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**Director General**
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James Michael Flaherty Building
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**Re: Consultation on the Clean Hydrogen Investment Tax Credit**

Electrochaea Corporation (Electrochaea) appreciates the opportunity to submit the following comments to the *Department of Finance Canada* for the Consultation on the Clean Hydrogen Investment Tax Credit. Electrochaea supports the availability of the clean hydrogen tax credit on eligible investments made as of the day of Budget 2023 and recommends that it should not be delayed.

## A. BACKGROUND ON ELECTROCHAEA

Electrochaea Corporation, a subsidiary of Electrochaea GmbH, is a provider of a power-to-gas biomethanation solution for the industrial-scale production of grid-quality synthetic methane[1], a process which utilizes clean hydrogen as a feedstock. Power-to-gas biomethanation, accomplished by a biological organism, which is a methanogenic archaeon, uses renewable power to produce clean hydrogen that is combined with carbon dioxide to form clean, renewable synthetic methane. The power-to-gas biomethanation process can decarbonize the gas grid by replacing fossil natural gas with renewable synthetic methane. Power-to-gas also provides long-duration renewable energy storage. Biomethanation utilizes clean hydrogen to store renewable energy in the C-H bonds of the synthetic methane molecule, thus it is an innovative method to store intermittent energy. The Canada Energy Regulator, as part of its Energy Future series, expects large electric capacity additions by 2050 dominated by wind and solar under all of six net-zero scenarios[2]. As intermittent renewable energy sources are increased, the temporal imbalance between production and consumption increases the demand for energy storage. Unlike a conventional battery, energy stored on the gas grid is not subject to loss-of-charge, nor loss of capacity, over time. The gas grid can also seasonally store the energy by time-shifting the availability of renewable energy, which may be especially needed during cold winter months. Power-to-gas biomethanation technology can play a significant role in meeting Canada's climate goals with the support and recognition of the value of the technology, and those like it, from agencies in the country. Electrochaea has been actively exploring potential biomethanation projects to serve the Canadian market.

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[1] Clean, synthetic methane is a replacement for fossil natural gas, as is renewable natural gas (RNG) or biomethane.
[2] https://www.cer-rec.gc.ca/en/data-analysis/canada-energy-future/2021/key-findings.html

## B. SPECIFIC COMMENTS ON THE CONSULTATION

2. **What would constitute appropriate carbon intensity tiers in the Canadian context? What makes such tiers appropriate?**
3. **Under what carbon intensity tiers are the different clean hydrogen production pathways in Canada expected to be found?**
4. **What level of support would be appropriate for each carbon intensity tier, including the proposed top rate of at least 40 percent?**

Hydropower should be eligible for the highest tier of support to achieve competitiveness with the US Clean Hydrogen Production Standard. To maintain competitiveness with the hydrogen-related incentives in the US, the carbon intensity (CI) tiers should match the support that the Inflation Reduction Act of 2022 (IRA) is providing for hydrogen production. However, because the Government of Canada's Fuel Life Cycle Assessment (LCA) Model is different from the US GREET Model regarding hydrogen production, we recommend different CI tiers than those adopted in the US. We recommend adopting CI tiers under the Canadian standards to ensure technologies that qualify for support under the US IRA will also qualify for the same level of support under the Canadian standard.

Comparing the CI for electrolysis using different electricity sources is one example to illustrate how to align incentives with Canada and the US. In the US, the GREET Model is the lifecycle tool used to measure the CI tiers. In the US context, renewable electricity sources such as hydropower, wind, and solar PV are given a CI of 0, qualifying those energy sources for the full incentive established in the IRA. However, those same renewable electricity sources are given higher values in the Government of Canada's Fuel Life Cycle Assessment Model, as shown in Table 1[3].

