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New York should reconsider its approach to large-scale hydropower in light of its renewable energy goals and the imminent loss of nuclear power from the Indian Point Energy Center ("IPEC"). New York has committed to obtain 50 percent of its energy from renewable resources and to reduce its greenhouse gas ("GHG") emissions by 40 percent from 1990 levels by 2030.[1] The planned closure of the nuclear reactors at IPEC by 2021, and the scramble to replace this power with something other than fossil fuels, has amplified doubts as to whether these goals will be met.

As demonstrated by the closure of the Vermont Yankee nuclear facility[2] as well as Germany[3] and Japan's[4] post-Fukushima experience, carbon emissions tend to rise when nuclear plants – which produce virtually no carbon emissions – go offline.[5] IPEC currently supplies approximately 25 percent of the electricity consumed in and around New York City.[6] Strategically located just north of New York City, IPEC directly feeds power to the City and its surrounding areas, avoiding some of the transmission constraints that begin around Albany. The New York Independent System Operator ("NYISO"), the State's grid operator, does not believe IPEC's closure will threaten the grid's reliability because, *inter alia*, three natural gas facilities could provide the compensatory megawatts.[7] According to NYISO, other measures – renewable generation, transmission, demand response, or energy efficiency -- could also make up this shortfall,[8] but if the history of nuclear retirements repeats itself, the additional fossil fuel generation likely would increase the State's emissions just as it struggles to remove carbon from the grid.

Transmitting large-scale hydropower from Québec, Canada is one possible solution to this quandary, but key powerline projects have been slow to break ground. This paper outlines the two solutions to this problem: (i) indirectly finance transmission by compensating large-scale hydropower for its environmental benefits as New York does for other low-carbon energy resources, and/or (ii) upgrade transmission infrastructure between New York's upstate and downstate regions on public policy grounds.

New York presently does not allow hydropower with reservoirs, like those in Québec, to qualify for State programs that compensate new renewable resources, such as wind or solar power, for their environmental attributes. As a result, transmission projects conveying hydropower require greater financing to pencil out. As to the second option, expediting transmission upgrades to relieve congestion in and around New York City could facilitate more renewable energy, including hydropower, onto the State's grid. Pursuing one or both of these policies could help bridge the gap between the State's ambitious climate goals and the trajectory of its current policies.

Large-Scale Hydropower is Ineligible for RECs or ZECs under New York's Clean Energy Standard

New York incentivizes clean energy generation mainly through the Clean Energy Standard ("CES").[9] The CES arises from the State Energy Plan, "a comprehensive roadmap to build a clean, resilient, and affordable energy system for all New Yorkers."[10] According to the State Energy Plan, New York will reduce its greenhouse gas emissions by 40 percent from 1990 levels and achieve 50 percent of its generation from renewable energy sources (excluding nuclear), all by 2030.[11]

Aspirational goals are commendable and useful, but achieving them is easier said than done. New York's 2004 Renewable Portfolio Standard sought to increase the proportion of renewable energy New Yorkers used to at least 25 percent by the end of 2013.[12] Six years later, the New York PSC issued another order increasing this goal to 30 percent by 2015.[13] Unfortunately, in 2016, New York obtained only 24 percent of its electricity from renewable sources, short of both goals.[14]

The CES attempts to avoid a repeat of this outcome by implementing policies to achieve the State's environmental goals, *i.e.* to "combat climate change and modernize the electric system to improve the efficiency, affordability, resiliency, and sustainability of the system."[15] The CES seeks to reduce the total emissions of air pollutants resulting from fossil fuel combustion – including carbon, nitrogen oxides, sulfur dioxide, and particulate matter – leading to "improved air quality and societal benefits from reduced health impacts and increased employee productivity."[16] Though economic development is a welcome ancillary benefit, the CES's primary stated purpose is to achieve the State Energy Plan's environmental goals.

With that objective in mind, the CES compensates carbon-free energy resources, such as wind, solar, and even certain nuclear facilities, by awarding them renewable energy credits ("RECs") and zero-emission credits (ZECs). Load serving entities, such as ConEdison, are required to purchase a certain percentage of RECs and ZECs based on how much electricity they distribute to their customers, or make alternative compliance payments. These costs are passed on to end-use electricity customers. Eligible resources for RECs include biogas, biomass, liquid biofuels, fuel cells, hydroelectric resources that do not create new impoundment, solar, tidal/ocean, and wind.[17]

ZECs are awarded "where there exists a public necessity to preserve the zero-emissions environmental attributes of a nuclear generating facility."[18] The New York Public Service Commission ("PSC") determines "public necessity" on a plant-by-plant basis by considering several criteria including whether the facility has made an historic clean energy contribution to New York's grid and whether the facility's projected revenues are sufficient to preserve its environmental attributes.[19] The programs seeks to address "a well-recognized externality that otherwise would lead to economic inefficiencies with respect to the costs incurred due to environmental damage, in particular, climate change."[20] IPEC is ineligible for ZECs because it receives "a much higher level of market revenues" due to its downstate location, and its zero-emissions attributes thus were not at risk.[21] The New York PSC determined that the Fitzpatrick, Ginna, and Nine Mile Point facilities, all of which are located upstate, were eligible for ZECs.[22]

Large-scale hydropower with storage impoundment is ineligible for RECs or ZECs.[23] Ostensibly this is due to the "environmental impacts of large impoundments, including methane emissions,"[24] but this impact does not appear to prevent existing large-scale hydropower with storage impoundment (in both Québec and New York) from counting towards the State's goal of obtaining 50 percent of its power from renewable energy by 2030.[25] Nor should it. Though the initial impoundment of a reservoir produces significant GHG emissions, this effect dissipates within a decade.[26] When amortized over the course of the facility's life cycle (construction, operation, and decommissioning), one industry-funded study showed that GHG emissions from Québec hydropower are on par with, if not fewer, than REC-eligible renewable sources.[27] Other lifecycle assessments more or less support this thesis.[28] The CES mentions methane emissions produced by impoundments, but does not compare it to lifecycle assessments for other eligible resources. Notably, whereas solar and wind farms can be built in New York and provide local employment, the largest source of hydropower exists north of the border and would likely compete with these instate generation resources.

