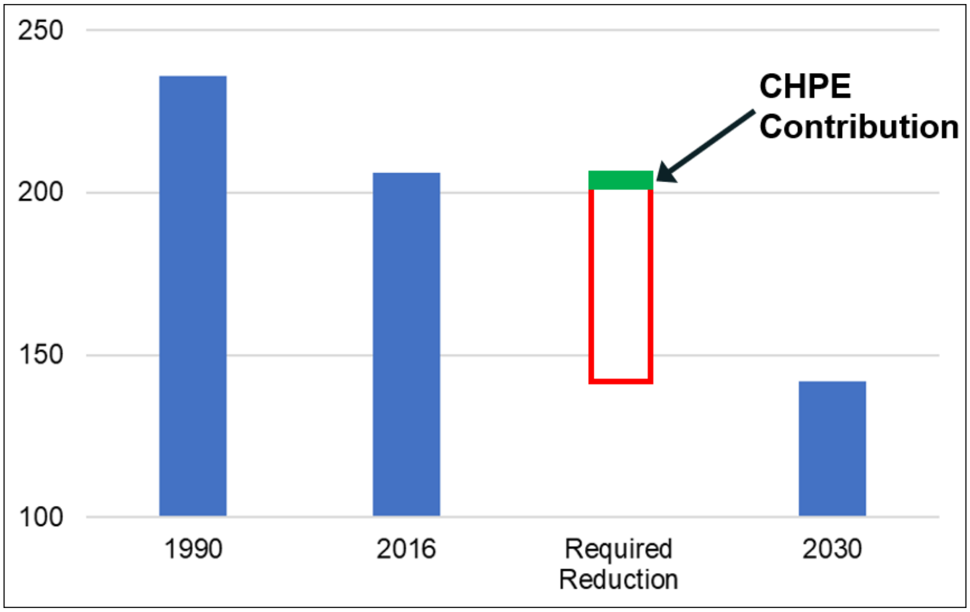
Year	New York GHG Limit (MMtCO2e)
2030	142
2050	35

This means that New York State would need to reduce its emissions from 2016 by a further 64 million metric tons in order to achieve emissions 40% below 1990 levels. CHPE's operations result in emission reductions in both CO2 and NOx emissions (both of which are counted in GHG inventory). In 2030, CHPE is forecasted to be responsible an emissions reduction of 4.0 million metric tons CO2e (from reduced CO2 and NOx), under a consumption-based standard. This means that the CO2e emission reductions associated with CHPE represent approximately 6.3% of the remaining 64 million metric ton emission reduction required to meet the 2030 target, which is illustrated in Figure 5.

[41] In late 2020, the NY DEC proposed The Revised Regulatory Impact Statement Part 496 using different accounting to set the 1990 statewide baseline GHG emissions at 410 million metric tons of CO2e. An inventory hasn't been completed to report the emissions using that same approach so values from the NYSERDA GHG Inventory report from 2016 is used for calculations within this report.

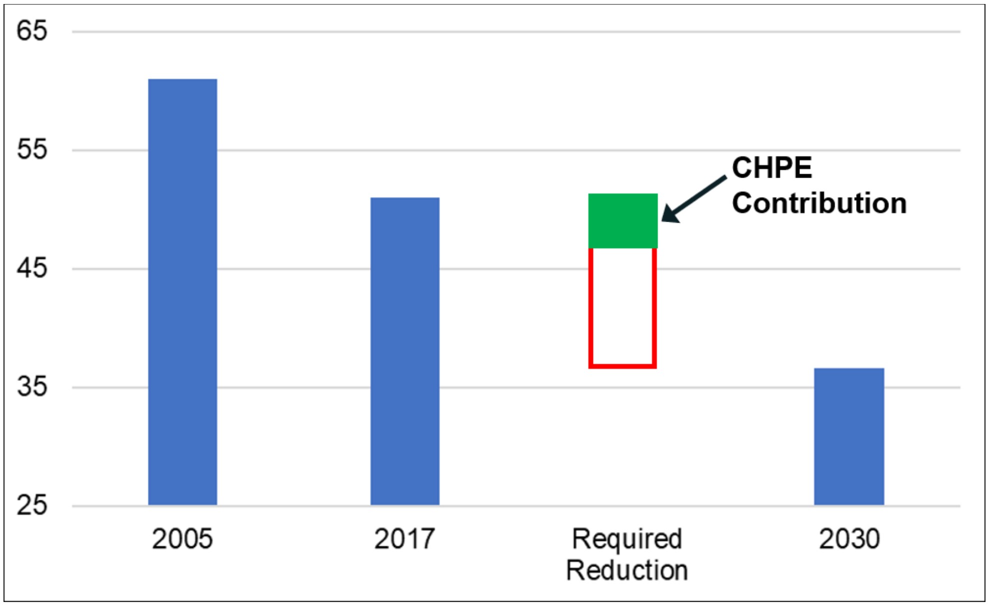
[42] Note that 2016 is the most recent year in which full-year GHG inventory data is available for the State of New York.

Figure 5: New York Economy-Wide GHG Emission Levels and Targets (MMtCO2e)



New York City also has its own GHG emissions reduction target, aiming to reduce emissions to at least 40% below 2005 levels by 2030 and 80% by 2050. According to the most recent New York City Greenhouse Gas Emissions inventory, [43] 2005 economy wide GHG emissions were approximately 61 million metric tons of CO2e and as of 2017 were approximately 51 million metric tons. To meet its emission reduction target in 2030, New York City needs to reduce its economy-wide emissions to 37 million metric tons. CHPE's CO2e emission reductions in 2030 represent approximately 28% of the remaining 14 million metric ton emission reduction required to achieve New York City's 2030 target.

Figure 6: New York City Economy-Wide GHG Emission Levels and Targets (MMtCO2e)



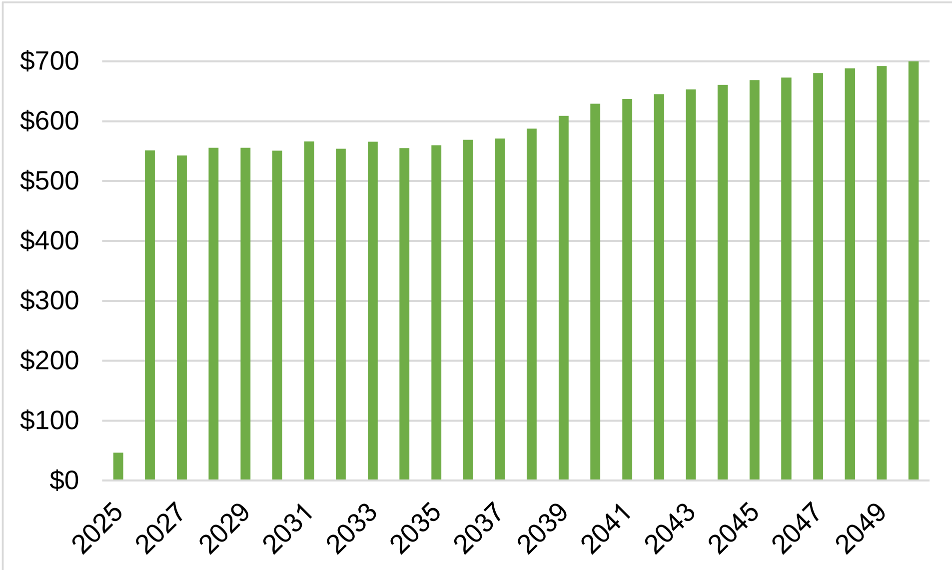
In addition to helping New York state and New York City to reach their 2030 goals, CHPE will also contribute to helping the region to reach its lofty 2050 GHG reduction targets. In 2050, CHPE will be responsible for 4.1 million metric tons of CO2e reduction. This is equal to 2% of the 171 million ton reduction New York state needs by 2050 and 11% of the 39 million ton reduction New York City needs to reach its 2050 target.

[43] Note that 2017 is the most recent year in which full-year GHG inventory data is available for New York City.

3.3.2 The Value of CO2 Emission Reductions CHPE Will Provide Is Significant

The CO2 emission reductions attributable to CHPE's operations will substantially benefit the State of New York and New York City. Applying the Social Cost of Carbon values published by the NY DEC to the 97 million metric tons of CO2 emission reductions attributable to CHPE results in a value of approximately $23.2 billion during the first 25 years of operation.

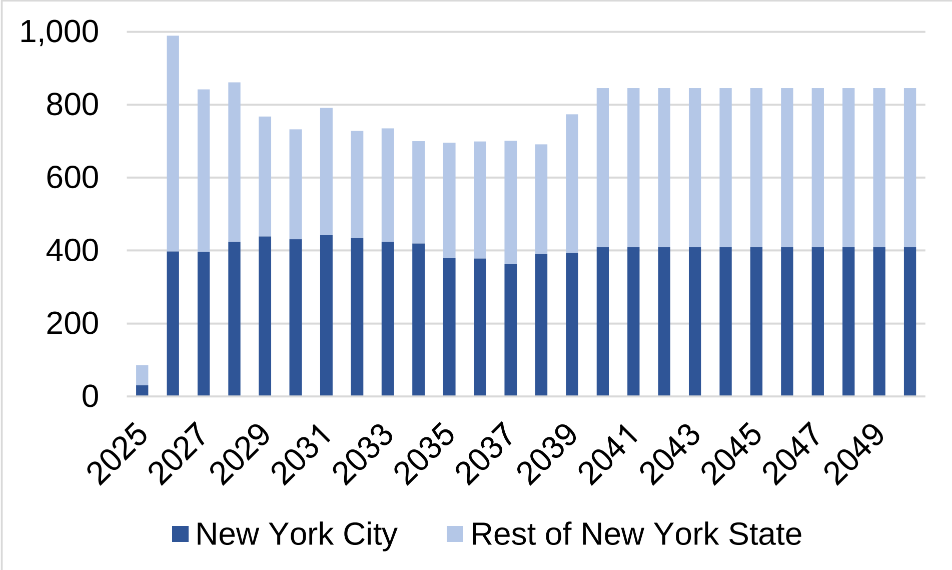
Figure 7: Value of CO_2 Emission Reductions from CHPE Operations ($ millions)



3.3.3 CHPE Will Reduce Local Air Pollutant Emissions in the State of New York and New York City

Similar to CHPE's impact on lowering CO2 emissions in New York, the displacement of fossil-fueled power generation will also result in emission reductions in pollutants like NOx, SOx, PM2.5, NH3 and VOCs, all of which are harmful to human health. CHPE is estimated to decrease local air pollutant emissions from New York state power plants by an average of 775 tons per year through 2050, of which approximately 50% will occur in New York City.

