February 07, 2022

VIA ELECTRONIC MAIL

Honorable Michelle Phillips, Secretary
State of New York Public Service Commission
Three Empire State Plaza
Albany, NY 12223-1350

RE: Case 15-E-0302: Comments of Riverkeeper Regarding Proposed Tier 4 Contract Award to the Champlain Hudson Power Express Project

Dear Secretary Phillips:

Riverkeeper is a 501(c)(3) non-profit membership organization whose mission is to protect and restore the Hudson River from source to sea and safeguard drinking water supplies, through advocacy rooted in community partnerships, science and law. On behalf of our more than 3,000 members in the Hudson River watershed, we appreciate the opportunity to submit these final comments regarding the award of Tier 4 credits to the Champlain Hudson Power Express ("CHPE") Project.

As you are aware, the CHPE project would bring Canadian Hydropower to New York City using a DC cable routed along the Hudson River. While we acknowledge that it is essential to build more transmission from upstate New York into New York City, we believe that there are two fatal flaws with the proposed CHPE project. First and most glaringly, Canadian hydropower is not a low carbon source of energy and the project will not directly reduce greenhouse gas emissions. Canadian hydropower also has many other unacceptable consequences that are detailed below. Second, we believe the Hudson should not be used as a conduit for power cables when there are viable land routes that would have less environmental impact.

A. Unlike Local Renewable Energy Canadian Hydropower is Not Low Carbon and CHPE Will Not Directly Reduce Emissions

The goal of Tier 4 is to increase delivery of clean energy into Downstate markets, including the cultivation of local renewables so that the state can meet its target of zero greenhouse gas emissions from the electricity sector by 2040.[1] As explained by that order PSL §66-p added to the PSL by the Climate Leadership and Community Protection Act ("CLCPA") requires zero emissions by 2040. *Id.* at 6. That requirement states "by the year two thousand forty (collectively, the "targets") the statewide electrical demand system will be zero emissions". PSL §66-p (2). Thus, there is a legal requirement for the state's electrical generation system to be zero emission by 2040 and the Tier 4 program is supposed to help make that happen. In practice, this gives rise to two requirements: 1) Tier 4 projects should reduce emissions; and 2) Tier 4 projects must not emit carbon after 2040. Even the selection criteria for the procurement require NYSERDA to evaluate if the project helps it meet the 2040 target.[2] As shown in detail below, the CHPE project cannot show that either of these conditions will occur.

Illustrating the effect of the zero emission by 2040 provision, DEC recently rejected air permit applications for two gas fired power plants, Danskammer and Astoria. Among other things the DEC's findings noted that continuing to emit greenhouse gases after 2040 would violate the CLCPA requirement.[3]

To evaluate the effects on greenhouse gas emissions, the first step is to acknowledge that hydropower in general is not low carbon. Dams transform natural landscapes into reservoirs. Many natural landscapes function as carbon sinks, and their inundation not only causes a loss of these natural sinks, but also results in a large and ongoing flux of greenhouse gas emissions including in the form of both carbon dioxide (where organic matter decomposes in the presence of oxygen) and methane (where decomposition occurs with limited oxygen). Recent studies challenge the notion that hydropower is a low-carbon resource, particularly on the time scales relevant to the CLCPA and the current climate crisis[4]. Hydro-Quebec has claimed its dams emit little methane, which may be correct, but a meta analysis of its own studies of carbon dioxide emissions showed that emissions per kwh from six of its sixty three impoundments ranged from

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[1] PSC Order Adopting Modifications to Clean Energy Standard (CASE 15-E-0302, 15 October 2020) at 11

[2] Petition Regarding Agreements For Procurement Of Tier 4 Renewable Energy Certificates at 14

[3] DEC Danskammer Decision https://www.dec.ny.gov/docs/administration_pdf/danskammer10272021.pdf

[4] E.G. Hertwich, Addressing Biogenic Greenhouse Gas Emissions from Hydropower in LCA, Environmental Science & Technology 9604-11 (Aug. 2, 2013) (global average emissions from hydropower are estimated to be 85 gCO2/kWh and 3 gCH4/kWh, with a multiplicative uncertainty factor of 2); L. Scherer & S. Phister, Hydropower's Biogenic Carbon Footprint, PLOS One (Sept. 14, 2016) (carbon footprint of hydropower is far higher than previously assumed, with a global average of 173 kg CO2 and 2.95 kg CH4 emitted per MWh of electricity produced, resulting in a combined average carbon footprint of 273 kg CO2e/MWh when using the global warming potential over a time horizon of 100 years (GWP100)); I.B. Ocko & S.P. Hamburg, Climate Impacts of Hydropower: Enormous Differences among Facilities and over Time, Environmental Science & Technology (2019) (finding some hydro impoundments have GHG emission impacts greater than gas and even coal on both short and long timeframes).

the equivalent of a combined cycle gas plant to twice the emission rate of coal power plants.[5] While there is some controversy about the exact amount of carbon dioxide emissions it is clear that they are substantial and that Hydro-Quebec's impoundments are some of the dirtiest in the world.

Explicitly recognizing that new impoundments emit greenhouse gases, the procurement has additionality criteria that exclude dams not under construction by June 18, 2020.[6] The PSC has recognized that "[n]ew impoundments were excluded from the recommendations in the White Paper because of the environmental damage that may result and the potential for greenhouse gas emissions to increase, contrary to the explicit goals of the CLCPA."[7] However, the exclusion for dams under construction allows emissions to increase. In addition, because power is fungible, Hydro Quebec could serve its existing customers in Canada with new dams while directing power from the existing dams to New York State without violating this requirement. In reality this limit on new impoundments is a woefully insufficient constraint on a huge entity like Hydro Quebec that serves two countries from multiple impoundments.