Large-scale hydropower receives some compensation for its environmental attributes through the Regional Greenhouse Gas Initiative ("RGGI"), but the effect is quite small and not enough to move the needle on key transmission decisions.[29] RGGI, a multi-state cap-and-trade system to which New York belongs, also subsidizes renewable energy resources but in a more resource-neutral way than the CES. RGGI sets a cap on regional GHG emissions from power plants of 25 megawatts or greater and participating States then sell emission allowances to fossil fuel-fired electric power generators. The costs of these allowances are reflected in the prices for which fossil fuel generators bid and contract their power. In this manner, all non-fossil fuel generation, including large-scale hydropower, becomes more competitive. The RGGI incentive remains quite small and has yet to precipitate a swift transition away from fossil fuels in participating states.[30]

Québec Hydropower Could Help Clean New York's Grid

Canadian hydropower could play a key role in helping New York meet its renewable energy and GHG-reduction goals. Québec, through its public utility Hydro-Québec, runs almost entirely on hydropower.[31] The province has access to about 37,000 megawatts of hydroelectric capacity and enough water stored in its reservoirs to meet almost an entire year's worth of New York State's energy demand.[32] Importantly, Québec appears to have capacity above and beyond what the provincial market and current international transmission infrastructure can support.[33] It is therefore unlikely that Québec would have to replace additional exported energy during the summer with imports from neighboring regions. Moreover, Québec's load peaks in the winter as the province relies mainly on electric heating, while New York's energy demand peaks in the summer.[34] Hydro-Québec claims it has an energy surplus to meet both Québec and New York's load demand.[35] In 2016, it exported 32.6 TWh to neighboring states and provinces, with 8.5 TWh going to New York alone, comprising a significant percentage of New York's clean energy mix.[36] Hydro-Québec began construction on a series of dams on the Romaine River in 2007 with the precise intention of selling excess power into the United States market.[37]

Power provided through new transmission would almost certainly displace fossil-fuel generation on the New York grid. Natural gas, not renewables, is the marginal source of wholesale supply in the State for most hours in the day.[38] Since the cost of hydropower is usually cheaper than the most-inefficient natural gas,[39] Canadian hydropower likely would outbid and replace the most inefficient natural gas resources on the NYISOadministered wholesale energy market. Large-scale hydropower with storage is also dispatchable and is eligible to bid into NYISO's capacity market.[40] Due to reliability requirements, New York City must have 81.6% of its capacity available to be generated within the city.[41] Hydropower transmitted via high voltage direct current ("HVdc") lines under certain conditions could count towards this quota, enabling the replacement of aging, dirtier natural gas "peaker" plants that run when in times of high demand, and would likely operate more frequently once IPEC closes.[42]

Synapse Energy Economics conducted an inquiry into whether and how IPEC could be replaced with clean energy resources, including hydropower, and provides a useful framework to consider New York's policy options. Commissioned by Riverkeeper and the Natural Resources Defense Council, the study concluded that New York could rely predominantly on energy efficiency, wind, and solar resources to replace IPEC's output and cost-effectively meet the State's 2030 goals.[43] Indeed, energy efficiency and behind-the-meter solar photovoltaic installations have contributed to New York's decade-long decrease in grid-provided electricity consumption from 167,341 to 160,798 GWh.[44] But New York's utilities have filed efficiency transition implementation plans ranging from 0.4% and 0.9% for the period 2016-2018.[45] This is well below the increase in efficiency contemplated by Synapse's study.

Synapse also modeled the effect of completing the proposed Champlain Hudson Power Express ("CHPE"). If built, the CHPE would bring up to 1,000 MW of hydropower from the Québec border to New York City through a 333-mile HVdc cable. Large sections of this cable would be buried underneath Lake Champlain and the Hudson River to minimize impacts to local communities and the environment. Under its current permit, CHPE is a merchant transmission project funded solely by private investment, which receives no subsidies either through state incentives or out-of-market contracts (including any power purchase agreements).[46]

Though the study determined that CHPE was not necessary to meet New York's 2030 goals, Synapse nevertheless concluded that CHPE provided an "option for accelerated production of low-carbon energy beyond the Clean Energy Standard's requirements and could supply more than 40 percent of the output of the IPEC station."[47] It forecast that CHPE would increase the percentage of renewable energy on New York's grid by *five percent* in 2030, to 54 or 55 percent depending on the aggressiveness of the State's energy efficiency implementation.[48] This would roughly equal the amount of progress New York made from 2004 to 2016 in increasing the percentage of renewable generation on the grid.[49]

Increased hydropower transmission, such as CHPE, could provide insurance against the risk that other clean energy developments underperform over the next decade. The Synapse study assumes that New York will meet its goal to develop up to 2.4 gigawatts of offshore wind power by 2030, as promised and without significant delay.[50] This could very well happen, but New York currently has no offshore wind farms, and there is only one offshore wind farm currently operating in the United States.[51] Unforeseen regulatory, operational, or technical barriers could complicate the development of this promising resource.