Figure 8: Air Pollutant Emission Reductions from CHPE (tons)



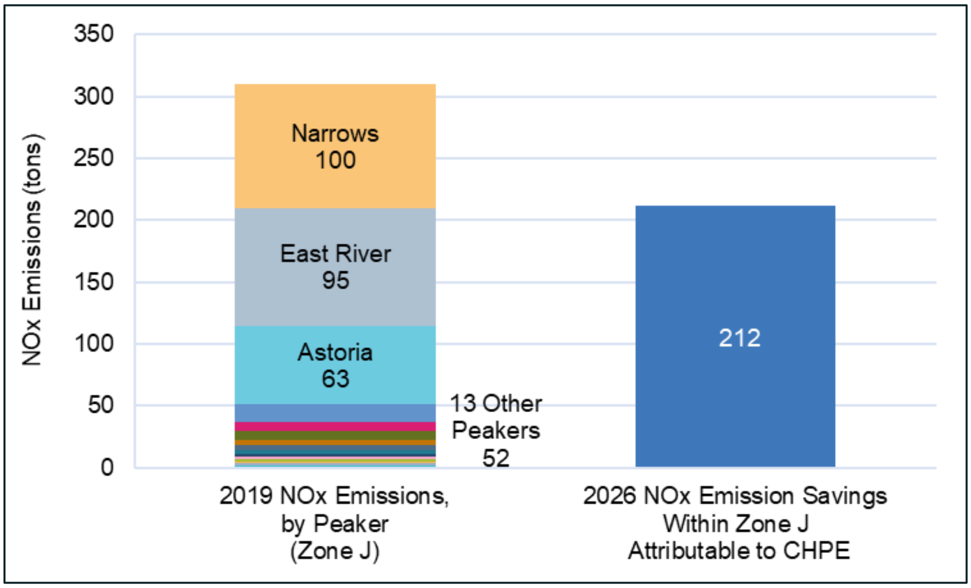
In CHPE's first full year of operations, 2026, local air pollutant emissions from fossil-fueled power plants are expected to decrease by nearly 20% in New York State.

Table 6: New York State Local Air Pollutant Emission Reductions from CHPE (2026)

	NOx	SO2	NH3	PM2.5	VOCs	Total
Emissions without CHPE (tons)	3,100	108	1,245	942	293	5,688
Emissions with CHPE (tons)	2,602	82	1,011	765	238	4,698
Emissions Delta (tons)	-498	-26	-234	-177	-55	-990
Emissions Delta (%)	-16%	-24%	-19%	-19%	-19%	-18%

Furthermore, of the 498 tons of NOx emission reductions attributable to CHPE across New York State, PA forecasts a 212-ton reduction to occur specifically within Zone J. To put these reductions in perspective, this is equivalent to removing 15 of New York City's 16 peaker plants from operation, based on 2019 emissions. This is shown in the figure below. Peaker plants in New York City are primarily located in or near Disadvantaged Communities and the benefits of decreasing their operation is discussed in Section 3.3.5.

Figure 9: NOx Emissions: New York City Peaker Plants vs. CHPE Emission Reductions



3.3.4 The Lives Saved and Value of Local Air Pollutant Emission Reductions CHPE Will Provide Is Significant

Based on the local air pollutant emission reductions described in the previous section, PA estimates that CHPE's operations will result in up to 6 lives saved each year with an economic benefit of up to $102.5 million per year across New York State, as shown in Table 7. These benefits primarily come from lower incidences of heart attacks and premature deaths. Through 2050, the cumulative economic benefit, using the mid-point of the high and low estimates, of improved health from lower air pollutant emissions in New York State is $1.9 billion; with an average of 4 lives saved annually.

Table 7: New York State Health Benefits from CHPE (2025-2050)

	Average Annual Lives Saved	Average Annual Economic Benefit
Low Estimate	3	$45.5 million
High Estimate	6	$102.5 million

In New York City, PA estimates that CHPE's operations will result in up to 4 lives saved each year with an economic benefit of up to $61 million per year, as shown in Table 8. And through 2050, the cumulative economic benefit, using the mid-point of the high and low estimates, of improved health from lower air pollutant emissions is $1.1 billion, with an average of 3 lives saved annually.

Table 8: New York City Health Benefits from CHPE (2025-2050)

	Average Annual Lives Saved	Average Annual Economic Benefit
Low Estimate	2	$27.0 million
High Estimate	4	$61.0 million

In New York City specifically, it's expected that the majority of the pollutant reduction will come from peaker plants whose locations are concentrated in areas of Disadvantaged Communities. And through reductions peaker plant operations due to CHPE, the positive health effects from decreased local air pollutant emissions is expected to be concentrated in these Disadvantaged Communities.

3.3.5 CHPE Will Positively Impact Health in Disadvantaged Communities

Environmental injustice acknowledges that low income communities and communities of color are disproportionately affected by pollution and impacts of climate change. It is more common for these communities to be located near heavily polluting industrial facilities and people of color have a higher risk of dying from health problems caused by pollution. [44] Conversely, climate justice is the practice of taking actions to address the ethical issues inherent to environmental injustice. As steps are taken to achieve targets that will reduce the causes of climate change, setting paired targets to benefit these disadvantaged communities will direct resources to residents that may not otherwise be able to fight climate change.

A contributor to environmental injustice in New York are the peaker plants located in New York City. Peaker plants are used to meet energy demand on days when load is high and transmission lines into New York City cannot meet the need for more electricity. These facilities require a large footprint of land and can produce both undesirable noise and smells, so are often developed on lower value, industrial land, with many near large public housing developments where higher concentrations of low-income New Yorkers live. Moreover, the operations required to ramp gas-fired peaker plants up and down, to meet sudden changes in electricity demand, results in them producing acute levels of pollution such as NOx, SO2, NH3, VOCs and PM2.5. These pollutants have been shown to worsen rates of respiratory diseases like asthma in the population, increase risk of heart attacks[45] and increase the likelihood of contracting and experiencing complications from COVID-19. [46] According to the City of New York's PlaNYC report from 2011, PM2.5 pollution in New York City causes more than 3,000 deaths, 2,000 hospital admissions for lung and heart conditions, and approximately 6,000 emergency department visits for asthma in children and adults yearly. [47].

Since peaker plants in New York are often located in or near Disadvantaged Communities (defined by NYSERDA as communities located within New York State Opportunity Zones[48]) this means the pollution from them has a disproportionate health impact on residents living in these communities. The establishment of Tier 4 REC program is designed to help meet the goals of the Climate Leadership and Community Protection Act (CLCPA). And one of the provisions in the CLCPA is that 40% of the program's benefits be directed to Disadvantaged Communities, whether through direct investment, creation of jobs or other incremental benefits such as reducing pollution from displaced thermal generation. By providing reliable, clean energy from hydroelectric power plants, CHPE will reduce the New York grid's reliance on its fossil-fueled peaker plants and thereby provide positive health impacts to Disadvantaged Communities.

See Figure 10 for a map showing that most peaker plants in New York City are within or adjacent to a Disadvantaged Community.

[44] Per the American Lung Association (https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities)

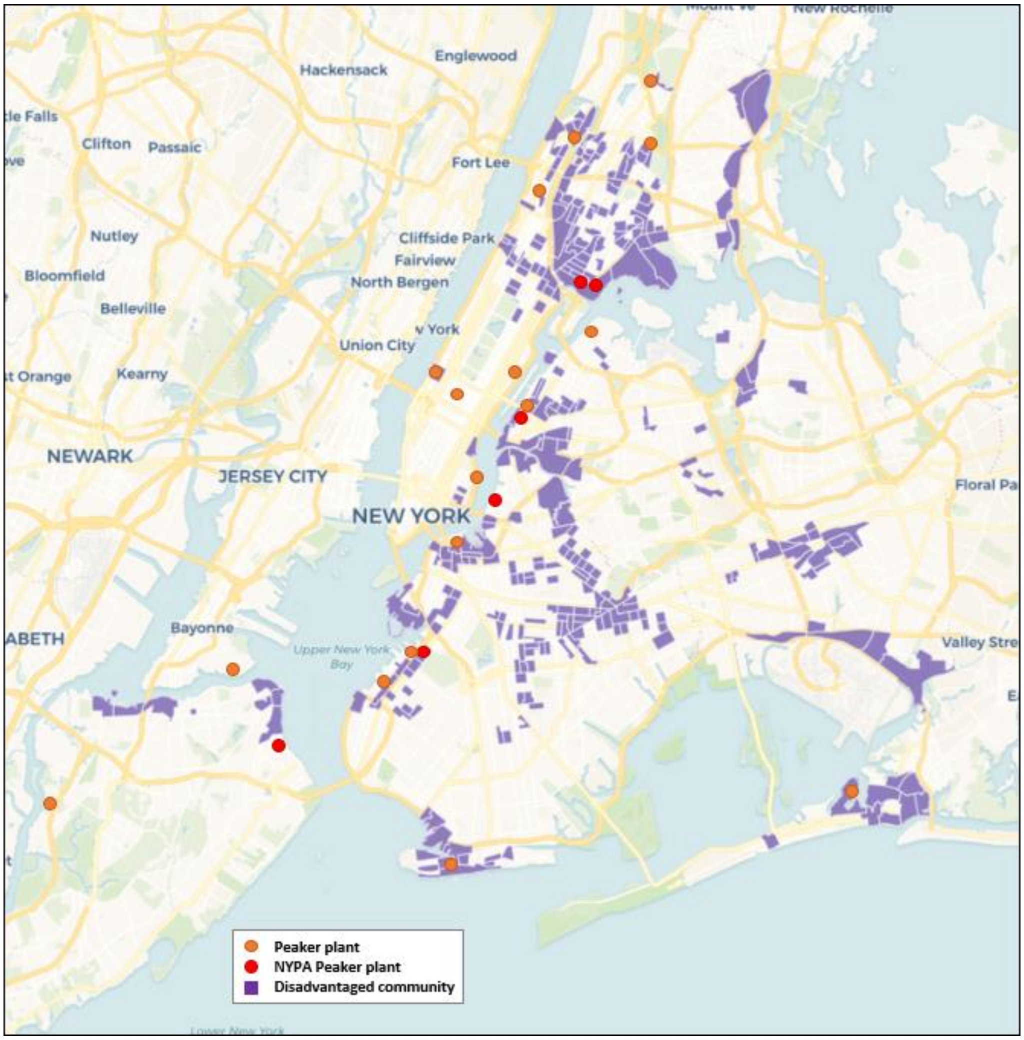
[45] Per the American Lung Association (https://www.lung.org/clean-air/outdoors/what-makes-air-unhealthy/particle-pollution)

[46] International Journal of Environmental Research and Public Health (https://pubmed.ncbi.nlm.nih.gov/33322089/)

[47] City of NY PlaNYC Report (http://1w3f31pzvdm485dou3dppkcq.wpengine.netdna-cdn.com/wp-content/uploads/2019/04/PlaNYC-2011-Update.pdf)

[48] https://www.nyserda.ny.gov/ny/disadvantaged-communities

Figure 10: New York City Peaker Plant Locations and Disadvantaged Communities



As shown in Table 9, approximately half of New York State's reduction in NOx, SO2, NH3, PM2.5 and VOC will occur in New York City. And as previously discussed, these improvements in air quality are anticipated to contribute both health and economic value in the local areas where emissions are reduced. Therefore, by reducing the operations of peaker plants located in Disadvantaged Communities, CHPE will be supporting climate justice in New York by reducing pollution in these communities.

