GREENWASHING AND CARBON EMISSIONS: UNDERSTANDING THE TRUE IMPACTS OF NEW ENGLAND CLEAN ENERGY CONNECT

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This report was commissioned by the Maine Renewable Energy Association, Natural Resources Council of Maine, and Sierra Club to understand the potential impacts of the New England Clean Energy Connect ("NECEC") on carbon emissions.

NECEC is a proposed transmission line with a capacity of 1,200 MW that would import around 9.5 TWh of energy from Québec into New England for purchase by Massachusetts utilities under Section 83D of the *Climate Protection and Green Economy Act*.[1] Although Central Maine Power ("CMP") and Hydro-Québec[2] claim that the electrical energy delivered via NECEC would be "clean energy" from Québec's existing hydroelectric system, there are a number of reasons why the energy flowing through NECEC may not be "clean," may not be hydroelectricity, and may not even be sourced from Québec. Furthermore, the NECEC project – a high voltage direct current ("HVDC") transmission line crossing 145 miles in Maine, including 53.5 miles of pristine areas -- also could hinder Maine's efforts to develop its own renewable energy resources which otherwise could reduce carbon emissions and create local jobs and economic opportunities. This report examines the impacts of NECEC on carbon emissions and concludes that NECEC will not result in a significant reduction in greenhouse gas emissions, and may even increase them.

Hydro-Québec has a financial incentive to sell as much excess energy that it can, subject to water and generation constraints, and divert exports from other markets into NECEC to achieve a higher price. Given its system characteristics and profit goals, Hydro-Québec could even purchase energy from other markets during low-priced hours in order to retain energy in the form of water waiting in its reservoirs for subsequent sale at higher prices to New England through NECEC. Furthermore, the significant inflow via a 1,200 MW transmission line into Maine could adversely affect the economic prospects for Maine renewables, which are likely to be deferred or delayed as a result of the project's impacts

[1] Mass. Gen. Laws Ch. 21N, Section 3 (a – d).

[2] Hydro-Québec refers to the parent company of Hydro Renewable Energy, Inc. ("HRE") which submitted a bid in response to the Massachusetts Section 83D request for proposal and Hydro-Québec US, the entity that is the counterparty to the Massachusetts contracts. Hydro-Québec is a provincially-owned company that manages the Québec power system via Hydro-Québec Power (generation), Hydro-Québec TransEnergíe (Transmission) and Hydro-Québec Distribution (distribution system delivery and retail services).

on the local transmission network. The net result would be a minimal impact on efforts to reduce total carbon emissions.

NECEC could divert energy sales from another market into New England; shifting flows between markets may not reduce total greenhouse gas emissions and could even increase total carbon injections into the atmosphere.

It is important to note that intertie capacity from Québec into other markets is not a constraining factor for Hydro-Québec exports. Even during 2017 when Hydro-Québec exports reached a record high, there was a significant amount of unused transmission capacity throughout the year, indicating that the constraint on increasing exports from Québec into other markets is due to limited availability of water to produce energy or other production constraints, not the amount of transmission capacity. Therefore, a new intertie merely allows Hydro-Québec to access a higher-priced, long-term contract with Massachusetts instead of selling into competitive spot markets at lower, more uncertain prices. The NECEC transmission line is not necessary to export additional clean energy from Québec into external markets.

Hydro-Québec's proposal in response to the Massachusetts Clean Energy RFP explicitly states that it would supply energy to NECEC from existing generation resources, and not from new sources of renewable energy developed to serve the line. Given that Hydro-Québec would maximize its exports without NECEC and sell whatever excess energy that it had into external markets,[3] Hydro-Québec would supply NECEC by simply shifting those exports into New England via NECEC at a higher contracted price. This shift in energy flows could create an offsetting impact in the other markets which would have to produce replacement energy, potentially resulting in offsetting carbon emissions. While Maine power plants would be forced to shut-down to accommodate energy flowing into NECEC, fossil fuel plants in other markets (including oil, natural gas and coal units), would fire-up in response to Hydro-Québec's shifting its energy sales, negating any potential climate benefits.[4]

Hydro-Quebec can and does buy energy from low-priced markets and then sells its "clean energy" at a higher price into other markets, potentially creating a similar impact

[3] External markets into which Hydro-Québec sells energy includes Ontario, New Brunswick, New York, Mid-Continent ISO, PJM, and New England.

[4] The relative carbon emissions impact of displacing New England generation with new generation in other markets depends on the carbon intensity of power plants on the margin in each market.

on carbon emissions in the atmosphere as if Hydro-Québec were generating power from fossil fuels directly.

As a result of its reservoir storage capability, Hydro-Québec can buy lower cost energy from markets where fossil fuel generators are operating, retain water in its reservoirs and then sell that water as hydropower at higher priced periods back into the same or other markets. This strategy was described publicly by the government of Québec back in 2004:

> . . . Hydro-Québec is able to purchase electrical energy from neighbouring markets at lower prices during certain periods, and then resell it later to neighbouring networks at higher prices.[5]

Hydro-Québec continues to declare its ability to engage in the buy-low/sell-high arbitrage opportunities in its Annual Reports.[6] At the Maine Public Utilities Commission (Maine PUC), CMP admitted on the record that the proposed power purchase agreements for energy via NECEC allow Hydro-Québec to use its existing resources and import/export interties to optimize profits.[7] In this way, Hydro-Quebec can claim that the electricity it sells is "clean" hydropower even if it is buying fossil fuel electricity to enable those energy sales. There is no way for anyone in New England to know when this happens, even though Hydro-Quebec has publicly acknowledged that this is their business model. So long as NECEC can assign energy from its dams to New England, the Massachusetts contracts ignore how Hydro-Québec is managing its system to meet its energy sales obligations.

NECEC would suppress the development of new renewable energy generation in Maine which, in contrast to Hydro-Québec's market-switching strategy, actually could lower greenhouse gas emissions and provide more local jobs and economic benefits than NECEC.

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[5] Minestere des Ressource natuelles, dela Faune et des parcs, Gouvernement du Quebec. 2004. "The Energy Sector in Québec, Context, Issues and Questions," p. 41.

[6] Hydro-Québec Annual Report 2017, p. 48, "Hydro-Québec supplies the Québec market with electricity and also sells power on wholesale markets in Canada and the United States. In addition, it is active in arbitrage transactions."

[7] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Technical Conference Transcript (Aug. 1, 2018), pp. 21-25.

The proposed transmission project is a direct line from Québec into New England via Maine that does not allow other renewables in Western Maine to interconnect. NECEC is anticipated to consume the existing transmission availability and could make the cost of interconnection by in-state renewable resources to the ISO-NE system at a different point in Maine more expensive. This means that new renewable energy projects, such as solar arrays and wind projects, would not be able connect to the grid as easily and could be unable to compete with renewables in other states. In contrast to Hydro-Québec's energy flows through NECEC, potential Maine-based renewable energy projects would result in greenhouse gas reductions, would employ people in Maine and New England, and provide greater environmental benefit.

The Massachusetts contracts pay a higher price for energy than Hydro-Québec otherwise would earn by selling into other markets under current conditions. Although there are certain penalties if threshold levels of hydroelectric energy are not delivered, the contracts do not require the energy to be incremental to historical levels or to what Hydro-Québec currently can produce. Hydro-Québec is allowed to replace its "clean energy" with substitutes, even if it results in higher emissions.

Adjusting CMP's model to reflect lower runoff conditions while maintaining Hydro-Québec's exports at historical levels illustrates how and why Hydro-Québec would have to resort to diverting exports and greenwashing.

CMP's model assumes that heavy water conditions would continue throughout the term of the contract. Changing one simple assumption in CMP's model of Hydro-Québec's system while maintaining exports at levels experienced during the past five years indicates that energy supplied via NECEC could be required to divert exports into other markets and even engage in greenwashing to meet its obligations.

The reality, however, is that Hydro-Québec is not confined to a single strategy or objective over the course of the contract. Hydro-Québec will manage its system, sales, exports and opportunities according to water conditions, market prices and production constraints. Such optimization will include diverting sales into other markets and greenwashing, as required to optimize profits.

The Massachusetts contracts do not preclude Hydro-Québec from engaging in purchasing energy from other markets to supply NECEC. The net result could be higher emissions.

ENERGYZT

GREENWASHING AND CARBON EMISSIONS: UNDERSTANDING THE TRUE IMPACT OF NECEC

This report examines the environmental impact of the proposed New England Clean Energy Connect ("NECEC") project on carbon emissions.[1]

NECEC is a 1,200 MW high voltage direct current ("HVDC") transmission line that would cross 145 miles of Maine natural resources from Bettie Township on the Québec border to Lewiston, Maine – of which 53.5 miles in Somerset Country would require construction of a new clearing along a previously undeveloped right of way. While this transmission project would have significant impacts on Maine's natural resources and ecosystems, the focus of this report is on whether the project would have a net impact on carbon emissions globally.

Greenwashing

The term greenwashing was created in 1986 in response to an increase in marketing and advertising that created the perception that a company's products, aims or policies were sustainable, clean and/or green, regardless of reality. The term greenwashing subsequently was applied to the electricity sector with respect to concerns that renewable energy claims did not reflect the true nature of the underlying energy source.

Hydro-Québec claims that NECEC will deliver 100% clean energy 100% of the time via NECEC.[2] This claim, however, is unsupported by the terms of the contracts with the Massachusetts utilities. Given Québec's interconnections with other markets, NECEC effectively allows Hydro-Québec to divert its energy sales from other markets into New England for a higher contractual price. In addition, under the terms of the contracts with

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[1] This report was commissioned by the Maine Renewable Energy Association ("MREA"), Natural Resources Council of Maine ("NRCM"), and Sierra Club.

- MREA: According to its website, "MREA leads the local and statewide policy debate on renewable energy generation in Maine, and works to ensure its efforts are united with those of its member companies." https://www.renewablemaine.org/
- NRCM: NRCM is a "nonprofit membership organization protecting, restoring, and conserving Maine's environment," https://www.nrcm.org/
- Sierra Club: With over 3.5 million members and supporters focused on "defending everyone's right to a healthy world," the Sierra Club is "the most enduring and influential grassroots environmental organization in the United States." https://www.sierraclub.org/home

[2] Commonwealth Magazine, John Carroll and Lynn St. Laurent, "Hydro-Quebec, Central Maine Power respond to critics," September 8, 2018,

https://commonwealthmagazine.org/opinion/hydro-quebec-central-maine-power-respond-to-critics/

Massachusetts utilities, Hydro-Québec would not be precluded from purchasing energy from other markets to sell directly into NECEC or for purposes of conserving water in its reservoirs for future supply to NECEC at a later time.

The practice of purchasing energy from one market in order to sell it into another market as hydroelectric energy at a later time can be referred to as "greenwashing." In effect, Hydro-Québec can procure supply from other markets in order to meet its clean energy obligations delivered via NECEC even though the environmental impact in those other markets could be the same as if the energy were supplied directly from fossil fuel generating resources. Massachusetts ratepayers effectively could be paying above-market prices for energy from existing resources outside of Québec that provide no incremental environmental benefit and could even increase carbon emissions.

There are many indicators that this project would not reduce carbon emissions and could even increase them. Hydro-Québec's interconnected system with significant reservoir storage, makes the origin of the energy being sold through NECEC into Massachusetts difficult to confirm, and thus the true impact on carbon dioxide emissions impossible to measure. The following factors make it likely that this proposed transmission line will have adverse environmental consequences despite being marketed as a "clean" energy project:

- **Incentive and Opportunity to Buy Low and Sell High:** Hydro-Québec's highly interconnected system configuration, especially with respect to other markets, creates opportunities for Hydro-Quebec to source the energy sold to Massachusetts via NECEC from other markets, where nuclear energy and fossil fuel generation is operating and effectively would supply Hydro-Québec's purchases.

- **Potential for Increased Carbon Emissions in other markets**: The diversion of existing sales of hydroelectricity from other markets, for example in New York, New Brunswick or Ontario, could increase carbon emissions in those markets, offsetting or even exceeding claimed carbon benefits of NECEC in New England.[3]

[3] The ultimate impact on total carbon emissions will depend on the relative carbon emissions intensity of the last plant required to generate energy or shut-down in response to Hydro-Québec's activities. If the states in the Northeast pursue their stated carbon reduction goals, the relative impact should go to zero as relative carbon emissions across markets converge.

- **Displacement of Existing and New Maine Renewable Resources:** Maine's potential for new renewable resources will be adversely impacted, delayed and deferred as a result of NECEC.

The outcomes described in this report are not theoretical. Under realistic assumptions about water conditions, Hydro-Québec would not be able to maintain exports at 2017 levels with NECEC unless it diverted sales from other markets and engaged in greenwashing during the first half of the contract. Hydro-Québec has engaged in the described behavior in the past and has every incentive to engage in this behavior to optimize its profits going forward.

1. OVERVIEW OF NECEC

Central Maine Power is proposing to build a new transmission line to bring existing Canadian hydroelectric energy into New England via Maine. NECEC was developed in response to the Massachusetts solicitation for clean energy under Section 83D of the *Climate Protection and Green Economy Act*.[4]

Of the forty-six submissions to the Massachusetts Section 83D Request for Proposal ("RFP"), NECEC is one of three projects that proposed to supply existing hydroelectricity from Hydro-Quebec via new transmission lines into New England. Northern Pass Transmission (NPT) was selected initially and offered 1,200 MW; NECEC was the next choice after New Hampshire refused to site Northern Pass, also offering 1,200 MW; and TDI's New England Clean Power Link (NECPL) would have transmitted up to 1,000 MW of energy from Québec's existing hydroelectric power system.[5] Aside from one other transmission project proposed by Emera, the forty-two (42) other projects included wind, solar, hydroelectricity or some combination, and includes renewable energy projects being developed in Maine.[6]

The assertion that NECEC supply would come from existing resources appears multiple times in Hydro-Québec's proposal in response to the Massachusetts clean energy request for proposal, as illustrated by the following excerpt.[7]

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[4] Mass. Gen. Laws Ch. 21N, Section 3(a – d).

[5] See the public versions of the bid submitted for each project located on the Massachusetts Clean Energy website: https://macleanenergy.com/83d/83d-bids/.

[6] Ibid.

[7] See for example, pages 4, 6 and 56.

> All of the hydroelectric generation units that comprise the HQ Hydropower Resources are in operation and, therefore, have already been constructed. Although new hydroelectric generation units may be added to the HQ Hydropower Resources portfolio in the future, **no new facilities or capital investments for hydroelectric generation units are required as part of this Proposal**.[8]

(emphasis added).

The RFP initially required bidders proposing to supply from existing projects to explain how the delivered energy would be incremental to historical levels. The requirement that the delivered energy be incremental also was incorporated into the template for the Power Purchase Agreement which defined "Qualified Clean Energy" to include "Incremental Hydroelectric Generation," defined as:

> "Incremental Hydroelectric Generation" means hydroelectric generation that represents a net increase in MWh per year of hydroelectric generation from the Seller as of the Effective Date as compared to the three-year historical average for the period January 1, 2014 through December 31, 2016 and/or otherwise expected delivery of hydroelectric generation from the Seller within or into the New England Control Area.[9]

Following negotiations between Hydro-Québec and the Massachusetts utilities, however, the signed version of the contract dropped the definition of "Incremental Hydroelectric Generation" and changed the definition of "Qualified Clean Energy" to exclude any reference to incremental hydroelectric generation.[10] Furthermore, there is no requirement that total deliveries into New England versus the historical averages be incremental, only

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[8] HRE Section 83D Application Form, submitted July 27, 2017, p. 63 (emphasis added).

[9] DRAFT* POWER PURCHASE AGREEMENT FOR FIRM QUALIFED CLEAN ENERGY FROM HYDROELECTRIC GENERATION BETWEEN [_____] [Buyer] AND [_____] [Seller] As of [_____], 201_ , p. 7.

