ONTARIO RIVERS ALLIANCE

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16 September 2022

Maryanna Lewyckyj
Ministry of Energy
77 Grenville Street
Toronto, ON
M7A 2C1

By email: Maryanna.Lewyckyj@ontario.ca

Re: ERO 019-5816 - Development of a Clean Energy Credit Registry

Dear Ms. Lewyckyj:

The Ontario Rivers Alliance (ORA) is a not-for-profit grassroots organization with a mission to protect, conserve and restore Ontario riverine ecosystems. ORA advocates for effective policy and legislation to ensure that development affecting Ontario rivers is environmentally and socially sustainable.

The ORA is pleased to respond to the Ministry of Energy's request for public input on its proposal to introduce a clean energy credit (CEC) registry and associated processes to support the creation, recognition, tracking and retirement of voluntarily purchased CECs within the province.

The basis of the CEC certification program is that an instrument is derived from the positive environmental attributes associated with clean electricity generation projects. A CEC is proposed to represent one megawatt-hour (MWh) of clean electricity that has been generated from a non-emitting source, such as solar, wind, bioenergy, hydroelectric and nuclear power. This program is designed to encourage and facilitate individual and corporation targets of 100 percent clean electricity generation and consumption.

ORA supports a Clean Energy Credit and Registry for a realistically targeted threshold of GHG emissions for a certified source of electricity generation that is grounded in science and integrity.

The ORA will primarily address hydroelectric generation as it is erroneously being considered a *"non-emitting source"* of "clean" energy. We will provide an argument for why it should not be considered clean and non-emitting. We will discuss the extensive body of published scientific evidence relating to hydroelectric and its serious environmental impacts (impaired water quality, degraded aquatic ecosystems, endangered aquatic species, etc.) and the substantial greenhouse gas (GHG) emissions generated daily and over the life of the facility.

Recommendation 1:
Due to the large body of evidence and studies published over the last 30 years reporting on the significant amounts of carbon dioxide (CO_2) and methane (CH_4) emissions released from hydroelectric reservoirs/headponds, that:

a. Hydropower be recognized and labeled as a GHG emitter;

b. that existing operators be required to measure diffusion, ebullition, and degassing of carbon dioxide and methane daily within the reservoir, at the turbines, spillway, and downstream of the dam; and
c. be required to report emissions to the certification authority daily.

Recommendation 2:
As a critical part of the certification process, to ensure the integrity of the process and to determine whether an electricity generator (new and existing) qualifies under the CEC program, all applicants must be required to undertake a credible independent third-party study to determine their average daily, seasonal, annual, and life cycle (including construction, operation, maintenance, upgrades and decommissioning) GHG emissions (carbon dioxide and methane), per megawatt-hour, of all components of the facility's operations. In the case of waterpower, measure the diffusion, ebullition, and degassing of carbon dioxide and methane emissions from the reservoir, the turbines, spillway, and downstream of the dam.

Recommendation 3:
Since there is no defensible argument for any zero-emission energy source at this time, the Ministry must set and enforce a strict, reasonable, and defensible GHG emission threshold standard, as well as environmental sustainability requirements, for a high-quality CEC. It will be essential for the Ministry or certification authority to strictly monitor the facility and enforce compliance with the CEC certification to ensure the program has integrity and provides value and assurance to the customer.

Recommendation 4:
Clean must mean more than just non-emitting. There must be core principles that ensure accurate and verifiable climate impact, is environmentally sustainable and responsible, and a form of electricity generation that does not kill or maim wildlife, degrade water quality or negatively impact Indigenous communities.

Recommendation 5:
a. A certified operator be provided with incentives to improve the clean and sustainable operation of their electricity generator (lower their emissions, mitigate adverse effects, install fish passage, etc...)
b. If an operator exceeds a threshold, they are out of compliance and must be removed from the program until the facility is brought back into compliance.
c. If an operator exceeds a threshold 5 to 10 times, they must be removed from the program until they mitigate the issue and bring their facility/operation into reliable compliance.