Table 9: Cumulative Air Pollutant Emission Reductions From CHPE (2025-2050)

Location	NOx	SO2	NH3	PM2.5	VOC	Total
New York State (tons)	10,207	419	4,757	3,597	1,118	20,097
New York City (tons)	5,247	173	2,425	1,833	570	10,247
% of Reduction in NYC	51%	41%	51%	51%	51%	51%

4 RESILENCY AND RELIABILITY BENEFITS TO THE STATE OF NEW YORK

This section examines the benefits that CHPE provides to the resiliency and reliability of New York state's electric grid, with a focus on how CHPE can support resiliency and reliability in a zero-emission electric grid (as envisioned in 2040 under the CLCPA).

More specifically, CHPE directly and uniquely contributes to the reliability and resiliency of NY's future electric grid:

CHPE Will Improve the Reliability Of New York's Electric Grid.

- CHPE's 10.4 TWh of fully dispatchable, clean energy is sourced from a diversified pool of 61 hydroelectric power plants in Québec with a capacity of 36,500 MW and annual generation of 176 TWh.

CHPE Will Improve the Resiliency of New York's Electric Grid.

- Québec's weather is distinct from New York's, and therefore CHPE's power supply is unlikely to be impacted by storm events affecting New York State. Moreover, since CHPE is comprised of 339 miles of buried cable, storm events are very unlikely to impact the line itself.

CHPE Will Support the Integration of Offshore Wind.

- PA estimates CHPE can help avoid offshore wind curtailment of 2.0 TWh to 5.4 TWh, with an associated value of $224 million to $588 million in 2040.

CHPE Will Not Impact Increase Transmission Congestion in Upstate New York.

- Since CHPE will not be sourcing new renewable generation from upstate New York, like other competing Tier 4 projects, CHPE will not worsen the transmission congestion that already exists.

4.1 Overview

One of the core principles of the CLCPA is to make New York communities more resilient to ever intensifying threats from global climate change. While electric reliability has an industry-defined metric (the Loss of Load Expectation, or LOLE) and is narrowly focused on avoiding power outages, resiliency is more formless and far-reaching. A common industry definition of resilience is the ability of a system or community to withstand, absorb and recover from potential hazards. In New York, climate change is exacerbating many of hazards; scientists expect rising sea levels, greater variability to temperature and precipitation, and an increased number and intensity of storms in the Atlantic like Super Storm Sandy.

Very recently, in other parts of the U.S., the growing threat of climate change to electric grid resiliency has been painfully felt. For example, in August 2020, very hot summer temperatures in California contributed to blackouts in the early evening as intermittent solar generation declined. The prior summer, massive wildfires were caused by the poor maintenance of aging, above-ground electric transmission infrastructure. Only a few months ago, in February, unprecedented cold winter temperatures drove record high electricity demand in Texas, knocked out over 30,000 MW of power generation, resulting in nearly four days of rolling blackouts with over $100 billion in estimated economic damage.

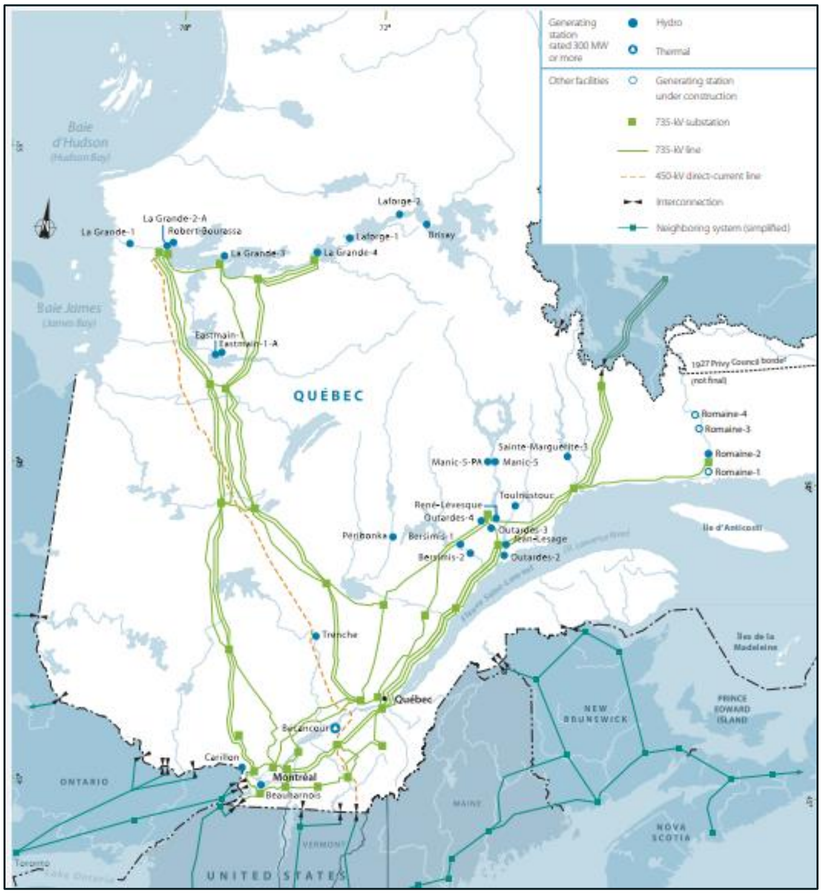
As New York adds more intermittent renewable generation to meet the decarbonization targets of the CLCPA, maintaining the resiliency and reliability of the electric grid must be considered alongside CO2 and local air pollutant emissions. And, as discussed in the rest of this section, CHPE uniquely provides New York State the opportunity to achieve the emission reductions required by the CLCPA while simultaneously improving the resiliency and reliability of New York's electric grid.

4.2 CHPE's Québec Power Supply and Buried Transmission Lines, Decrease the Impact of Storm Events on The NYISO Grid

CHPE uniquely enables New York access to a diversified pool of hydro generation located across Québec. Notably, CHPE will not be supplied by one or a handful of power generators, but rather by system sales from Hydro-Québec's pool of 61 individual hydroelectric power plants with a nameplate capacity of 36,500 MW capable of producing over 175 TWh of clean energy. [49]. CHPE's 10.4 TWh of clean energy represents only 6% of Hydro-Québec's clean energy pool.

By having access to a network of power generators capable of producing clean energy significantly in excess of CHPE's needs, CHPE improves the resiliency of the NYISO grid by eliminating the negative impact of a single generator outage (because any individual power generator outage would not other impact energy flows over the line), and provides an unprecedented form of new, baseload clean energy with a 95% capacity factor.

Figure 11: Map of Québec Hydrogeneration



Furthermore, Québec is geographically very large and distinct from New York, nearly all of the large-scale, hydroelectric generators in the province are located well north of load centers near the U.S. border - averaging a distance of nearly 900 miles from New York City. It is to be expected, given this distance, that Québec experiences different weather patterns than New York, and, as a result, the probability of an extreme weather event impacting both Québec and New York simultaneously is quite low.

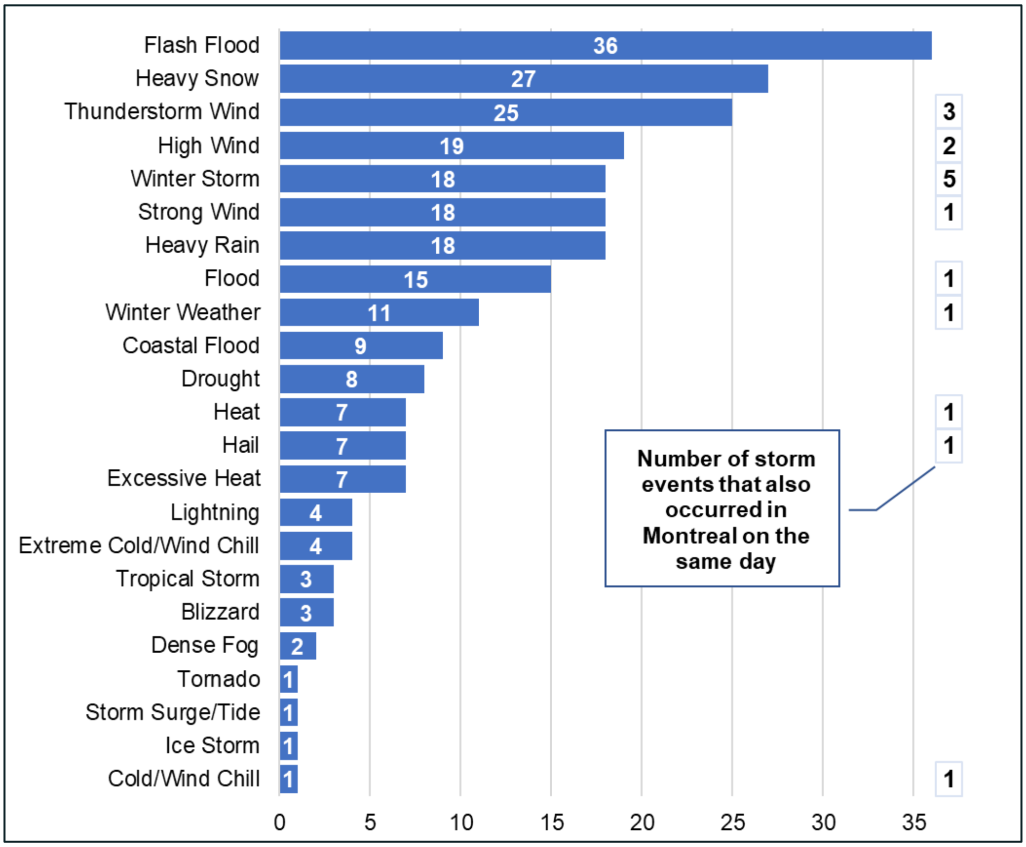
To analyze the correlation or lack thereof between Québec and New York, PA reviewed 30 years of NOAA-declared storm events for New York City and Montreal. [50]. Since 1990, there have been 245 distinct daily storm events in New York City. The greatest number of events concern flash flooding or were otherwise associated with summer thunderstorms. There are also a significant number wind and winter storm events. However, and importantly, of the 245 distinct daily storm events in New York City there were only 16 instances where Montreal was also experiencing a storm event. In other words, the observed coincidence of