Greater access to hydropower could help meet New York's rising demand from electric vehicles and heating, which cut against Synapse's assumptions of continued reductions in electricity demand. Due to the study's scope, Synapse does not examine or account for potential increased load from the State's other climate initiatives, namely the beneficial electrification of transportation and heating. Under the Charge NY program, New York State aims to accommodate more than 30,000 plug-in electric vehicles by 2018 and one million by 2025.[52] New

York City is currently conducting a pilot program for electric buses that it hopes to expand in the coming years.[53] Electrifying the current New York City bus fleet by 2030 would by itself require around 0.31 TWh of additional electricity each year.[54] New York also promotes the adoption of air-source and geothermal heat pumps as a replacement for fossil fuel-generated space and water heating in buildings.[55] Should beneficial electrification accelerate in either the transportation or heating sector, electricity demand could increase beyond what clean energy resources, including energy efficiency improvements, are expected to provide. Thus, if for nothing else other than a hedge, New York should seriously consider increased transmission of hydropower in order to meet its 2030 goals.

Option 1: Promote Merchant Transmission by Compensating Large-Scale Hydropower With Storage Impoundment for its Environmental Attributes

Due to costs, CHPE, which received its final permit in 2015, has yet to break ground.[56] Developers claim that the CHPE could be constructed for $2.2 billion,[57] but some analysts say this estimate is far too low. A similar HVdc line from Bergen County, New Jersey to New York City cost $850 million though it spans only seven miles.[58] In light of the project's length, some industry experts believe the CHPE would be nearly impossible to build without additional state subsidies.[59] As of this writing, there are still no offtakers committed to purchasing CHPE-supplied power.[60]

Compensating new large-scale hydropower with storage impoundment for its environmental attributes could make profitable currently-stalled transmission projects like CHPE. With this resource appropriately valued, CHPE's developer presumably could charge a higher price to Hydro-Québec for the right to transmit hydropower through the line to New York. This would increase the projected profitability of the project from the developer's point of view. In this way, the lower cost of hydropower could offset the cost of the transmission line, resulting in a more competitive all-in price for CHPE-provided power. If the CES had included large-scale hydropower with storage impoundment as a Tier 1 resource, and thus eligible for RECs, perhaps such transmission infrastructure would have been constructed. New York REC prices for the latest compliance year are $17.01/MWh,[61] while the all-in price of energy in New York City in 2016 was around $55/MWh.[62]

A resource-neutral carbon tax, as contemplated by a NYISO-commissioned Brattle Group study, or raising RGGI prices to meet the social cost of carbon, also could provide an incentive to build the line.[63] However, the New York PSC noted that the latter option was quite costly and, according to one analysis, would only spur development of a single natural gas plant.[64] There was no discussion in the CES of what effect, if any, such a subsidy would have on transmission projects from Canada. The costs of large infrastructure projects are opaque, but that level of incentive could make CHPE, and other transmission projects connecting large-scale hydropower, cost-effective.[65]

It bears emphasizing that such reforms would in no way guarantee the construction of CHPE. At a minimum price tag of $2.2 billion, the project could very well be too costly when compared to other alternatives, even with all positive environmental externalities internalized into the price of power and transmission. It nevertheless would put hydropower on equal footing with other renewables going forward, and by providing accurate price signals, would encourage investment in the lowest cost clean energy solution to IPEC's closure.[66]

Option 2: Relieving Existing Transmission Congestion on New York's Grid

CHPE is not the only way to take advantage of Canadian hydropower. Alternatively, policymakers could increase transmission capacity within New York with an aim of facilitating the integration of renewable energy resources into the grid and lower energy prices for downstate consumers. Though targeted at transmission congestion generally, this policy would have the effect of allowing more large-scale hydropower to penetrate the New York grid. This is because there is a large disparity between upstate and downstate capacity; fossil fuels make up 85% of downstate generation and only 35 % of upstate generation.[67] Relieving transmission limits, especially those affecting New York City, likely would benefit other upstate, cost-competitive generators, as well as Québec hydropower. Accordingly, this solution may be more politically palatable for policymakers who would prefer to not promote foreign energy sources over domestic ones.

In the United States, New York is considered a "poster child" for congestion.[68] The State's downstate region (New York City, Long Island, and the Hudson Valley) annually uses 66 percent of the state's electric energy, but only generates 53 percent.[69] Transmission bottlenecks along corridors that bring renewable energy downstate from Canada and upstate New York accounted for 30 percent of day-ahead congestion revenues in 2016.[70] In fact, during the CES proceedings, New York City opposed ZECs in part because "due to geography and system constraints . . . it is unlikely that the electricity or the economic benefits . . . will be enjoyed downstate."[71]

The New York PSC could find that there is a public policy need for transmission upgrades because they help achieve the CES's renewable energy and GHG-reduction targets. This regulatory step would enable NYISO to facilitate the construction of transmission projects under the Federal Energy Regulatory Commission's ("FERC") Order No. 1000. Under this Order, which was issued in 2011, NYISO transmission planning processes must consider transmission needs driven by public policy requirements established by state or federal laws or regulations.[72] Public utility transmission providers, like NYISO, must establish procedures to identify transmission needs driven by public policy requirements and evaluated proposed solutions to those transmission needs.[73]

Fortunately, the New York PSC and NYISO have been engaged in such a process over the past several years, and there are signs it will soon bear fruit. In 2012, Governor Cuomo announced New York's Energy Highway initiative to, among other things, give downstate customers access to upstate generation resources. Following its announcement in the State of the State address, the New York PSC opened a proceeding to solicit formal transmission proposals, and subsequently established a competitive process under Article VII of the State's Public Service Law to consider various alternatives.[74] In 2015, the New York PSC issued orders identifying a public policy transmission need in (i) western New York to increase utilization of renewable energy from the Robert Moses Niagara Hydroelectric Power Station and imports from Ontario,[75] and (ii) for certain upgrades across the Central East and Upstate New York/Southeast New York portions of the AC transmission system.[76] Two years later, NYISO approved the western New York transmission upgrades, making it the first project selected using NYISO's Public Policy Transmission Planning Process approved by FERC under Order No. 1000.[77] The project expects to be in service by June 2022.[78]

As to upstate/downstate congestion, in January 2017, the New York PSC reaffirmed that a public policy transmission need exists for the Central East and Upstate New York/Southeast New York portion of the AC transmission system.[79] These transmission needs would bring 1,000 MW of power from upstate to downstate, similar to the amount of energy CHPE would provide.[80] In November, FERC approved NYISO's tariff revisions establishing that downstate ratepayers would pay for 90 percent of the transmission project's cost.[81] No decision yet has come down from NYISO, but the grid operator expects to complete evaluation of this project in "early 2018."[82] If approved, this project could go a long way towards increasing access to clean energy resources, including hydropower, for downstate consumers, and by the same token, help New York achieve its climate goals.