[10] See for example, *Central Maine Power Co., Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232*, Exhibit No. NECEC-16, POWER PURCHASE AGREEMENT FOR FIRM QUALIFIED CLEAN ENERGY FROM HYDROELECTRIC GENERATION BETWEEN MASSACHUSETTS ELECTRIC COMPANY AND NANTUCKET ELECTRIC COMPANY d/b/a NATIONAL GRID AND H.Q. ENERGY SERVICES (U.S.) INC., as of June 13, 2018, [REDACTED].

penalties if Hydro-Québec fails to meet the new set of requirements, which is described in Exhibit H to the power purchase agreement. Although Exhibit H is redacted, CMP witnesses testified before the Maine PUC in public session that Hydro-Québec does not have to make incremental delivery of power into New England, but can pay penalties instead.[11]

The Maine PUC Technical expert, London Economics, testified that this ability to trade between markets and obtain a higher price is a "key motivator" for NECEC.[12]

Key Insight

The signed contracts do not require Hydro-Québec to deliver incremental energy from its existing hydroelectric projects. Instead, if it is economic or strategic to do so, Hydro-Québec can choose to not deliver incremental energy and pay penalties instead. The contracts do not monitor or preclude Hydro-Québec from engaging in purchases from other markets for its own domestic use to allow for sales of its hydroelectricity at a premium to Massachusetts utilities under the contracts.

The NECEC project, as submitted to the Section 83D RFP, is a collaboration between CMP and two wholly-owned subsidiaries of Hydro-Québec -- Hydro-Québec TransEnergíe (HQT) and Hydro Renewable Energy (HRE). HRE subsequently was replaced by Hydro-Québec US in the signed power purchase agreements, placing the obligation on a US-based affiliate of Hydro-Québec that has limited assets in the event of default.

Under publicly available contracts and proposals, the NECEC transmission line would have a capacity of 1,200 MW. HQT would build and operate the transmission line on the Québec side and CMP would build and operate the portion of the transmission line located in Maine. Hydro-Québec would make available to Massachusetts a minimum of 8.5 TWh up to 9.5 TWh of electricity per year at the discretion of the Massachusetts distribution utilities engaged in the procurement.[13]

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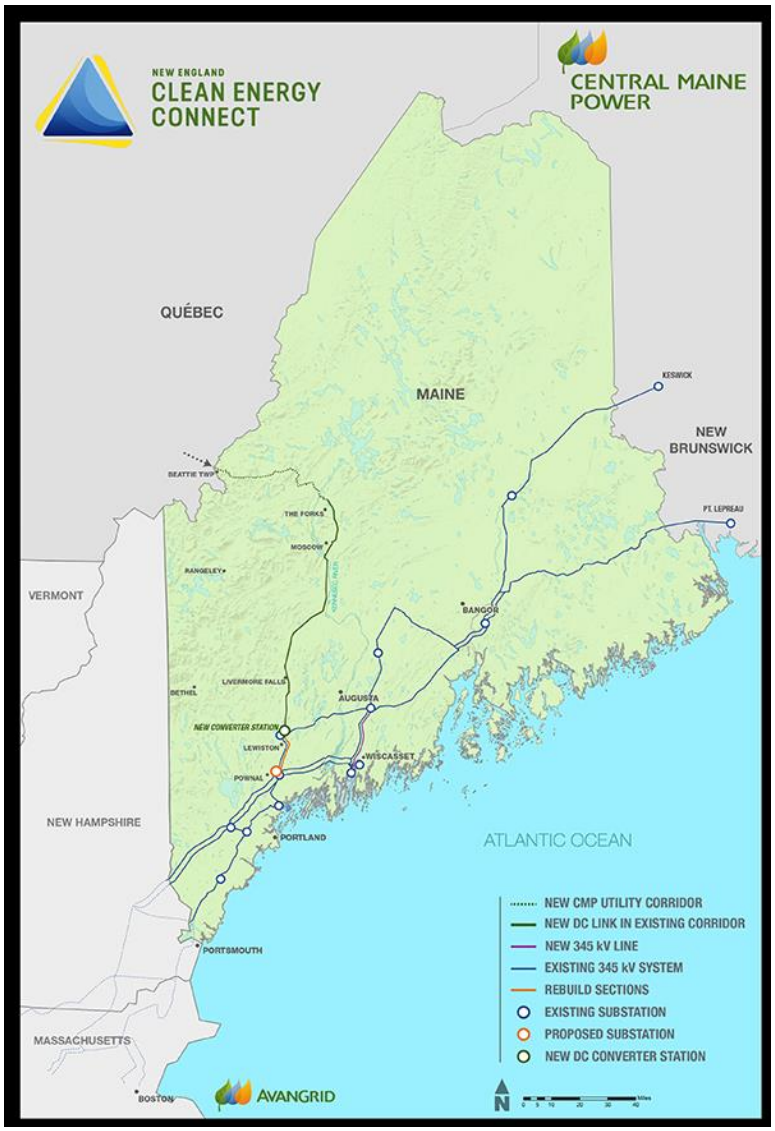
[11] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Technical Conference Transcript (Aug. 1, 2018), pp. 28 – 35.

[12] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Technical Conference Transcript (Sep. 19, 2018), pp. 21-25.

[13] Section 83D, Request for Proposal Application Form, submitted by Hydro Renewable Energy Inc., p. 3, https://macleanenergy.com/83d/83d-bids/

Figure 1 illustrates the proposed path of the NECEC project and interconnection between Québec and Lewiston, Maine.

Figure 1: Proposed NECEC Project[14]



The injection point at Lewiston, Maine, is not ideal. Maine is connected to the ISO-NE system through a long high voltage AC line and energy must pass through at least four interfaces before arriving in Massachusetts. The Maine generation system produced only 11.5 TWh of energy in 2017 compared to 17 TWh in 2010. According to the U.S. EIA,

[14] NECEC, https://www.necleanenergyconnect.org/map

electricity imports from Québec that already have occurred are one of the reasons for the reduction in Maine generation:

> Maine's Renewable Portfolio Standards (RPS) require electricity providers to fuel 30% of their electricity generation with renewable resources. In addition to policy initiatives, electricity imports from Canada—notably from Quebec—have been contributing an increasingly larger share to Maine's total generation, displacing natural gas-fired generation as the primary source. Since 2012, electricity imports from Canada have more than tripled . . . [15]

Imports into Maine from Québec already have displaced a significant portion of Maine's natural gas plants. NECEC would continue the trend of displacement by nearly matching the total amount of energy generated by Maine power plants in 2017. If NECEC were to proceed injection of such a significant amount of energy into Maine, Maine's existing generators, including biomass plants, will be displaced. NECEC also will have an adverse impact on transmission availability, congestion and losses. As a result, new renewable energy generation would find it more costly to connect to the system in Maine for delivery into the rest of New England. These higher interconnection costs would make it more difficult for Maine renewable resources to compete with the rest of New England.

Under the agreement with Hydro-Québec, CMP would build the transmission line on the Maine portion of the line. CMP anticipates the need to invest in a number of transmission upgrades to incorporate NECEC into the system; a critical part of the existing ISO-NE transmission system, Surowiec-South, currently has only 200 MW of availability for incremental energy flows without upgrades.[16] CMP's proposed upgrades, however, would simply move congestion down to the Maine-New Hampshire Interface which has an interface limit of around 1,900 MW and does not have enough capacity to flow NECEC out of Maine in all hours without the additional cost of congestion and incremental line losses.[17]

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[15] EIA Form 923 data, https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2018/09_27/

[16] ISO-NE, Final Maine Resource Integration Study ("MRIS"), March 2018, Available at https://www.iso-ne.com/staticassets/documents/2018/03/final_maine_resource_integration_study_report_non_ceii.pdf

[17] *Central Maine Power Co., Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232,* Exhibit No. TLB-1, "Testimony of Tanya L. Bodell," April 30. 2018.

The total cost for CMP's transmission line build-out and upgrades is estimated to be $950 million. Under the proposed structure, Maine ratepayers would not be responsible for any payments to build the transmission line. However, Maine ratepayers also would not obtain any direct rights to capacity on the transmission line or energy being delivered across NECEC. Therefore, any benefit to Maine that could result from the proposed transmission line would be indirect impacts.

Given the global nature of carbon emissions, the impact on Maine's carbon emissions alone or even New England's carbon emissions across the broader region cannot be examined without consideration of the impact on surrounding areas. In assessing the net impacts of NECEC on carbon dioxide emissions, therefore, it is necessary to consider the total impact of NECEC across multiple markets.

Key Insight

NECEC does not offer any direct benefits to Maine residents. Whereas Massachusetts is estimated to receive hundreds of millions of dollars in direct benefits, Maine would not receive any direct benefits associated with energy deliveries dedicated to Maine ratepayers. Instead, the potential impact of NECEC to Maine includes the net impact of NECEC on global emissions and should be examined across multiple markets.

2. SOURCE OF QUÉBEC HYDROELECTRIC SUPPLY

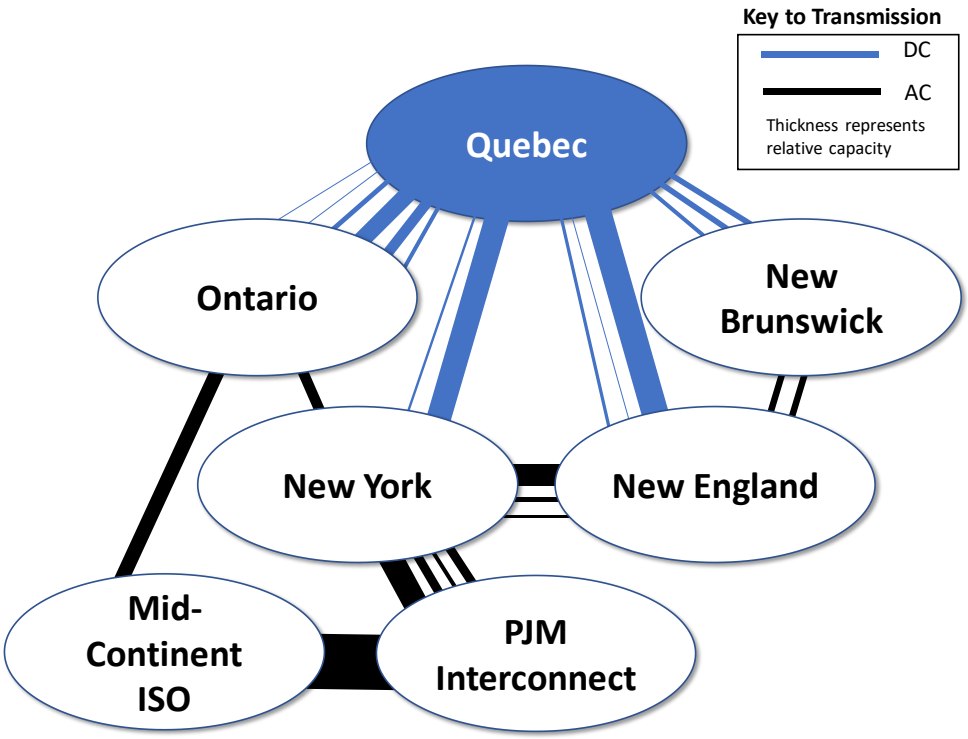
Hydro-Québec owns and operates a large system of hydroelectric generation and other power generating capabilities along with an extensive transmission network. In order to understand how Hydro-Québec is likely to supply energy via NECEC, it is important to understand the current and anticipated state of its system, the amount of excess energy it could produce with or without NECEC and what Hydro-Québec otherwise would do with that energy in the absence of NECEC.

This section provides a high-level summary of the Hydro-Québec system; Appendix B provides a more detailed overview.

2.1 Québec is interconnected with multiple markets

Québec is physically interconnected to four other markets via DC tielines – New England, Ontario, New York and New Brunswick (**Figure 2**).

Figure 2: Interties and transmission lines between Québec and major markets



In addition, by wheeling through other markets, Hydro-Québec can sell into PJM and the Mid-Continent ISO -- two markets that are explicitly listed in Hydro-Québec's application for a blanket export license.[18] Both New York and New Brunswick connect with New England via an AC transmission interconnection, allowing Hydro-Québec to sell energy into New England via New York and New Brunswick. In addition, Hydro-Québec can and does sell into New York via Ontario.[19]

The ability to purchase from other markets and store an equivalent amount of energy by

[18] National Energy Board, Application by Hydro-Québec, "Application for a Blanket Electricity Export Permit Pursuant to s.119.03 of the National Energy Board Act and s.9 of the National Energy Board Electricity Regulations," Application Submission Date 19/02/2010, p. 4.

"(3) Provide a brief description of the export markets (e.g. geographic area, NERC region, etc.) to be served. Les marchés visés sont les marchés nord-américains desservis par le New York Independent System Operator, Inc., l'ISO New England Inc., le Midwest Independent Transmission System Operator, Inc. et la PJM Interconnection, LLC."

[19] National Energy Board, Analysis of Commodity Tracking System Data,

https://apps.neb-one.gc.ca/CommodityStatistics/Statistics.aspx?language=english

reducing flow through its turbines provides valuable flexibility to Hydro-Québec. This flexibility is particularly profitable during low water conditions when Hydro-Québec would have less energy to sell into external markets or high-priced years when the difference between peak and off-peak energy prices is greater.

The higher-priced, long-term NECEC contract is an example of the way Hydro-Québec can arbitrage between markets – buying low in one market and then reselling that energy at a higher price elsewhere. The above-market price of the contracts with Massachusetts utilities also would allow Hydro-Québec to maximize profits through optimization of its imports and exports while selling under a lucrative long-term contract.

2.2 The National Energy Board issues energy export licenses

In order to sell any energy commodity products into the US, Hydro-Québec must obtain a license from the National Energy Board (NEB). The NEB considers a number of factors before issuing a license, including:

- **Other Provinces:** Whether or not there could be adverse consequences to other provinces in Canada; and

- **Environment:** Impact on the environment.

As explained below, these requirements, combined with the characteristics of Hydro-Québec's system, makes it very clear that Hydro-Québec would have to divert sales from other markets in order to deliver electricity products via NECEC (thereby negating any impact on carbon emissions) and/or purchase electricity products from other markets in order to meet its firm commitments under the Massachusetts contracts (i.e., greenwashing).

2.2.1 Other Provinces

Specific export licenses for Hydro-Québec indicate that the NEB also looks at whether or not there would be an adverse impact on other provinces. The license issued to Hydro-Québec for contractual sales to Vermont specifically notes in the preamble:

> AND WHEREAS the Board is satisfied that the parties interested in buying electricity for consumption in Canada have been given fair market access to any electricity proposed for export under this permit;

> AND WHEREAS the Board is satisfied that the proposed exports will not cause any unacceptable effects on provinces other than those from which exports will occur; [20]

The focus on potential impacts on other Canadian provinces could make it difficult for Hydro-Québec to reduce sales into Ontario or New Brunswick or engage in behaviors that could adversely impact those provinces. Therefore, the bulk of the export reductions could come from New York.

2.2.2 Environment

The NEB also is tasked with considering the environment and would be required to perform a detailed review of potential environmental impacts if the proposed source of energy sales is to come from new generation facilities. In the case of the 10-year blanket export license issued to Hydro-Québec in 2010 for up to 30 TWh of firm and interruptible energy for export, the NEB specifically noted:

> Regarding the impact of the proposed exportation on the environment, the Board is of the view that there is no nexus between the proposed export and new facilities, changes to existing facilities, or modifications to the operation of existing facilities and environmental effects. As a result, the Board is satisfied that further consideration of the environmental effects of the proposed export is not required.
>
> To ensure that a potential nexus would not arise in the future, the Board has incorporated a condition into the permit, which in relation to any single export contract, limits the ability of the Applicant to rely on the permit to a maximum period of five years. The Board is of the view that a sales contract of five years or less is not sufficient to support the construction of new facilities or modifications to existing facilities, to serve the demands of an export contract.[21]

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[20] National Energy Board, Permit EPE-370, IN THE MATTER OF section 119.03 of the National Energy Board Act (the Act) and the regulations made thereunder; and IN THE MATTER OF an application by Hydro-Québec for authorization to export electricity to H.Q. Energy Services (U.S.) Inc. dated 4 March 2010 by Hydro-Québec for authorization to export electricity to H.Q. Energy Services (U.S.) Inc., pursuant to section 119.03 of the National Energy Board Act (the Act), Issued August 18, 2011.

[21] National Energy Board, "Letter accompanying the issuance of a licence in response to Application dated 19 February 2010 for authorization to export electricity pursuant to Section 119.03 of the National Energy Board Act (Act)1 by Hydro-Québec," October 29, 2010, p. 3.

In this context, it is understandable why Hydro-Québec so clearly indicated that it would only supply energy from its existing portfolio of hydroelectric projects that already are built for purposes of the Clean Energy RFP – to say otherwise may run afoul of the NEB licensing requirements. If supply were to be from new construction, the NEB could require an extensive environmental review.