[49] Per Hydro-Québec (https://www.hydroQuébec.com/generation/#:~:text=Hydro%2DQu%C3%A9bec's%20generating%20fleet%20comprises,dams%20and%2091%20control%20structures.)

[50] As a proxy to allow for the use consistent data sets, PA used Clinton County, New York, which is approximately 30 miles from Montreal.

storm events in New York City and Montreal over the past 30 years is less than 10%. This lack of correlation between the two geographies and the connection CHPE enables between them increases the resiliency of New York's grid by minimizing the impact of an extreme weather event on New York's power supply.

Figure 12: New York City NOAA-Declared Storm Events Since 1990



In spanning the geographic distance to bring Hydro-Québec's generation to New York City, CHPE's 339-mile HVDC route to New York City is entirely underground, with 40% of the route subterraneous and the rest submarine (via the Hudson and East Rivers or Lakes George and Champlain). This enables CHPE to avoid outage risks that are typical of overhead power lines. More specifically, overhead power lines are vulnerable to wind events (directly as well as indirectly, via branches or other debris), lightning strikes, and can accumulate snow and ice in winter. A New York City study in 2013 conducted by the Office of Long-Term Planning and Sustainability found that "*Con Edison's non-network system, primarily overhead in nature, had significantly higher outage frequency than did the company's [buried] network system.*"[51]

In recognition of their increased resiliency attributes, ConEd and other electric utilities routinely identify key overhead segments of the transmission system for undergrounding, as part of their storm hardening efforts, particularly along key segments. For example, in the wake of Superstorm Sandy, PSEG in New Jersey undergrounded 20 miles of transmission lines. There are also power system benefits associated with underground power lines. For example, underground cables can provide reactive support during periods of peak demand, which according to ConEd, is due to the greater "capacitive reactance" associated with underground cables.

CHPE can also help avoid future overhead transmission buildout that would otherwise be needed to accommodate greater amounts of upstate New York wind and solar, which would otherwise need to be built in place of CHPE's 10.4 TWh of clean energy. For example, the 2019 CARIS report noted that renewable generation in its 70x30 modeling scenario was curtailed "due to local transmission bottlenecks", which would require a transmission buildout of overhead wires to alleviate. Similarly, the Utility Study (summarized in the Brattle Report) conducted to assess transmission needs identified numerous local transmission upgrades

[51] Source: [power_lines_study_2013.pdf (nyc.gov)]

needed to facilitate CLCPA compliance. Phase 1 upgrades to address transmission needs in the next decade are already underway and expected to cost $6.8 billion with additional Phase 2 upgrades needed to support CLCPA compliance but not yet scoped. [52]. Most of these upgrades would be accomplished with overhead transmission lines, which weakens the resiliency of the New York grid by increasing its exposure to storm events. CHPE's buried transmission lines are unimpacted by storm events and therefore strengthen the resiliency of New York's grid.

4.3 CHPE Can Support the Integration of Offshore Wind

As previously discussed, New York leads the U.S. in its decarbonization goals, with 100% clean energy required from the power sector by 2040. Therefore, in order to meet this goal, New York will need to bring on significant amounts of baseload clean energy (such as CHPE), intermittent on-shore wind and off-shore wind.

On the latter, due to the geography of New York state, off-shore wind interconnections are limited to Zones J and K. And although these two zones represent the majority of New York's electricity demand, load, their ability to absorb and manage the amounts of off-shore wind generation that are likely needed to achieve CLCPA compliance by 2040 is uncertain. CHPE is able to support the integration of increasing amounts of off-shore wind in New York by (1) exporting off-shore wind generation during times of excess production, and (2) ramping up/down to respond to sudden changes in off-shore wind generation. In fact, CHPE's ramping potential and the associated benefit to off-shore wind integration were recently cited in an Analysis Group report, commissioned by the NYISO, entitled Climate Change Impact and Resilience Study Phase II. [53]

While neither operating mode is likely to be CHPE's primary function when it initially enters service, as New York moves towards CLCPA compliance and the NYISO grid grapples with ever increasing amounts of intermittent renewable generation, it is possible that CHPE's operating profile may change in ways that are not currently contemplated. The fact that CHPE has the potential to (1) export excess off-shore wind generation[54] and thereby minimize off-shore wind curtailment and (2) rapidly ramp to respond to sudden changes in off-shore wind generation supports the future reliability of the NYISO grid.

4.3.1 CHPE Can Help Minimize Off-Shore Wind Curtailment

To estimate the benefit that CHPE can provide by helping minimize off-shore wind curtailment, PA evaluated the first year of CLPA compliance, 2040. Since the Reference Case, as previously discussed, was developed to demonstrate the infra-marginal benefits CHPE can provide to the NYISO grid in terms of CO2 and harmful pollutant emission reductions, PA utilized the 2040 CCP2-CLCPA Case reflected in The Analysis Group's report Climate Change Impact and Resilience Study Phase II. In this CLCPA-compliant case, The Analysis Group modeled a New York electric grid that was 100% compliant with the CLCPA's 2040 electric grid target, and assumed 21,000 MW (nameplate) of off-shore wind would be built to help achieve that compliance. As The Analysis Group did not explicitly calculate off-shore wind curtailment in its analysis, PA developed a model to simulate off-shore wind curtailment in 2040, based on 21,000 MW of off-shore wind capacity, with assumptions for energy storage capacity and transfer capability between NYISO zones. Notably, PA's analysis (consistent with The Analysis Group) assumed a CLCPA compliant load forecast, which is significantly higher than that used in Reference Case and therefore, all else equal, reduces the instances of off-shore wind curtailment (since there is more electric demand to absorb the off-shore wind generation.

[52] Initial Report on the New York Power Grid Study (https://brattlefiles.blob.core.windows.net/files/20842_initial_report_on_the_new_york_power_grid_study.pdf)

[53] Climate Change Impact and Resilience Study Phase II - NYISO (https://www.nyiso.com/documents/20142/15125528/02%20Climate%20Change%20Impact%20and%20Resilience%20Study%20Phase%202.pdf/89647ae3-6005-70f5-03c0-d4ed33623ce4)

[54] From a technical perspective, once operational CHPE will be able to flow energy bidirectionally. However, certain permits would need to be amended and NYISO approval would be required to enable these bidirectional flows. If this situation occurs during the term of the PSA, the parties will need to discuss appropriate adjustments to the PSA.

As shown in Table 10, PA estimates CHPE could help reduce NYISO off-shore wind curtailment in 2040, in a CLCPA-compliant electric grid, by approximately 25%, depending on the level of off-shore wind generation operating on the system.

Table 10: Estimated Off-Shore Wind Curtailment In 2040 With and Without CHPE

Off-Shore Wind Generation Scenario	OSW Curtailment (MWh)[55]		Avoided OSW Curtailment Generation (MWh)
	Without CHPE	With CHPE	
Median	**7,745,387**	**5,685,549**	2,059,838
High	**24,443,166**	**19,042,127**	5,401,039

The value of this avoided curtailed offshore wind generation PA estimates to be in in the range of $224 million to $588 million, as shown in Table 11. This assumes that NYISO would need to add lithium-ion battery energy storage, to provide an equivalent amount of avoided off-shore wind generation curtailment as can be provided by CHPE. [56]

Table 11: CHPE Avoided Off-Shore Wind Generation Curtailment Benefit

Offshore Wind Generation Scenario	Avoided OSW Curtailment Generation (MWh)	Avoided OSW Curtailment Benefit
Median	2,059,838	$224 million
High	5,401,039	$588 million

4.3.2 CHPE Can Support Grid Reliability by Responding to Sudden Changes in Offshore Wind Generation

Though one of the benefits of offshore wind is its relatively flat generation profile, it is still an intermittent resource with hourly fluctuations in production. A large portion of the time, these fluctuations in production are small, but there are times when they can be significant. CHPE can help integrate offshore wind by adjusting its output to respond to sudden, and potentially large, changes in offshore wind generation. This integration is especially important as New York adds offshore wind *and* retires its dispatchable thermal generation in order to achieve CLCPA compliance by 2040. In the carbon-free world of 2040 New York will largely be left with only two choices, based on current technology, to manage offshore wind ramping – CHPE and energy storage.

In order to evaluate the reliability benefit that CHPE can provide to the NYISO grid by responding to offshore wind ramp, PA analyzed the hourly deviations in offshore wind generation reflected in the PA analysis discussed in the prior section. Furthermore, for conservatism, PA assumed that the 7,100 MW of nameplate lithium-ion battery storage included in PA's analysis responds to offshore wind ramp before CHPE is called upon. It should be noted the 7,100 MW is more than double New York's 3,000 MW by 2030 storage mandate.

As shown in

Table ***12***, based on the 21,000 MW of offshore wind and 7,100 MW of battery storage assumed to be on the system in 2040, there are over 250 hours when the 1-hour ramp of offshore wind exceeds battery storage capacity and nearly 1,500 hours (nearly 20% of the year) when the 4-hour ramp exceeds battery storage capacity.