Certification

The Ministry is seeking to facilitate the generation and consumption of 100 percent clean and non-emitting electricity; however, emission-free energy does not exist at this time. All electricity generation facilities produce emissions throughout their life cycle, including construction, operation, maintenance, upgrades, and decommissioning, and must be considered and made clear to the CEC customer. It is crucial that CECs carry strong integrity and are credible, consistent, and reliable. If an individual or corporation purchases a CEC, they must receive what was advertised and purchased. It means that GHG emissions must actually be measured and monitored daily through a method grounded in evidence-based science.

If the CEC is to be of high quality and have integrity, the government must first set and enforce a definitive threshold standard for clean and non-emitting electricity. To provide an individual or corporation with an opportunity to purchase a high-quality CEC, the electricity source must be accurately assessed through a rigorous certification process. If an electricity generation facility emits GHGs, it must be identified, measured, monitored, and labeled as an emitter.

Environmental sustainability of the generator is essential to any CEC certification program and must be required before it is granted. All forms of electricity generation have some form of environmental impact - solar replaces habitat, wind kills birds and bats, hydropower harms fish and mussels, and nuclear produces waste.

If a "non-emitter" exists, it is not hydroelectric. It would be unethical and fraudulent to knowingly sell 100 percent clean and non-emitting hydroelectric CECs when there is such a large body of evidence to the contrary.

Greenhouse Gases:

GHG emissions of methane (CH_4) and carbon dioxide (CO_2) may be released from reservoirs through four different pathways to the atmosphere: (1) diffusive flux at the reservoir surface, (2) gas bubble flux in the shallow zones of a reservoir, (3) water degassing flux at the outlet of the powerhouse downstream of turbines and spillways, and (4) flux across the air–water interface in the river downstream of the dam.[1]

Methane is a potent greenhouse gas with a heat-trapping capacity 28 to 34 times greater than carbon dioxide over a 100-year time scale, and measured over a 20-year time period, that ratio grows to 84 to 86 times.[2]

Methane is generated in reservoirs from bacteria living in oxygen-starved environments. *"These microbes eat organic carbon from plants for energy, just like people and other animals, but instead of breathing out carbon dioxide, they breathe out methane."*

The fuel for these emissions is the rotting organic matter left behind when the reservoir is initially flooded, as well as the vegetation, litter, and organic matter that washes into the system regularly from rain events and seasonal flooding. Lakes and rivers can be both a source and a sink of GHG emissions; however, when this organic matter and sediment continually accumulate behind the dam, it fuels emissions and guarantees the continued release of methane and carbon dioxide from the reservoir throughout the life of the dam.

Additionally, river networks with high nutrient and sediment loading from agricultural or wastewater effluent provide microbial communities with a more significant source of nutrients that can deplete sediment oxygen and fuel even more methane production. When water bodies become eutrophic, algal blooms can result in excessive nutrient loading that further enriches reservoir sediments that fuel methane.[3] This is why methane production can vary significantly

[1] *Yang, Le; Lu, Fei; Zhou, Xiaping; Wang, Xiaoke; Duan, Xiaonan; Sun, Binfeng, 2014. Progress in the studies on the greenhouse gas emissions from reservoirs.*
[2] *Myhre, G., Shindell, D, Breon, F.-M., Collins, W., Fuglestvedt, J., Huang, J., Koch, D., Lamarque, J.F., Lee, D., Mendoza, B., Nakajima, T., Robock, A., Stephens, G., Takemura, T., Zhang, H., Anthropogenic and natural radiative forcing. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Chapter 8, Table 8.7; Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S. K., Boschung, J., Nauels, A., Bex, V., Midgely, P. M., Eds.; Cambridge University Press: Cambridge, U.K. and New York, U.S.A., 2013.*
[3] *West, W.E.; Coloso, J.J.; Jones, S.E. Effects of algal and terrestrial carbon on methane production rates and methanogen community structure in a temperate lake sediment. Freshw. Biol. 2012, 57 (5), 949−955.*
Online: https://www3.nd.edu/~sjones20/ewExternalFiles/Westetal2012_FWB.pdf

from location to location and is very site-specific. Therefore, certification would need to be very site-specific when evaluating GHG emissions coming from a hydroelectric facility and its reservoir.