These high emissions mean that Canadian hydropower is far from emissions free. Because the contract term for the CHPE project is 25 years, the proposed CHPE project would operate beyond 2040. Approving it would therefore violate the zero emission requirement of PSL §66-p, which originated from the CLCPA. On these grounds alone, the Public Service Commission ("PSC") should reject this contract. In addition, helping with this goal is a requirement of the procurement. There is a rich irony in the failure of NYSERDA to understand that it was proposing that the state spend billions of dollars to subsidize a project that fails to meet a key requirement of the state's own climate mitigation laws. Other alternatives were proposed to NYSERDA that do actually deliver low carbon energy to New York City. Those are the projects that the state should be subsidizing.

Hydro-Quebec deliberately overbuilt its capacity in the last decade because it was committed to expansion, largely driven by exports to the US market. In accordance with that strategy, three other export projects have been proposed and one, serving Massachusetts with a line through Maine, has been approved. There is a danger that if Hydro-Quebec can get premium prices for power from its existing dams, it will build more. While Hydro-Quebec has undertaken to build no new dams as a result of the CHPE project, the CHPE project cannot be viewed in isolation, because it is clear that it is part of a larger group of projects that are designed to facilitate Hydro-Quebec's ongoing expansion. Riverkeeper asked Hydro-Quebec for a commitment not to build new dams, but the company refused. At minimum, the company will complete the Romaine 4 dam, which is only being completed to serve the export market. The flooding of Romaine 4 will itself lead to major additional greenhouse gas emissions. It would be

[5] Decl. of Dr. Brad Hagar (attached).
[6] Order Adopting Modifications To The Clean Energy Standard at 18.
[7] *Id.*

a tragedy if New York taxpayers contributed to more greenhouse gas emissions by funding what is supposed to be a clean energy project to reduce climate risks.

A second additionality criterion is the so-called "Supplier GHG Baseline."[8] This purports to ensure that the supplier generates more energy from its existing dams than it has before. However, including Romaine 4 as an "existing" dam will automatically allow Hydro Quebec to avoid much of the effect of this provision. Obviously once that new dam comes online, there will be more power available, but that power will be associated with high greenhouse gas emissions. In addition, the way that the Agreement with Hydro Quebec implements this constraint is highly permissive. For example, it appears that Hydro Quebec can take credit for demand side efficiency improvements in Canada.[9] This makes no sense, because those reductions should not be counted as part of New York's efforts to reduce greenhouse gases. Furthermore, the way it is applied is that HydroQuebec can accrue a deficit by failing to generate additional energy for a long time before the requirement is even applied.[10] This means that Hydro Quebec can divert supplies from Canadian customers to serve New York for years before it hits any constraint at all. As the PSC correctly noted "The Supplier GHG Baseline is central to the integrity of the Tier 4 concept and cannot be compromised."[11] Despite this strong directive from the PSC, the proposed contract with HydroQuebec sets forth a highly compromised version of the Supplier GHG Baseline.

If the existing dams were generating surplus capacity, some might find justification in using it because the emissions from impoundments do not vary with the power production. However, we have carefully evaluated the amount of surplus capacity that could be available to serve this project and other proposed sales of power to the US market. We understand from Hydro-Quebec that in 2018 it had around 10 TWhr of water spillage, up from 4.6 TWhr in 2017. If the approved Maine transmission line ("NECEC") is built it will take up 9.45 TWhr. Thus, it appears that the currently available surplus, as defined by actual water spillage, will be taken up by the new Maine line. We understand that there are ongoing developments, such as Romaine 4 (245 MW by 2020) and efficiency improvements (around 500 MW by 2025), but it seems that any available surplus in 2025 will be less than the 1 GW that the original CPHE project was designed to supply.

NorthBridge Energy Partners ("NorthBridge") undertook a similar analysis and reached similar conclusions. They concluded that, in the absence of the NECEC and CHPE projects neither the construction of any additional facilities nor completion of Hydro-Québec's Romaine

[8] *Id.* at 90.
[9] Proposed Purchase and Sale Agreement with HSUS at H2-3.
[10] *Id.*
[11] Order Adopting Modifications To The Clean Energy Standard at 89.

4 dam would be necessary.[12] By contrast, NorthBridge found that "[w]hile there is some significant quantity of excess energy and additional capacity available beyond existing domestic and export commitments, it is apparent that it varies considerably on an annual basis, and is far from sufficient to consistently support both transmission corridors and associated contracts."[13] NorthBridge concludes that: "The only way to meet the new demand from NECEC and CHPE without new dam construction, would be to back down some level of existing exports to either the U.S. or the Canadian province."[14]

Thus, it appears that the bulk of the power surplus that Hydro-Quebec is claiming exists is actually being sold on the spot market, primarily in upstate New York. Moving this power to New York City through the CHPE cable would not produce a reduction in greenhouse gases unless more renewable capacity is built upstate. The PSC made a mechanism called the "Supplier Energy Baseline" designed to prevent this problem optional for NYSERA. The proposed contract between NYSERDA and Hydro Quebec does not contain any reference to this mechanism. Therefore, it is highly likely that it will occur.

In short, NYSERDA is proposing that the state pay subsidies set aside for low carbon energy to a high carbon energy source. It has also undermined or omitted the protections that were designed to limit this purchase causing additional greenhouse gas emissions. Instead of relying on this Heath Robinson approach that probably may not lead to any greenhouse gas emission reductions, the state should instead select an option that is powered by in-state renewable resources. That way, we would get a major reduction in greenhouse gases and a major economic benefit upstate.

B. **Canadian Hydropower Has Large Environmental Justice Impacts**

Using Canadian hydropower raises many environmental justice concerns. Land was taken without consent for dam building and the methylmercury bioaccumulation in fish that serve as a critical food source for indigenous peoples, leading to a risk of mercury poisoning.

In letters and filings, the Pessamit Innu and Innu Nation of Canada have expressed their opposition to new transmission lines enabling exports of hydropower from generating stations that flooded these territorial lands.[15] According to the Pessamit, twenty-nine percent of Hydro-Québec's installed capacity in the Province of Quebec was built on traditional Pessamit

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[12] *http://northeastmegadamresistance.org/wp-content/uploads/2020/03/NorthBridge-Canadian-Hydro-Exports-1.pdf.* at 4.

[13] *Id.* at 4.

[14] *Id.* at 4.