2.3 Québec's energy versus capacity

In order to understand the source of Hydro-Québec's energy into New England via NECEC, an examination of Hydro-Québec's system – both energy and capacity -- is in order. Capacity is provided by existing or planned generating plants that could be available to generate electrical energy when needed. Energy is the electricity that flows when those generating plants are operating. The distinction is important because the contracts with Massachusetts are for energy only – not capacity.[22]

Furthermore, the contracts are for firm energy; firm energy that is not backed by specified resource capacity needs to be firmed with another resource. In this case, Hydro-Québec's system and the ability to optimize energy purchases and sales across its four system interties could provide the firming without the need to dedicate specific hydroelectric units to the contract. This section explains further why the contracts with the Massachusetts utilities are for firm energy only and the implications for greenwashing and carbon emissions.

Québec's system is a winter-peaking system and, as such, Hydro-Québec is required to maintain generation capability above its peak demand in the winter. However, water flow is at its lowest during the winter months, requiring Québec to rely on stored water in its reservoirs to produce energy. Therefore, Hydro-Québec's energy production capacity is limited by its already-built generation capacity and reservoir levels.[23]

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[22] Although the contracts require Hydro-Québec to attempt to qualify to provide capacity into the ISO-NE market, there is no penalty if such capacity is not available or does not clear the market, "For the avoidance of doubt, but without limiting the condition set forth in Section 3.4(b)(ii), **Seller shall have no obligation during the Services Term** to pay for such Network Upgrades or **to complete the Forward Capacity Auction qualification process**" (emphasis added).

[23] As with any large hydroelectric system operator, Hydro-Québec manages its reservoir levels to be able to meet its energy needs over the course of the year and under adverse run-off conditions over multiple years as well as during peak periods.

The North American Electric Reliability Council (NERC) projects that Québec could be short of its required reserve margins by 2024 unless another 1,100 MW of prospective resources are obtained.

> Under the Prospective Scenario, a total of 1,100 MW of expected capacity imports are planned by the Québec area. These purchases have not yet been backed by firm long-term contracts. However, on a yearly basis, the Québec area proceeds with short-term capacity purchases (UCAP) in order to meet its capacity requirements if needed.[24]

In other words, Québec is projected to require nearly the equivalent of NECEC's potential capacity by 2023 according to NERC. If Hydro-Québec must purchase capacity to meet its own provincial needs, it would not be able to sell capacity into another market such as ISO-NE unless it is purchasing sufficient capacity from other markets.[25] In fact, Hydro-Québec already appears to be engaging in capacity arbitrage – purchasing short-term capacity from New York's UCAP market and Ontario (500 MW), and selling 462 MW into the higher-priced ISO-NE Forward Capacity Market ("FCM") for FCA9 (June 2018 –May 2019).[26]

ISO-NE explicitly requires that a resource bidding into the capacity market as a New Import Capacity Resource backed by an external control area such as the Québec system to show that its load and capacity projections for the external Control Area has sufficient excess capacity to back the bid.[27] If Hydro-Québec intends to rely on specific generating

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[24] NERC, 2017 Long-term Reliability Assessment, pp. 55-56, Under the prospective scenario, a total of 1,100 MW of expected capacity imports are planned by the Québec area, although these purchases have not yet been backed by firm long-term contracts. https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_12132017_Final.pdf

[25] Ibid., pp. 53-54. Ontario also will not be in a position to renew the current sale of 500 MW of capacity to Québec.

[26] ISO-NE, "Forward Capacity Auction Capacity Obligations," https://www.iso-ne.com/markets-operations/markets/forward-capacity-market/

[27] See ISO-NE Market Rules (Effective Date, 9/28/2018 - Docket # ER18-2078-000), Market Rule 1, Section 13, paragraph III.13.1.3.5.3:

> III.13.1.3.5.3. Imports Backed by an External Control Area. . .
>
> If the New Import Capacity Resource will be backed by an external Control Area and the capacity will be imported over an Elective Transmission Upgrade and the capacity will be imported over an interface that has not achieved Commercial Operation as defined in

resources to bid power, those resources must be identified and shown to be unencumbered from other capacity supply obligations.[28]

The shortfall in capacity does not correspond to a shortfall in energy because Québec has reservoirs and can store water to generate excess energy across the year whereas capacity requirements are an instantaneous need at the point of peak demand on the system. Given the natural flows of precipitation and snow melt in Québec, the province is flush with water in the late spring and early summer months. That water is used to produce energy as well as to replenish the reservoirs for the winter. Water is converted into energy and sold into other markets in order to maximize profits.

In addition to energy sales, Hydro-Québec also engages in arbitrage opportunities where it purchases from one market at a lower price and either sells directly into another market or stores the purchased energy in the reservoir in order to sell energy at a later time.

Figure 3 illustrates how Hydro-Québec has used purchased energy imported into Québec historically to support its export sales into other markets. For example, in 2010, imports supported nearly half of its exports (10.7 TWh imported versus 23.3 TWh exported). Without those purchases, Hydro-Québec either would have had to reduce exports or fall below minimum reservoir levels.[29]

> Schedule 25 of Section II of the Transmission, Markets and Services Tariff, the provisions regarding site control (Section III.13.1.1.2.2.1) and critical path schedule (Section III.13.1.1.2.2.2) shall apply in addition to the requirement that the Project Sponsor **submit system load and capacity projections for the external Control Area showing sufficient excess capacity during the Capacity Commitment Period to back the New Import Capacity Resource for the length of the multi-year contract** (emphasis added).

[28] Ibid, Section III.13.1.3.5.2.

[29] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Response to NRCM-002-021, Attachment 1.

Figure 3: Hydro-Québec total exports and imports[30]

Year	[1] Exports (TWh)	[2] Imports (TWh)	[3] Net Exports (TWh)
2008	21.3	6.1	15.2
2009	23.4	4.9	18.5
2010	23.3	10.7	12.6
2011	26.8	6.0	20.8
2012	31.8	1.7	30.1
2013	32.2	1.4	30.8
2014	26.6	1.2	25.4
2015	29.9	0.6	29.3
2016	32.7	0.1	32.6
2017	34.9	0.5	34.4

NOTES:
[1] See "Hydro-Québec at a Glance, p. 2 across the Annual Reports for a consistent set of data on electricity sales outside of Québec. For 2012 and earlier, there is conflicting information in other areas of the report, which is ignored for purposes of developing this table.
[2] Derived as the difference between reported Exports and Net Exports.
[3] Net Electricity Exports, p. 12 (2016 Annual Report), p. 12 (2014 Annual Report).

As a general proposition, Québec has excess energy over the course of the year that it can sell into other markets at a profit and already is doing so. Revenue from sales to external markets has exceeded $1.5 billion over the past few years.[31] In 2017, Hydro-Québec earned $1.575 billion from electricity exports and issued more than $2 billion back to the Québec government as a dividend for the fifth consecutive year.[32] Selling exports has become a necessity for Hydro-Quebec, as indicated by Hydro-Québec CEO Éric Martel's recent comment, "Without exports, our profits are in trouble."[33]

[30] Compiled using Hydro-Québec Annual Reports 2012 – 2017.

www.hydroquebec.com/about/financial-results/annual-report.html

[31] Hydro-Québec Annual Reports.

[32] 2017 Hydro-Québec Annual Report, p. 3,

http://www.hydroquebec.com/data/documents-donnees/pdf/annual-report.pdf

[33] Financial Post, "Without exports our profits are in trouble: Hydro-Quebec plugs into U.S. markets for growth," April 20, 2018, https://business.financialpost.com/commodities/energy/without-exports-our-profits-are-in-trouble-hydro-quebec-plugs-into-u-s-markets-for-growth.

The Massachusetts contracts represent a higher value opportunity for Hydro-Québec than their existing exports because it is an above-market, fixed price contract. It is an arbitrage opportunity across markets that Hydro-Québec describes in its Annual Reports as an activity in which it engages. As the Maine PUC Technical Expert noted,

> With a new outlet for its energy, such as NECEC, HQP will have an increased ability to capture higher energy prices in ISO-NE's energy markets, forfeiting sales to other lower-priced markets . . . This arbitrage opportunity is the core of HQP's exporting strategy and the key motivator for HQP in contracting with NECEC.[34]

2.4 Economic Incentives to Buy, Divert or Build

There are multiple ways that Hydro-Québec could meet its firm energy commitment to NECEC:

1) **Buy:** Purchase energy directly from other markets.

2) **Divert:** Reduce energy sales into other markets.[35]

3) **Upgrade:** Invest in existing hydroelectric facilities to obtain higher maximum output levels.

4) **Build:** Invest in new impoundments and associated hydroelectric facilities to increase system output.

Hydro-Québec's response to the RFP indicated that Hydro-Québec would use only existing facilities; there would be no upgrades or new facilities required to meet the requirements in the contracts.[36] A new license with the NEB also would have to use existing facilities or be subject to an extensive environmental impact review. According to

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[34] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Technical Conference Transcript (Sep. 19, 2018), pp. 21-25.

[35] Rob Ferguson, The Star, "Ontario signs deal for electricity from Quebec in bid to defuse anger over hydro bills," October 21, 2016, https://www.thestar.com/news/queenspark/2016/10/21/ontario-signs-deal-for-electricity-from-quebec-in-bid-to-defuse-anger-over-hydro-bills.html.

[36] HRE Section 83D Application Form, submitted July 27, 2017, pp. 4, 6, 56, and 63.

Hydro-Québec's own study, a new facility would cost more than the contract price for at least the first half of the contract, making it an uneconomic solution at least initially (see Appendix B, **Figure B - 10**). Furthermore, a new hydroelectric facility in Québec would take around 10 years to build, well into the NECEC contract period even if it could be economically justified.

Hydro-Québec would not be able to use the upgrades for NECEC. The response to the RFP explicitly noted that no new upgrades would be required.[37] Furthermore, Hydro-Québec's own load projections indicate that it would need around 6.2 TWh of upgrades to meet incremental load by 2023; additional load growth through 2034 would require the entirety of potential upgrades to keep sales into other markets constant during the 20-year NECEC contract period.[38]

CMP has argued that Hydro-Québec has sufficient water in storage to supply NECEC without diverting sales into other markets.[39] This conclusion, however, is based on the assumption that recent high water conditions will continue; under an assumption of lower runoff conditions, Hydro-Québec would need to divert sales to meet its obligations to supply NECEC (see Appendix B, section B.5). Furthermore, there is no reason why Hydro-Québec would not sell any available energy that it had in the absence of NECEC, subject to economic prices and transmission availability, which is plentiful and has not been fully utilized in the past (see Appendix B, section 8.3).

Therefore, in order to supply NECEC, Hydro-Québec would either have to divert sales that otherwise would occur and/or purchase energy from other markets.

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[37] Ibid., p. 63.

[38] Hydro Québec, Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec, April 2018, pp. 27-28 ("Load in Québec was assumed in all scenarios to grow by 0.42% per year for a total increase of 28.7 TWh between 2015 and 2050."). If, as reported in footnote 5, 144 TWh of hydroelectricity is available, there would be only 13 TWh of additional energy available through upgrades. This amount would be consumed by Québec load growth by around 2034 given the 0.42% load growth assumed by the study.

[39] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Rebuttal Report of Dickinson, et. al., July 13, 2018, pp. 30 – 35.

Key Insight

It would be uneconomic for Hydro-Québec to build new hydroelectric facilities to meet the need of NECEC energy supply under current conditions. This buttresses the case that Hydro-Quebec would not provide new renewable energy and therefore NECEC would not lower greenhouse gas emissions.

Under the Massachusetts contracts, Hydro-Québec receives an energy price that starts at $51.50 / MWh in 2023 and rises to around $82.40 / MWh in 2042. The starting price is lower than the cost of building new facilities which Hydro-Québec assumes to be $70/MWh.[40] Instead, Hydro-Québec would simply divert energy from other markets which have been trading at between $20 and $40/MWh, consistent with futures prices for energy to be delivered into New York (see Appendix B, **Figure B - 12** and **Figure B - 13**). Although upgrades could cost less, those reported upgrades already are required to meet Québec's domestic load growth. Therefore, it would be more economic for Hydro-Québec to divert lower-priced energy sales from other markets into NECEC or greenwash low-priced purchases.[41]

Key Insight

Given the stated source of this energy and economic incentives, the natural source of supply would be a diversion of energy away from other markets.

3. GREENWASHING: SOURCING PURCHASES FROM OTHER MARKETS

Hydro-Québec also could purchase energy from markets with low or even negative prices to meet its energy commitments. The ability to purchase imports in order to conserve water in its reservoirs for use during higher-priced periods creates a profit-maximizing opportunity that Hydro-Québec is uniquely positioned to pursue. The impact on the environment could be the same as if Hydro-Quebec were generating energy in those

[40] Energyzt confirmed that all dollar figures in the Deep Decarbonization study are in US dollars via conversation with Evolved Energy Research, one of the authors of the report.

[41] Hydro-Québec notes in its Section 83D application form that it may upgrade or build new facilities in the future, but that these are not required to supply NECEC. Given Hydro-Québec's need for new capacity, if any upgrades or capacity additions could occur regardless of NECEC, then they should be incorporated into the scenarios with and without NECEC when estimating the impact of NECEC on carbon emissions.

markets from fossil fuels directly. This section describes how Hydro-Québec has engaged in greenwashing in the past and is incentivized to continue to do so in the future.

3.1 Hydro-Québec's strategic plays across markets

The ability to buy-low and sell high is an arbitrage opportunity, and is cited in Hydro-Québec's annual reports as an activity that it engages in along with selling energy into other markets.[42] Hydro-Québec has engaged extensively in such arbitrage opportunities in the past, purchasing nearly 50 percent of its exports in 2010 (Appendix B, **Figure B - 6**). Such purchased energy is likely to include carbon-emitting resources.[43]

This strategy has been a long-standing approach for Hydro-Québec, referenced in 2004 by the Government of Québec:

> Hydro-Québec is able to purchase electrical energy from neighbouring markets at lower prices during certain periods, and then resell it later to neighbouring networks at higher prices. If rainfall conditions permit, and once Québec's own energy security has been guaranteed, Hydro-Québec Production's unused supplies can be exported (net export sales) to neighbouring markets.[44]

While this type of arrangement can help Hydro-Quebec to maximize its profits, it also creates a "greenwashing" situation where Hydro-Quebec can create the perception that its energy is clean and renewable when it is not. Specifically, Hydro-Quebec's interconnectedness would allow the NECEC energy to appear to come from Hydro-Québec's hydroelectric plants when, in reality, such excess energy was only enabled through purchases from fossil fuel plants.

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[42] For example, see 2017 Hydro-Québec Annual Report, Notes to Consolidated Statements, p. 50 of 94.

[43] Many of the surrounding markets have stated objectives to decarbonize the grid in order to achieve lower carbon emissions from the power sector. This decarbonization would make the impact of import/export optimization converge over time.

[44] Minestere des Ressource natuelles, dela Faune et des parcs, Gouvernement du Quebec. 2004. The Energy Sector in Québec, Context, Issues and Questions. p. 41.

3.2 Greenwashing is possible under the contracts

The Massachusetts contracts have no way to monitor, prevent, or penalize Hydro-Québec for engaging in purchases from other markets in order to conserve water in its reservoirs for sale though NECEC. Although the Massachusetts contracts do require Hydro-Québec to "tag" its electrons through the ISO-NE Generation Information System (GIS), the tracking system simply tags imports from Hydro-Québec as coming from a specific hydroelectric facility. However, the GIS does not track Hydro-Québec's total system dispatch or decisions.

Under the contracts with Massachusetts utilities, Hydro-Québec is not required and therefore is unlikely to provide the details for its entire system operations, energy imports and energy sales. Without an understanding of Hydro-Quebec's entire system, it will look as if the Massachusetts utilities are purchasing hydroelectricity when, in fact, those purchases may be enabled by purchases from other markets that allowed Hydro-Quebec to conserve the water in its dams for production when NECEC supply was required.

The inability to track energy flows into and out of Hydro-Quebec's system allows Hydro-Québec to effectively "greenwash" any energy it purchases from other markets and convert it into "clean energy" for purposes of its contracts. At best, Hydro-Québec would be receiving the system mix which would include whatever was operating at the time of the purchases. In reality, Hydro-Québec's purchases from other markets could be enabling carbon-emitting resources to operate when they otherwise would be turned off. For example, low cost coal from New Brunswick or natural gas from New York could be the incremental plant's fuel source that effectively allows Hydro-Québec to purchase from another markets in order to conserve water to service NECEC. Under such conditions, NECEC actually would be increasing fossil fuel use in other markets outside of ISO-NE that would not have occurred in the absence of NECEC.