Table 1: Life Cycle Tool CI Comparison

| | **CI Result (kg $CO_2e$/kg $H_2$)** | |
|---|---|---|
| **Electricity Source for Electrolysis** | **Canada LCA Model CI** | **US GREET Model CI** |
| Hydropower | 1.470 | 0 |
| Wind | 0.005 | 0 |
| Solar PV | 0.002 | 0 |
| Nuclear | 0.371 | 0.364 |

Since the CI of the different forms of renewable electricity are not the same using the LCA tools used in Canada and the US, we recommend different CI tiers be used. The tier that should receive the largest percentage tax credit should be a CI of <1.5 kg $CO_2e$/kg $H_2$. This level permits the inclusion of electrolytic hydrogen production using hydropower electricity. Considering that 60% of Canada's total electricity production is from hydropower[4], the government should ensure that this dominant renewable source of electricity is eligible for the highest level of support as it is in the United States' scheme. The "Hydrogen Strategy for Canada" published in 2020 advocates for electrolytic hydrogen production via hydroelectric generation capacity as a clean and abundant option[5]. Therefore, clean hydrogen produced from solar PV, wind and hydropower should all be eligible for the proposed top investment tax credit rate of at least 40 percent.

[3] kg $CO_2$/kg $H_2$ values were found assuming 205.5 MJ of electricity is required to produce 1 kg of $H_2$ for each electricity source.
[4] https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-canada.html#:~:text=More%20than%20half%20of%20the,and%20petroleum%20(Figure%202
[5] https://www.nrcan.gc.ca/sites/nrcan/files/environment/hydrogen/NRCan_Hydrogen-Strategy-Canada-na-en-v3.pdf

5. **What equipment is required at clean hydrogen production facilities? Is there equipment that is external to the facility that may be needed to support clean hydrogen production and how should the government consider eligibility for that equipment under the clean hydrogen investment tax credit or other investment tax credits?**

Power-to-gas biomethanation can support clean hydrogen production. Biomethanation produces grid-quality renewable synthetic methane, a replacement for all uses of fossil natural gas, using clean hydrogen and carbon dioxide. While hydrogen is more difficult and expensive to store and transport than natural gas, it can be used directly to produce synthetic methane which can be easily stored and transported in the existing gas infrastructure. As markets for clean hydrogen develop, risks will be reduced if multiple end users are supported. New sectors which use clean hydrogen will drive and expand the clean hydrogen market[6].

Investment mechanisms should be inclusive of innovative technologies that can stimulate clean hydrogen market growth. Biomethanation will achieve full-scale commercialization only in the years ahead. Such new innovative technologies will be required to achieve Canada's commendable decarbonization goals, where existing technologies may be necessary, though insufficient. Given the urgency to reduce GHG emissions, investment in technologies that have reached and are reaching commercial readiness, but have low adoption rates, should be expanded. Investment mechanisms should include such technologies to accelerate their availability and leverage their readiness for widespread commercialization. A full portfolio of tools is needed to achieve Canada's climate goals and limiting support for clean hydrogen production will stifle needed innovation.

Electrochaea believes that the "Clean Hydrogen Investment Tax Credit" should be inclusive of innovative technologies that can stimulate clean hydrogen production such as electrofuels, synthetic fuels manufactured using carbon dioxide or carbon monoxide in combination with clean hydrogen produced by electrolysis. For example, in Europe, renewable fuels derived from electricity, such as clean hydrogen or synthetic methane, are grouped as "Renewable Fuels of Non-Biological Origins" (RFNBOs) and benefit from joint support mechanisms such as subsidies or quotas. Among other means of support, the government can consider extending the eligibility criteria to the "Investment Tax Credit for Carbon Capture, Utilization, and Storage" to include electrofuels. Alternatively, an investment tax credit for the production of biofuels (inclusive of renewable natural gas and synthetic methane), similar to the one that will be implemented in Quebec in 2023[7], is also an appropriate measure.

