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Standing Committee on Environment and Sustainable Development

Sixth Floor, 131 Queen Street

House of Commons Ottawa

ON K1A 0A6

Via email: ENVI@parl.gc.ca

RE: Brief on Clean Technologies

Next Hydrogen is pleased to provide feedback to the House of Commons Standing Committee on Environment and Sustainable Development pursuant to its study on Clean Technologies in Canada. This briefing will describe Next Hydrogen's innovative water electrolysis technology and how it can be used to curb emissions within Canada and globally.

Next Hydrogen is an Ontario-based Canadian clean technology company and a leader in the green electrolyser space. We are involved in researching, demonstrating, manufacturing in Canada, and deploying green electrolysers at home and abroad. Our mission is to drive reduced costs of green hydrogen production from renewable energy sources and enable the widespread adoption of green hydrogen solutions to decarbonize the global economy.

Founded in 2008, our company has evolved to become a leader in the development, commercialization, and sale of water electrolysis technology and adoption of green hydrogen fuel solutions. Next Hydrogen makes it economical to generate hydrogen on-site and at scale by enabling unprecedented operational flexibility through our revolutionary electrolyser design. Our electrolysers were created specifically for variable operation to capture the entire output range of intermittent or fluctuating sources of electrical power, including renewables, using significantly smaller or fewer units than a traditional electrolyser solution.

We have been awarded 39 patents, with more pending, across multiple jurisdictions, and we were recently ranked #1 among publicly traded companies in the Future 50 Fastest-Growing Sustainable Companies in Canada by Corporate Knights.

Next Hydrogen is providing hydrogen generation solutions to decarbonize industrial processes and transportation. In partnership with Canadian Tire, we created one of the largest on-site hydrogen generation projects globally in Ontario; a first-of-its-kind "green hydrogen system", the project utilizes hydrogen powered forklifts and electrolysis fuel technology to produce 1.5 tonnes of hydrogen per day. What's more, we also have fuel cell vehicle programs with Hyundai and Kia underway.

It is estimated that hydrogen technology could represent 25% of global energy needs by 2050. As such, countries representing 70% of the world's GDP have incentives to use clean technology to dramatically drive down emissions. Our water electrolysis technology provides Canada with the opportunity to significantly lower carbon emissions, while simultaneously supporting job growth and economic development.

I. Technology Overview

Next Hydrogen has developed an advanced, large (multi-MW) scale water electrolyser that produces green hydrogen from water and green electricity. Our product is a large-scale, electrolytic hydrogen generator. Core to the system is the electrolyser module, where electricity is used to produce clean hydrogen gas which is sent to downstream user processes or hydrogen storage for use as a clean fuel. If electricity from renewable energy sources, such as wind and solar, are utilized, then green hydrogen is produced with no GHG emissions.

Our current NH300 model system is a turnkey system used for small, on-site hydrogen production, and is provided in a containerized form for accessible shipping and installation. We currently are developing scaled-up modules and multi-unit systems with greater hydrogen production capacities to match with large, difficult to abate industrial and transportation applications.

Next Hydrogen's design features numerous unique and innovative design benefits, including:

(1) **High gas production rates:** Our innovative design allows for operation at very high hydrogen production capacities (2-2.5 times higher than conventional electrolysis technologies) using high current densities resulting in more cost-effective operation of the electrolysis module. This drastically lowers the capital cost on a per unit production basis.

(2) **Dynamic Operation tied to Renewables:** Our innovative fluid flow design allows the entire output of intermittent or fluctuating sources of electrical power to be captured, while also using significantly fewer units than other available electrolysers. This allows customers to take advantage of low-cost grid electricity opportunities and to capture highly variable renewable energy for green hydrogen production in a cost-effective manner. Our electrolysers also feature a "boost" mode, which allows customers to make more hydrogen faster when electricity is least expensive, thereby reducing operational costs without incurring additional capital costs.

(3) **Inherent scalability:** Each half cell exhibits the same fluid flow, regardless of the total number of cells in an electrolyser module. The modular system allows the technology to be scaled to meet the needs of very large capacity hydrogen projects.

II. Market for Green Hydrogen

In 2020, the overall market for hydrogen was 70 million tons per year valued at $155 billion, primarily in petrochemicals refining and ammonia production related to fertilizers. The market is expected to grow significantly as hydrogen energy applications are adopted for transport, power generation, industrial energy and building heat and power. Countries around the world are including hydrogen power in their net-zero strategies through regulations and policies that support development efforts.