There is no reason to assume that Hydro-Québec would not engage in the same strategy that it described in 2004, and clearly executed upon from 2008 through 2012, referenced in its annual reports as recently as 2017 and could pursue without penalty under the Massachusetts contracts. As a result, Massachusetts ratepayers would be paying multiples on the market price for something that is not truly Québec hydroelectricity. Hydro-Québec effectively would be an expensive broker purchasing energy that Massachusetts ratepayers otherwise could obtain through competitive markets.

Key Insight

The higher price in the NECEC contract and the inability to accurately account for the Hydro-Quebec system creates perverse incentives for Hydro-Québec to engage in arbitrage opportunities by purchasing cheaper and, potentially, higher emitting energy from other markets to meet the NECEC firm energy supply obligations.

3.3 NECEC energy may not come from Québec

The risk of Hydro-Québec engaging in buy-low/sell-high opportunities is not theoretical. Futures prices in New York for peak hours are trading at around $41/MWh for 2023; off-peak prices would be even lower.[45] It therefore would be economic for Hydro-Québec to divert energy away from New York to sell via NECEC.

The estimated energy price discrepancy between market prices and energy prices in the NECEC contract undoubtedly will incentivize Hydro-Québec to ensure that there is enough water in its reservoirs to meet the requirements of the GIS tracking system and contract requirements to be able to claim that its energy supply via NECEC is "clean energy."[46] Although it would appear that the energy was coming from Québec, it actually would have been sourced from another market either via diversion of exports or purchases from lower-priced markets.

Key Insight

Hydro-Québec has every incentive to arbitrage between markets, and already does so. The lucrative arrangements under the NECEC contract create an even greater incentive for Hydro-Québec to greenwash energy by buying from other markets to supply NECEC.

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[45] CME Group, NYISO Zone A Day-Ahead Peak Calendar-Month 5 MW Futures Quotes, October 11, 2018, https://www.cmegroup.com/trading/energy/electricity/nyiso-zone-a-5-mw-peak-calendar-month-day-ahead-lbmp-swap-futures.html.

[46] The actual price for energy under the NECEC contract has been disclosed to the public as part of the filings to the Massachusetts Department of Public Utilities. The energy price starts at around $51 / MWh in 2023, rising to around $82 in 2043. Adding in transmission charges over NECEC, the delivered energy price in Lewiston starts at $66/MWh, rising to around $103/MWh in 2042. In addition, Massachusetts ratepayers would have to pay for the cost of transmission, including congestion and losses, required to bring the energy from Lewiston, Maine into Massachusetts.

3.4 No guarantee that NECEC would be incremental to New England

The Massachusetts contracts do not guarantee that energy flowing through NECEC would be incremental.

The Massachusetts RFP originally required hydroelectric imports to be "incremental to New England" and required a showing of what Québec's imports into New England has been over the prior three years.[47] The template for the contract included as part of the RFP also included a definition for incremental energy to be delivered:

> "Incremental Hydroelectric Generation" means Firm Service Hydroelectric Generation that represents a net increase in MWh per year of hydroelectric generation from the bidder and/or affiliate as compared to the 3-year historical average and/or otherwise expected delivery of hydroelectric generation from the bidder and/or affiliate within or into the New England Control Area.

However, the final contracts excluded the entire definition of "Incremental Hydroelectric Generation." Although the contract does include penalties for Hydro-Québec's failure to deliver adequate amounts of "clean energy" under the Attachment H to the contract, the penalties are limited, allowing Hydro-Québec to make an economic decision as to how to manage its system to optimize profits taking into account the opportunity costs of sales into other markets versus NECEC.

Key Insight

Hydro-Québec's system characteristics plus the AC transmission connections between those interconnected markets and a contract that does not even have a definition for "Incremental Hydroelectric Generation" makes it difficult to track and ascertain the true source of Hydro-Québec's energy that would flow via NECEC. There is no guarantee that the energy would be incremental. There is no guarantee that it would come from Québec. There is no guarantee that it would be "clean" and there is no guarantee that total carbon emissions would be reduced.

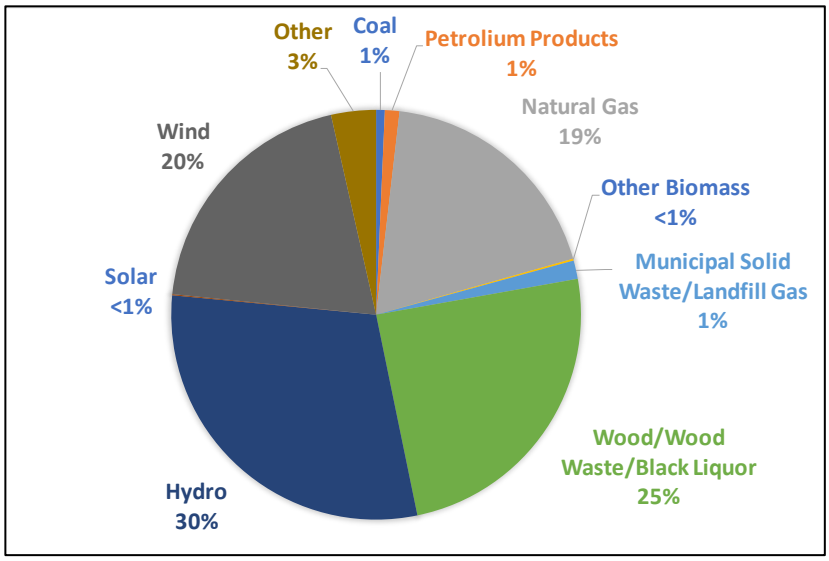
[47] NECEC Section 83D Application Form, p. B (redacted).

4. ADVERSE IMPACT ON MAINE RENEWABLES

Another adverse environmental impact of NECEC relates to its consequences on the development of renewable resources in Maine. According to the U.S. Energy Information Administration, Maine's in-state retail customers consumed around 11.5 TWh of energy in 2016.[48] ISO-NE's load forecasts underlying the 2018 CELT report project that Maine load will total around 13.5 TWh in 2023.[49] Regardless, adding 9.5 TWh to a system with nearly equivalent amount of supply and demand could be extremely disruptive to existing and new resources.

In 2017, approximately 75 percent of the electrical energy produced was from renewable resources (**Figure 4**).[50]

Figure 4: Maine generation mix by fuel type[51]



[48] U.S. EIA, State Profiles, Maine, https://www.eia.gov/electricity/state/maine/

[49] ISO-NE, 2018-2027 Forecast Report of Capacity, Energy, Loads, and Transmission *(CELT)*, http://isonewswire.com/updates/2018/5/8/2018-forecast-of-capacity-energy-loads-and-transmission-is-p.html

[50] U.S. EIA, State Profiles, Maine, https://www.eia.gov/state/?sid=ME

[51] Energyzt analysis of https://www.eia.gov/electricity/data/eia923/ and https://www.eia.gov/state/print.php?sid=ME

Maine frequently exports energy from its diverse system mix to the rest of New England across long transmission lines, especially when natural gas supply is constrained during extreme winter conditions.

According to the US EIA, the amount of Maine-based generation output declined over the past decade partially due to increasing imports from Québec.

> Maine's Renewable Portfolio Standards (RPS) require electricity providers to fuel 30% of their electricity generation with renewable resources. In addition to policy initiatives, electricity imports from Canada—notably from **Quebec—have been contributing an increasingly larger share to Maine's total generation, displacing natural gas-fired generation as the primary source. Since 2012, electricity imports from Canada have more than tripled**, increasing from 0.8 GWh in 2012 to 2.7 GWh in 2017.[52]

(emphasis added).

NECEC would bring even more Québec imports directly into Maine and would have adverse impacts on existing and future renewable developments in Maine. Existing renewable resources – primarily biomass and hydroelectric dams in Maine – could face reductions to energy margins as a result of NECEC. New renewable developments would face higher costs to connect and higher price premiums, making them less competitive than potential similar renewable developments in other New England locations outside of Maine.

4.1 Reduced operating margins

Adding around 9.5 TWh into Maine's system would have adverse consequences for Maine's existing renewable resources, particularly biomass and hydroelectric generators. NECEC would decrease energy prices that those plants receive from ISO-NE for energy they generate and reduce the energy margins required to keep the plants operational.[53]

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[52] US EIA, Natural Gas Weekly Update, "Renewables surpass natural gas as the primary electricity-generating source in Maine," https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2018/09_27/.

[53] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. TLB-1, Prepared Surrebuttal Testimony of Tanya L. Bodell, August 17, 2018, p. 8.

The total impact of potentially lower prices would be less than 0.6 percent of an average Maine residential ratepayer bills.[54] Most of the decrease in energy prices to Maine ratepayers would be due to increased congestion and losses tied to transporting so much more energy out of Maine into the rest of New England.[55] In effect, the majority of any potential energy price reduction resulting from NECEC is due to inefficiencies tied to the higher waste of energy through increased losses.[56]

Key Insight

NECEC would adversely impact existing renewable resources in Maine for very little economic and carbon emissions benefit.

4.2 Higher costs for Maine renewables to connect to ISO-NE

A recent study performed by ISO-NE estimated that there is currently around 200 MW of capacity available for new renewables to connect in Western Maine and an additional 600 MW of estimated transmission capacity that can be accessed with upgrades.[57] NECEC's Section 83D Application Form claims that it can increase the capacity at the Surowiec-South line with upgrades by 1,000 MW. Regardless, the fact that NECEC would use the 200 MW of existing headroom and add only the incremental amount it requires leaves little excess transmission capability for Maine renewables under development.[58]

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[54] This calculation assumes a delivered retail rate of around $130/MWh.

[55] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. TLB-1, Prepared Direct Testimony of Tanya L. Bodell, April 30, 2018, Figure 8, p. 23.

[56] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Technical Conference, September 7, 2018, pp. 37, 50, 53, 68. See also EXM-004-006_Uplan Results.xlsx.

[57] ISO-NE, Maine Renewable Integration Study,

Central Maine Power Co., Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. NECEC-36 originally submitted as Attachment 1 to CMP-014-001.

[58] This argument was posed by Francis Pullaro from RENEW in his submission on April 30, 2018, to the *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232.

Furthermore, congestion would simply shift from the Surowiec-South Interface to the Maine-New Hampshire Interface, where no new upgrades are planned.[59] The Maine-New Hampshire Interface currently allows for up to around 1,900 MW of energy flows at any point in time. The addition of NECEC pushes those flows to the maximum level more often, increasing losses and congestion charges.

In addition, NECEC increases losses that would be incurred by all generators in Maine. Losses represent wasted energy that is lost because of transmission line inefficiencies. As current increases, losses increase by the square of the energy flows. The exponential relationship ensures that losses increase as flows increase. Higher losses mean that more energy has to be produced to deliver the same amount to demand.

In ISO-NE, this translates into a lower price for energy produced at the generator site in Maine. Lower prices are a market signal that discourages new generation plants from being built. Therefore, NECEC's adverse impact on losses and congestion effectively will send the signal to renewable resource developers that they should not build in Maine, all else equal.

Currently, several western Maine renewable developments are in front of NECEC. Some of the renewable resource developments slated for northern Maine already have fallen behind NECEC in the queue as of May 22, 2018. Although the renewable developments in front of NECEC would not face higher upgrade costs, CMP in its Section 83D Application Form noted that it expects to supersede most of the Maine renewable resources in the ISO-NE queue:[60]

> These other generation projects are instead being evaluated as part of the ISO-NE MRIS in a "clustered" basis. As discussed in Section 6.9, CMP believes that these projects will fall below the NECEC Transmission Project in the queue through the cluster study process that ISO-NE is seeking to implement, thereby leaving the NECEC Transmission Project only behind

[59] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. TLB_1, Testimony of Tanya L. Bodell, April 30, 2018.

[60] Both the northern and western clusters were ahead of NECEC in the queue when it issued its proposal in response to the Massachusetts Clean Energy RFP. Since then, the northern cluster did not fund a cluster study and fell behind NECEC in the queue.

> the three queue projects included in the NECEC system impact study performed by the Avangrid transmission planning group.[61]
>
> . . .
>
> Should each of these projects decline to commit to fund the necessary transmission upgrades in order to participate in the cluster study, they will drop down in the queue (or drop out entirely), thereby significantly reducing the number of projects holding queue positions before the NECEC Transmission Project and expediting the timeline for ISO-NE to complete the required system impact studies for the NECEC Transmission Project.[62]

For those renewable resources that are behind NECEC in the queue, the net impact would be increased costs for Maine renewable resources to upgrade transmission as part of their interconnection requirements if NECEC were to proceed. Such renewable resources would be deferred or delayed – potentially indefinitely – with a lost opportunity to create a net reduction in carbon emissions.

Key Insight

Because of the increased cost of upgrading transmission due to the NECEC, development of renewable resources in Maine could be deferred or indefinitely delayed.

5. IMPLICATIONS FOR CARBON EMISSIONS

Given the interconnectivity of Québec and New England, the analysis of NECEC's impact on carbon dioxide emissions must extend beyond the boundaries of New England to other interrelated markets. Such an analysis requires a detailed production cost model that can run a projection of what the markets would do with and without NECEC and the associated diversion of Québec excess energy exports.

Two studies are in the public domain that apply two different production cost models to analyze the impact of carbon dioxide emissions under the assumption that total excess

[61] NECEC Section 83D Application Form, p. 83, footnote, 21.

[62] Ibid., p. 85.

energy available for export into other markets by Hydro-Québec is held constant:[63]

- **Energyzt Analysis:** Assessment of the impact of NECEC on carbon emissions, presented in the testimony of James M. Speyer before the Maine PUC Docket No. 2017-00232, April 30, 2018; and

- **ESAI Study:** "Analysis of Greenhouse Gas Emissions Impacts: New Class I Resources vs. Existing Large Hydro," Prepared for GridAmerica Holdings, Inc., September 2017, focused on the impact of Northern Pass Transmission.

Even though the ESAI study examines the impact of Northern Pass Transmission, the findings are relevant to NECEC which is a similar type of project that includes a new 1,200 MW transmission line between Québec and New England, as well as around 9.5 TWh of baseload energy flows from Hydro-Québec under contract with the Massachusetts utilities.

These studies make four significant conclusions that are consistent with the discussion above:

1) **Excess energy is the same with or without a new Intertie (e.g., NECEC or Northern Pass):** Hydro-Québec exports into other markets are limited by water availability, not transmission delivery capability. Therefore, the total amount of excess energy that Hydro-Québec has available to sell into external markets will remain the same with or without NECEC.

2) **Hydro-Québec would divert external sales to meet new energy requirements:** In order to meet new firm energy requirements associated with a long-term power purchase agreement to be delivered over a new tieline such as NECEC or Northern Pass, Hydro-Québec would reduce energy sales into other markets.[64]

3) **Higher carbon emissions elsewhere offset the impact in New England:** As a

[63] Interestingly, both CMP's expert (Daymark) or the Maine PUC Expert (London Economics) calculated the impact on carbon emissions for New England only, and did not present an estimate of how NECEC would impact total carbon emissions across other markets that would be impacted by NECEC.
[64] The Maine PUC Technical Expert, London Economics Incorporated, makes the same assumption for purposes of its analysis of the NECEC Minimum Offer Price Rule. *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Transcript (Sep. 19, 2018).

result of Hydro-Québec's diversion of energy sales from other markets into New England via a new transmission line from Québec, carbon dioxide emissions would be higher in other markets from which energy sales are diverted.

4) **The offset in other markets could result in higher total emissions in some years:** The amount by which carbon emissions would exceed the savings in New England depends on where Québec sources its energy. However, it is NECEC could result in higher total carbon emissions than otherwise would occur if the transmission line were not to proceed.

Each of these points is elaborated upon below with respect to the impact on total carbon dioxide emissions from importing Québec hydroelectricity across a 1,200 MW HVDC transmission line into New England.

5.1 Excess energy is the same with or without a new intertie

Both the Energyzt Analysis and the ESAI Study conclude that Hydro-Québec has a limited pool of excess energy that already is and would continue to be optimized subject to constraints such as water conditions, reservoir management decisions, and firm commitments.

Intertie capacity into other markets is not a constraining factor. Both studies conclude that it is economical for Hydro-Québec to export all of its surplus energy and that Hydro-Quebec has a low marginal cost of production and sufficient transmission capacity into external markets to continue to do so going forward. Therefore, a new intertie merely allows Hydro-Québec to access a higher-priced, long-term contract market in Massachusetts and is not necessary to transport clean energy that otherwise would be wasted.