[15] *See, e.g.*, Comments of the Innu Nation to Maine Dept. of Envtl. Protection regarding Central Maine Power's application for NECEC transmission line (Apr. 13, 2020).

lands without Pessamit consent.[16] Moreover, the Innu Nation of Canada's lands were flooded by the Churchill Falls Generating Station without their consent.[17] The Churchill Falls Generating Station accounts for approximately 1/6th of the Hydro-Québec system's total energy generation.[18] The Innu Nation of Canada has requested that sign-off from the tribe be required prior to construction of new transmission interties that will increase U.S. reliance on hydroelectric power from the Hydro-Québec system.[19] Other First Nations bands, the Innu First Nation of Pessamit and the Atikamekw First Nation of Wemotaci, are specifically opposing new transmission routes elsewhere in the U.S. to exert pressure on Hydro-Québec to address the historic damage to their communities.[20]

In their letters to the Canadian Prime-Minister, the Grand Chief of Innu Nationand Chiefs of the Innu-Atikamekw-Anishinabek stated that Hydro-Québec violated their constitutional rights and breached of several articles of the *United Nations Declaration on the Rights of Indigenous Peoples* (UNDRIP). They stated "Hydro-Québec claims to offer green energy to American consumers, while making billions of dollars in profits at the expense of the Indigenous peoples whose ancestral lands it exploits. We are tired of this. That's why we're calling on the Canadian and American governments to intervene on our behalf."[21]

Moreover, methylmercury in impoundments bioaccumulates in food webs and exposes communities that consume local birds, fish, and other marine animals to higher levels of the neurotoxin.[22] This is a problem at most new dams, but a Harvard Study predicted Romaine 4 would have the highest levels of methylmercury.[23] This study of dozens of dams in Canada found that more than 90 percent of these dams expose indigenous populations to methylmercury contamination which results from flooding river valleys. Methylmercury contaminates the riverine and coastal food web. It bioaccumulates in the fish, birds, seals and other species upon which local communities rely. According to the Harvard study, on average indigenous communities' exposure to the neurotoxin would double after the dams are built and upstream areas are flooded. Although there are methods to follow that could minimally reduce the production of — and thus communities' exposure to — methylmercury, the provincial

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[16] Rene Simon, "My Turn: Hydro-Quebec Cannot Rewrite History" (Aug. 27, 2017), *Concord Monitor*, available at https://www.concordmonitor.com/Pessamit-Innu-say-Hydro-Quebec-can-no-longer-hide-the-facts-11991318

[17] Press Release: Innu Nation of Canada Opposes Central Maine Power's Transmission Line Permit (Apr. 14, 2020), available at https://turtletalk.files.wordpress.com/2020/04/innu-nation-press-release-on-cmp-ne-clean-energy-connect.pdf.

[18] Comments of the Innu Nation to Maine Dept. of Envtl. Protection regarding Central Maine Power's application for NECEC transmission line at 8 (Apr. 13, 2020).

[19] *Id.* at 1.

[20] The Innu First Nation of Pessamit, Quebec Export of Electricity to the United States – The moment of truth for Pessamit and Wemotaci First Nations (Aug. 5, 2020), available at https://www.newswire.ca/news-releases/quebec-export-of-electricity-to-the-united-states-the-moment-of-truth-for-pessamit-and-wemotaci-first-nations-832638069.html

[21] https://www.prnewswire.com/news-releases/canada-and-us-first-nations-unite-against-hydro-quebec-301258762.html

[22] *See* Dierdre Lockwood, Dams increase mercury exposure for Canadian indigenous communities (Nov. 21, 2016), available at https://cen.acs.org/articles/94/web/2016/11/Dams-increase-mercury-exposure-Canadian.html.

[23] https://www.cbc.ca/news/canada/newfoundland-labrador/harvard-research-hydroelectric-projects-methylmercury-1.2879212 (Nov. 9 2016)

governments have failed even to implement these protective measures. In the case of Nalcor's construction of the Muskrat Falls hydropower dam, the government approved using the protective capping measures, but the Department of Municipal Affairs and Environment failed to issue a permit in a timely manner. And more recent studies show that the capping measures will only decrease methylmercury by 1 or 2 percent.

C. **Using the Hudson as a Conduit is Unnecessary and Unacceptable**

The Hudson River Estuary is the second largest spawning ground and fish nursery on the East Coast of the United States and is considered critically important habitat for a wide variety of species for all or part of their life history. Yet, for all its importance, once again the Hudson River is being threatened with further damage despite centuries of anthropogenic abuse and neglect, and despite public demands for the protection and restoration of the river. The Hudson River currently holds the ignominious distinction as the country's largest Superfund site, and as a result of industrial pollution the fish in the river are no longer suitable for human consumption. Even worse, the populations of every iconic Hudson River fish or fishery are in desperate states of decline. Most exist as mere shadows of their former abundance, with both species of sturgeon endemic to the Hudson classified as endangered. The river cannot continue to suffer industrial damage and disruption without further irreversible impacts to its ecological function. Just as each river has a unique flow signature and nutrient budget, each will have a different response to human demands, but in nearly every case the result will be a loss of ecological integrity and a decline in environmental health.

The CHPE cable is proposed to be buried 7 feet into the river sediments where possible, but it will be installed by jed-plow where possible. Where there are insufficient sediments it will rest on rock, covered by concrete tiles. There are a number of problems with this approach. First, the Hudson is contaminated by PCBs, coal tar, and a range of other contaminants. Stirring up those contaminants during construction could cause ecological harm and could contaminate drinking water intakes used by seven communities along the Hudson, serving over 100,000 people in all. Second, the marine industry is concerned that anchors deployed in an emergency could snag the cable. Third, it is well documented that many species of fish, including sturgeon, can detect magnetic fields caused by buried cables and change their behavior.

As studies continue to expand with regard to the effects of fields, it is becoming readily apparent that fishes of such as the eels, lamprey, catfishes, sharks, rays, sturgeons, salmonids, tunas, herring, flatfishes, cods, and most bony fishes, as well as marine mammals and turtles are sensitive to electric fields, and some will shy away from electromagnetic pulses from conducting cables. While the current state of the science does not allow for precise prediction of this effect,

the endangered species in the Hudson should not be put at risk by allowing this uncontrolled experiment to go ahead.