The total amount of GHGs emissions from a hydroelectric facility is dependent upon many factors, including the impounded reservoir, terrain, amount of organic matter, air-water temperature, reservoir depth and size, vegetation (algae and plant/tree litter), pH values, oxygen levels, flow velocity, water level fluctuations, wind speeds, precipitation, wetlands within the impoundment zone, and facility operating strategy (cycling and peaking to maximize power generation). Every hydroelectric facility is unique in its complexity and must be carefully studied and continually assessed and monitored to determine the total daily, seasonal and annual GHG emissions per MWh emanating from the system.[4]

Hydroelectric is neither Clean nor Non-Emitting:

Most governments and industry claim that hydroelectric generates clean energy, which is understood in most circles to mean that it does not emit GHGs. However, the collateral environmental damage caused by dams and waterpower facilities has been well documented for decades, including the loss or serious decline in migratory fish species (waterpower facilities are key factors in the listing of some iconic fish species as species at risk in Ontario and elsewhere)[5,6,] declining biodiversity[7], impaired water quality (including elevation of mercury concentrations in fish tissue), and are critical threats to imperiled aquatic species.[8] Significant ecological damage from waterpower has been ongoing for many decades in Ontario and other locations worldwide.[9] In the past, attempts to effectively mitigate many of these impacts have been sporadic to non-existent in Ontario.

The role of reservoirs as polluters and GHG emitters has resulted in a flurry of independent peer-reviewed studies laying out the facts. However, the hydropower industry has done a thorough job of promoting waterpower through its powerful misinformation megaphone to let the world believe it is clean and non-emitting while turning a blind eye to the growing body of evidence to the contrary.

A recent study out of Quebec quantified the long-term historical and future evolution of GHG emissions from 1900 to 2060, examining the cumulative global surface area of 9,195 reservoirs in four different climate zones (boreal, temperate, subtropical, and tropical) around the world. It reported that *"reservoir-induced radiative forcing continues to rise due to ongoing increases in*