The total amount of excess energy available to Hydro-Québec to sell into other markets varies between the studies, but would be somewhere between 33 to 38 TWh per year, of which between 20 and 25 TWh would be exported to the United States in the base case.[65] Hydro-Québec's own study assumes that exports to the U.S. would remain constant at

[65] ESAI provides a projection for 2017 to 2026 that ranges from 36.2 to 38.2 (ESAI, p. 5). The Energyzt Analysis projects that there would be 33.5 TWh in 2023 if purchases were reduced to reflect Romaine-3 coming online.

22.4 TWh without a build-out of new hydroelectric facilities.[66]

The Technical Expert of the Maine PUC estimates that the amount of firm energy that would be available to flow into the US would total 21.5 TWh in 2021 based on a supply and demand comparison.[67] Existing transmission lines would allow for the entirety of this amount of excess energy to be sold into US markets. Therefore, there appears to be consensus about the amount of excess energy that Hydro-Québec would have available for sale into the United States. Regardless of the estimate, the NECEC energy supply obligation of up to 9.4 TWh would be a sizable portion of any available excess energy that Hydro-Québec would sell.

Key Insight:

A new transmission line from Québec into New England such as NECEC would not create an incremental increase in total exports of hydroelectric power from Quebec into other markets.

5.2 Hydro-Québec would divert exports to meet new energy requirements

Accepting that Hydro-Québec's excess energy is the same with or without a new intertie, each study applies a different methodology to divert energy from other markets into the new intertie.

The Energyzt Analysis used historical averages for the base case flows from Québec into the U.S.. Assuming that exports to the U.S. would remain the same, the Energyzt analysis then removed the equivalent of the NECEC flows from New York into NECEC, starting with the lowest-priced hours first.

ESAI created a base case that: 1) held contractual flows fixed; and 2) applied the remaining excess energy into the highest priced markets during the highest-priced hours first, followed by the next highest priced hours/markets until the surplus energy was allocated. For the case with a new transmission line and flows from Québec, ESAI then reallocated energy from the base case starting with the lowest-priced hours in the lowest-priced markets first. The result is that energy tends to be diverted predominantly from

[66] Deep Decarbonization Study, p. 30.

[67] See *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, London Economics response to GINT-001-049.

New York and Ontario into Northern Pass.[68]

The models were then rerun with the reallocated energy to calculate total carbon dioxide emissions generated by each power plant in the model.

5.3 Higher carbon emissions incurred elsewhere offset emissions in ISO-NE

In both analyses, higher emissions in other markets resulting from Québec's diversion of exports into those markets offset the impacts from the proposed transmission line and Québec energy supply in New England. A comparison of the results of the two analyses for 2023 under projected low gas price and low carbon price conditions is presented in **Figure 5**.

Figure 5: Impact on carbon emissions in 2023 under low gas and low carbon prices

	Change in Carbon Emissions by Market (Million MT)	
Market	**ESAI Analysis[69]**	**Energyzt Analysis[70]**
New England	(2.4)	(3.3)
NYISO	1.0	2.3
PJM	0.1	0.5
MISO	0.2	0.5
Ontario	1.0	0.1
TOTAL Across Markets	**(0.1)**	**0.1**

[68] ESAI, Table 5, p. 15.

[69] ESAI Study, Table 5, p. 15. For comparative purposes, the signs have been switched. ESAI denotes decreases in carbon emissions as a positive number whereas Energyzt denotes it as a negative value. In addition, the ESAI results were presented in short tons and converted to metric tons for comparison with the Energyzt Analysis results using a conversion rate of 0.9072 metric tons per one short ton.

[70] *Central Maine Power Co., Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232,* Exhibit No. JMS-4.

Key Insight:

Under low natural gas and low carbon price conditions, an increase in carbon emissions from the diversion of Québec exports from other markets into a transmission line into New England offsets the impact from the proposed transmission line and Québec energy supply into New England, resulting in no net impact, and in the case of the Energyzt Analysis, results in an increase in total carbon emissions.

The impact that NECEC has on total carbon emissions will depend on market conditions. The Energyzt analysis also examined an alternative case of high natural gas prices and high carbon prices that were assumed by the NECEC expert in its application to the Maine PUC. Under those conditions, carbon dioxide emissions in New England would be lower than the low natural gas-price case due to the fact that less efficient units would be more expensive and therefore displaced by operating the more efficient units more often. Under this scenario, diverting exports from Québec from New York into Massachusetts tends to have a much greater impact on carbon emissions, resulting in an increase in total carbon emissions of 0.4 million metric tons in 2023 (**Figure 6**).

Figure 6: Carbon emissions impact in 2023 under high gas and high carbon prices

State/Region	Carbon Emissions (Million MT)		Net Carbon Emissions Impact (Million MT)
	No NECEC	With NECEC	
ISO-NE	26.8	23.8	(3.0)
NYISO	25.8	28.1	2.3
PJM	396.8	397.8	1.1
MISO	351.0	350.9	(0.1)
Ontario	3.6	3.7	0.1
Total	**804.0**	**804.4**	**0.4**

As noted in the Energyzt testimony summarizing the results of the analysis, the increase in total emissions is the equivalent of building "a new 250 MW combined cycle gas power plant running at a 40 percent capacity factor or average emissions from around 80,000 automobiles averaging 4.75 metric tons of carbon emissions over the course of a year."[71]

[71] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. JMS-1.

Key Insight:

Under conditions of higher natural gas prices and higher carbon prices, carbon emissions could increase.

In summary, NECEC would have a negligible impact on total carbon emissions and could even increase them when the effect on other markets is considered. Hydro-Québec's diversion of energy exports from other power markets to service NECEC results in incremental carbon emissions as power plants in those markets fire-up generators to make up the missing energy flows. In effect, there is no net impact to carbon emissions, and possible adverse consequences, when Hydro-Québec diverts its surplus energy resources into NECEC.

6. ANALYSIS OF GREENWASHING POTENTIAL USING CMP's MODEL

As part of the Maine PUC hearing, CMP offered a model to assess the ability of Hydro-Québec to meet its NECEC obligations while maintaining exports at historical levels. The model purports to determine whether or not Hydro-Québec's sales via NECEC can be incremental.[72]

The simplistic model suffers from three fundamental flaws (described in more detail in Appendix B):

1) **The CMP Model Answers the Wrong Question:** The real question is whether NECEC reduces global emissions, and the CMP model does not address this question at all. To do so would require an analysis of what carbon emissions would be with and without NECEC, which the model does not do.

2) **CMP Assumes a Sudden Availability of Incremental Exports:** CMP assumes that Hydro-Québec does not sell its excess energy into other markets unless NECEC is built. In fact, there is plenty of excess transmission capacity servicing the interconnected markets that Hydro-Québec could use to sell its excess energy that currently is stored in its reservoirs and the incentive to do so prior to NECEC coming online.

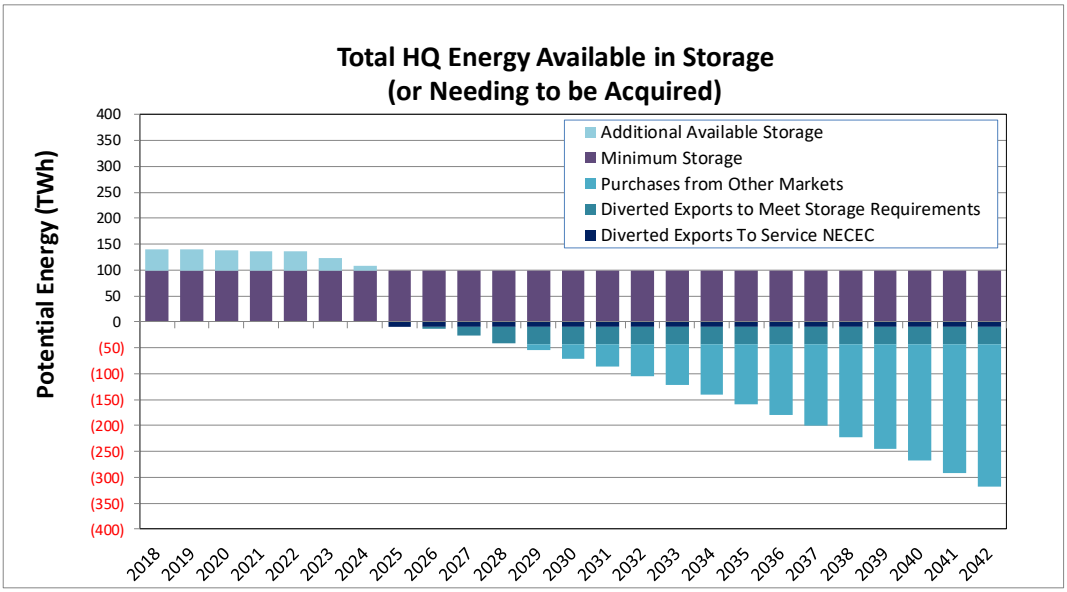
3) **Sensitivity to Key Assumptions:** The model is incredibly sensitive to key

[72] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, CMP Response to NRMC-032-021, Attachment 1.

assumptions, including how much runoff would Hydro-Québec receive. CMP implicitly assumes high water conditions that have been experienced in 2017 and the years before will continue for the entirety of the contract, allowing for high levels of energy availability that allows incremental exports compared to historical levels. Making a small adjustment to this assumption has a significant impact.

Adjusting a single assumption -- the assumed availability of water and potential generation output by only six percent to reflect lower runoff than the high water conditions experienced in 2017, it is clear that Hydro-Québec would not be able to service NECEC without diverting energy from other markets and engaging in greenwashing through purchases from other markets (**Figure 7**).

Figure 7: Hydro-Québec operations per the CMP Model with lower runoff



In reality, Hydro-Québec is not confined to a single strategy over the course of the contract. Hydro-Québec will manage its system, sales, exports and opportunities according to water conditions and market prices. NECEC simply imposes another fixed obligation onto the system against which Hydro-Québec will optimize its operations. Such optimization will include diverting sales into other markets and greenwashing, as required to optimize profits.

This activity is allowed under the "clean energy" contracts with Massachusetts utilities.

7. CONCLUSION

Under the terms of the contracts with Massachusetts utilities, Hydro-Québec would not be precluded from purchasing energy from other markets to sell directly into NECEC or for purposes of conserving water in its reservoirs for future supply to NECEC at a later time. Massachusetts utilities would have no ability to monitor or prevent this possibility from occurring. Massachusetts ratepayers effectively could be paying above-market prices for power from existing resources outside of Québec that provide no incremental environmental benefit and could even increase carbon emissions.

CMP's own model of the Hydro-Québec system does not include realistic assumptions. Adjusting the model to reflect lower runoff conditions and an objective of maintaining exports at historical levels illustrates a realistic scenario under which Hydro-Québec would have to divert energy and engage in greenwashing behavior. Under these conditions, Hydro-Québec would have to do both in order to maintain exports at 2017 levels.

Hydro-Québec's sales via NECEC do not have to be incremental to Québec's historical hydroelectric generation sales into New England. The energy does not have to be incremental to what Hydro-Québec otherwise would sell into other markets. There is no guarantee that Massachusetts ratepayers would receive 100% "clean energy" given the greenwashing game that Hydro-Québec is able to play. There is no guarantee that the environment would receive a net reduction in carbon emissions; total carbon emissions in other markets could increase to a level that any reduction in New England carbon emissions would be negated or even exceeded. If NECEC were allowed to proceed, the only guarantee is that Québec would receive billions of dollars in future dividends and Maine's renewables industry will be adversely impacted.

It is unlikely that NECEC will benefit the climate. At best, the NECEC could have negligible impact on global greenhouse gas emissions. However, there are a number of conditions under which NECEC actually could increase global carbon emissions as Hydro-Québec engages in profit-maximizing behavior around its firm rights to capacity on the NECEC transmission line and contracts with Massachusetts utilities.

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APPENDIX B:
OVERVIEW OF QUEBEC'S ELECTRICITY SYSTEM AND EXPORTS

Hydro-Québec owns and operates a large system of hydroelectric generation and other power generating capabilities along with an extensive transmission network. Hydro-Québec's generating capacity in 2017 was 37,309 MW from 87 generating stations. Additional sources, such as wind, solar and purchases from third parties create total nameplate capacity of 47,857 MW.[1]

In understanding what electricity products are likely to be sold via NECEC, it is important to distinguish between energy and capacity. Capacity is provided by existing or planned generating plants that could be available to generate electrical energy when needed. Energy is the electricity that flows when those generating plants are operating. The distinction is important because the contracts with Massachusetts are for energy – not capacity.[2]

Furthermore, the contracts are for firm energy; firm energy that is not backed by capacity needs to be firmed with another resource – in this case, Hydro-Québec's ability to optimize energy purchases and sales across its four system interties. This section explains further why the contracts with the Massachusetts utilities are for firm energy only and the implications for greenwashing and carbon emissions.

[1] Hydro-Québec - TransÉnergie, Plan Directeur, 2020, http://www.hydroquebec.com/data/transenergie/pdf/hqt-plan-directeur-2020.pdf

[2] Although the contracts require Hydro-Québec to attempt to qualify to provide capacity into the ISO-NE market, there is no penalty if such capacity is not available or does not clear the market (see NECEC-16, section 7.5., "For the avoidance of doubt, but without limiting the condition set forth in Section 3.4(b)(ii), **Seller shall have no obligation during the Services Term** to pay for such Network Upgrades or **to complete the Forward Capacity Auction qualification process**" (emphasis added).

B.1 QUÉBEC'S CAPACITY

In order to meet reliability standards, each region is required to maintain an amount of generating resources above its maximum demand for power. In Québec, where the system peaks in winter, Hydro-Québec strives to maintain a level of installed and purchased capacity above its winter peaking load. Targeted reserve requirements are 12.9 percent above peak demand.[3] However, waterflow is at its lowest during the winter months, requiring Québec to rely on stored water in its reservoirs to produce energy in addition to its normal flows. Its energy production capacity is limited by its available generation capacity and reservoir levels.

The North American Electric Reliability Council (NERC) projects that Québec will be short of its required reserve margins by 2024 unless another 1,100 MW of prospective resources are obtained.[4] Québec is not in a position to sell 1,200 MW of capacity into New England or any other market during the winter months. If anything, Québec will need to purchase that level of capacity resources from other markets to meet its required reserve margins. Assuming that NECEC will provide 1,090 MW of capacity into New England results in an immediate shortfall for Québec against its targeted reserve margins, as shown in **Figure B-1**.[5]

This is particularly problematic for New England which requires capacity to be sold year-round. In other words, Québec will not be in a position to commit capacity into New England via NECEC– which is why the contracts with Massachusetts are for firm energy only. Therefore, Québec either would have to withdraw its current capacity sales into New England and New York to meet its own reserve requirement

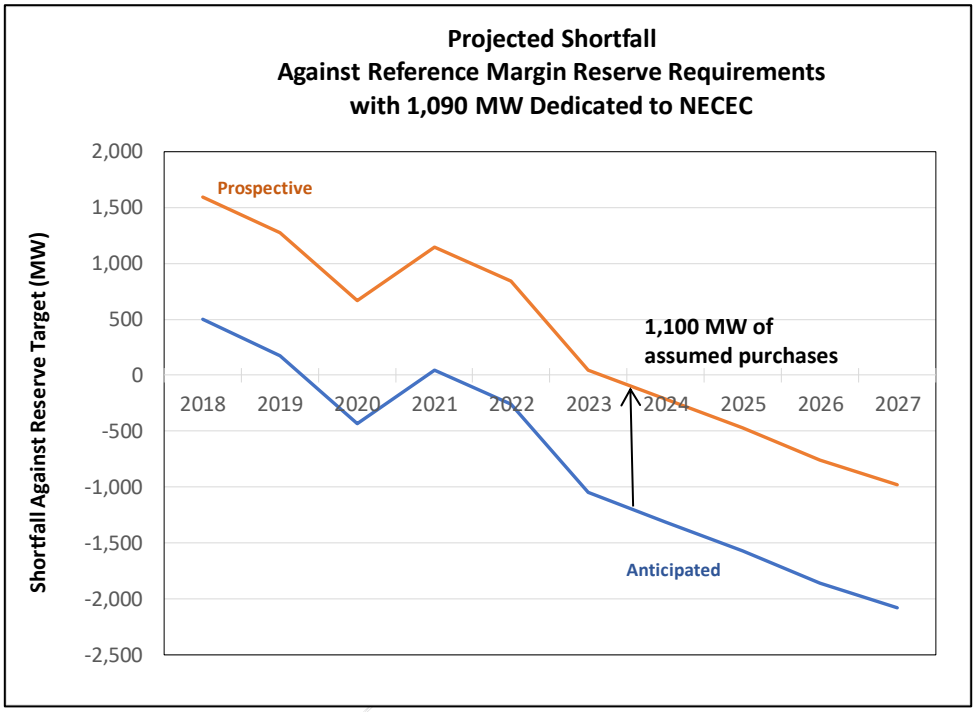
[3] NERC, 2017 Long-term Reliability Assessment, pp. 55.