Looking ahead, it is worth noting that the lack of transmission at the border also limits the amount of electricity Hydro-Québec can export into New York, and the extent to which it can participate in wholesale capacity auctions.[83] For instance, NYISO limits the amount of installed capacity that can be allocated to Hydro-Québec to 1,115 megawatts.[84] Since the CES does not explicitly exclude electricity generated from large-scale hydropower with storage from counting towards the State Energy Plan targets, it leaves open the door for the New York PSC to identify increasing access to cheap large-scale hydropower as a public policy need.[85]

Conclusion

Be it through renewable energy incentives or increased transmission, New York should find a way to unlock the vast potential of clean energy resting just north of the border. The CES currently disadvantages large-scale hydropower vis-à-vis other renewable resources and construction of key transmission projects that could mitigate this effect has proceeded at a slow pace. Achieving climate goals under these conditions would be challenging enough, but the imminent loss of IPEC's two gigawatts of zero-emission power raises the stakes considerably. As the date of IPEC's closure draws nearer, policymakers should consider whether the current framework is aligned with the goals they seek to achieve.

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[1] *See* 2015 New York State Energy Plan, available at https://energyplan.ny.gov. New York City also has committed to reduce greenhouse gas emissions by 40 percent by 2030 from 2005 levels, and 80 percent by 2050, and these goals rely on the State successfully meeting its grid decarbonization objectives. *See* https://www1.nyc.gov/site/sustainability/codes/80x50.page.

[2] When the Vermont Yankee Nuclear Power Station, which produced four percent of New England's total generation, closed in 2014, the region's CO2 emissions rose from 726 lbs/MWh to 747 lbs/MWh. *See* 2015 ISO New England Electric Generator Air Emissions Report, at 22 (Jan. 2017); *see also* Robert Walton, *New England CO2 emissions spike after Vermont Yankee nuclear closure*, UTILITY DIVE (Feb. 6, 2017).

[3] Angela Merkel's 2011 decision to phase out nuclear power after the Fukushima accident caused Germany's CO2 emissions to increase despite being a leader in wind and solar power. *See* Peter Teffer, *Germany to let slip 2020 climate target*, EU OBSERVER (Jan. 9, 2018), https://euobserver.com/environment/140475.

[4] Japan increased reliance on LNG and coal imports in the wake of Fukushima, which caused its carbon emissions to rise. *See* Sophie Yeo, *Analysis: The legacy of the Fukushima nuclear disaster*, CARBON BRIEF (Mar. 10, 2016).

[5] *See* U.S. Energy Information Agency, *Fort Calhoun becomes fifth U.S. nuclear plant to retire in past five years* (Oct. 31, 2016), https://www.eia.gov/todayinenergy/detail.php?id=28572 (noting fossil fuels replaced lost nuclear capacity from the Crystal River, San Onofre, and Kewaunee facilities).

[6] Vivan Yee & Patrick McGeehan, *Indian Point Nuclear Power Plant Could Close by 2021*, N.Y. TIMES (Jan. 6, 2017) (noting IPEC can generate "about one-fourth of the power consumed in New York City and Westchester County").

[7] Those plants are Bayonne Energy Center II Uprate (Zone J, 120 MW), CPV Valley Energy Center (Zone G, 678 MW), and Cricket Valley Energy Center (Zone G, 1,020 MW). *See* NYISO, *Generator Deactivation Assessment Indian Point Energy Center*, at 2-3 (Dec. 13, 2017). The report concluded that the 100 MW of capacity would have to be added in the Lower Hudson Valley (Zones G, H, I, or J) by 2021, rising to 200 MW of additional capacity in 2022-2023. *Id.* at 5. By 2027, 600 MW of new generation would need to be added in Zone G, or 400 MW within Zones H, I, or J. *Id.*

[8] NYISO notes that resource needs capacity could be met through "generation, transmission, energy efficiency, and demand response measures." *Id.* at 4.

[9] *See* New York Public Service Commission, *Order Adopting a Clean Energy Standard* (Aug. 1, 2016) ("CES Order").

[10] 2015 New York State Energy Plan Overview, available at https://energyplan.ny.gov/-/media/nysenergyplan/2015-overview.pdf.

[11] *Id.*

[12] New York Public Service Commission, *Order Regarding Retail Renewable Portfolio Standard*, at 3 (Sept. 24, 2004) (Case No. 03-E-0188).

[13] New York Public Service Commission, *Order Establishing New RPS Goal and Resolving Main Tier Issues*, at 13 (Jan. 8, 2010) (Case No. 03-E-0188).

[14] NYISO, *Power Trends 2017: New York's Evolving Electricity Grid*, at 11; U.S Energy Information Administration, *New York State Energy Profile* (last updated July 20, 2017) https://www.eia.gov/state/print.php?sid=NY. New York appears to have met the 2004 goal in 2014. *See* CES Order, *supra* note 9, at 19 ("New York's total electric generation mix in 2014 was 37% gas, 31% nuclear, 23.5% hydro, 4.5% coal, 3.5% wind, solar, biomass and biogas, 1.3% solid waste, and 0.4% oil."); NYISO, *Power Trends 2015: Rightsizing the Grid*, at 7 (2016) (25 percent of New York's electricity generated by renewable sources in 2014).