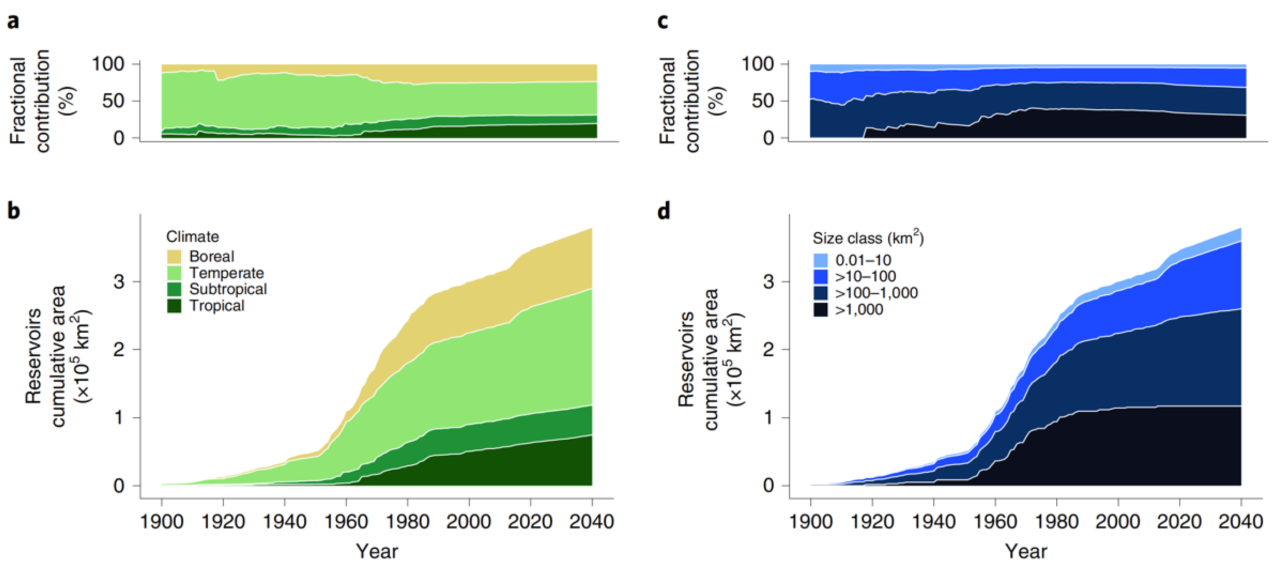
[4] *Yang, Le; Lu, Fei; Zhou, Xiaping; Wang, Xiaoke; Duan, Xiaonan; Sun, Binfeng. Progress in the studies on the greenhouse gas emissions from reservoirs.*
[5] *MacGregor, R., Casselman, J., Greig, L., Dettmers, J., Allen, W.A., McDermott, L., and Haxton, T. 2013. Recovery Strategy for the American Eel (Anguilla rostrata) in Ontario. Ontario Recovery Strategy Series. Prepared for Ontario Ministry of Natural Resources, Peterborough, Ontario. x + 119 pp. P-45.*
[6] *MacGregor, R., Haxton, T., Greig, L., Casselman, J.M., Dettmers, J.M., Allen, W.A., Oliver, D.G., and McDermott, L. 2015. The demise of American Eel in the upper St. Lawrence River, Lake Ontario, Ottawa River and associated watersheds: implications of regional cumulative effects in Ontario. Pages 149–188 in N. Fisher, P. LeBlanc, C. A. Rose, and B. Sadler, editors. Managing the impacts of human activities on fish habitat: the governance, practices, and science. American Fisheries Society, Symposium 78, Bethesda, Maryland.*
[7] *Carew-Reid, J., Kempinski, J., and Clausen, A. 2010. Biodiversity and Development of the Hydropower Sector: Lessons from the Vietnamese Experience – Volume I: Review of the Effects of Hydropower Development on Biodiversity in Vietnam. ICEM – International Centre for Environmental Management, Prepared for the Critical Ecosystem Partnership Fund, Hanoi, Viet Nam. Online: https://www.icem.com.au/documents/biodiversity/bioHPdevt/Volume%20I%20Biodiversity%20and%20development%20of%20hydropower-Vietnam%20experience.pdf*
[8] *Wilcove D.S., Rothstein, D., Dubow, J., Phillips, A., Losos, E. 1998. Quantifying threats to imperiled species in the United States BioScience 48: 607–615. Online: http://faculty.washington.edu/timbillo/Readings and documents/global div patterns origins/general tropical biodiv conservation/Wilcove_et_al Bioscience_1998 Quantifying_threats_to biodiv.pdf*
[9] *World Commission on Dams. 2000.*

reservoir methane emissions, which accounted for 5.2% of global anthropogenic methane emissions in 2020".[10]

> *"While CO_2 and CH_4 diffusion are modeled as decreasing with reservoir age, ebullition and degassing remain constant, such that these two latter emission pathways grow increasingly important with time. Thus, while CO_2 diffusion was the dominant flux pathway in the twentieth century, C–CH_4 emissions, mainly via ebullition and degassing, are expected to surpass C–CO_2 around 2032 and account for 75% of reservoir C emissions by 2060. In addition, the higher greenhouse warming potential of CH_4, relative to CO_2, amplifies the climate impact of CH_4 emissions. Furthermore, estimated fluxes do not account for future global temperature increases or water eutrophication changes, both of which would probably stimulate CH_4 emissions more strongly than CO_2. Methane emissions, and especially CH_4 ebullition and degassing are expected to dominate future reservoir C-GHG release (39% and 32% in 2060, respectively; (Fig. 2 - below), implying that mitigation efforts aimed at reducing CH_4 fluxes via pathways could be quite effective."* [11]