There are common overall barriers to entry for the commercialization of green hydrogen in high-emitting markets, including:

(1) **Large-scale production:** electrolysis must be scaled up significantly to meet the growing hydrogen needs of industrial and transport applications.
(2) **Electricity costs:** the cost of green hydrogen heavily depends on access to low-cost, efficient, and renewable power.
(3) **Other hydrogen sources:** green hydrogen will need to compete with other forms of generation, including grey (fossil fuel-based) and blue (carbon capture and storage technology-based) hydrogen.
(4) **Robust solutions:** Ensuring the technology available meets lifetime, reliability, performance and bankability targets will lead to broader adoption.

Certain high-emitting market segments have carbon emissions that are difficult to reduce and require large-scale, renewable energy-based hydrogen to achieve net-zero emission targets. They also face barriers to entry and other market dynamics in adopting green hydrogen. These key market segments, and the associated challenges in green hydrogen production, include:

(1) Industrial hydrogen:

a. **Ammonia:** Used in fertilizer production, chemicals, and potentially as an energy carrier, green hydrogen can be used as a feedstock for ammonia. To meet the large-scale needs of hydrogen demand in this sector, electrolysis must be scaled up and the cost of hydrogen should achieve $3.50/kg in 2030 to be competitive. Although each major ammonia producer has announced strategies for green hydrogen, the market is still in development.
b. **Methanol:** Methanol can be generated by combing green hydrogen and CO2, but production requires access to significant and consistent sources of CO2 and renewable energy. The cost of hydrogen needs to meet $3.35/kg to be cost-effective for methanol production. Currently, clean methanol production is in the early stage of implementation, with 20 plants currently operated or planned worldwide, and significant interest in Europe and California.
c. **Steel:** Green hydrogen can displace fossil fuels used in electric arc furnaces that produce iron, enabling nearly carbon neutral steel production. Large scale production is needed in this sector, however initial market entry with other hydrogen production sources is expected. For green hydrogen to be economically feasible in steelmaking, the cost of hydrogen should reach

$2.25/kg. Several steel companies are seeking to invest in green hydrogen use, with some small-scale pilots underway.

(2) Transport fuel:

a. **Vehicles and trucks:** Fuel cell electric vehicles is another application of green hydrogen. The development and adoption of hydrogen-powered vehicles is dependent on advancements in hydrogen fuel production. High capital costs can be reduced by deploying hydrogen fuel at a large scale. Long-term, hydrogen fuel should reach $4.50/kg to be competitive with diesel, while in the short-term, cost targets of $6.50-$15.50/kg are sufficient for smaller-scale deployments. Many fuel-cell electric vehicles are in demonstration stages, while material handling is commercial-ready and transit buses are seeing significant expansion.

Amidst a supply chain shortage-driven economic downturn, and increasingly protectionist trade policy tendencies, the need to support both the growth of Canadian companies and the onshoring of key production inputs and products in Canada is imperative. Canada is faced with both an immense opportunity in supporting Canadian clean technology, but also an imperative to secure a local supply chain of clean hydrogen, if we want to remain an economically competitive nation. Accordingly, Canada ought to support the growth of domestic companies, and the onshoring of research, development, and manufacture of Canadian-made technologies, such as green electrolysers.

III. Emissions Reductions Potential - Canada & Overseas

Water electrolysis leverages the power from renewable energy sources (RES), such as wind and solar, to generate near-zero emissions “green hydrogen”, which can be used to decarbonize both large-scale industrial applications, such as oil refining, ammonia, steel, and methanol applications, as well as mobility applications, such as heavy-duty transport, mining, and material handling equipment. Next Hydrogen’s technology gives large industrial and mobility applications the opportunity to decarbonize their activities by using economic green hydrogen.

Currently, 95% of hydrogen is produced from fossil fuel sources, creating 830 million tonnes of CO_2 emissions annually. As such, transitioning hydrogen production to low-carbon sources is essential to reducing overall emissions that contribute to climate change. Electrolysis of renewable energy is the only carbon-free pathway for hydrogen production.

Large-scale industrial GHG emissions alone total 5 GT CO_2 annually, accounting for approximately 10% of global GHG emissions. Transportation, on the other hand, accounted for 7.2 GT CO_2 worldwide in 2020. Oil refining, green ammonia and steel markets can be decarbonized by replacing “grey” hydrogen feedstock made from fossil fuels with green hydrogen, all of which involve technically straightforward transitions. There are also decarbonization pathways for other large industrial emitters that do not utilize hydrogen, such as cement plants, through “blue” solutions using carbon capture and storage. Such solutions are only available if secure, permanent storage or sequestration is available. However, carbon capture and utilization (CCU) uses green hydrogen to turn captured CO_2 into valuable green feedstock like methanol, a process known as P2X (Power to X). This approach may be attractive to large industrial emitted since they can reduce their emissions without changing their processes (except for adding carbon capture technology), while also producing a valuable green feedstock.