Table 12: Offshore Wind Generation Ramp Greater Than 7,100 MW In 2040

	Ramping Period (# of hours)

[55] Curtailment calculated post export capacity and BESS charging

[56] PA estimates 4-hour lithium-ion battery storage to have a levelized cost of energy (LCOE) of approximately $109/MWh in 2040.

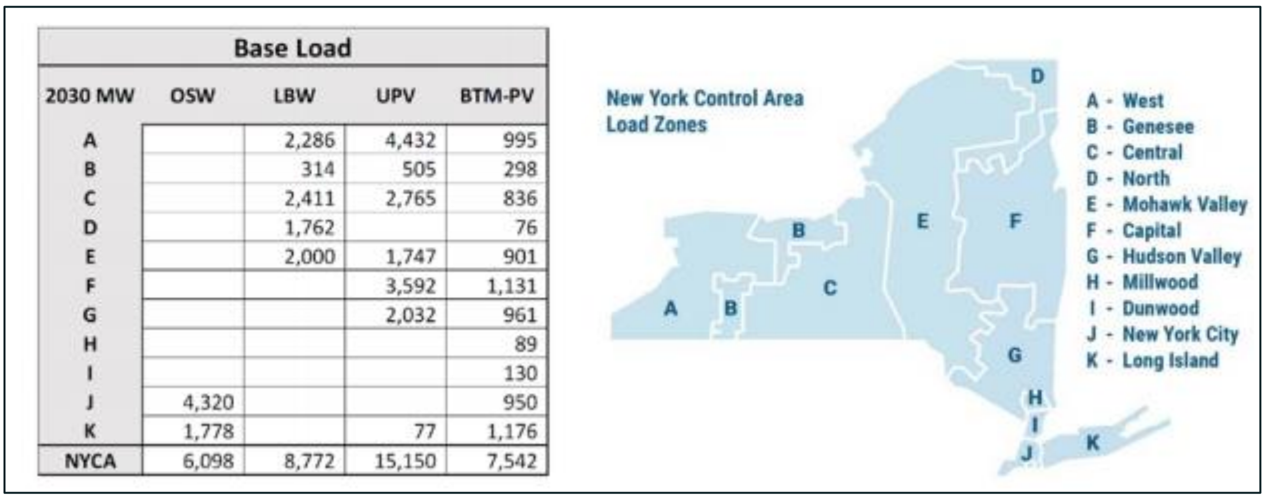
Offshore Wind Generation Scenario	1-Hour Ramp	4-Hour Ramp
Median	259	1,462
High	289	1,499

Since current lithium-ion battery storage technology is primarily 4-hour duration, this analysis indicates CHPE can play a critical role in responding to large and lengthy fluctuations in offshore wind generation by adjusting its output. And by doing so, CHPE will support the reliable integration of offshore wind in New York.

4.4 CHPE Will Not Increase Transmission Congestion in Upstate New York

By relying on a dedicated HVDC transmission line to supply 10.4 TWh of reliable, clean energy to Zone J, CHPE does not require new renewable generation. This is an important consideration because the overwhelming majority of New York's onshore wind and solar resources are located upstate, in Zones A-F, as illustrated in Figure 13 from the CARIS 70x30 Case. Notably, the CARIS 70X30 Case includes '…an assumed generic incremental HVDC connection of 1,310 MW between Hydro-Quebec and New York City.' In other words, the CARIS 70X30 Case includes CHPE.

Figure 13: Total 2030 Renewable Capacity in CARIS 70x30 "Base Load" Case[57]



Base Load				
2030 MW	OSW	LBW	UPV	BTM-PV
A		2,286	4,432	995
B		314	505	298
C		2,411	2,765	836
D		1,762		76
E		2,000	1,747	901
F			3,592	1,131
G			2,032	961
H				89
I				130
J	4,320			950
K	1,778		77	1,176
NYCA	6,098	8,772	15,150	7,542

Moreover, as discussed at length in the 2019 CARIS report New York's upstate transmission system is currently unequipped to integrate the renewable generation shown in Figure 13. The report states the following ("emphasis added"):

*'Results show that renewable generation pockets are likely to develop throughout the state as **the existing transmission grid would be overwhelmed by the significant renewable capacity additions**. In each of the five major pockets observed, renewable generation is curtailed due to the lack of sufficient bulk and local transmission capability to deliver the power. The results support the conclusion that **additional transmission expansion, at both bulk and local levels, will be necessary to efficiently deliver renewable power to New York consumers.'***

Since many of CHPE's Tier 4 competitors plan to rely on new upstate renewable generation, the buildout of the upstate transmission system, or lack thereof, is an important consideration in their viability. CHPE has a substantial timing advantage over these competing Tier 4 projects, as they are likely to require some level of transmission buildout. For example, the AC Public Policy Transmission Projects took 12 years to complete. As a fully-permitted Tier 4 project, which relies on Québec hydro generation, the benefits associated with CHPE can accrue far sooner to New York communities than any alternative.

[57] Excerpted from Initial Report on the New York Power Grid Study, January 2021, at page 16.

APPENDIX A: SUMMARY OF THE MODELING RESULTS

A-1 Annual Benefit Forecast

Table 13 and Table 14 outline the annual results of PA's analysis for (1) direct and indirect economic output benefits, (2) wholesale electricity savings, (3) property tax payments, and (4) CO2 and local air pollutant emission reduction benefits, from CHPE's construction and operations.

Table 13: Annual Benefits to the State of New York from CHPE ($millions, 2021-2025)

	2021	2022	2023	2024	2025
(1) Direct Economic Output	**116.8**	**176.0**	**234.6**	**233.1**	**244.6**
(2) Indirect/Induced Economic Output (includes 2a)	**80.4**	**99.1**	**123.8**	**119.8**	**124.5**
(2a) Wholesale Electricity Cost Savings	**0.0**	**0.0**	**0.0**	**0.0**	**63.8**
Energy Cost Savings	0.0	0.0	0.0	0.0	19.4
Capacity Cost Savings	0.0	0.0	0.0	0.0	44.4
(3) Property Tax Payments	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(4) Value of CO2 Emission Reductions	**0.0**	**0.0**	**0.0**	**0.0**	**51.9**
(5) Value of Local Air Pollutant Emission Reductions	**0.0**	**0.0**	**0.0**	**0.0**	**4.6**
Total Economic Benefits [Sum of (1) to (5)]	**197.2**	**275.2**	**358.5**	**352.9**	**425.6**

Table 14: Annual Benefits to the State of New York from CHPE ($millions, 2026-2034)

	2026	2027	2028	2029	2030	2031	2032	2033	2034
(1) Direct Economic Output	**21.3**	**16.4**	**17.0**	**23.8**	**24.4**	**18.8**	**20.8**	**20.3**	**22.4**
(2) Indirect/Induced Economic Output (inc. 2a)	**919.9**	**1,098.2**	**1,360.2**	**1,112.2**	**869.6**	**1,459.9**	**931.7**	**728.6**	**621.8**
(2a) Wholesale Electricity Cost Savings	**925.1**	**1,073.3**	**1,323.7**	**956.1**	**807.1**	**1,432.1**	**884.9**	**668.8**	**544.9**
Energy Cost Savings	220.8	216.7	217.8	232.2	245.2	257.3	274.7	285.7	343.1
Capacity Cost Savings	704.3	856.7	1,106.0	723.9	561.9	1,174.8	610.2	383.1	201.8
(3) Property Tax Payments	**39.3**	**39.8**	**40.3**	**40.9**	**43.7**	**45.6**	**46.2**	**46.8**	**49.9**
(4) Value of CO2 Emission Reductions	**628.2**	**632.3**	**661.0**	**675.8**	**684.4**	**719.1**	**719.1**	**750.7**	**752.5**
(5) Value of Local Air Pollutant Emission Reductions	**48.6**	**50.1**	**59.9**	**63.0**	**63.5**	**65.2**	**72.0**	**68.0**	**61.5**
Total Economic Benefits [Sum of (1) to (5)]	**1,657.3**	**1,836.9**	**2,138.5**	**1,915.6**	**1,685.6**	**2,308.6**	**1,789.8**	**1,614.4**	**1,508.1**

Table 15: Annual Benefits to the State of New York from CHPE ($millions, 2035-2042)

	2035	2036	2037	2038	2039	2040	2041	2042
(1) Direct Economic Output	**53.7**	**29.9**	**29.6**	**33.0**	**32.7**	**33.4**	**34.2**	**34.9**
(2) Indirect/Induced Economic Output (inc. 2a)	**795.8**	**730.7**	**496.6**	**520.7**	**877.1**	**564.8**	**595.2**	**628.7**
(2a) Wholesale Electricity Cost Savings	**684.9**	**627.6**	**407.0**	**385.1**	**740.4**	**445.9**	**460.6**	**476.6**
Energy Cost Savings	385.3	391.0	419.0	425.0	488.2	499.8	516.8	534.0

Capacity Cost Savings	299.5	236.6	-12.0	-39.9	252.2	-53.9	-56.2	-57.4
(3) Property Tax Payments	**50.5**	**52.6**	**53.4**	**56.6**	**57.4**	**58.2**	**60.5**	**64.0**
(4) Value of CO2 Emission Reductions	**776.2**	**805.9**	**826.7**	**869.3**	**920.8**	**972.6**	**1,006.4**	**1,041.2**
(5) Value of Local Air Pollutant Emission Reductions	**66.8**	**70.8**	**70.0**	**73.6**	**73.5**	**80.3**	**82.6**	**85.1**
Total Economic Benefits [Sum of (1) to (5)]	**1,742.9**	**1,689.9**	**1,476.2**	**1,553.1**	**1,961.5**	**1,709.2**	**1,778.8**	**1,853.9**

Table 16: Annual Benefits to the State of New York from CHPE ($millions, 2043-2050)

	2043	2044	2045	2046	2047	2048	2049	2050
(1) Direct Economic Output	**35.7**	**36.5**	**37.3**	**38.1**	**38.9**	**39.8**	**40.6**	**41.5**
(2) Indirect/Induced Economic Output (inc. 2a)	**662.1**	**697.0**	**732.7**	**773.6**	**812.8**	**853.6**	**897.6**	**942.6**
(2a) Wholesale Electricity Cost Savings	**492.9**	**509.3**	**525.5**	**542.0**	**558.5**	**575.1**	**591.6**	**608.0**
Energy Cost Savings	551.6	569.3	586.9	604.7	622.5	640.6	658.5	676.4
Capacity Cost Savings	-58.7	-60.0	-61.3	-62.7	-64.0	-65.4	-66.9	-68.4
(3) Property Tax Payments	**64.9**	**65.8**	**66.7**	**73.7**	**75.7**	**77.6**	**83.0**	**88.0**
(4) Value of CO2 Emission Reductions	**1,077.1**	**1,114.1**	**1,152.1**	**1,184.4**	**1,224.6**	**1,266.0**	**1,301.3**	**1,345.0**
(5) Value of Local Air Pollutant Emission Reductions	**87.5**	**90.0**	**92.5**	**94.7**	**96.9**	**99.1**	**101.4**	**103.8**
Total Economic Benefits [Sum of (1) to (5)]	**1,927.3**	**2,003.3**	**2,081.3**	**2,164.6**	**2,249.0**	**2,336.2**	**2,423.9**	**2,520.9**

A-2 Annual Jobs and Compensation Forecast

Table 17 outlines the results of PA's analysis related to estimated direct and secondary (indirect and induced) job creation and compensation within New York (all values are presented in nominal $s). Jobs and compensation benefits are also discussed in Section 2.2.3.