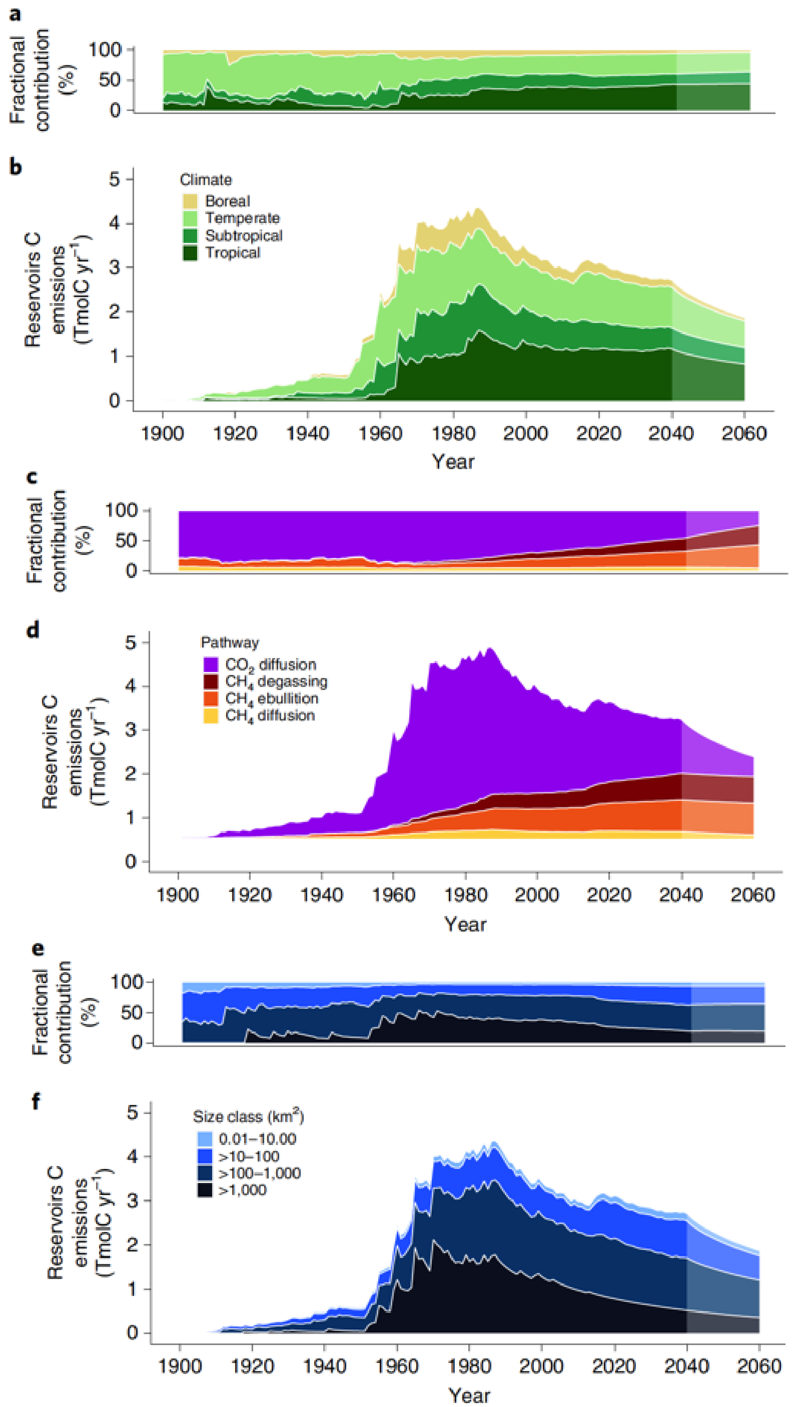
> *While temperate systems dominate global reservoir area (Fig.1), tropical and subtropical systems jointly surpassed temperate reservoirs as C emitters in the mid-1960s, and their relative contribution has increased steadily since, such that it is expected to reach 64% of total reservoir C emissions by 2060 (Fig.2).* [11]