[15] CES Order, *supra* note 9, at 3.

[16] *Id.*

[17] *Id.* at 105, Appx. A.

[18] *Id.* at 124.

[19] *Id.* The PSC, in its discretion, determines whether public necessity exists "on the basis of (a) the verifiable historic contribution the facility has made to the clean energy resource mix consumed by retail consumers in New York State regardless of the location of the facility; (b) the degree to which energy, capacity and ancillary services revenues projected to be received by the facility are at a level that is insufficient to provide adequate compensation to preserve the zero-emission environmental values or attributes historically provided by the facility; (c) the costs and benefits of such a payment for zero-emissions attributes for the facility in relation to other clean energy alternatives for the benefit of the electric system, its customers and the environment; (d) the impacts of such costs on ratepayers; and (e) the public interest." *Id.*

[20] *Id.* at 133.

[21] *Id.* at 125 n.85, 130. Nuclear power, however, does not count towards the State's fifty percent renewable energy goal. *Id.* at 45.

[22] *Id.* at 156-157.

[23] *Id.* at 105-106, Appx. A at 3. As long as there is no new storage impoundment, hydroelectric upgrades and low-impact run-of-river hydroelectric facilities are eligible REC resources. *Id.* The CES Order also put in place a geographic requirement that all facilities must be located in New York or in a control area adjacent to the New York Control Area. *Id.* Québec hydropower likely would meet this requirement.

[24] *Id.* at 105-106.

[25] Neither the State Energy Plan nor the CES Order states that large-scale hydropower with storage impoundment, be it foreign or domestic, would be excluded when assessing progress towards the State's renewable energy targets. The New York Department of Public Service included non-RPS eligible, large-scale hydropower to determine the State's renewable energy in 2014. *See* New York Dep't of Public Service, *Staff White Paper on Clean Energy Standard*, at Appx. B, at 3 (Jan. 25, 2016) (Case No. 15-E-0302).

[26] *See* Hydro-Québec, *Understanding Québec Hydropower: Among the Lowest Greenhouse Gas Emissions of All Electricity Generation Options*; http://www.hydroquebec.com/data/developpement-durable/pdf/ghg-emissions.pdf. Methane emissions from reservoirs in northern Québec tend to be low because they are located in sparsely populated areas with low vegetation and consist of cold water with a high oxygen content. *Id.*; *see also* Cristian J. Teodoru, *et al.*, *The net carbon footprint of a newly-created boreal hydroelectric reservoir*, at 8-9 GLOBAL BIOGEOCHEMICAL CYCLES (May 17, 2012) (methane emissions were small compared to C02 fluxes and declined steeply with time after flooding).

[27] Hydro-Québec, *supra* note 26.

[28] Life cycle assessments (LCAs) of GHG emissions for large-scale hydropower with storage impoundment in boreal regions produce a range of estimates, and the precise LCA for Canadian hydropower is beyond the scope of this paper. That said, a limited review of the literature suggests that certain hydroelectric facilities could have a lower carbon footprint than some of the other REC-eligible resources. *See* Intergovernmental Panel on Climate Change, *Renewable Energy Sources and Climate Change Mitigation: Summary for Policymakers and Technical Summary*, at 84-85 (2012) (originally published in 2011) ("[T]he majority of lifecycle GHG emission estimates for hydropower cluster between about 4 and 14 g CO2eq/kWh, but under certain scenarios there is potential to emit much larger quantities of GHGs, as shown by the outliers."); CIRAIG (International Reference Centre for the Life Cycle of Products. Processes and Services), *Technical Report: Comparing Power Generation Options and Electricity Mixes*, at 50, Appx. A (Nov. 2014) (indicating 17 g CO2eq/kWh for Hydro-Québec facilities with reservoirs)). Steinhurst *et al.* put forward a much higher estimate of 160 to 250 g CO2eq/kWh for Hydro-Québec's Eastmain 1 reservoir. William Steinhurst, *et. al*, *Hydropower Greenhouse Gas Emissions*, SYNAPSE ENERGY ECONOMICS at 9 (Feb. 14, 2012). This estimate appears to conflict with other LCAs of Eastmain 1. *See, e.g.*, Teodoru, *supra* note 23, at 11 (43 g CO2eq/kWh, without addition of Eastmain 1-A power station); Alain Tremblay, *et al.*, *Measuring Greenhouse Gas Emissions from a Canadian Reservoir*, HYDRO REVIEW, Volume 29, No. 5 (July 2010) (around 58 g CO2eq/kWh, without addition of Eastmain 1-A power station). Steinhurst *et al.* does not explain why it assumes such a high emissions rate after Year 4 of the project (238 g to 147 g CO2eq/kWh). *Id.* at 9; compare with Hanne Lerche Raadal *et al.*, *Life cycle greenhouse gas (GHG) emissions from the generation of wind and hydro power*, RENEWABLE AND SUSTAINABLE ENERGY REVIEWS 15 (Apr. 11, 2011) (LCAs from 0.2 to 152 g CO2eq/kWh, with a standard deviation 54.5 g CO2eq/kWh).

[29] For instance, the March 14, 2018 RGGI auction produced a clearing price of $3.79 for an allowance to emit one short ton of carbon dioxide. *See* RGGI Auction 39, https://www.rggi.org/Auction/39.