6. **What are the most common methods used to prepare clean hydrogen for transportation, including the various forms that hydrogen could take (e.g., compressed gas, liquid, or intermediate "hydrogen carrying" products like ammonia or methanol)? What stationary infrastructure is required to prepare hydrogen for transportation, either domestically or internationally?**

Synthetic methane is a hydrogen carrier. As a low-carbon intensity energy source, clean hydrogen is an attractive resource for Canada's decarbonization plan. While recognizing its advantages, it is also important to acknowledge that hydrogen can be challenging to store and transport. For example, it can embrittle some current infrastructure materials such as pipeline steel, posing challenges for its wide-spread, near-term use without significant investment[8]. On the other hand, power-to-gas biomethanation uses renewable power to produce clean hydrogen which is then combined with carbon dioxide to form renewable synthetic methane, a substitute for natural gas in all its applications. Storing hydrogen in the form of renewable methane makes it possible to utilize existing gas infrastructure and equipment (distribution networks, injection points, natural gas boilers, etc.), avoiding the new construction of specific hydrogen infrastructure. Renewable methane meets the CI standards anticipated for both the Canadian and US regulations and can be transported either domestically

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[6] In the 2021 tracking report from the International Energy Agency on hydrogen, it is concluded that "demand growth in new sectors (e.g. for some transport and industrial applications, production of synthetic fuels and electricity storage)," will drive the expansion of the clean hydrogen market. https://www.iea.org/reports/hydrogen

[7] https://home.kpmg/ca/en/home/insights/2022/08/quebec-businesses-going-green.html#:~:text=Measure%20announced%20in%20the%202022%20Qu%C3%A9bec%20budget&text=Qu%C3%A9bec%20proposes%20to%20offer%20the,sale%20and%20use%20in%20Qu%C3%A9bec.

[8] https://www.energypolicy.columbia.edu/sites/default/files/file-uploads/Green%20hydrogen%20report,%20designed,%2009.07.21.pdf

or internationally through the existing gas grid infrastructure that has already been built out over the past centuries. Ultimately, biomethanation captures important benefits from clean hydrogen while delivering renewable methane suited to grid-scale use and reduction in GHG emissions.

**7. Life cycle carbon intensity calculation:**

**a. Are there any concerns with using the Government of Canada's Fuel Life Cycle Assessment Model for calculating the life cycle carbon intensity of clean hydrogen production?**

In comparing Canada's hydrogen program with other clean hydrogen incentives around the world, we believe the different scope of the Government of Canada's Fuel Life Cycle Assessment Model disadvantages hydrogen produced using hydropower. Namely, both the GREET model used for the US Inflation Reduction Act (IRA) and the underlying rules for Renewable Fuels of Non-Biological Origin (RFNBO) in the European Union (EU) give hydropower a carbon intensity (CI) value of zero as a renewable energy source. However, in Canada's Fuel Life Cycle Assessment Model, hydropower has a much higher CI (shown in Table 1). Depending on how the support tiers are established, there is a risk of disadvantaging Canada's own strong hydropower base against countries with similar energy profiles. For example, under the proposed EU rules on RFNBOs, producers in countries with a share of over 90% renewable electricity in the grid can source grid power directly to produce qualified hydrogen. The definition of renewable electricity under Article 2 (1) of Directive (EU) 2018/2001[9] includes hydropower, enabling producers in countries such as Sweden to automatically qualify due to their high proportion of hydropower on the grid[10]. To maintain competitiveness globally for hydrogen production, we recommend highlighting the important role that hydropower can play and avoid potential disadvantages that may arise when using Canada's Fuel Life Cycle Assessment Model.

**b. What additional guidance or support could be provided to help with the calculation of life cycle carbon intensity of clean hydrogen production with this model?**

<u>Wide availability of training resources.</u> To facilitate the correct calculations by practitioners, webinars and workshops should be held, and manuals should be distributed. For this program, it is important that LCA practitioners be able to correctly evaluate projects and therefore assess the correct tax credit while mitigating overall project risk. While the OpenLCA platform is widely used, specific guidance and instruction for Canada's Clean Hydrogen program should be made available.