D. **Conclusion**

As shown above, the CHPE project fails to meet the most basic requirement of a clean energy project, because it will not directly reduce greenhouse gas emissions and it will continue to emit greenhouse gases after 2040, when New York's climate laws require the electric grid to be emissions free. Adding insult to injury, this project would take up billions of dollars in taxpayer subsidies that should be paid to a project that would reduce greenhouse gas emissions.

Compounding the many negative impacts associated with this project, giving Hydro-Quebec a lucrative contract could induce the building of more dams and further injure indigenous peoples who have already been gravely injured by past and ongoing dam construction. More locally, using the Hudson as a conduit for an electric cable threatens to stir up PCB laden sediments, potentially damaging drinking water supplies, interfering with fish migration, and affecting shipping.

Riverkeeper had negotiated a settlement with the developers of CHPE nearly a decade ago, when it was seen as an essential alternative to Indian Point, which had devastated the river ecosystem and put local communities at risk for generations. We have had the courage to take a second hard look at this project, in light of the alternatives available, and essential facts that have since emerged, including the dire and multifaceted impacts of hydropower. The PSC, too, must take this hard look and change course before it wastes billions of taxpayer dollars on a false climate solution that violates environmental justice principles.

For these reasons, the PSC should reject NYSERDA's choice of this flawed project and instead urge NYSERDA to select a proposal that utilizes renewable resources other than hydropower, preferably generated in New York, and one that has selected a route that minimizes the use of the Hudson as a conduit for the cable. Thank you for your consideration.

Respectfully submitted,

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UNITED STATES DISTRICT COURT
DISTRICT OF MAINE

SIERRA CLUB, et al.,

Plaintiffs,

v.

UNITED STATES ARMY CORP OF ENGINEERS, et al.,

Defendants.

CIVIL NO. 2:20-CV-00396-LEW

DECLARATION OF BRADFORD H. HAGER IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

I, Bradford H. Hager, hereby declare:

1. I am the Cecil and Ida Green Professor of Earth Sciences at the Massachusetts Institute of Technology (MIT), where I co-direct one of MIT's Low Carbon Energy Centers. I have a B.A. in Physics from Amherst College (1972), and an A.M. in Geology (1976) and a Ph.D. in Geophysics from Harvard University (1978). My curriculum vitae is attached as **Exhibit 1**.

2. I split my time between MIT and my home in Mercer, Maine. I am an avid outdoorsman– over the years my family and I have spent about ten months on canoe trips on the rivers of northern Quebec in the areas discussed here. I worry about the planet that our children will inherit, and I am especially concerned about continued growth in global carbon emissions and their harmful environmental impact. I strongly believe that, in making decisions about energy sources, it is essential to consider the best available scientific evidence on carbon emissions.

3. A well-established fact important for evaluating the environmental impact of the proposed NECEC project is that greenhouse gasses (GHGs), including carbon dioxide and methane, are well mixed into Earth's atmosphere soon after they are emitted. This means that GHGs emitted *locally* affect climate *globally*. The relevant climate question is what would be the change in total *global* emissions of GHGs that would result from NECEC, *not* whether NECEC would give a net reduction in *local* GHG emission in New England. As an extreme example, although Massachusetts could lower its *local* GHG footprint by importing all of its power from coal-burning power plants in the Midwest, *global* emissions would increase – clearly a bad result for climate. Likewise, in order to assess the global impact that NECEC would have on GHG emissions, the GHG emissions from power provided by Hydro Québec must be quantified.

4. The crucial point that it is global, not local GHG emissions that are important for climate change appears not to be recognized in the U.S. Army Corps of Engineers' ("Corps") July 7, 2020 Environmental Assessment/Finding of No Significant Impact (hereinafter "EA/FONSI"). For example, on page 44, the EA/FONSI seems to miss the point that it is the global GHG emissions that matter, stating "Carbon emissions. The project is expected to provide a substantial reduction in greenhouse gases . . . within the New England region . . ." Similar language emphasizing local reduction of GHG appears on pp. 41, 42, 48, 56, 59, 113, and 118. The focus on regional, not global emissions is attributed to CMP on p. 121: "CMP has consistently noted that a key benefit of the project is its potential to reduce regional greenhouse gases (GHG). Their application and the administrative record contains a great deal of analysis that is meant to support their assertion that the GHG emission reductions in the region resulting from the NECEC would be in the range of approximately 3.0 to 3.6 million metric tons per year, which they note is equivalent to removing approximately 700,000 passenger vehicles from the road." However, continuing with this analogy, to the extent that these passenger cars were put back on the road in Quebec, there would be no such benefit globally.

5. To calculate the total change in GHG emissions that would result from NECEC requires determining the emissions from generation in Québec. The scientific evidence on the greenhouse gas emissions associated with Hydro-Québec's power generation is highly controversial. On December 5, 2019, I testified about this controversy at the public hearing held by the Army Corps of Engineers regarding NECEC. I also submitted a white paper to the Corps as part of that agency's review, documenting how Hydro-Québec's controversial claim that its greenhouse gas footprint is very low, comparable to wind, is contradicted by estimates published

by independent scientists. The opinions I express in this declaration are consistent with those I provided to the Corps through my written and oral testimony.

6. Over the past decade, scientists have recognized and documented the surprisingly large emissions of carbon dioxide (CO2) and methane by some hydropower facilities (references are attached as **Exhibit 2**). Two of the main factors that control this greenhouse gas (GHG) footprint are the area of the forest flooded and the age of the reservoir. Hydropower generated from damming narrow, steep valleys above tree line is cleaner than that generated from damming broad, forested lowlands. New reservoirs emit approximately five times as much CO2 as old reservoirs due to the decay of drowned trees and soil disturbances that release GHGs. It can take decades for these emissions to decrease.