[30] The CES puts the RGGI effect for zero-emission resources at $10.41 per short ton carbon. *See* CES Order, *supra* note 9, at 50-51; *see also* David Roberts, *The Northeast's carbon trading system works quite well. It just doesn't reduce much carbon*, VOX (Feb. 28, 2017). It should be noted that RGGI recently announced a proposed additional 30 percent cap reduction by 2030 relative to 2020 levels. *See* RGGI, Inc., *RGGI States Announce Proposed Program Changes: Additional 30% Emissions Cap Decline by 2030*, Press Release (Aug. 27, 2017).

[31] Hydro-Québec is a province-owned utility. Its sole shareholder is the Québec government, which guarantees nearly all of Hydro-Québec's debt. *See* Hydro-Québec, *Investor Relations*

(http://www.hydroquebec.com/investor-relations (last accessed April 16, 2018). Hydro-Québec is profitable and contributed over $4 billion to the Québec government's revenue in 2017, including dividends, water-power royalties, the public utilities tax, and guarantee fees related to debt securities. *See* Hydro-Québec, *2017 Annual Report*, at 23 (2017).

[32] Hydro-Québec, 2017 *Annual Report*, at 77 (2017). Hydro-Québec, the current capacity is around 37,000 MW and the province has 176 TWh of energy stored in their reservoirs. *Id.* at 29; Hydro-Québec, *Hydro-Québec: A Natural Ally for the Energy Transition in the Northeast* (last accessed April 16, 2018).

[33] Recently, Hydro-Québec has been forced to spill out excess water due to lack of demand and to comply with reservoir water level restrictions. *See* Charlotte Paquet, *Les vannes de Manic-3 et Outardes-2 fermees depuis quelques jours – Bersimis-1 laisse encore filer de l'eau*, LE MANIC (Dec. 6, 2017), http://www.lemanic.ca/les-vannes-de-manic-3-et-outardes-2-fermees-depuis-quelques-jours-bersimis-1-laisse-encore-filer-de-leau/.

[34] *See* James H. Williams, Ryan Jones, Gabe Kwok, & Benjamin Haley, *Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec. A report of the Sustainable Development Solutions Network in cooperation with Evolved Energy Research and Hydro-Québec*, at 20 n. 1 (April 8, 2018) ("Buildings in Québec are today primarily all electric due to a history of low-cost hydro and encouraged load growth making the system strongly winter peaking. Today the Northeast has summer peaking systems and complements loads in Québec well.").

[35] Hydro-Québec, *Hydro-Québec: A Natural Ally for the Energy Transition in the Northeast* (last accessed April 16, 2018).

[36] *Id.* at 4. New York had 41.3 TWh of renewable energy in 2014. See Staff CES White Paper at 7. New York City consumed around 54 TWh of energy from both renewable and non-renewable sources in 2016. NYISO, *2017 Load & Capacity Data Report ("Gold Book")*, at 23 (2017) (Table 1-4a shows Zone J annual energy to be 53,653 GWh in 2016).

[37] Joe Ryan & Jim Polson, *Hydro-Quebec building dams to solve U.S. nuclear woes*, THE GLOBE AND MAIL (Oct. 13, 2017), https://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/hydro-quebec-aims-to-export-to-us-northeast-as-nuclear-reactors-close/article36586320/.

[38] *See, e.g.*, Potomac Economics, *2016 State of the Market Report for the New York ISO Markets*, at ii (May 2017) ("A strong relationship between energy and natural gas prices is expected in a well-functioning, competitive market because natural gas-fired resources are the marginal source of supply in most intervals.").

[39] In 2017, Hydro-Québec's net electricity exports were 34.4 TWh and totaled Can$1,575 million. See *2017 Annual Report*, *supra* note 31, at 29. That's an average of Can$45.78 /MWh.

[40] *See, e.g.*, Analysis Group, *NYISO Capacity Market: Evaluation of Options*, at 29 (May 2015) (noting NYISO typically is a net importer of capacity from Hydro-Québec).

[41] Due to reliability requirements, New York City must have 81.6% of its capacity available to be generated within the city. *See* New York State Reliability Council, LLC, *Technical Study Report: New York Control Area Installed Capacity Requirement For the Period May 2017 to April 2018*, at 2, 15 (Dec. 2, 2016). HVdc lines, such as CHPE, with unforced capacity deliverability rights ("UDRs") "can be used satisfy such locational capacity requirements" under certain conditions. *Id.*; *see also* Julia Trayer, *Written Direct Testimony Submitted on Behalf of Champlain Hudson Power Express, Inc. and CHPE Properties, Inc.*, at 8-9, 12 (June 7, 2012) (New York PSC Case No. 10-T-0139) ("CHPE is assumed to be awarded 600 MW of UDRs, meaning it contributes to the local capacity requirements of NYC as well as the overall resource adequacy of the NYCA.").

[42] *Id.* Many factors in a given year increase and decrease the New York State Reliability Council's determination of an Installed Reserve Margin (IRM) so it is difficult to predict the effect of one project on locational capacity requirements. *See* New York State Reliability Council, *supra* note 41, at 2. On the one hand, the Reliability Council's modeling indicates that having no internal transmission constraints in New York State would lower the IRM by 2.9%. *Id.* at 25. On the other hand, increasing the amount of variable renewable energy in the New York State likely would increase the IRM. Additional wind capacity, for instance, increased the IRM by 0.4% in the 2017 Capability Year. *Id.* at 2. That said, CHPE is less likely to increase in-city generation requirements when compared to other transmission sources since it would be a separate, direct HVdc line providing dispatchable hydropower, and its reliability is less correlated with the reliability of other generation and transmission infrastructure.