**c. What should be included in the scope of the life cycle carbon intensity calculation? How could this extend to clean hydrogen that is produced alongside co-products, or as a by-product of an industrial process?**

<u>Well-to-gate system boundary for life cycle carbon intensity calculation.</u> To focus on all the greenhouse gas emissions caused by hydrogen production, Electrochaea recommends a well-to-gate scope that ends with the produced hydrogen. A well-to-gate system boundary for clean hydrogen production includes emission sources that affect the CI of the produced hydrogen. This boundary should include emissions that are directly caused by the production process as well as indirect upstream and downstream impacts. Direct process emissions are any greenhouse gases released at the production facility including combustion or other chemical reactions. Indirect upstream emissions should include the extraction, processing, and delivery of any energy source including fuel or electricity, or other feedstocks used in the process. Indirect downstream emissions include the processing, transport, or disposal of any waste or emissions generated at the hydrogen production facility. This may be especially important when carbon capture and sequestration are used to reduce the produced hydrogen's CI.

<u>Exclusion of electrical and transmission infrastructure.</u> We recommend excluding the impact of the construction of any electrical infrastructure including generating and transmission infrastructure. We also recommend excluding the impact of the construction of the clean hydrogen production facility. These types of impacts are

[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001
[10] https://sweden.se/climate/sustainability/energy-use-in-sweden

relatively small when distributed across the technology's lifespan of 20-25 years and would likely vary by site and manufacturer. This approach is in alignment with that taken by the US GREET lifecycle model.

Co-products that displace other processes should be included in the calculation. Lifecycle greenhouse gas emissions should be allocated to co-products from the clean hydrogen production process in a way that reflects the actual displacement of other energy sources or industrial processes. Therefore, we recommend a system expansion approach to best capture the benefits of utilizing these co-products. For example, a co-product of steam should be credited with the emissions savings associated with the amount of natural gas combustion required to produce that same amount of steam. We also advocate for the explicit inclusion of any utilized process heat as an eligible co-product, even if it is not steam. The electrolysis process releases heat that can be incorporated into other processes, and if that heat is incorporated into another process, it can promote emissions savings. Likewise, oxygen is a potentially valuable co-product of electrolysis and should be compared against the displacement of traditional oxygen production methods such as through cryogenic methods.

8. **Once hydrogen is being produced, by how much would the carbon intensity differ from the carbon intensity that was expected based on the design of the plant? Does this differ by production pathway? Is it possible to ensure that the carbon intensity of the clean hydrogen produced will be within a certain band and would this change over time? For the different clean hydrogen production pathways, what ongoing monitoring and calculations are done to measure carbon intensity once a clean hydrogen facility begins production?**

Indirect book accounting factors for electrolysis. The sourcing of renewable electricity is crucial to ensure that electrolytic hydrogen qualifies as clean. Indirect book accounting factors, such as renewable electricity certificates (RECs), should be included to source renewable electricity since it would encourage investment in a variety of technologies. For electrolysis, being able to secure clean electricity from a grid connection simplifies project logistics and reduces the investment risk for the installation of electrolyzers. However, it is important that the use of indirect book accounting factors be verified during operation, since the source of electricity greatly impacts the lifecycle carbon intensity of the produced hydrogen. Timing and vintage should consist of yearly matching in the same calendar year and a wide geographical scope should also be considered to maintain coherent markets and operational stability for electrolyzers.

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Electrochaea believes that the Clean Hydrogen Investment Tax Credit is an important step to accelerate the decarbonization of Canada's energy supply by incentivizing new innovative technologies such as our power-to-gas biomethanation process. Accordingly, Electrochaea appreciates the opportunity to submit these comments.

Sincerely,

**Mich Hein**
CEO
Electrochaea Corporation