Fig.1 | Evaluation of reservoir area. a-d, Global cumulative surface area of reservoirs through time, categorized by climate zone (**a**,**b**) and by reservoir size (**c**,**d**). (**a**,**c**) Fractional contribution of each climate zone (**a**) and size class (**c**) to total global reservoir surface area through time. [11]



[10] *Soued, C., Harrison, J.A., Mercier-Blais, S. et al. Reservoir CO_2 and CH_4 emissions and their climate impact over the period 1900–2060. Nat. Geosci.* ***15****, 700–705 (2022). https://doi.org/10.1038/s41561-022-01004-2*

Fig. 2 | Reservoir emissions through time. a–e, Temporal trends of reservoir yearly global carbon emission rate, categorized by climate (**a,b**), by flux pathway (**c,d**) and by reservoir size (**e,f**), with the fractional contribution of each category to the total (**a,c,e**). Lighter shading after 2040 indicates higher uncertainty of values beyond that date, owing to the simplifying assumption that no new reservoir construction will take place beyond that year. [11]



The study indicates that carbon dioxide and methane diffusion decrease within the first 20 or more years of a new reservoir being created; however, methane emissions through ebullition and degassing persist. Hydroelectric reservoirs are certainly not “clean” or “non-emitting”.

A Swiss study of a temperate hydropower reservoir indicates that “*the total methane emissions coming from Lake Wohlen, was on average > 150 mg CH_4 m^{-2} d^{-1}, which is the highest ever documented for a midlatitude reservoir. The substantial temperature-dependent methane emissions discovered in this 90-year-old reservoir indicate that temperate water bodies in older headponds can be an important but overlooked methane source”*.[11]

There are numerous other studies indicating that GHG emissions, primarily methane and carbon dioxide, are generated from all man-made reservoirs.

Run of River Hydropower:

Other than closed-looped Pumped Storage Hydro, the only lower-impact type of hydroelectric power generation is run-of-river, but a true run-of-river has no water storage capacity. In fact, building a true run-of-river facility is often not cost-effective on smaller rivers because of the high construction cost and the small amount of power produced as a result of low and unreliable flows. The Ontario Power Authority found efficiency to be as low as 15 to 30% of Installed Capacity.[12]

The daily, seasonal, and annual variations of small hydro operations are intermittent and unreliable. This is because generation peaks during the high flows of spring when power is in low demand and produces at its lowest during the hot summer months when consumption and demand are most heightened. During the low flow season of summer or during drought conditions, many true run-of-river and even some peaking (storage) facilities, especially on smaller rivers, cannot operate efficiently and must be shut down.

To further highlight this point, in 2014, an analysis was conducted by the Independent Electricity Systems Operator (IESO) to determine the best means of connection to remote First Nation communities and to enable forecasted growth of the Ring of Fire mining operation in northern Ontario. The analysis concluded that "*Northern hydroelectric generation is an energy limited resource known to have significantly reduced output and availability during drought conditions of the river system supplying these generating units.*[13] In fact, the recommendation of this report was to not build any new hydroelectric facilities but primarily build new transmission lines.

Run-of-river dams still accumulate sediment and litter behind the dam and release GHG emissions at the turbine intake, spillway, and downstream of the dam. A cost/benefit analysis should be required to determine whether these types of projects are environmentally and/or economically viable and whether they could even qualify for certification and CECs.