7. A study published recently in the peer reviewed scientific literature (Scherer & Pfister, 2016) assessed the GHG emissions of approximately 1,500 hydro facilities, including most of those providing power to Hydro-Québec. Scherer & Pfister (2016) ranked six of Hydro-Québec's reservoirs among the top 25% of GHG emitters of hydro plants worldwide. The emissions of these six range from about that of a modern natural gas power plant, which is about 400g CO2e/kWh, to over twice that of coal power plants, which is about 1,000 gCO2e/kWh.

8. Hydro-Quebec claims to be a source of green energy, with emissions of 17 kg CO2e/MWh, comparable to wind power (**Exhibit 3**). This number comes from a technical report paid for by Hydro-Quebec (CIRAIG, 2014) that is not a peer reviewed publication in a scientific journal. Hydro-Quebec's claimed emission value of 17 kg CO2e/MWh is much lower than the estimates its scientists have published in the peer-reviewed literature (e.g., 150 – 670 kg CO2e/MWh, Teodoru et al., 2012). The CIRAIG (2014) estimate of Hydro-Québec emissions is misleading. Their estimate is not the average emissions for the entire system, but rather it is the

median value for Hydro-Québec's individual generating facilities, which is dominated by small reservoirs that do not generate much power. The much larger energy-averaged value is the appropriate one to consider in evaluating the environmental impact of the total system (Scherer & Pfister, 2016).

9. Given the huge discrepancy between the low CIRAIG (2014) estimate used by Hydro-Québec and the much higher GHG emissions that are documented in the peer reviewed literature, it is critical to resolve this controversy via a serious, open, and formal federal review and an Environmental Impact Statement. The EA/FONSI (pdf p. 122) instead relies on additional information provided by CMP and Hydro-Québec, as well as by DOE, which directed a peer review of all of the various analyses be performed by an agency contractor. As an initial observation, the fact that DOE felt it necessary to hire a contractor to perform a peer review of the GHG emission data and information related to the project shows this is an area of ongoing and significant scientific debate and controversy. In other words, if the matter were well-settled, there would be no need to expend taxpayer dollars to perform such a review. However, I am unable to address the specifics of either the additional information or the DOE review because they were not provided by the Corps or DOE. Without providing open access to this information, the Corps EA/FONSI cannot be viewed as resolving the controversy.

10. By studying the peer reviewed literature and accompanying online supplementary materials, I have assembled published GHG emissions of 18 of Hydro-Quebec's major reservoirs, each generating in excess of 1 terawatt-hour (TWh) per year of electricity, for a total of over 150 TWh altogether. These can be compared to the emissions from other power sources.

11. The bar chart in Figure 1 shows the range of carbon footprints for common power sources. The numbers on the vertical axis give the GHG emissions in kilograms of CO2

equivalent (kg CO2e) per megawatt hour (MWh) of energy generated. The dark bars span the ± 25% ranges from various sources, ranging from the dirtiest on the left (coal) to the cleanest on the right (wind and nuclear). In the middle, with the largest range by far, is hydropower. The light bar for hydropower spans the ± 40% range. Note that 10% of the world's hydropower has a GHG footprint that plots off the top of this chart.

12. Hydro-Québec emissions documented by Hertwich (2013) and Scherer and Pfister (2016) are shown in black font. Measured values (Hertwich, Roman font) are used when available; otherwise model values (Scherer & Pfister, italic font) are used. The range in values for the study of the variations in emissions in the initial four years after filling the Eastmain-1 reservoir (Teodoru et al, 2012) are shown in red. After the initial flooding, emissions were above modern gas, approaching coal. After four years, they drop off to a value about half that of a modern natural gas plant.

13. There is a tremendous range in these estimates of Hydro-Quebec's emissions. The Brisay plant fed by the Caniapiscau reservoir, which makes the largest lake in Quebec, has a substantially greater carbon footprint than that of coal. The huge Churchill Falls plant, which produces 31 TWh/yr, about three times that to be transmitted by NECEC, has an estimated GHG footprint comparable to a modern natural gas plant. All but three of these Hydro-Quebec reservoirs have much greater carbon emissions than wind. The energy-weighted GHG footprint of these reservoirs obtained from data published in the peer-reviewed literature is 175 kg CO2e/MWh, a factor of 10 greater than the number claimed by Hydro-Québec and also a factor of 10 greater than their estimate for wind.