[43] Bob Fagan, Alice Napoleon, Spencer Fields, & Patrick Luckow, *Clean Energy for New York: Replacement Energy and Capacity Resources for the Indian Point Energy Center Under New York Clean Energy Standard (CES)*, Synapse Energy Economics, Inc., at 3-5 (Feb. 23, 2017); Natural Resources Defense Council, *Indian Point's Nuclear Power Can Be Replaced with Low-Carbon Options Led by Increased Energy Efficiency and Renewables* (Feb. 23, 2017); https://www.nrdc.org/media/2017/170223.

[44] 2017 Gold Book, *supra* note 36, at 23. In its latest report, NYISO predicts that these figures will continue their downward trajectory, declining by 2027 to 154,971 GWh for the State and 50,612 GWh for the City. *See id.* at 12. Moreover, each year, over the past five years, NYISO's forward-looking estimates of energy usage have been revised downward. In 2017, NYISO issued a baseline energy forecast predicting a steeper decline in statewide electricity usage over the next ten years (-0.23% annually) than prior reports from 2016 (-0.16%), 2015 (0%), 2014 (0.16%), 2013 (0.47%), and 2012 (0.59%). *See id.* at 2; 2016 Gold Book at 11; 2015 Gold Book at 11; 2014 Gold Book at 11; 2013 Gold Book at 11; & 2012 Gold Book at 11.

[45] American Council for an Energy-Efficient Economy, https://database.aceee.org/state/new-york.

[46] *See* TDI USA Holdings Corp. Complaint in *TDI USA Holdings Corp. v. New York Independent System Operator, Inc.*, FERC Docket No. EL15-33-000, at 2, 12–13 (Dec. 16, 2016); *id.* at Attachment C, Affidavit of Donald Jessome ¶ 612.

[47] Fagan *et al.*, *supra* note 43, at 4.

[48] *Id.* at 20, Table 5 (forecasting CHPE increases percentage of all renewables by 5 percent by 2030).

[49] New York's percentage of renewable generation rose from 19.3% in 2004 to 24% in 2016. *See supra* notes, 12 & 14.

[50] Synapse's model reflects New York's target of obtaining 2,400 MW of offshore wind energy by 2030 in all scenarios, *i.e.* 600/1200/1800/2400 MW attained by, respectively, 2024/2026/2028/2030. *See* Fagan et al., *supra* note 43, at 9, 11. Governor Cuomo has called for at least 800 megawatts of offshore wind power to be procured between two solicitations—in 2018 and 2019. *See* NYSERDA, *New York State Offshore Wind*,

https://www.nyserda.ny.gov/offshorewind; *see also* NYSERDA, *New York State Offshore Wind Master Plan: Charting a Course to 2,400 Megawatts of Offshore Wind Energy*, available at https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/New-York-Offshore-Wind-Master-Plan.

[51] The 30 MW Block Island Wind Farm is the only offshore wind farm currently operating in the United States. *See* http://dwwind.com/project/block-island-wind-farm/.

[52] *See* Charge NY, https://www.nyserda.ny.gov/All-Programs/Programs/ChargeNY; NYSERDA Electric Vehicle Rebates, https://www.nyserda.ny.gov/Researchers-and-Policymakers/Electric-Vehicles.

[53] Ameena Walker, *MTA rolls out new electric buses for 3-year pilot program*, CURBED NEW YORK (Jan. 9, 2018), https://ny.curbed.com/2018/1/9/16870024/mta-electric-buses-pilot-program.

[54] This figure is derived from Judah Adler's *Electric Bus Analysis for New York City Transit*, COLUMBIA UNIVERSITY (May 2016) and the following assumptions: (i) modern electric buses use around 2kWh/mile; (ii) each NYC bus travels around 27,600 miles/year, totaling 55,200 kWh/year per bus; and (iii) NYC Transit and MTA bus have a combined fleet of about 5,700 buses for public transportation. Under these assumptions, if the entire fleet went electric, it would require 314.64 GWh (0.31 TWh) of energy each year in and around Zone J.

[55] *See* Natural Resources Defense Council & Vermont Energy Investment Corporation, *Driving the Heat Pump Market: Lessons Learned from the Northeast* (Feb. 20, 2018).

[56] The CHPE received its Certificate of Environmental Compatibility and Public Need from the State of New York Public Service Commission on April 18, 2013, its Presidential Permit from the United States Department of Energy on October 6, 2014, and a permit from the U.S. Army Corps of Engineers on April 20, 2015. *See* Champlain Hudson Power Express: Project Development Portal, http://www.chpexpress.com/permits.php. The project has been subject to multiple delays. In 2015, it was expected to be in operation by 2018. *See TDI USA Holdings Corp.*, 150 FERC ¶ 61140, 61979 (Feb. 26, 2015). Currently, it is expected to be in service in 2022. *See* http://www.chpexpress.com/about.php (last accessed Apr. 9, 2018).

[57] *See* Champlain Hudson Power Express: Project Development Portal, www.chpexpress.com (last accessed Apr. 18, 2018).

[58] Matthew L. Wald, *Merits of a Power Line From Quebec Are Debated*, N.Y. TIMES (Aug. 19, 2012); Electric Light & Power, *Hudson Transmission Project now delivering electricity to New York City* (June 3, 2013) (noting "about $850 million" cost of project). Incidentally, the Hudson Transmission Partners line underperformed in its first three years of operation. *See* David Giambusso, *Underperforming NJ-NY transmission line becomes money pit for state authority*, POLITICO (June 27, 2016).

[59] Scott Waldman, *State pushes to link energy-hungry markets with new power sources*, POLITICO (May 24, 2016).

[60] *See* Susan Hellauer, *Earth Matters: Champlain Hudson Power Express—11 Things to Know*, NYACK NEWS & VIEWS (Feb. 7, 2018) ("Earth Matters could not determine whether there are any New York buyers committed to purchasing the TDI/CHPE power yet.").