[11] *DelSontro, Tonya, McGinnis, Daniel F., Sobek, Sebastian, Ostrovsky, Ilia, Wehrli, Bernhard, 2010, Extreme Methane Emissions from a Swiss Hydropower Reservoir: Contribution from Bubbling Sediments. Online: https://pubs.acs.org/doi/full/10.1021/es9031369*
[12] *North of Dryden Integrated Regional Resource Plan – January 27, 2015, by OPA/IESO. P-56 & 124. Online: http://www.noma.on.ca/upload/documents/north-of-dryden-report-2015-01-27.pdf*
[13] *North of Dryden Integrated Regional Resource Plan – January 27, 2015, by OPA/IESO. P-56 & 124. Online: http://www.noma.on.ca/upload/documents/north-of-dryden-report-2015-01-27.pdf*

Peaking/Cycling Operations:

Many hydroelectric facilities rely on peaking or cycling operating strategies to maximize power generation during peak demand hours. This results in hourly and/or daily water level fluctuations, result in a wetting and drying effect over vast areas of the reservoir. This wetting and drying increases the amount of GHGs released into the atmosphere.

For instance, researchers used a database based on satellite imagery. It contained monthly data on the size of water surface areas from around 6,800 dams worldwide between 1985 and 2015. For these 30 years, the scientists were thus able to determine exactly when, where, and for how long the dams were not completely filled and how large the dry areas were. On average, 15% of the total reservoir surface was not covered by water. The scientists used this figure to further calculate the carbon release from these areas. *"Our calculations show that carbon emissions from dams had been significantly underestimated. On a global average, they release twice as much carbon as they store. Their image as a net carbon store in the global carbon cycle must be reconsidered."* [14]

Conclusion:

Just because hydroelectric facilities are not spewing out smoke does not mean they are clean or emission-free. In fact, waterpower makes a significant daily contribution to the earth's accumulation of GHGs into our atmosphere[15] and has resulted in significant and ongoing impacts on water quality, water quantity, ecological processes, fish and wildlife populations, and habitat[16], as well as to aboriginal communities.

A very high environmental and socio-economic price has been paid in the past in terms of losses to valued natural resources due to the installation of dams and waterpower facilities. The socio-economic costs of these losses are generally ignored[17,18] and rarely reported to the public.

It is imperative that legislation, policy, and the CEC certification and guidelines properly recognize all sources of GHG emissions and lay the groundwork for a meaningful, measurable, and accountable process. If GHG emissions are not accurately identified or accounted for, and measured, this government will only send us deeper into climate peril.

In closing, the ORA requests that the Minister remove the label of clean and non-emitting from hydroelectric generation. Certification will mean nothing if there is no verifiable science-based method of reducing world GHG emissions. Furthermore, it would be unethical to mislead the public and corporations into believing they are paying for clean and non-emitting electricity when they are, in fact fueling climate change.

We have attempted to keep this submission as short as possible; however, many more studies could be cited to support the argument that hydroelectric is not clean or non-emitting.

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[14] *Science Daily, May 13, 2021, Helmholtz Centre for Environmental Research - UFZ*

[15] *Scherer, L, Pfister, S., 2016. Hydropower's Biogenic Carbon Footprint. Online: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0161947 - :~:text=Hydroelectric reservoirs are a source,emissions at the global scale*

[16] *PEW Environment Group. 2011. A Forest of Blue: Canada's Boreal. Online: https://www.pewtrusts.org/en/research-and-analysis/reports/2011/03/16/a-forest-of-blue-canadas-boreal*

[17] *Wang, G., Fang, Q., Zhang, L., Chen, W., Chen, Z., Hong, H. 2010. Valuing the effects of hydropower development on watershed ecosystem services: Case studies in the Jiulong River Watershed, Fujian Province, China, Estuarine Coastal and Shelf Science. 86.3*

[18] *Institute for Fisheries Resources.1996. Cost of Doing Nothing: The economic burden of salmon declines in the Columbia River basin. Report No. 1 of 3. Online: https://pcffa.org/wp-content/uploads/2016/10/CDNReport-Columbia.pdf*

Please include the ORA in any other related consultations and let me know if you have any questions or need any clarification.

Thank you for the opportunity to comment on this important issue.

Respectfully,

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