Table 17: Jobs and Compensation Impacts from CHPE in New York (2021-2050)

Year	Period	Direct Jobs	Secondary Jobs	Total Compensation ($millions)
2021	Construction	67	797	76
2022		296	1,110	114
2023		745	882	144
2024		826	680	140
2025		290	1,230	149
2026	Operation	51	4,820	338
2027		31	5,064	401
2028		32	6,152	496
2029		54	4,458	409
2030		54	3,748	320
2031		34	6,307	526
2032		38	3,904	339
2033		35	2,965	266
2034		40	2,458	229
2035		48	3,070	302
2036		42	2,760	270
2037		38	1,822	185
2038		43	1,813	198
2039		40	3,102	324
2040		39	1,918	212
2041		39	1,965	223
2042		39	2,031	236
2043		39	2,099	248
2044		39	2,167	260
2045		39	2,234	273
2046		39	2,302	288

Year	Period	Direct Jobs	Secondary Jobs	Total Compensation ($millions)
2047		39	2,371	302
2048		39	2,440	317
2049		39	2,508	333
2050		39	2,577	349

A-3 Air Pollutant Reduction Forecast

Table 18 outlines the results of PA's analysis related to estimated air pollutant reductions in New York State. Pollutants are also discussed in Section 3.3.3.

Table 18: Pollutant Emission Reductions Attributable to CHPE Operations (tons, 2025-2050)

Year	CO_2 (metric tons)	NOx	SO2	NH3	PM2.5	VOCs
2025	347,311	36	2	24	18	6
2026	4,084,066	498	26	234	177	55
2027	3,963,404	396	17	215	163	51
2028	3,995,559	406	20	219	165	51
2029	3,940,167	363	16	195	148	46
2030	3,877,173	349	14	185	140	43
2031	3,930,770	392	16	192	145	45
2032	3,793,465	356	16	179	135	42
2033	3,848,413	362	16	179	136	42
2034	3,724,184	356	13	166	126	39
2035	3,708,570	359	13	163	123	38
2036	3,718,637	351	14	168	127	39
2037	3,708,366	351	14	168	127	39
2038	3,766,281	342	12	169	128	40
2039	3,854,324	403	15	179	135	42
2040	3,933,569	444	18	193	146	45
2041	3,933,569	444	18	193	146	45
2042	3,933,569	444	18	193	146	45
2043	3,933,569	444	18	193	146	45
2044	3,933,569	444	18	193	146	45
2045	3,933,569	444	18	193	146	45
2046	3,933,569	444	18	193	146	45
2047	3,933,569	444	18	193	146	45
2048	3,933,569	444	18	193	146	45
2049	3,933,569	444	18	193	146	45
2050	3,933,569	444	18	193	146	45

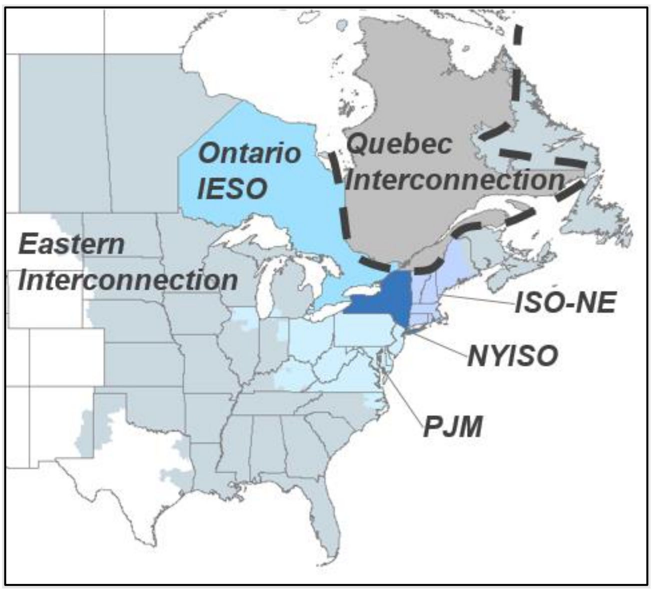
APPENDIX B: DESCRIPTION OF THE MODELING METHODOLOGY AND ANALYSIS

B-1 Wholesale Electricity Modeling

To evaluate the wholesale electricity and environmental benefits from CHPE, PA used its proprietary electricity market modeling process. This process has been vetted in regulatory and litigation proceedings, including some of the largest bankruptcies in the power sector.

At the core of PA's proprietary modeling process, PA uses an industry standard chronological dispatch simulation model, AURORA, to simulate the hourly operations of the power plants and transmission lines within the Eastern and Québec Interconnections – as illustrated in Figure 14 – with a focus on the NYISO system. This model enables PA to analyze inter and intra-market hourly energy flows and the operating profile of the power plants and transmission lines within a given system; in this case NYISO and the adjacent systems of PJM, Ontario IESO, Hydro-Québec, and ISO-NE. The AURORA model is widely used by electric utilities, power market regulators, independent system operators and other market consultants.

Figure 14*:* North American Electric Interconnections



To analyze the environmental and economic benefits of the Project, PA modeled the NYISO electricity system under two scenarios - referred to as the Reference Case and the Study Case – for 2025 through 2040. CHPE's operations post-2040, and associated emission reduction impacts, were held constant. Wholesale energy and capacity costs were escalated at an inflation rate of 2.2%.

The Reference Case modeled the NYISO system without CHPE, while the Study Case assumed CHPE would provide 10.4 TWh per year of clean energy and 1,250 MW of firm capacity sales into the system. The Study Case is identical to the Reference Case with the exception of the addition of CHPE.

The Reference Case and The Study Case included all new renewable resources that have received contracts with NYSERDA as of February 28, 2021, but assumed a 20% degradation rate, in line with NYSERDA's assumption in its June 2020 White Paper on Clean Energy Standard Procurements. [58] Additionally, over 6 GW of offshore wind is added by 2030, in line with the 26 TWh of offshore wind generation assumed in NYSERDA's White Paper, with a further 3 GW added by 2035 in order to meet New York's 9 GW of offshore wind by 2035 mandate. Finally, 3 GW of battery storage are added by 2030 in order

[58] https://www.nyserda.ny.gov/-/media/Files/Programs/Clean-Energy-Standard/20200714-CLCPA-white-paper.pdf

to meet New York's mandate, with an additional ~5 GW of battery storage added beyond 2030 as needed to meet reliability needs.

Neither the Reference Case nor the Study Case reflect compliance with the CLCPA's 70% renewable energy by 2030 nor 100% clean energy by 2040 targets. This approach was taken in order to model CHPE as an inframarginal clean energy resource and contributor to CO2 and local air pollutant reductions. This enables the reader to evaluate the incremental benefits CHPE can provide to New York by lowering pollutant emissions and helping New York State make progress towards its short and long-term decarbonization targets.

B.1.1 Determining Wholesale Electricity Cost Savings and CO2 Emission Reductions

As previously discussed, PA's analysis forecasted CHPE's operations to result in wholesale electricity cost savings and CO2 emission reductions for New York ratepayers. These findings were determined using the aforementioned AURORA model. Two primary assumptions that impact the level of electricity cost savings and CO2 emission reductions are (1) natural gas prices, and (2) peak electricity demand growth.

1. Natural gas price assumptions

PA relied on the natural gas prices from NYISO's 2019 CARIS report, published in July 2020. [59] This report provides delivered prices for Zones A-E, F-I, J, and K separately, all of which were incorporated in PA's analysis.

2. Electricity demand assumptions

PA relied on the 2021 peak demand forecast for 2021. [60] For peak demand beyond 2021, PA relied on the projected year-over-year changes from the 2020 Gold Book forecast, and applied those to the official peak demand forecast for 2021. [61] Energy demand projections are based on the 2020 Gold Book.

It is important to note that the 2021 Gold Book does not assume New York will be in full compliance with CLCPA targets.

3. How electricity cost savings are calculated

The electricity cost savings (made up of energy and capacity cost savings) to New York ratepayers were calculated using the AURORA model (energy cost saving) and PA's ICAP auction simulation model (capacity cost savings). As discussed in Section 1, CHPE was assumed to begin commercial operations in December 2025 with the ability to generate 1,250 MW of electricity at a capacity factor of 95%.

The AURORA model simulated the NYISO system, and the adjacent PJM, Ontario IESO, Hydro-Québec, and ISO-NE systems, with and without CHPE in the market. CHPE was forecasted to lower wholesale energy prices, and thereby lower energy costs, by reducing the system's reliance on expensive fossil-fueled power plants to generate electricity as a result of its low production cost of electricity – which results in CHPE operating ahead of these fossil-fueled power plants. These dynamics and how wholesale energy prices decrease as a result of CHPE's 1,250 MW of clean energy were described in Section 2.2.1 of this report.

The ICAP auction simulation model simulated NYISO's capacity auctions with and without CHPE and its 1,250 MW of firm capacity sales in the market. CHPE was forecasted to lower wholesale capacity prices in NYISO and thereby lower capacity costs, by increasing the amount of low-cost capacity that is available to be purchased. This dynamic and how wholesale capacity prices decrease as a result of CHPE's 1,250 MW of firm capacity sales was described in Section 2.2.1 of this report.