IV. Recommendations

1. **Commercialization of green hydrogen in high-emitting markets:** As mentioned above, there are several barriers to the commercialization of green electrolysers for high-emitting markets.

   Green hydrogen is tipped to play a key role in helping achieve GHG emissions targets globally. The sector is currently enjoying an unprecedented political and business momentum, with the number of policies and projects around the world expanding rapidly. Focused government policy is required at the Canadian level to allow Canadian companies to compete with other jurisdictions such as the United States, who has passed a suite of incentives, including hydrogen investment and production tax credits via the enacted Inflation Reduction Act. The cost of inaction is that investment, innovation and demonstration activities of Canadian companies in the space will tend to go to the United States. Simply put, government support is required for Canadian companies in the electrolyzer development space to achieve the cost compression and market growth needed to compete on equal footing with overseas competitors.

   In particular, government policy ought to focus on supporting development, market demonstration, and scale up of technologies and bringing down costs to allow green hydrogen to become widely used.

   - RECOMMENDATION 1: That the Government of Canada provide support for innovation, research & development, and market demonstration of new large-scale technologies, including the scale-up of green electrolysis systems. The Canada Growth Fund and the Canadian Innovation and Investment Agency announced in Budget 2022 must have a focus in supporting these activities, which at present represent a gap in the suite of programs available at the federal level.

   - RECOMMENDATION 2: That the Government of Canada's Investment Tax Credit on clean hydrogen be fast tracked at the full 30 per cent. Additionally, that it be complimented with a hydrogen production tax credit comparable to the U.S. Production Tax Credit enacted via the Inflation Reduction Act.

   - RECOMMENDATION 3: That the Government of Canada's response to the Inflation Reduction Act include measures that match financial assistance for clean energy demonstrations in industrial facilities, like the Inflation Reduction Act's Section 50161: Advanced Industrial Facilities Deployment Program.

2. **Securing a Domestic Green Hydrogen Supply Chain**: The Hydrogen Strategy for Canada highlights as part of the economic opportunity analysis highlights that,

only considering the domestic demand for hydrogen production and revenues from the local manufacturing and services, the hydrogen and fuel cell sector has the potential to generate almost $50 billion in sector revenue in 2050. Revenues for the manufacturing of electrolyser equipment, fuel cell stacks and engineering and consulting services are estimated based on a conservative market share of 5% of the domestic market. Positioning Canada as a leader in the space requires early movement in the development of a local supply chain. Seizing opportunities

- RECOMMENDATION 4: Establish a Hydrogen Pillar under the Strategic Innovation Fund Net Zero Accelerator to support research, innovation, market demonstrations and scaled-up development of green hydrogen to better position Canada as a competitive, clean technology leader.

- RECOMMENDATION 5: Align research and development funding opportunities for publicly-traded Small and Medium-sized Enterprise (SME) companies with funding currently available to Canadian-Controlled Private Corporations (CCPCs), by providing similar tax incentives such as Scientific Research and Experimental Development (SR&EDs).

3. **Create a comprehensive, long-term policy and regulatory framework that supports the development of green hydrogen:** Policies, regulations, and GHG reduction targets have enabled green hydrogen project development in other regions. The Government of Canada has a robust plan to achieve net-zero emissions by 2050. To achieve this ambitious target, Canada must rapidly scale up its clean technology sector within Canada and adopt low-emissions sources of energy, including green hydrogen. Within Canada, there is a lack of cross-jurisdictional, long-term policy support for green hydrogen, which hinders scalability and economic investment. Policy and regulatory mechanisms can work to de-risk investments into hydrogen and consolidate the jurisdictional differences in hydrogen-related policies.

- RECOMMENDATION 6: Continue implementing carbon pricing mechanisms to reflect the externalized costs of GHG emissions from fossil fuel-based energy. As a result, carbon pricing will stimulate deeper economic investment into green hydrogen as a cost-effective and clean fuel alternative.

- RECOMMENDATION 7: Reinforce Clean Fuel Regulations to accelerate the growth of green hydrogen for energy. These regulations will create an incentive for emitters to decarbonize through the adoption of green hydrogen as a clean fuel.

Sincerely,

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