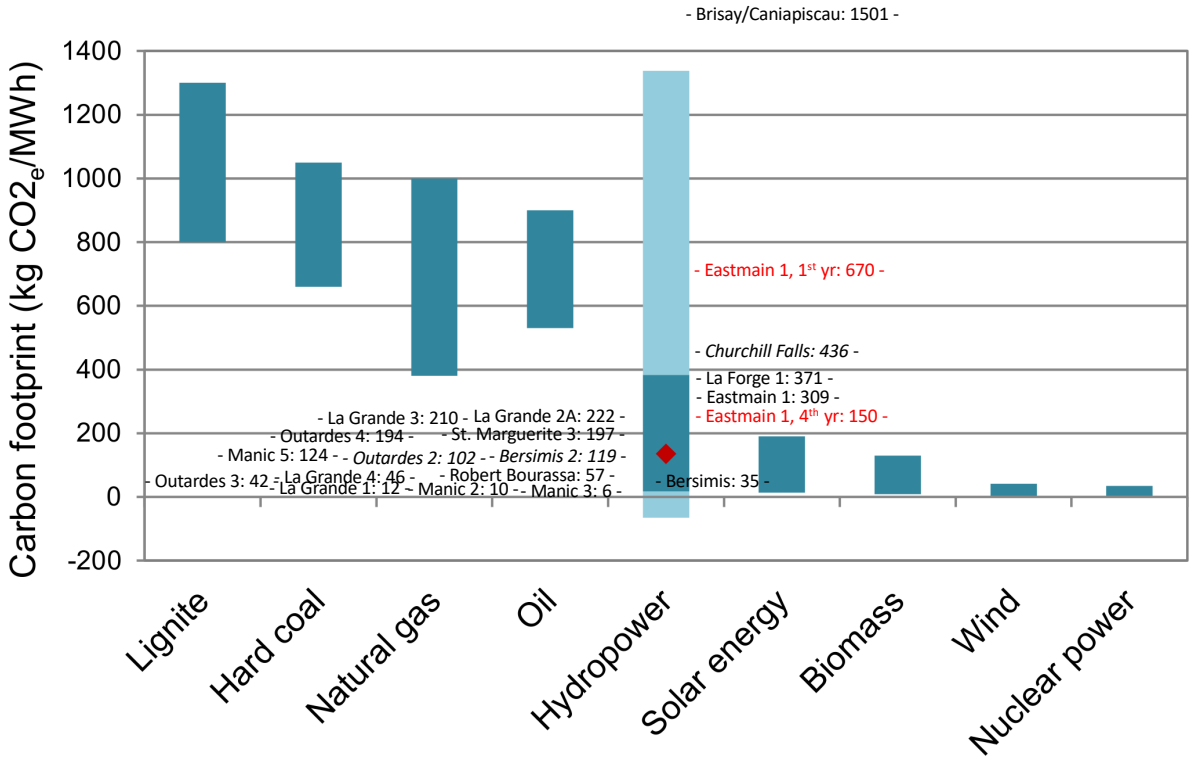

Figure 1. GHG carbon footprints in units of (kg CO2e/MWh) for a range of energy sources, modified from Scherer and Pfister (2016). The dark blue bars span the ± 25% ranges for each source type. For hydropower, the light bar spans the ± 40% range and the red diamond is the median for the facilities in their global database. Black text gives emissions for the Hydro-Québec facilities each generating more than 1 TWh/yr, as documented by Hertwich (2013) and Scherer and Pfister (2016). Measured values (Hertwich, regular font*) are used when available; otherwise model values (Scherer & Pfister, italic font) are used. The range in emissions in the initial four years after filling the Eastmain-1 reservoir (Teodoru et al, 2012) are shown in red.*

14. The diagram of a watershed in Figure 2 provides an intuitive understanding of the wide range in variation of hydropower's carbon footprint. Deep reservoirs in narrow mountain valleys with little vegetation have low emissions. Shallow lowland reservoirs that flood vast

areas of forest emit much more carbon. Many of Hydro-Québec's reservoirs are nothing like the much cleaner reservoirs of Switzerland and Iceland that dam deep, narrow valleys above tree line. Rather, many of Hydro-Québec's reservoirs flood vast tracts of low-lying woodlands, resulting in massive deforestation.

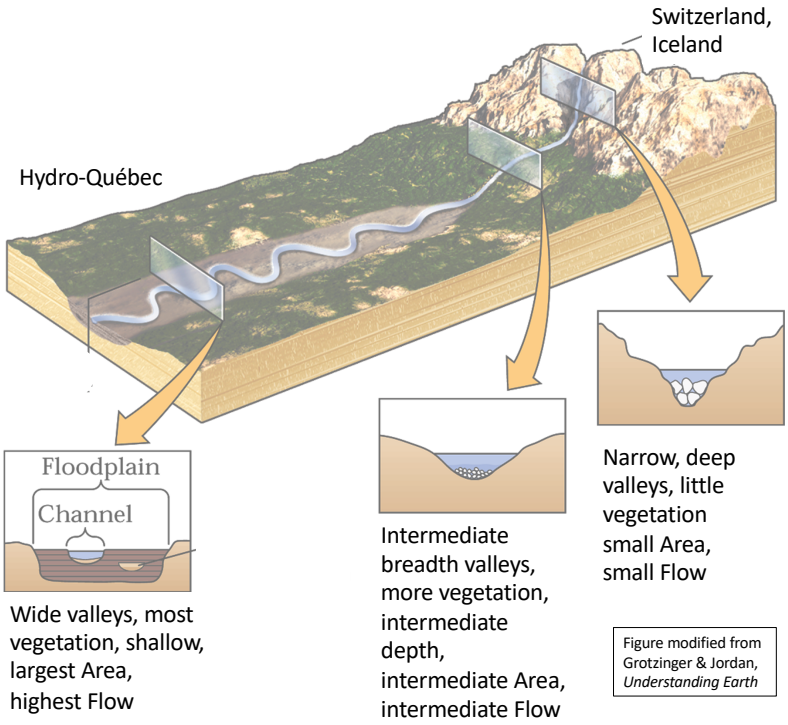

Figure 2. Diagram of a watershed illustrating a major cause of the wide range in variation of hydropower's carbon footprint. Deep reservoirs in narrow mountain valleys with little vegetation, such as those in Switzerland and Iceland, have low emissions. Shallow lowland reservoirs that flood vast areas of forest, like many of Hydro-Québec's, emit much more carbon.

15. In addition, the GHG emissions from the decay of submerged trees and disturbed soils in newly created reservoirs are many times higher than emissions from reservoirs that are several decades old. Hydro-Québec's diverting substantial power from its system via NECEC raises the risk that it will need to build more new reservoirs in order to satisfy future demand that would

otherwise be met by the power sent to New England. The risk that NECEC will lead to the construction of new reservoirs needs to be assessed in order to accurately quantify the additional environmental risk posed by Hydro-Québec GHG emissions resulting from NECEC.

16. The information provided by the EA/FONSI clearly demonstrates, by contradictory quotes from its own sources, that the question of whether NECEC would result in the construction of new reservoirs is not settled and remains controversial. On p. 123, the review states that CMP has demonstrated "The NECEC will not require the construction of new dams in Canada and are thus, not expected to result in any incremental GHG emissions." However, statements by both the Maine PUC and a DOE contractor contradict this claim. On p. 122 of the pdf, it is stated twice that "The Maine PUC concluded that, 'the NECEC will result in significant incremental hydroelectric generation from existing and *new* sources in Quebec.'" (italics added). On p. 123, the review states "the DOE contractor concluded that it is likely that Hydro-Québec would be able to meet the energy delivery requirements for NECEC with its current and *planned incremental* supply," (italics added). These statements suggesting new sources would be used to provide the power to be carried by NECEC call into question the validity of the statement on p. 53 of the EA/FONSI: "Claims and public concerns that the Project will actually result in increased GHG emissions associated with the creation or construction of hydroelectric generation facilities or reservoirs appear to be unfounded."