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[59] https://www.nyiso.com/documents/20142/2226108/2019-CARIS-Phase1-Report-Final.pdf/bcf0ab1a-eac2-0cc3-a2d6-6f374309e961

[60] https://www.nyiso.com/documents/20142/1401192/2021-ICAP-Forecast.pdf/b0ba579e-696c-b4a8-c9bf-484fce6a57fb

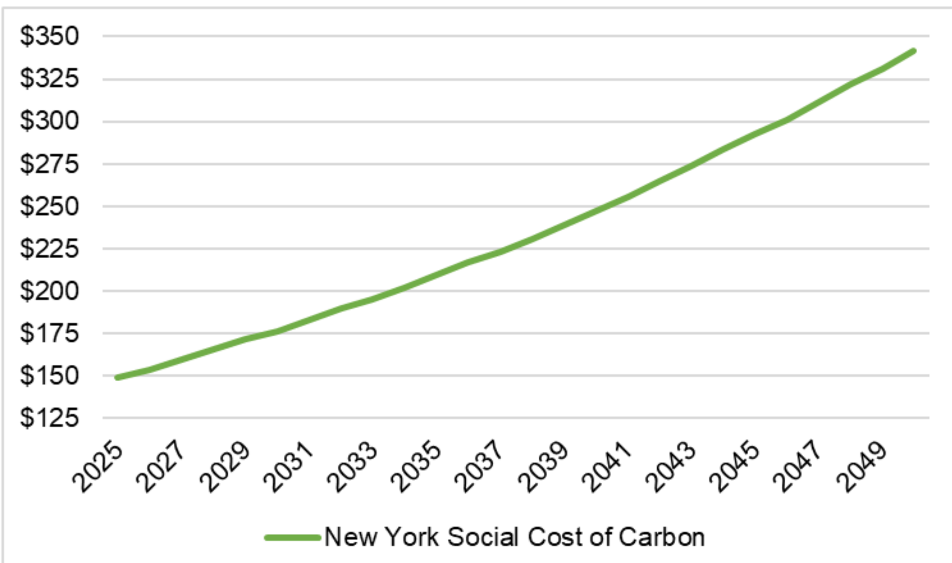
[61] https://www.nyiso.com/documents/20142/2226333/2020-Gold-Book-Final-Public.pdf/9ff426ab-e325-28bc-97cf-106d792593a1

4. How CO_2 emission reductions and environmental benefits are calculated

Similar to how energy cost savings were calculated, PA relied on the AURORA model to simulate the operations of the NYISO system and the adjacent PJM, Ontario IESO, Hydro-Québec, and ISO-NE systems, with a specific focus on how CHPE would change the operations of CO_2-emitting power plants. Similar to how CHPE creates energy cost savings, CHPE is forecasted to create CO_2 emission reductions by reducing the NYISO system's reliance on CO_2-emitting fuel oil and natural gas-fired power plants to generate electricity as a result of its low production cost of electricity – which results in CHPE operating ahead of these CO_2-emitting power plants.

Once the CO_2 emission reductions from CHPE were quantified, PA calculated the environmental benefit of the reductions (i.e., the value of avoided CO_2 emissions) based on the New York DEC Social Cost of Carbon calculation[62]. The Social Cost of Carbon is a monetized estimate of the societal damages, including agricultural productivity changes, human health risks, and flooding damages, associated with increases in CO_2 emissions. Specifically, the NY Social Cost of Carbon starts at $149/metric ton in 2026, escalating to $342 by 2050. However, because New York participates in the Regional Greenhouse Gas Initiative ("RGGI"), the NY Social Cost of Carbon was also reported by reducing the forecasted price of RGGI CO_2 allowances to calculate the environmental benefit of CO_2 emission reductions, since the RGGI allowance value was already captured in the decrease in wholesale energy costs from CHPE. The net CO_2 cost that was applied to the forecasted CO_2 emission reductions from CHPE is illustrated in Figure 15 below.

Figure 15*:* New York Social Cost of Carbon Value ($/metric ton)



B-2 Economic Impacts Modeling

To estimate the economic benefits, PA's used an Input-Output ("I-O") analysis. I-O analysis accounts for inter-industry relationships within a defined geographic area (e.g. New York) and estimates how the local and regional economies are affected by a given investment, using economic activity multipliers. In this case, that investment is the construction and operation of CHPE.

The specific model PA used to conduct the I-O analysis was IMPLAN – Impact Analysis for Planning. IMPLAN is an economic analysis tool that takes data from multiple government sources and employs an

[62] PA used the Social Cost of Carbon value calculated using a 2% social discount rate which is consistent with the NY Department of Environmental Conservation's discount rate recommendation for decision making by state entities. PA used the SCC values published by the NY DEC in the October 2020 Value of Carbon Guidance documents (https://www.dec.ny.gov/regulations/56552.html). Note that on February 26, 2021, President Joe Biden signed an executive order reinstating the Obama administration's SCC figures adjusted for inflation and called for a comprehensive update of the SCC by January 2022.

estimation method based on industry accounts, an I-O Matrix, uses multipliers to estimate how changes in income and spending benefit regional economies. IMPLAN estimates are generated by interacting CHPE's direct expenditures (e.g., jobs created and compensation paid) with the Regional Input-Output Modeling System (RIMS II) multipliers for New York, which were provided by the U.S. Bureau of Economic Analysis ("BEA").

Multiplier analysis is based on the notion of feedback through I-O linkages among firms and households who interact in an economy. Firms buy and sell goods and services to other firms and compensate households. In turn, households buy goods from additional firms using the compensation received. This interaction creates economic output in an economy. Similarly, capital projects such as CHPE (1) create jobs, which in turn (2) compensate households and increase household disposable income that (3) is used to purchase goods and services in an economy, which (4) also creates economic output.

Economic benefits represent the jobs, income, output, and fiscal benefits created from both the direct jobs created and compensation paid by CHPE, but also from feedback effects where other local firms require more labor and inputs to meet rising demand for their output, which was stimulated by CHPE's construction and operation. Collectively, these total benefits can be categorized into direct, and indirect and induced effects.

Direct effects reflect those impacts resulting from CHPE's direct expenditures, such as CHPE hiring workers. Indirect effects reflect supply chain impacts from CHPE's direct expenditures, such as the incremental jobs and compensation at local contractors or material providers that are supported by investment in CHPE's construction (truckers, concrete providers, etc.). Lastly, induced effects reflect impacts created by household spending of income earned directly from CHPE or indirectly through businesses that are impacted by CHPE or through ratepayer savings resulting from the operation of CHPE.

B-3 Air Pollution Impacts Modeling

To evaluate the health effects resulting from changes in air pollution levels in New York state and New York City, PA uses a screening tool with an integrated model that measures health effects at county-level resolution. This analysis uses the US Environmental Protection Agency's (EPA) Co-Benefits Risk Assessment (COBRA) Screening model. COBRA estimates how changes in air pollution particulate matter can result in various health effects, which are then translated to the economic results of these health outcomes.

In our analysis, EPA's COBRA model functions in three stages: reading in the user-determined emissions changes and population by county, calculating the health effects which results from those emissions changes, and outputting estimates of the dollar value implications of those adverse health effects.

Fine particles (PM2.5) are responsible for many adverse health effects. The small size of PM2.5 particles makes it easier to reach deeper locations in our lungs, leading to a variety of harmful long-term health consequences. A reduction in PM2.5 is associated with fewer cases of adverse health effects.

The model accepts changes in different county-level emissions categories in a base case and a scenario case. Using a Source-Receptor matrix (S-R Matrix), COBRA estimates the formation and dispersion of PM2.5 resulting from the emissions of PM2.5 and PM2.5 precursors (SO2, NOx, NH3, VOC). This matrix is constructed based on air quality models that simulate particle dispersion and outlines the relationships between the locations of pollution emitters and a single receptor in the center of each county. This permits COBRA to link emissions from different sources to the spatial concentration of fine particles that lead to adverse health conditions.

Based on the differences in particle concentrations that COBRA estimates from emissions changes using the S-R Matrix, the model estimates the changes in different health risks. COBRA evaluates how the changes in these pollutants affect fourteen "health endpoints", or selected health conditions and other effects affecting the population that have societal cost. These include premature mortality (high and low estimates), nonfatal heart attacks (high and low estimates), infant mortality, hospital admits (all respiratory), hospital admits – cardiovascular (except heart attacks), acute bronchitis, upper respiratory symptoms, lower respiratory symptoms, emergency room visits (asthma), minor restricted activity days, work loss days, and asthma exacerbation.

For each health risk, COBRA employs a unique “health endpoint function” that quantifies how much change in one adverse health effect can be expected due to a change in the concentration of fine particles. Each health endpoint is related to one or more peer-reviewed articles from scientific literature from which a set of health endpoint incidence factors by population age group is referenced.

Once COBRA has estimated health outcomes due to a change in emissions, the model assigns economic value to the change in adverse health conditions. Each health effect is associated with a health impact economic valuation that considers the age of the population affected, the adverse health condition, and the discount rate selected in the model. The economic values are determined using a specified discount rate of either 3% or 7% to reflect a more conservative or progressive economic growth forecast (a 3% discount rate is applied in this analysis). These economic valuations assign “unit values” to health conditions which reflect the cost of willingness-to-pay to avoid illness, treatment/effect mitigation of the health effect, or of lost wages. By applying these unit values to the number of avoided statistical cases estimated for each health effect, COBRA estimates the total economic value of emissions reductions on a yearly basis.

APPENDIX C: ALTERNATE BID – NEW SCOTLAND CONVERTER

C-1 New Scotland Converter

This Appendix C describes the benefits to New York State resulting from the New Scotland Converter, CHPE's Alternate Bid. The New Scotland Converter will enable up to 500 MW of upstate solar generation, to be built by a New York Supplier, to access CHPE for delivery into Zone J whenever the solar is generating electricity.

PA understands that a New York Supplier has submitted a proposal to NYSERDA under the Tier 4 RFP conditioned on NYSERDA's acceptance of this Alternate Bid and proposing to use the New Alternate Transmission to supply the solar generation into Zone J via CHPE with the New Scotland Converter configuration. As part of that proposal, PA understands the New York Supplier has described the benefits associated with the 500 MW of solar.