[4] NERC, 2017 Long-term Reliability Assessment, pp. 55-56, Under the prospective scenario, a total of 1,100 MW of expected capacity imports are planned by the Québec area, although these purchases have not yet been backed by firm long-term contracts.
https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_LTRA_12132017_Final.pdf

[5] NERC, 2017 Long-term Reliability Assessment, pp. 53-54. Ontario will not be in a position to renew the current sale of 500 MW of capacity to Québec. However, the Maritimes, New York and New England are projected to have excess capacity that could be sold to Québec.

levels or optimize its purchases and sales of capacity across the interconnected markets. NECEC could be used to meet Québec's shortfall in capacity, not the other way around.

Figure B - 1: Hydro-Québec shortfall against reserve margins with NECEC[6]



NOTE: Anticipated resources reflect what already exists or is being built; prospective resources include potential purchases that could be used to meet the targeted levels. Reference Margin Level = Installed Reserve Margin Requirement

Therefore, if Québec is going to build any new upgrades or new impoundment structures, it would be because of its own need for new capacity, not to service other markets. Those additional capacity investments would occur regardless of NECEC.

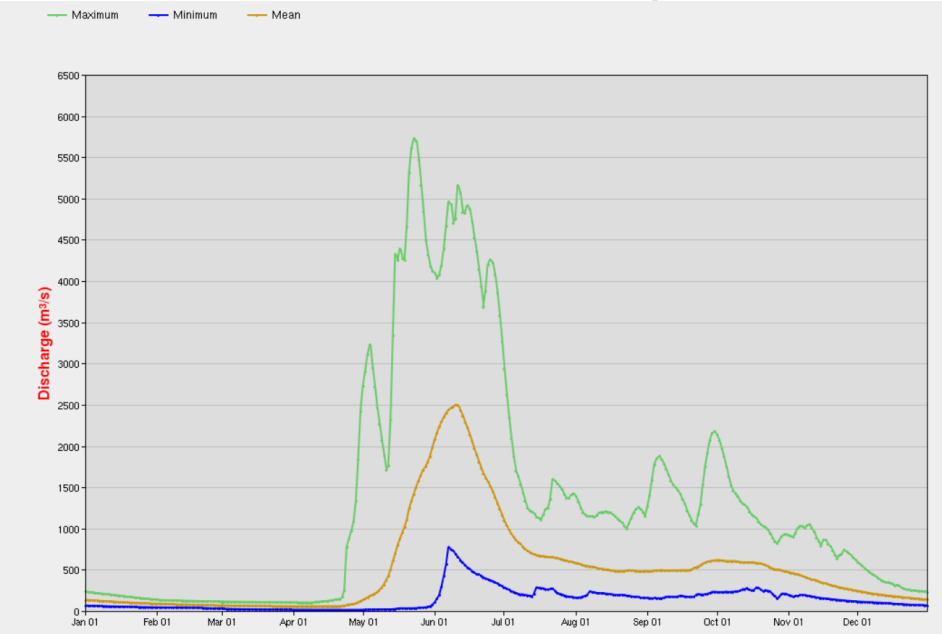
[6] NERC, 2017 Long-Term Reliability Assessment, p. 55 adjusted for 1,090 MW reduction for potential NECEC commitments.

B.2 HYDRO-QUÉBEC'S ENERGY

The shortfall in capacity does not correspond to a shortfall in energy because Québec can store water to generate excess energy across the year whereas capacity requirements are an instantaneous need at the point of peak demand on the system. Québec's generation capacity is dominated by large hydroelectric generation, some renewable resources predominantly purchased from third parties, and small percentage of thermal plants located in remote regions.

Given the natural flows of precipitation and snow melt in Québec, the province is flush with water in the late spring and summer months (**Figure B - 2**). That water is used to produce energy as well as to replenish the reservoirs for the winter.

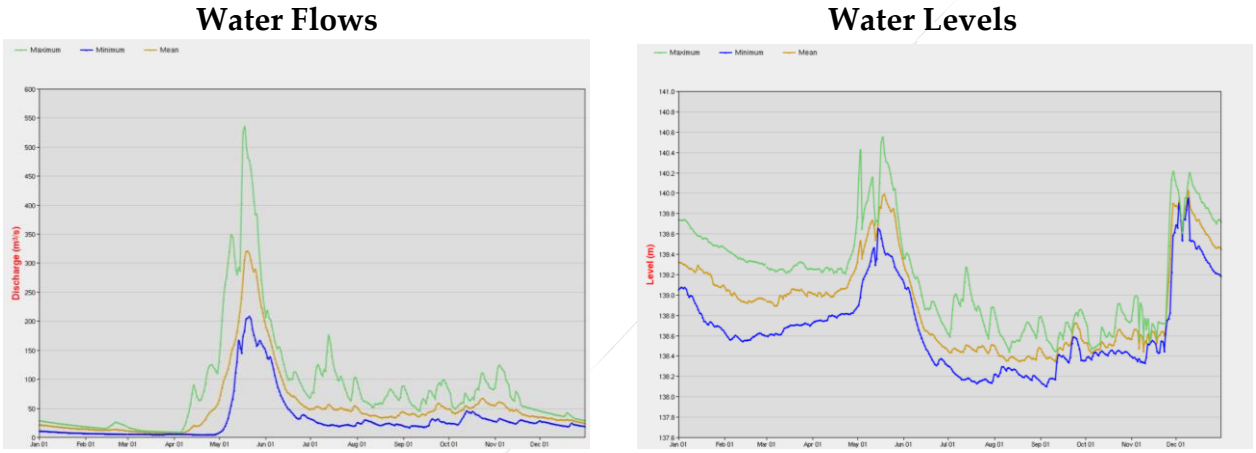
Figure B - 2: Daily flow for Baleine River (1956 – 2013)[7]



[7] Government of Canada, Hydrometric Flow Data, Daily Discharge Graph for BALEINE (RIVIERE A LA) À 40,2 KM DE L'EMBOUCHURE (03MB002) [QC], https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html

Reservoir management is a critical function of Hydro-Québec, which must meet its firm commitments while balancing between ensuring that reservoir levels do not drop below optimal levels for production in the winter and early spring while ensuring that snow melt does not exceed reservoir capacity and spill in the summer months. **Figure B - 3** illustrates the management of reservoir levels versus average snowmelt for Churchill Falls, the largest single resource that Hydro-Québec Power has access to (5,428 MW under contract). Although waterflows are negligible November through March and peak in May and June, reservoir management allows Hydro-Québec to draw down on its reservoirs during the winter periods and maximize generation during peak periods as require.

Figure B - 3: Daily discharge for Churchill Falls (2009 – 2014)[8]



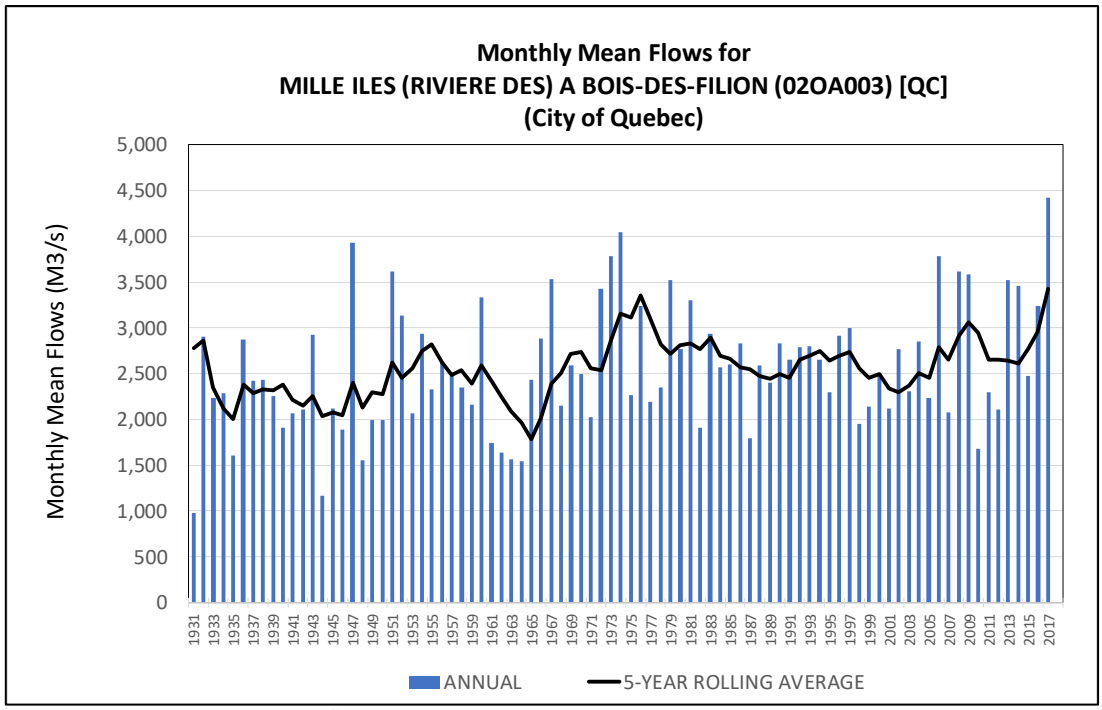
Hydro-Québec also manages its reservoirs to ensure that potential energy is optimized. If reservoirs cannot be too low or the water will fall below the generator intake tunnels, preventing the production of electricity. If too high, water may have to be spilled – released through upstream chutes without producing electricity. Reservoir management allows Hydro-Québec to manage the energy available in its system over multiple years.

The ability to manage across multiple years is important as the average precipitation varies on a year-by-year basis, as illustrated above with the range of water flows at Baleine

[8] Government of Canada, Hydrometric Flow Data, Daily Discharge Graph for CHURCHILL RIVER ABOVE CHURCHILL FALLS TAILRACE (03OD008) [NL], https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html

and Churchill Falls. **Figure B - 4** shows variation in monthly flows at Québec City, the location with the most consistent records of monthly water flows. The bars are annual water flows; the line represents a 5-year rolling average for the past 90 years. As can be seen, 2017 was a record water flow year and the five-year average flows ending 2017 exceed the previous high set in 1976.

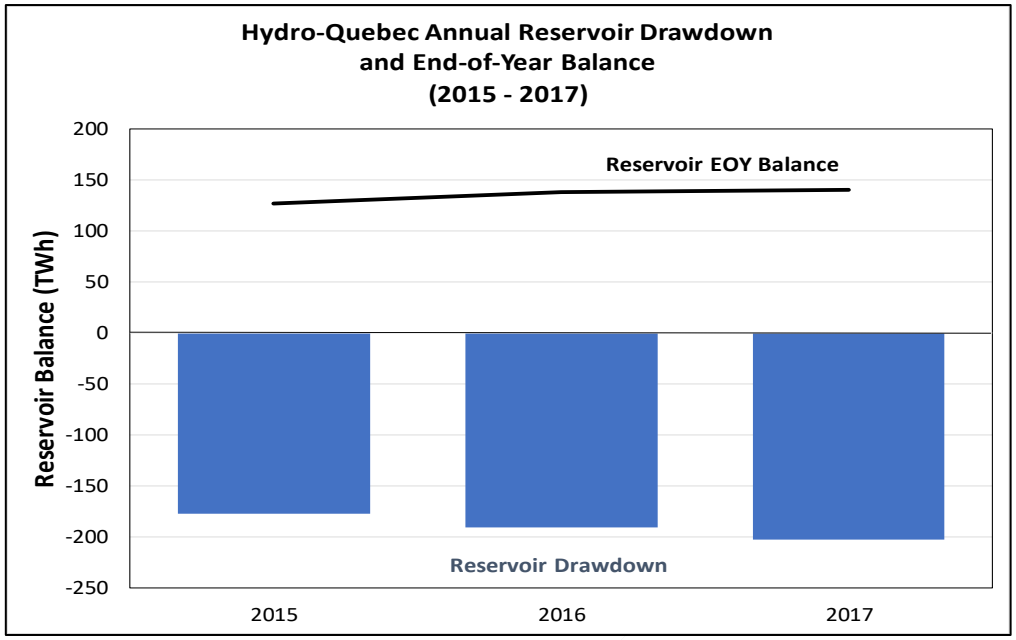
Figure B - 4: Daily flows for Québec City (1931-2017)[9]



The high precipitation and flow levels required significant drawdown on its reservoirs to maintain levels below maximum. Despite the increasing draw-down, year-end levels remained higher in 2017 than at the end of the previous three years (**Figure B - 5**). This is indicative of heavy water conditions through precipitation and snow melt.

[9] Government of Canada, Hydrometric Flow Data, Daily Discharge Graph for Monthly Discharge Statistics Data for MILLE ILES (RIVIERE DES) A BOIS-DES-FILION (02OA003) [QC], https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html

Figure B - 5: Hydro-Québec reservoir draw-down (2015-2017)[10]



Hydro-Québec's annual reports support the fact that 2017 and the prior years experienced high runoff conditions.

Per the 2017 HQ Annual Report:

> In 2017, net electricity exports reached a historic volume of 34.4 TWh and contributed $780 million to net income. As a result of an effective sales strategy, smooth operation of generating and transmission facilities **and high runoff**, net exports increased by 1.8 TWh over the previous record, set in 2016.[11]

(emphasis added).

[10] Calculated based on Hydro-Québec Annual Reports.

[11] Hydro-Québec Annual Report 2017, p. 22.

Per the 2016 HQ Annual Report:

> EXPORTS REACH A HISTORIC HIGH Net electricity exports rose by 3.3 TWh compared to 2015, reaching a historic high of 32.6 TWh and contributing $803 million to net income. This is a 1.8-TWh increase over the previous record, set in 2013, made possible by the smooth operation of generating and transmission facilities, in particular, **as well as high runoff and favorable weather conditions**. These factors, combined with the skillful development and deployment of the sales strategy, enabled the company to take advantage of business opportunities on external markets. The record volume of exports is all the more remarkable given the unavailability of a major power transmission link between Québec and New England in April and May 2016 due to scheduled maintenance. Finally, **because of the high runoff in 2016**, Hydro-Québec ended the year with record reservoir storage of 138.2 TWh.[12]

(emphasis added).

These annual reports also make it clear that variability in runoff is one of the key uncertainties and one which Hydro-Québec manages in various ways:

> **One of the principal uncertainties that Hydro-Québec faces relates to natural water inflows . . . It therefore manages its reservoir storage on a multiyear basis and maintains an adequate margin between its generating capacity and its commitments.** This allows the division to compensate for variations in runoff, replenish its reserves or take advantage of business opportunities.[13]

(emphasis added).

[12] Hydro-Québec Annual Report 2016, p. 25.

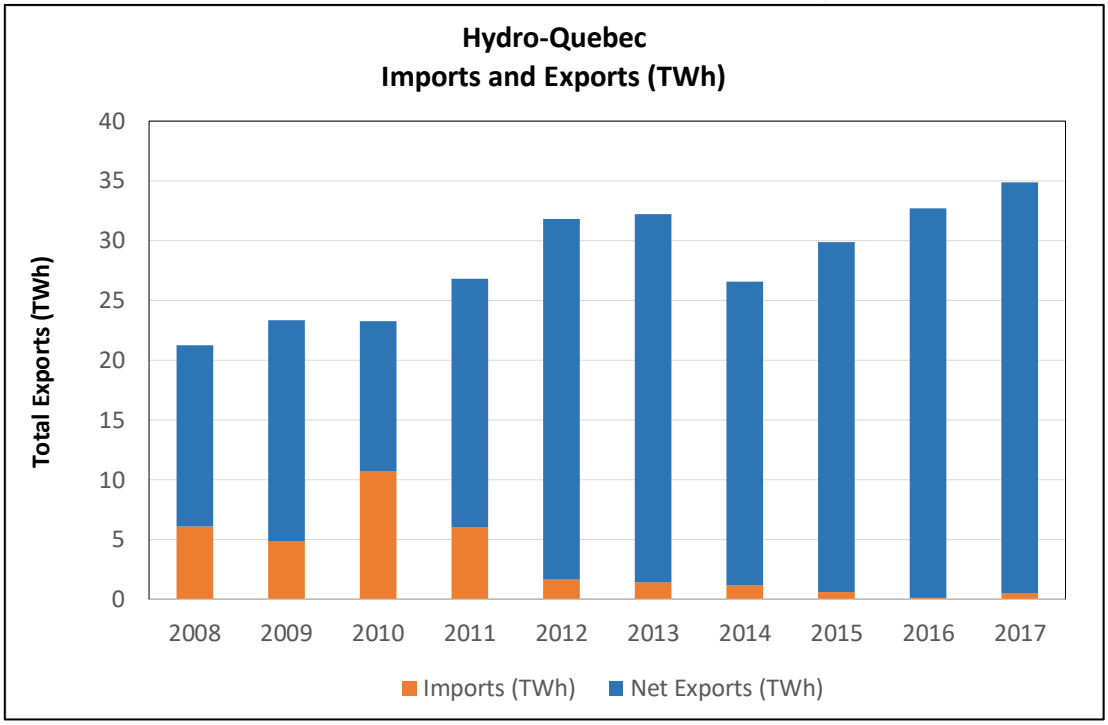
[13] Ibid., pp. 42, 44.