[61] See NYSERDA, 2017 Compliance Year, https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/REC-and-ZEC-Purchasers/2017-Compliance-Year. Current ZEC prices are 17.54/MWh. *See* NYSERDA, 2018 Compliance Year, https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Standard/REC-and-ZEC-Purchasers/2018-Compliance-Year.

[62] Potomac Economics, *2016 State of the Market Report*, *supra* note 38, at 14.

[63] Samuel A. Newell, Roger Leuken, Jurgen Weiss, Kathleen, Spees, Pearl Donohoo-Vallett, & Tony Lee, *Pricing Carbon into NYISO's Wholesale Energy Market to Support New York's Decarbonization Goals*, BRATTLE GROUP (Aug. 10, 2017).

[64] *See* CES Order, *supra* note 8, at 133-134. The PSC also noted that raising the RGGI price is not within the States' unilateral control. *Id.*

[65] For instance, Fagan *et al.* assumed for modeling purposes a levelized cost of $85/MWh for CHPE-provided energy. Fagan *et al.*, *supra* note 40, at 7 n.19 (using 2016 dollars over a 40 year lifespan of project). Disclaiming any specific knowledge as to financing requirements, energy prices, or utilization rates, the researchers employed this estimate as an illustration because it is "within a range of possible outcomes." *Id.*

[66] Another option would be for New York City to agree to purchase a portion of CHPE's power via a long-term power purchase agreement. In 2015, CHPE's developers proposed such an arrangement in response to New York City's request for information about supplying the City with renewable power. *See* Transmission Developers, Inc. *et al.*, *Response to Request for Information: Supplying New York City with Renewable Power*, Pin No. 85616RFI001, at 14 (Sept. 10, 2015). At present there is no such agreement, with CHPE's cost presumably being the biggest barrier, as New York City already benefits from relatively cheap energy provided by the New York Power Authority. *See* New York Power Authority, *NYPA Customers*, https://www.nypa.gov/power/customers/nypa-customers (noting NYPA electricity to public entities, including the City of New York, "saving taxpayers hundreds of millions of dollar a year on electric bills).

[67] NYISO, *Power Trends 2017*, *supra* note 14, at 28 (Figure 15).

[68] Emily S. Rueb, *How New York City Gets Its Electricity*, N.Y. TIMES (Feb. 10, 2017).

[69] NYISO, *Power Trends 2017*, *supra* note 14, at 45.

[70] Potomac Economics, *2016 State of the Market Report*, *supra* note 38, at ii.

[71] CES Order, *supra* note 15, at 56.

[72] FERC, *Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities*, 76 FR 49842-01 (Aug. 11, 2011) (FERC Order No. 1000).

[73] *Id.*

[74] *See* New York Public Service Commission, *Proceeding on Motion of the Commission to Examine Alternative Current Transmission Upgrades*, Case No. 12-T-0502.

[75] New York Public Service Commission, *Order Addressing Public Policy Requirements for Transmission Planning Purposes*, Case 14-E-0454, at 30 (issued July 20, 2015)

[76] New York Public Service Commission, *Order Finding Transmission Needs Driven by Public Policy Requirements*, Case 12-T-0502, (issued December 17, 2015). This order also addressed, Case No. 14-E-0454, a proceeding initiated so that the New York PSC could fulfill its role on behalf of the State of

New York pursuant to the Public Policy Transmission Planning Process regulated by FERC to identify transmission needs driven by public policy requirements. *Id.*

[77] NYISO, *Western New York Public Policy Transmission Planning Report* (Oct. 17, 2017).

[78] *Id.* at 78.

[79] New York Public Service Commission, *Order Addressing Public Policy Transmission Need for AC Transmission Upgrades*, Case No. 12-T-0502 *et al.* (Jan. 24, 2017).

[80] NYSERDA, *The Energy to Lead: Biennial Report to the 2015 State Energy Plan*, at 81, *available at* https://energyplan.ny.gov/Plans/2015-Update.

[81] FERC, *Order Accepting Tariff Revisions*, 161 FERC ¶ 61,160 (Nov. 16, 2017) (Dkt No. ER17-1310-001). The project that NYISO selects likely would be entitled to recover its development and construction costs under the NYISO's tariffs. *Id.*

[82] NYISO, *Power Trends 2017: New York's Evolving Electric Grid*, *supra* note 15, at 43.

[83] Analysis Group, *supra* note 40, at 90 ("During summer months, transmission limits appear to bind supplies from [Hydro-Quebec]."); Potomac Economics, *2016 State of the Market Report*, *supra* note 38, at 46 ("Variations in Hydro Quebec imports are normally caused by transmission outages on the interface. Hence, average net imports rose 23 percent in 2016 primarily because of fewer transmission outages.").

[84] For the Capability Year 2018-2019, only 1,115 megawatts of capacity from Quebec can be allocated to the New York Control Area. *See* NYISO, *Install Capacity Manual*, version 6.39, at 4-43 (Mar. 2, 2018). This figure excludes unforced capacity deliverability rights. *Id.*

[85] Additionally, in June 2017, the New York Power Authority issued a Large Scale Renewables Request For Proposals ("RFP") for the procurement of one TWh or more to support the development of the State's power infrastructure and large-scale, cost-effective renewable projects. In addition to CHPE, Hydro-Québec proposed to enhance existing infrastructure to provide an additional 700 GWh per year in New York. According to the press release, the company would also cooperate with U.S. developers in the design of the transmission infrastructure needed in New York and construct the corresponding transmission facilities needed in Québec. *See* Hydro-Québec, *Hydro-Quebec offers New York a firm, renewable energy commitment* (Sept., 8, 2017); http://news.hydroquebec.com/en/press-releases/1271/hydro-quebec-offers-new-york-a-firm-renewable-energy-commitment/. NYPA has yet to announce the results of this RFP.