17. In summary, the carbon footprints of some of Hydro-Québec's power documented in the peer-reviewed scientific literature make it among the dirtiest hydro in the world, in terms of GHG emissions. The discrepancy between these high values and Hydro-Québec's claimed very low carbon footprint, comparable to wind, is a substantial controversy that requires a thorough Environmental Impact Statement to resolve. The EA/FONSI has instead relied (pdf p. 122) on

information furnished by CMP, by Hydro-Québec, and an undisclosed review by a DOE agency contractor. Without access to the DOE review, the only way I can reconcile the conclusions attributed to it with the peer reviewed scientific literature is to assume that the DOE review addressed the reduction in GHG emissions only in New England and neighboring markets without considering the global impact. It is the total GHG emissions that would result from NECEC that would drive climate change.

18. For full disclosure, my wife, Patricia C. Hager, is past President of the Board of NRCM. That fact has no impact on the scientific evidence presented here.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this __2nd_ day of_November,__ 2020 in _Mercer, Maine_____.

Bradford H. Hager

Exhibit 2: References

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U.S. Army Corps of Engineers, Department of the Army Environmental Assessment and Statement of Findings re: NAE-2017-01342 (referred to as the "EA/FONSI") (July 7, 2020).

Exhibit 1

BRADFORD H. HAGER

Education

Ph.D., Geophysics, Harvard University, 1978
Thesis: *Mantle Flow Driven by the Lithospheric Plates*
A.M., Geology, Harvard University, 1976
B.A., Physics, Amherst College, 1972, *summa cum laude*

Professional Experience

Co-Director, MITEI Center for carbon capture, use, and sequestration, 2016 -
Director/Associate Director, Earth Resources Laboratory, 2012 –
Associate Department Head, Dept. of Earth, Atmospheric & Planetary Sciences, MIT, 2008 – 2010.
Cecil and Ida Green Professor of Earth Sciences, MIT, 1989 -
Professor of Geophysics, Caltech, 1989
Associate Professor of Geophysics, Caltech, 1985 - 1989
Assistant Professor of Geophysics, Caltech, 1980 - 1985
Assistant Professor, Department of Earth and Space Science, SUNY Stony Brook, 1979 - 1980
Chaim Weizmann Postdoctoral Fellow, Harvard University, 1978 - 1979
Teaching and Research Fellow, Geology, Harvard University, 1974 - 1977
Teacher, Physics and Mathematics, Cushing Academy, Ashburnham, Massachusetts, 1972 - 1974

Selected Professional Activities

NRC U. S. Geodynamics Committee Member, 1988 - 1992; chair 1996 - 2000.
NRC Geodesy Committee, Global Fiducial Network Subcommittee, 1989 - 1991
NEPEC Parkfield Earthquake Prediction Experiment Evaluation Working Group (chair) 1992 - 1993
University GPS Consortium Steering Committee, 1984 - 1989; 1994 - 1996
Southern California Integrated GPS Array Coordinating Board, 1994 - 1997; Advisory Board, 1999 – 2005.
NRC Review Committee for NASA's Earth Science Enterprise Research Strategy for 2000-2010, 2000.
Southern California Earthquake Center 2, Fault Systems Working Group Chair, 2001 – 2006.
EarthScope Plate Boundary Observatory Standing Committee, 2003 – 2005.
NRC Committee to Review NASA's Solid-Earth Science Strategy, 2004.
NRC "Earth Science and Applications from Space: A Community Assessment and Strategy for the Future," member of Executive Committee and chair, Solid Earth Hazard, Resources, and Dynamics Committee, 2004 - 2007.
Jet Propulsion Laboratory Advisory Council, 2006 – 2017
Computational Infrastructure for Geodynamics, Executive Committee, 2006 – 2008.
NASA DESDynI Mission Science Study Group, co-chair, 2008 – 2012
NRC Committee on the Assessment of NASA's Earth Science Program, 2011 – 2012.
NASA DESDynI-R Science Definition Team, co-lead, solid Earth, 2012 – 2016
NASA NISAR Science Team, 2016 - 2019

Selected Ongoing Institute and EAPS Activities

MIT Energy Education Task Force (EETF), co-chair.
MIT Energy Minor Oversight Committee (EMOC).
MIT Energy Minor Faculty Advisor, Science.
University Coalition for Fossil Energy Research (UCFER), MIT Representative, Technical Advisory Council (TAC).
EAPS Solid Earth Search Committee, 2018 – 2019.

Awards and Honors

Alfred P. Sloan Foundation Fellow, 1982 - 1986
American Geophysical Union - James B. Macelwane Award, 1986
American Geophysical Union - Fellow, 1986
Distinguished Visiting Scientist, Jet Propulsion Laboratory, 1992 -
Orson Anderson Scholar, Los Alamos National Laboratory, 1996
Woollard Award, Geological Society of America, 2001
Hewitt Dix Memorial Lecture, California Institute of Technology, 2002
Fellow, American Academy of Arts and Sciences, 2009
Augustus Love Medal, European Geophysical Union, 2011
Inge Lehmann Medal, American Geophysical Union, 2013

Principal Research Interests

The physics of geologic processes, including mantle convection, crustal deformation, earthquake physics, precision modern geodesy using GPS and InSAR, reservoir geomechanics, induced seismicity, and CO2 sequestration.

Refereed Publications

Large-scale heterogeneities in the lower mantle: correlation with the gravity field, Adam M. Dziewonski, Bradford H. Hager and Richard J. O'Connell, *J. Geophys. Res., 82,* 239-255, 1977.

Subduction zone dip angles and flow driven by plate motion, Bradford H. Hager and Richard J. O'Connell, *Tectonophysics, 50*, 111-133, 1978.

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Kinematic models of large-scale flow in the Earth's mantle, Bradford H. Hager and Richard J. O'Connell, *J. Geophys. Res., 84,* 1031-1048, 1979.