B.3 HYDRO-QUÉBEC'S EXPORTS

Given the extensive water flows that had occurred in 2017 and the previous five years, it is not surprising that Hydro-Québec exported a record amount of energy at around 34. 4 TWh for 2017. This record amount included annual snowmelt as well as significant draw-down of its reservoirs to maintain appropriate reservoir levels. In addition, Hydro-Québec imported less energy than it had in the past.

Hydro-Québec's annual reports show the historical amount of excess energy it has sold into external markets, net of imports (**Figure B - 6**).

Figure B - 6: Hydro-Québec total exports and imports (2008-2017)[14]



In general, Québec has excess energy over the course of the year that it can sell into other markets at a profit. This was especially true during the past five years when water flows

[14] Calculated based on Hydro-Québec Annual Reports.

were particularly heavy. During the mid- to late-2000s, when water flows were not as heavy, Hydro-Québec exported less and purchased from other markets. Between 2008 and 2012, imports were approximately one-third of Hydro-Québec's total exports; in 2010, Hydro-Québec purchased nearly half of the energy that it exported.

The percentage of imports as a portion of exports has declined over the past few years, as a combination of heavier water conditions and increased capacity build-out has allowed Hydro-Québec to engage in greater export transactions without purchases. However, history shows that Hydro-Québec is in a position to arbitrage between markets – buying low-priced energy from one market and selling stored reservoir water converted into energy into higher-priced markets.

Figure B - 7: Sales Outside of Québec in 2017[15]

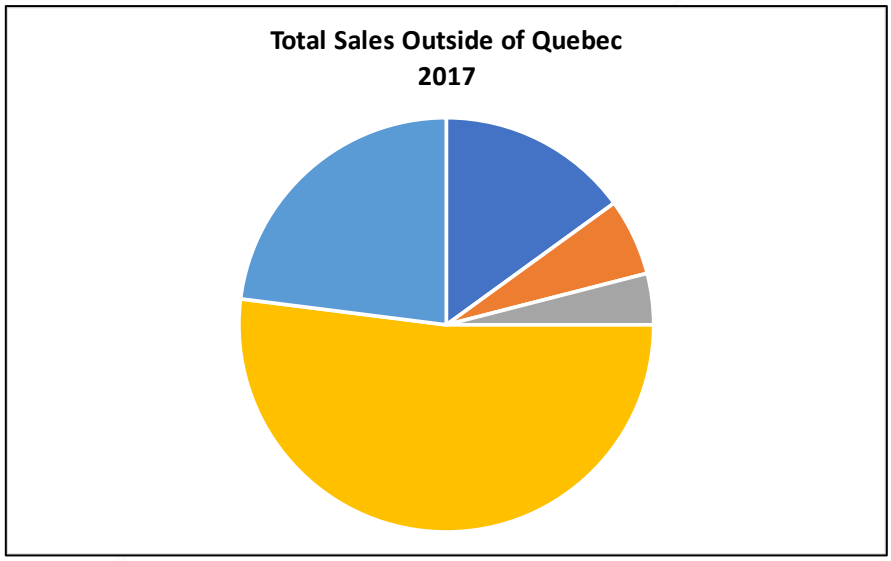
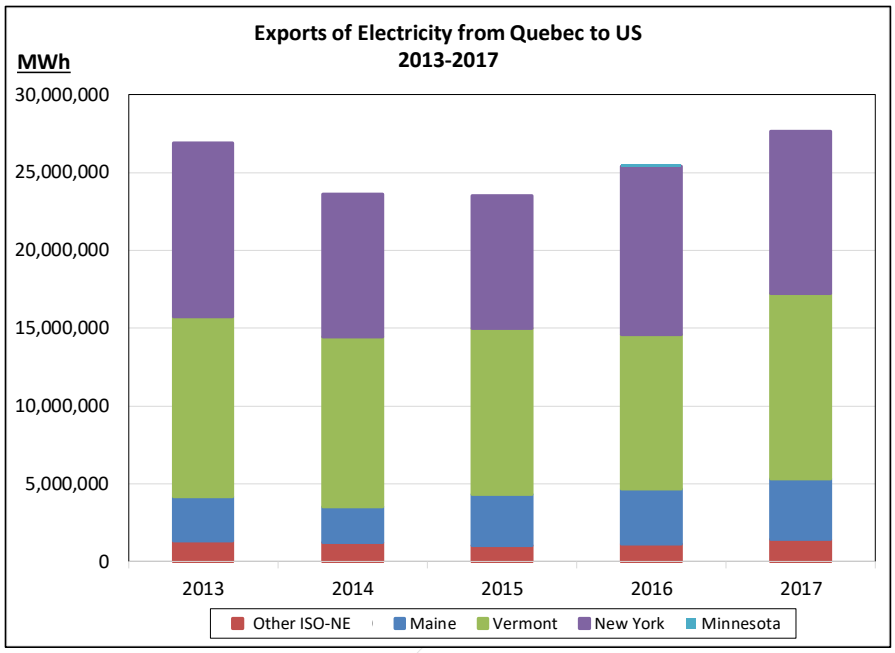


Figure B - 8 illustrates the level of exports from Québec over the past five years into the US. Total electricity exports into New York, New England and other markets ranged from 23.5 TWh to 27.7 TWh between 2013 and 2017. This is consistent with Hydro-Québec's website which claims, "Every year, Hydro-Québec has approximately 25–30 TWh

[15] Hydro-Québec 2017 Annual Report.

available for sale to markets outside Québec."[16] Approximately 90 percent of all exports into the United States from Québec are sold by Hydro-Québec or one of its affiliates.[17]

Figure B - 8: Electricity exports from Québec to the US on an annual basis[18]



Revenue from sales to external markets – which has ranged from $750 million to $1.5 billion over the past few years[19] -- is paid as a dividend to the Québec government. This level of profitability relies on exports, as indicated by Hydro-Québec's CEO Éric Martel.[20] The vast majority of Hydro-Québec's energy exports are sold to the United States.

[16] Hydro-Québec website: FAQs about exports, www.hydroquebec.com/international/en/faq.html

[17] Energyzt analysis of National Energy Board, Monthly Electricity Export Reports for Canada to the US.

[18] National Energy Board, Monthly Electricity Export Reports for Canada to the US; New England ISO represents sales into ISO-NE outside of flows into Maine and Vermont.

[19] Hydro-Québec Annual Reports.

[20] Financial Post, "Without exports our profits are in trouble: Hydro-Quebec plugs into U.S. markets for growth," April 20, 2018, https://business.financialpost.com/commodities/energy/without-exports-our-profits-are-in-trouble-hydro-quebec-plugs-into-u-s-markets-for-growth

Figure B - 9: **Electricity exports from Québec to the US on a monthly basis**[21]

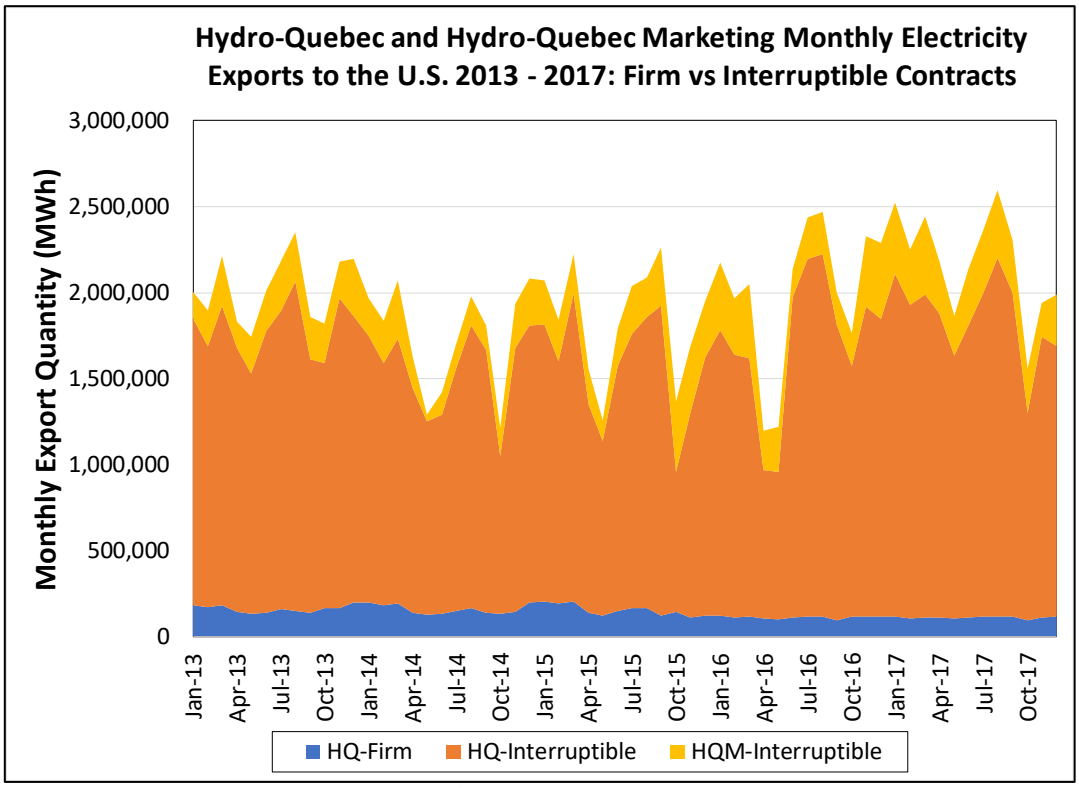


Figure B - 9 graphs sales from Hydro-Québec into U.S. markets on a monthly basis. Most of Hydro-Québec's sales are interruptible, which means that they are non-firm energy sales into non-firm spot markets. This chart also illustrates seasonal increases in sales during higher priced seasons (i.e., summer and winter). This pattern is consistent with opportunistic sales into other markets in the summer and winter peaks. Hourly flows from Québec into external markets (not shown) tell the same story -- exports generally increase during peak hours and fall during off-peak hours, illustrating Hydro-Quebec's profit motive to maximize sales during higher-priced periods.

Although total energy sales vary from year to year and month to month based on weather conditions, new capacity, reservoir management decisions and market conditions, Hydro-

[21] Energyzt analysis of National Energy Board, Monthly Electricity Export Reports for Canada to the US.

Québec has an incentive to maximize its available energy sales to the highest-priced markets during the highest-priced periods. Such sales are subject to Hydro-Québec's own firm commitments, water management decisions, generation capacity limits, and transmission constraints.

B.4 PROJECTED LOAD GROWTH IN QUÉBEC

There are multiple ways that Hydro-Québec could meet its firm capacity commitments going forward: Buy, divert, upgrade and build. **Figure B - 10** presents Hydro-Québec's own estimates of potential expansion opportunities and estimated costs (reported in US Dollars) to compare the cost of these alternatives.

Figure B - 10: Cost comparison of meeting NECEC obligations[22]

Hydro Bin	Potential (TWh)	Levelized Fixed Cost ($/kW-yr)	Levelized Cost of Electricity ($/kWh)
1	157	Current: 106 Post-2030: 133	Current: 0.02 Post 2030: 0.025
2	10	372	0.07
3	10	531	0.10
4	15+	690	0.13

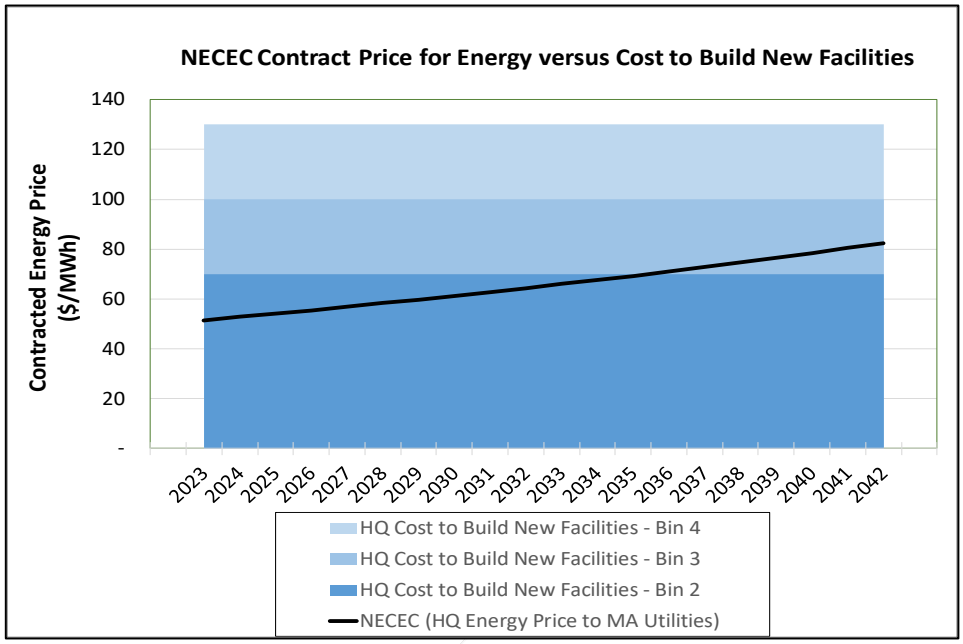
Although upgrades are the least costly option, this option is not available to Hydro-Québec for purposes of exports. Upgrades only offer 13 TWh of additional energy all of which is required to meet Hydro-Québec's growing load through 2034 (half of that amount is required through 2023, when the NECEC contract takes effect).[23] Furthermore, some of

[22] Ibid., p. 28. All dollar values are reported in US Dollars per Energyzt conversation with Evolved Energy Research, one of the authors of the report.

[23] Hydro Québec, Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec, April 2018, pp. 27-28. Per Footnote 5 which indicates 144 TWh already is available, there would be only 13 TWh of additional energy available through upgrades. This would be consumed by Québec load growth by around 2034 given the load growth assumed by the study:

the potential for increased storage depends on wetter conditions than historically has been the case.[24]

Figure B - 11: Comparison of NECEC contract price to a new hydro facility[25]



The cost of building new impoundments is significantly higher – around $70 to $130 / MWh. The energy price in the contracts with Massachusetts utilities starts at $51/MWh and rises to around $82/MWh. As the contracted energy price is higher than the NECEC contract price for energy, it would be uneconomic for Hydro-Québec to build new facilities to meet its obligations under the contracts with Massachusetts utilities (**Figure B - 11**).