As such, the benefits described in this appendix relate solely to the incremental economic benefits of the construction and operation of the New Scotland Converter and associated property tax payments.

The incremental economic benefits of the New Scotland Converter can be summarized as follows:

- The New Scotland Converter will create an average of 64 direct full-time jobs during construction. New Scotland will also support the creation of an average 3 direct, full-time jobs in the State of New York during the first 25 years of operations.
- The New Scotland Converter will create $175 million in total economic output in the State of New York during construction, and an additional $263 million during its first 25 years of operations.
- The New Scotland Converter will contribute $45 million in property taxes in the first 25 years of operation, funding towns and school districts across the State of New York.

C-2 Annual Jobs and Compensation Forecast

Tables 19 through 22 outline the results of PA's analysis related to (1) estimated direct and secondary (indirect and induced) job creation and compensation, and (2) property tax payments within New York attributable to the New Scotland addition to CHPE (all values are presented in nominal $s).

Table 19: Annual Benefits to the State of New York from CHPE ($millions, 2021-2025)

	2021	2022	2023	2024	2025
(1) Direct Economic Output	**116.8**	**176.0**	**234.6**	**233.1**	**244.6**
(1a) New Scotland Incremental Impact	**1.0**	**12.9**	**25.1**	**33.0**	**41.6**
(2) Indirect/Induced Economic Output (includes 2a)	**80.4**	**99.1**	**123.8**	**119.8**	**124.5**
(2a) Wholesale Electricity Cost Savings	**0.0**	**0.0**	**0.0**	**0.0**	**63.8**
Energy Cost Savings	0.0	0.0	0.0	0.0	19.4
Capacity Cost Savings	0.0	0.0	0.0	0.0	44.4
(2b) New Scotland Incremental Impact	**0.5**	**6.4**	**13.1**	**18.2**	**23.0**
(3) Property Tax Payments	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(3a) New Scotland Incremental Property Tax Payments	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
(4) Value of CO2 Emission Reductions	**0.0**	**0.0**	**0.0**	**0.0**	**51.9**
(5) Value of Local Air Pollutant Emission Reductions	**0.0**	**0.0**	**0.0**	**0.0**	**4.6**
Total Economic Benefits [Sum of (1) to (5), and (1a) + (2b) + (3a)]	**199**	**294**	**397**	**404**	**490**

Table 20: Annual Benefits to the State of New York from CHPE ($millions, 2026-2034)

	2026	2027	2028	2029	2030	2031	2032	2033	2034
(1) Direct Economic Output	**21.3**	**16.4**	**17.0**	**23.8**	**24.4**	**18.8**	**20.8**	**20.3**	**22.4**
(1a) New Scotland Incremental Impact	**4.1**	**4.3**	**4.5**	**4.7**	**5.0**	**5.2**	**5.5**	**5.8**	**6.1**
(2) Indirect/Induced Economic Output (includes 2a)	**919.9**	**1,098**	**1,360**	**1,112**	**869.6**	**1,459.9**	**931.7**	**728.6**	**621.8**
(2a) Wholesale Electricity Cost Savings	**925.1**	**1,073**	**1,323**	**956.1**	**807.1**	**1,432**	**884.9**	**668.8**	**544.9**
Energy Cost Savings	220.8	216.7	217.8	232.2	245.2	257.3	274.7	285.7	343.1
Capacity Cost Savings	704.3	856.7	1,106	723.9	561.9	1,174	610.2	383.1	201.8
(2b) New Scotland Incremental Impact	**2.0**	**2.0**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**	**2.6**	**2.8**
(3) Property Tax Payments	**39.3**	**39.8**	**40.3**	**40.9**	**43.7**	**45.6**	**46.2**	**46.8**	**49.9**
(3a) New Scotland Incremental Property Tax Payments	**1.2**	**1.2**	**1.3**	**1.3**	**1.4**	**1.4**	**1.5**	**1.5**	**1.6**
(4) Value of CO2 Emission Reductions	**628.2**	**632.3**	**661.0**	**675.8**	**684.4**	**719.1**	**719.1**	**750.7**	**752.5**
(5) Value of Local Air Pollutant Emission Reductions	**48.6**	**50.1**	**59.9**	**63.0**	**63.5**	**65.2**	**72.0**	**68.0**	**61.5**
Total Economic Benefits [Sum of (1) to (5), and (1a) + (2b) + (3a)]	**1,665**	**1,844**	**2,146**	**1,924**	**1,694**	**2,318**	**1,799**	**1,624**	**1,519**

Table 21: Annual Benefits to the State of New York from CHPE ($millions, 2035-2042)

	2035	2036	2037	2038	2039	2040	2041	2042	2043
(1) Direct Economic Output	**53.7**	**29.9**	**29.6**	**33.0**	**32.7**	**33.4**	**34.2**	**34.9**	**35.7**
(1a) New Scotland Incremental Impact	**6.4**	**6.7**	**7.1**	**7.4**	**7.8**	**8.2**	**8.4**	**8.6**	**8.8**
(2) Indirect/Induced Economic Output (includes 2a)	**795.8**	**730.7**	**496.6**	**520.7**	**877.1**	**564.8**	**595.2**	**628.7**	**662.1**
(2a) Wholesale Electricity Cost Savings	**684.9**	**627.6**	**407.0**	**385.1**	**740.4**	**445.9**	**460.6**	**476.6**	**492.9**
Energy Cost Savings	385.3	391.0	419.0	425.0	488.2	499.8	516.8	534.0	551.6
Capacity Cost Savings	299.5	236.6	-12.0	-39.9	252.2	-53.9	-56.2	-57.4	-58.7
(2b) New Scotland Incremental Impact	**2.9**	**3.0**	**3.1**	**3.3**	**3.4**	**3.5**	**3.6**	**3.8**	**3.8**
(3) Property Tax Payments	**50.5**	**52.6**	**53.4**	**56.6**	**57.4**	**58.2**	**60.5**	**64.0**	**64.9**
(3a) New Scotland Incremental Property Tax Payments	**1.6**	**1.7**	**1.7**	**1.8**	**1.9**	**1.9**	**1.9**	**2.1**	**2.1**
(4) Value of CO2 Emission Reductions	**776.2**	**805.9**	**826.7**	**869.3**	**920.8**	**972.6**	**1,006**	**1,041**	**1,077**
(5) Value of Local Air Pollutant Emission Reductions	**66.8**	**70.8**	**70.0**	**73.6**	**73.5**	**80.3**	**82.6**	**85.1**	**87.5**
Total Economic Benefits [Sum of (1) to (5), and (1a) + (2b) + (3a)]	**1,754**	**1,701**	**1,488**	**1,566**	**1,975**	**1,723**	**1,793**	**1,868**	**1,942**

Table 22: Annual Benefits to the State of New York from CHPE ($millions, 2043-2050)

	2044	2045	2046	2047	2048	2049	2050
(1) Direct Economic Output	**36.5**	**37.3**	**38.1**	**38.9**	**39.8**	**40.6**	**41.5**
(1a) New Scotland Incremental Impact	**9.0**	**9.2**	**9.4**	**9.6**	**9.8**	**10.0**	**10.2**
(2) Indirect/Induced Economic Output (includes 2a)	**697.0**	**732.7**	**773.6**	**812.8**	**853.6**	**897.6**	**942.6**
(2a) Wholesale Electricity Cost Savings	**509.3**	**525.5**	**542.0**	**558.5**	**575.1**	**591.6**	**608.0**
Energy Cost Savings	569.3	586.9	604.7	622.5	640.6	658.5	676.4
Capacity Cost Savings	-60.0	-61.3	-62.7	-64.0	-65.4	-66.9	-68.4
(2b) New Scotland Incremental Impact	**3.9**	**4.0**	**4.1**	**4.2**	**4.3**	**4.4**	**4.6**
(3) Property Tax Payments	**65.8**	**66.7**	**73.7**	**75.7**	**77.6**	**83.0**	**88.0**
(3a) New Scotland Incremental Property Tax Payments	**2.1**	**2.2**	**2.3**	**2.4**	**2.4**	**2.4**	**2.6**
(4) Value of CO2 Emission Reductions	**1,114**	**1,152**	**1,184**	**1,224**	**1,266**	**1,301**	**1,345**
(5) Value of Local Air Pollutant Emission Reductions	**90.0**	**92.5**	**94.7**	**96.9**	**99.1**	**101.4**	**103.8**
Total Economic Benefits [Sum of (1) to (5), and (1a) + (2b) + (3a)]	**2,018**	**2,097**	**2,180**	**2,265**	**2,353**	**2,441**	**2,538**

C-3 Annual Jobs and Compensation Forecast

Table 23 outlines the results of PA's analysis related to estimated direct and secondary (indirect and induced) job creation and compensation within New York attributable to the incremental impact from the New Scotland Converter (all values are presented in nominal $s).

Table 23: Jobs and Compensation Impacts from the New Scotland Addition to CHPE in New York (2021-2050)

Year	Period	Direct Jobs	Secondary Jobs	Total Compensation ($millions)
2021	Construction	5	3	0.6
2022	Construction	52	32	0.6
2023	Construction	82	55	0.6
2024	Construction	86	64	0.6
2025	Construction	94	75	0.6
2026	Operations	3	3	0.6
2027	Operations	3	3	0.6
2028	Operations	3	3	0.6
2029	Operations	3	3	0.6
2030	Operations	3	3	0.6
2031	Operations	3	3	0.6
2032	Operations	3	3	0.6
2033	Operations	3	3	0.6
2034	Operations	3	3	0.6
2035	Operations	3	3	0.6
2036	Operations	3	3	0.6
2037	Operations	3	3	0.6
2038	Operations	3	3	0.6
2039	Operations	3	3	0.6
2040	Operations	3	4	0.6
2041	Operations	3	4	0.6
2042	Operations	3	4	0.6
2043	Operations	3	4	0.6
2044	Operations	3	4	0.6
2045	Operations	3	4	0.6

Year	Period	Direct Jobs	Secondary Jobs	Total Compensation ($millions)
2046	Operations	3	4	0.6
2047	Operations	3	4	0.6
2048	Operations	3	4	0.6
2049	Operations	3	4	0.6
2050	Operations	3	4	0.6

About PA.

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As strategies, technologies and innovation collide, we create opportunity from complexity.

Our diverse teams of experts combine innovative thinking and breakthrough use of technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

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