On the thermal state of the earth, Richard J. O'Connell and Bradford H. Hager, in Adam M. Dziewonski and E. Boschi, eds, *Physics of the Earth's Interior,* Soc. Italiana di Fisica, Bologna, 270-317, 1980.

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Rheology, plate motions and mantle convection, Bradford H. Hager and Richard J. O'Connell, in S. K. Runcorn, ed., *Mechanisms of Continental Drift and Plate Tectonics,* Academic Press, London, 199-223, 1981.

A simple global model of plate dynamics and mantle convection, Bradford H. Hager and Richard J. O'Connell, *J. Geophys. Res., 86,* 4843-4867, 1981.

Melt segregation for partially molten source regions: the importance of melt density and source region size, Edward Stolper, David Walker, Bradford H. Hager, and James F. Hays, *J. Geophys. Res., 86,* n. B7, 6261-6271, 1981.

Subduction, back-arc spreading and global mantle flow, Bradford H. Hager, Richard J. O'Connell, and Arthur Raefsky, *Tectonophysics, 99,* 165-189, 1983.

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The distribution of earthquakes with depth and stress in subducting slabs, Marios S. Vassiliou, Bradford H. Hager, and Arthur Raefsky, *J. Geodyn., 1,* 11-28, 1984.

Convection experiments in a centrifuge and the generation of plumes in a very viscous fluid, Henri-Claude Nataf, Bradford H. Hager and Ron F. Scott, *Annales Geophysicae, 2,* 303-310, 1984.

Geoid anomalies in a dynamic Earth, Mark A. Richards and Bradford H. Hager, *J. Geophys. Res., 89,* 5987-6002, 1984.

A tomographic image of mantle structure beneath Southern California, Eugene D. Humphreys, Robert W. Clayton and Bradford H. Hager, *Geophys. Res. Lett., 11,* 625-627, 1984.

Lower mantle heterogeneity, dynamic topography and the geoid, B. H. Hager, R. W. Clayton, Mark A. Richards, Robert P. Comer, and Adam M. Dziewonski, *Nature, 313*, 541-545, 1985.

A critical assessment of viscous models of trench topography and corner flow, J. Zhang, B. H. Hager, and A. Raefsky, *Geophys. J., R. astr. Soc., 83,* 451-475, 1985.

Finite elements and the method of conjugate gradients on a concurrent processor, G. A. Lyzenga, A. Raefsky and B. H. Hager, 1985 *ASME International Computers in Engineering Conference & Exhibit, August 4-8, Boston, Conference Proceedings.*

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Exhibit 3

Hydro Québec

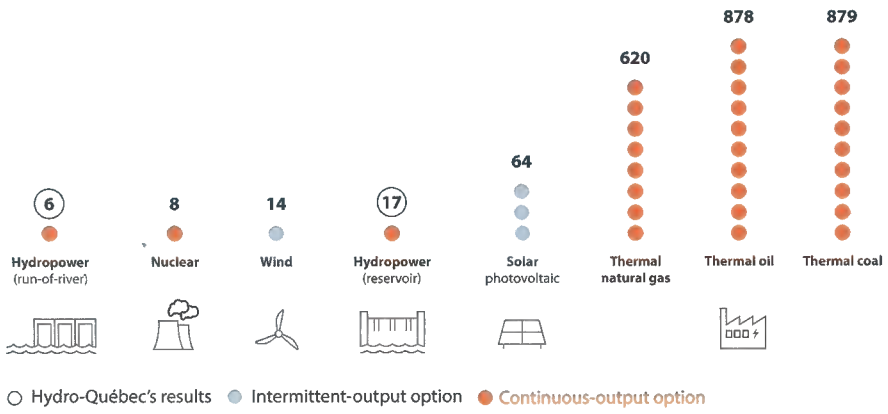
UNDERSTANDING QUÉBEC HYDROPOWER

AMONG THE LOWEST GREENHOUSE GAS EMISSIONS OF ALL ELECTRICITY GENERATION OPTIONS

All forms of electricity generation emit greenhouse gases (GHG) over the course of their lifespan (construction, operation and decommissioning). For hydropower, GHG emissions are mainly carbon dioxide, and to a lesser extent, methane, resulting from decaying vegetation in flooded land. Based on a life cycle analysis, net GHG emissions from Québec hydropower are significantly lower than electricity generation from natural gas and coal, and on par with wind.[1]

GHG EMISSIONS

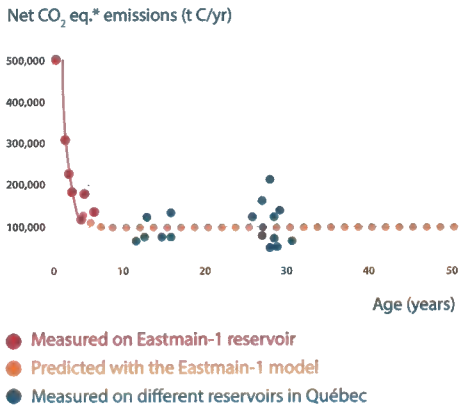
Power generation options (g CO_2 eq.*/kWh)



Temporary emissions

Hydro-Québec has been a pioneer in the study of greenhouse gas emissions from hydroelectric reservoirs. Our studies show that emissions peak immediately after reservoir creation, and **decline to natural lake levels within five to ten years.**[2]

Future Projections of Net GHG Emissions



METHANE IS NOT AN ISSUE IN QUÉBEC RESERVOIRS

Northern reservoirs emit little methane for two main reasons:

Location

Vegetation is very sparse in the **northern environments** where Hydro-Québec's reservoirs are located. Additionally, they are **far from agricultural or urban areas,** so run-off that reaches them is very low in organic matter and in nutrients. Less organic matter means that Québec reservoirs and lakes are less productive ecosystems than those in other regions.

Cold temperatures

Cold water contains **more dissolved oxygen** than warm water, leading to the formation of more carbon dioxide and less methane when organic matter decomposes. Some carbon in sediments decomposes to form methane due to low oxygen levels, but this will turn into carbon dioxide in the presence of oxygen in the water as it migrates to the surface. There is enough oxygen in one metre of the water column to oxidize the methane produced.