In contrast, Hydro-Québec has only been making between $20 to $40 / MWh on its exports

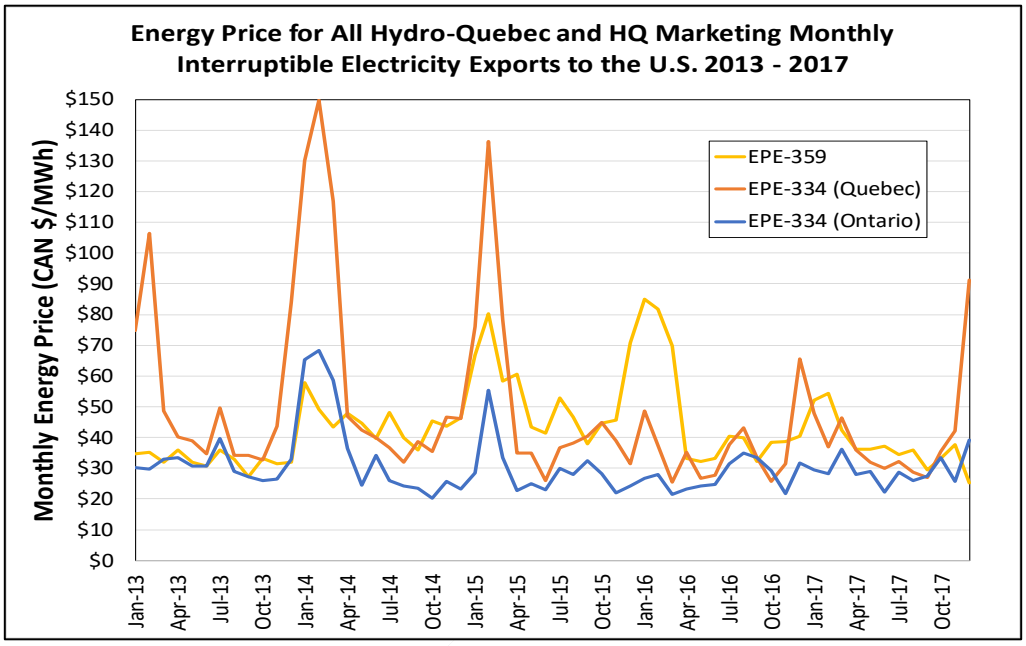
"Load in Québec was assumed in all scenarios to grow by 0.42% per year for a total increase of 28.7 TWh between 2015 and 2050."

[24] Hydro-Québec et. al., "Deep Decarbonization in the Northeastern United States and Expanded Coordination with Hydro-Québec," April 2018, p. 28.

[25] Contract prices derived from publicly-available information concerning the price under the Massachusetts contracts presented to the Massachusetts Department of Public Utilities. Cost to build new facilities is based on the Deep Decabonization Study

(peak and off-peak) except during winter price spikes (**Figure B - 12**). Off-peak hours, the periods when Hydro-Québec would be most likely to divert energy for sales to NECEC, is likely to be on the lower end of this range.

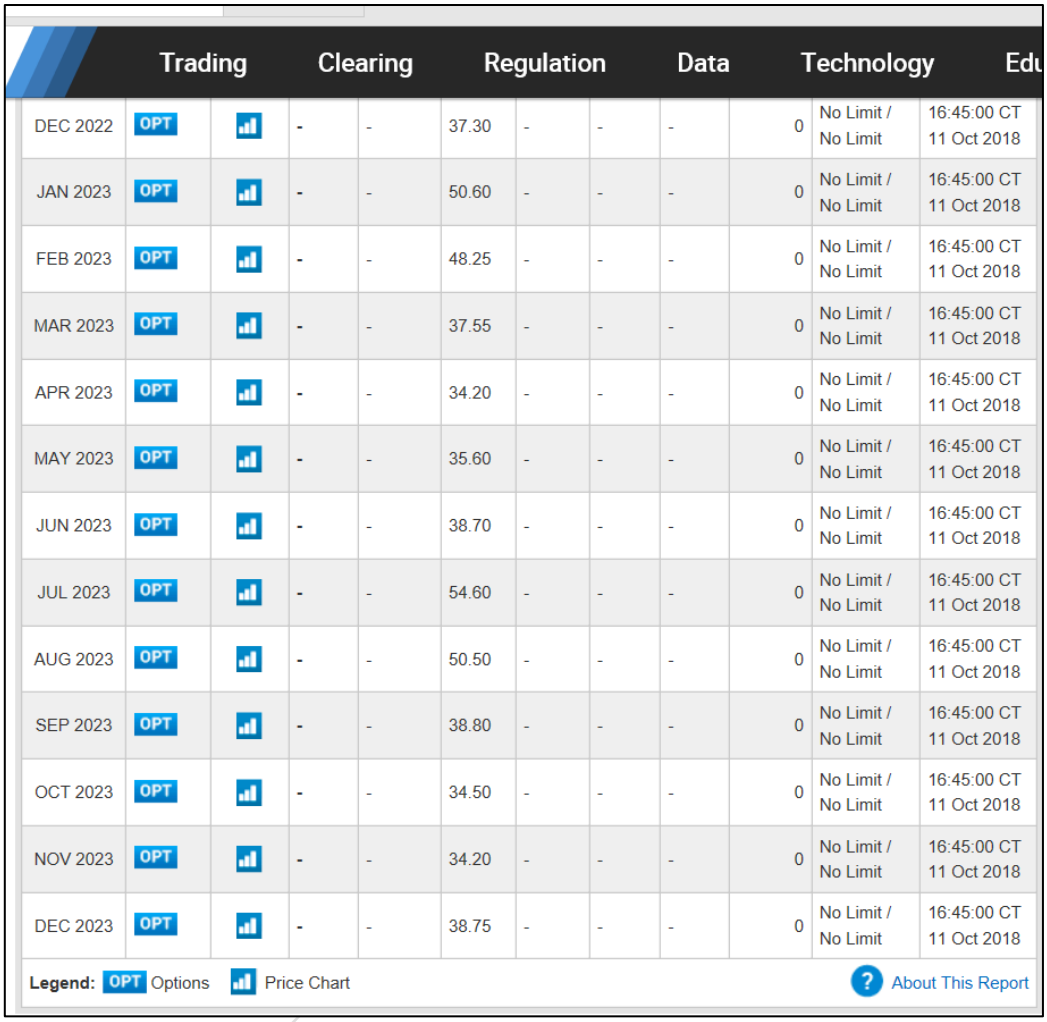
Figure B - 12: Hydro-Québec average price for interruptible energy by license[26]



The futures market indicates a projection of electrical energy prices in New York that is consistent with historical prices, and would be significantly below the contract price. Futures for New York peak prices for zone A, which tend to be higher than the North Zone where Hydro-Québec interconnects into New York, are averaging around $41/MWh for 2023. If off-peak hours are considered, Hydro-Québec could make money by simply diverting the entirety of its exports into New York into NECEC, or buying from other markets during off-peak hours to conserve its water for sale via NECEC.

[26] Energyzt analysis of National Energy Board, Monthly Electricity Export Reports for Canada to the US.

Figure B - 13: CME Group, NYISO Zone A – Peak Hour Futures Contract Price[27]



	Trading		Clearing		Regulation			Data	Technology	
DEC 2022	OPT		-	-	37.30	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
JAN 2023	OPT		-	-	50.60	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
FEB 2023	OPT		-	-	48.25	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
MAR 2023	OPT		-	-	37.55	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
APR 2023	OPT		-	-	34.20	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
MAY 2023	OPT		-	-	35.60	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
JUN 2023	OPT		-	-	38.70	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
JUL 2023	OPT		-	-	54.60	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
AUG 2023	OPT		-	-	50.50	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
SEP 2023	OPT		-	-	38.80	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
OCT 2023	OPT		-	-	34.50	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
NOV 2023	OPT		-	-	34.20	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018
DEC 2023	OPT		-	-	38.75	-	-	-	0	No Limit / No Limit	16:45:00 CT 11 Oct 2018

Legend: OPT Options Price Chart About This Report

Given where market prices are trading, it generally would be more economic for Hydro-Québec to simply divert sales away from markets with prices below that level in order to service NECEC or, if it is more economic to do so, purchase energy from lower priced markets to generate energy to sell to Massachusetts under a long-term contract.

[27] CME Group, NYISO Zone A On-peak Price as of October 11, 2018, https://www.cmegroup.com/trading/energy/electricity/nyiso-zone-a-5-mw-peak-calendar-month-day-ahead-lbmp-swap-futures.html

Hydro-Québec notes in its Section 83D application form that it may upgrade or build new facilities in the future. Given Hydro-Québec's need for new capacity, any upgrades or capacity additions that do occur would happen regardless of NECEC, and should be incorporated into the scenarios with and without NECEC when estimating the impact of NECEC on carbon emissions.

B.5 RECALCULATION OF CMP'S PROJECTIONS

In response to claims that Hydro-Québec would supply NECEC by diverting sales from other markets, CMP presented a calculation of energy available from Hydro-Québec's system going forward.[28] The calculation purports to show that Hydro-Québec would have a sufficient amount of incremental energy as a result of higher storage levels and therefore would not have to decrease exports into other markets below historical levels.

The simplistic model suffers from three fundamental flaws:

1) **The CMP Model Answers the Wrong Question:** The real question is whether NECEC reduces global emissions, and the CMP model does not address this question. To do so would require an analysis of what carbon emissions would be with and without NECEC. Given the recent set of high water conditions, Hydro-Québec has stored energy that it could use to generate energy going forward. This does not mean that sales via NECEC would be incremental over the entire term of the contract or that the stored water would not otherwise be sold as exports into other markets in the absence of NECEC. Therefore, the model cannot address what the net effect on emissions would be.

2) **CMP Assumes a Sudden Availability of Incremental Exports:** According to the CMP model, Hydro-Québec does not sell its excess energy into other markets unless NECEC is built. This results in reservoir levels remaining high up to the point where NECEC comes online. In fact, there is plenty of excess transmission

[28] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Rebuttal Testimony of Thorn Dickinson, Eric Stinneford, and Bernardo Escudero on Behalf of Central Maine Power Company, July 13, 2018; CMP Response to NRMC-032-021, Attachment 1.

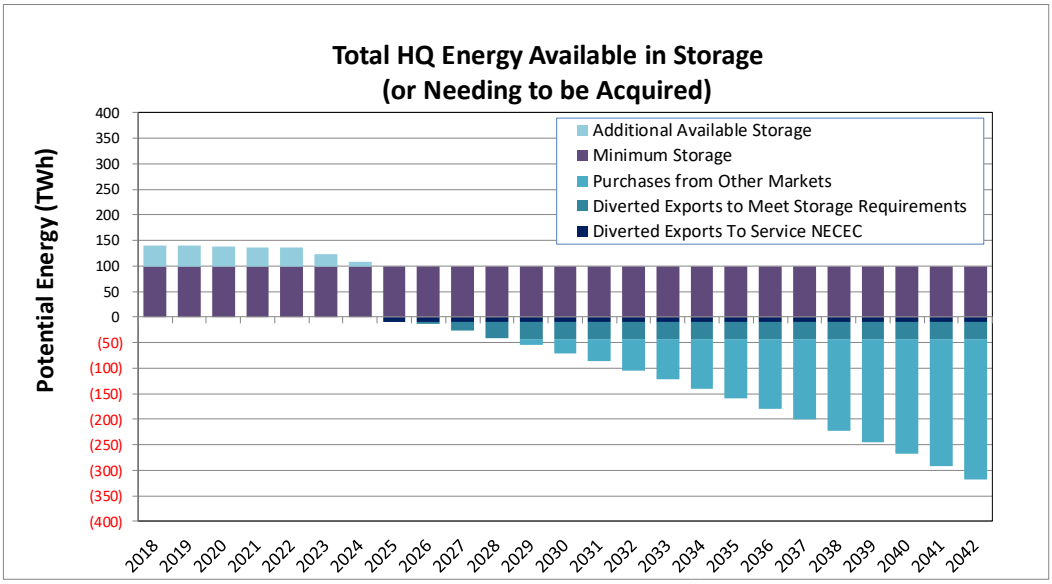
capacity servicing the interconnected markets that Hydro-Québec could use to sell its excess energy that currently is stored in its reservoirs. Historically, there has been around 16 to 18 TWh of unused transfer capacity across the tielines that Hydro-Québec could have used to sell its energy.[29] Intertie capacity is not the constraint for Hydro-Québec exports. Furthermore, by conserving water in storage to service NECEC, there would be an adverse impact on environmental emissions in other markets that otherwise could be mitigated if Hydro-Québec were to sell that energy prior to the NECEC contract.

3) **Water Conditions:** The model is incredibly sensitive to one key assumption – how much runoff would Hydro-Québec receive implicitly assumes high water conditions that have been experienced in 2017 and the years before will continue for the entirety of the contract, allowing for high levels of energy availability that allows incremental exports compared to historical levels. Assuming that Hydro-Québec will enjoy lower run-off levels – even a small reduction in the CMP assumption of 6 percent – dramatically changes the result. With this one change, Hydro-Québec would be unable to meet NECEC obligations while maintaining historical export levels without having to reduce exports and purchasing energy from other markets to meet its obligations.

Addressing only the assumed water conditions to reflect lower runoff conditions going forward compared to the recent high water years confirms that there are conditions under which: 1) Hydro-Québec would not have the excess energy required to maintain exports at recent levels; and 2) if Hydro-Québec did not divert energy from other markets into NECEC or reduce its exports to below historical levels, it would have to make other adjustments. Specifically, Hydro-Québec would have to divert exports into NECEC for sale into New England almost immediately under the contract and would have to begin greenwashing sometime during the first half of the contracts (**Figure B - 14**).

[29] *Central Maine Power Co.*, Request for approval of CPCN for the New England Clean Energy Connect, Maine P.U.C. No. 2017-000232, Exhibit No. JMS-3, Technical Report: Hydro-Québec Exports, April 2018, Figure 6, pp. 7-8.

Figure B - 14: Hydro-Québec operations with lower runoff conditions



In other words, doing nothing more to the CMP model other than reducing the assumed starting point for generation to reflect reasonable runoff conditions shows that Hydro-Québec will need to add new capacity to the system which is counter to what Hydro-Québec has stated NECEC would require and would be uneconomic given the NECEC contract prices for energy. Therefore, Hydro-Québec would have to manage its total export levels to meet its NECEC obligations and/or greenwash purchases from other markets.

In reality, Hydro-Québec is not confined to a single strategy over the course of the contract. Hydro-Québec will manage its system, sales, exports and opportunities according to water conditions and market prices. NECEC simply imposes another fixed obligation onto the system against which Hydro-Québec will optimize its operations. Such optimization will include diverting sales into other markets and greenwashing, as required to optimize profits.

B.6 CONCLUSIONS ON QUÉBEC'S SYSTEM AND SALES

According to NERC's long-term reliability assessment projections, Québec's system currently is projected to be short on capacity – without another acquisition of 1,100 MW of

potential capacity resources, the province will be short of its targeted reserve requirements by 2023. Therefore, it would be unlikely that Hydro-Québec would be able to sell additional capacity into the ISO-NE market via NECEC unless it increases purchased capacity from other markets beyond what is required to maintain its own targeted reserve margins.

In contrast to its projected shortfall in capacity, Hydro-Québec has excess energy. Hydro-Québec maximizes its profits by selling that excess energy into other markets. Historically, there has been a significant amount of unused capacity on the transmission interties between Québec and other markets indicating that the constraint is not transmission, but Hydro-Québec's availability of energy (i.e., water). Therefore, if NECEC were built, the energy would be supplied by diverting energy sales from other markets.

Hydro-Québec has issued public statements that it could meet NECEC requirements with existing reservoir storage and upgrades. Any energy available through reservoir storage could be, and most likely would be, sold into other markets. The entirety of the upgrades are required to meet projected domestic load growth through 2034. Therefore, NECEC would be supplied by diverted energy.

CMP has testified that Hydro-Québec has enough water in its reservoirs to meet its obligations to NECEC while maintaining exports into other markets at historical levels. Their conclusions, and the underlying model supporting those conclusions, assumes that the high water conditions of 2017 and the previous years would continue indefinitely. This is unrealistic. Simply changing the assumed level of potential energy to reflect alternative conditions indicates that Hydro-Québec would be unable to maintain its sales into other markets plus its energy obligations into NECEC without diverting exports and greenwashing energy purchased from other markets.

Understanding Québec's system is key to understanding potential environmental impacts of NECEC. Hydro-Québec is not likely to upgrade its system to meet incremental sales into other markets as those upgrades are needed to meet its own projected load growth. Hydro-Québec is not likely to sell capacity via NECEC as it requires an incremental 1,100 MW of capacity in order to meet its projected requirements in 2023. Lastly, Hydro-Québec is not likely to sell incremental energy into NECEC as it has the incentive to maximize sales of its excess energy into other markets and divert the lowest-priced hours into NECEC.

NECEC reflects an alternative way for Hydro-Québec to sell energy into an existing market in which it already trades. The large size of NECEC and associated energy supply commitment would enable Hydro-Québec to convert roughly one-third of its existing sales into low-priced spot markets into a higher-priced contract. In order to meet this commitment, Hydro-Québec will be able to manage its system, reservoirs, exports and imports given water conditions and market prices. The net impact on carbon emissions in the environment could be negligible and may even have adverse consequences if NECEC diverts energy from markets with higher emissions on the margin compared to New England.