CARBONEUTRAL GREEN HYDROGEN

SUBMISSION TO
MEMBERS OF THE STANDING COMMITTEE
ON NATURAL RESOURCES
RENEWABLE AND LOW-CARBON FUEL INDUSTRY

FRIDAY MAY 14, 2021
1:00 p.m. to 3:00 p.m. ET
VIDEO CONFERENCE - VIRTUAL

BY NORMAND GOYETTE
PRESIDENT AND CEO
H_2 V ENERGIES INC.

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PREAMBLE

H_2 V Énergies Inc. thanks the Government of Canada for its contribution to the construction of a new national clean and efficient energy project, which it has always wanted to lead in and show the pathway in its objective to position the country on an energy consumption regime compatible with the preservation of the resources entrusted to the Government.

The Net Zero Emissions 2050 goal, based on Bill C-12, an Act respecting transparency and accountability in Canada's efforts to achieve net-zero greenhouse gas emissions by the year 2050, contributes to the new planetary horizon to which Canada has decided to adhere. The bill is not only based on essential issues, but it also opens up the possibility of addressing many immediate challenges for Canadian communities with objectives of growth, cooperation, and integration. Within this framework proposed by the government, H_2 V Énergies (H_2 V), based on its production process, will accelerate the transition to a greener, more sustainable world, and thus make Canada very competitive internationally.

The energy transition cannot succeed without the unconditional support and policies of a government that will implement the necessary institutional funding and collaboration frameworks.

H_2 V, as an innovative start-up in the field, is happy to participate in this pivot transition. We appreciate the opportunity to present our vision and discuss with government officials the complex issues of building infrastructures that will support foreign trade through the export of green hydrogen produced in Canada.

H_2 V wishes to demonstrate that there are solutions to resolve most of the difficulties in implementing the Canadian hydrogen strategy.

A BRIEF HISTORY OF CANADA ON HYDROGEN

In the 1981 report entitled "Energy Alternatives", a special House of Commons committee on alternative energy and petroleum replacement recommended that Canada invests significantly in production technologies and systems running on hydrogen in order to position Canada as a hydrogen world leader. In another October 1981 report, the Ontario government's Hydrogen and Energy task force reached similar conclusions.

In 1985, the federal government commissioned a report from the Federal Advisory Group on the possibilities offered by hydrogen. A major finding of the June 1987 report "Hydrogen - National Mission to Canada" predicted the major global use of hydrogen for the next decades.

In 1988, Quebec was considering exporting hydrogen to the European Community. The launch of a pilot project to manufacture the first four hydrogen powered buses took place in Geel, Belgium. As early as 1995 in Canada, a bus with an internal combustion engine using a mixture of liquefied natural gas and hydrogen was operating in the streets of Montreal.

INTRODUCTION

The first H_2 V green hydrogen plant (α, alpha plant) in Bécancour (Quebec) represents a launching ramp to promote carbon-neutral green hydrogen on the North American and international scene. Because of its unique process of converting renewable biomass into hydrogen, and therefore into green bio-hydrogen, it will *de facto* become a global showcase.

H_2 V will produce and sell annually at a fair and equitable price, more than 50,000 tons of certified green, traceable, compressed, and 99.97% pure hydrogen. H_2 V will then supply emerging hydrogen markets in a renewable energy context and meet the energy transition needs and Canadian Government targets.

The company is able to supply industrial consumers with massive amounts of green bio-hydrogen (GBH), in fact the greenest, purest, and cheapest presently available on markets. It will thus contribute significantly to achieving Canada's greenhouse gas (GHG) reduction, sustainable development, and fight against climate change objectives.

The main sectors outlets for H_2 V green bio-hydrogen are listed below:

- Exports, with contribution to the trade deficit reduction, depending on the country;
- Gradual decarbonization of natural gas networks;
- Oil refining and fertilizers;
- Reducing agent for metal ores in steel/metal industries;
- Road, rail, and maritime mobility;
- Stationary and mobile fuel cell applications for “Data Centers” and other power plants;
- Chemical industry, treatment processes, aeronautics and astronautics;
- Electrical peak management (intelligent networks "Smart grid");
- Production of biojet fuels (kerosene) and other biofuels.

FOOD AND EDIBLE GRADE CO_2 MARKET

As a co-product, the H_2 V Bécancour plant will produce 960,000 tons year of biogenic, food-grade, and edible carbon dioxide (CO_2) to be sold on markets.

In the food industry, carbon dioxide is used in the processing, packaging, transportation and refrigeration of meats, frozen foods, dairy products and as an inert atmosphere for perishable packaged foods. The demand of green biogenic CO_2 is in high demand and growing.

In addition, in different forms, CO_2 is used in various aspects of the healthcare industry and is an important input molecule for many municipal wastewater treatment systems.

H_2 V is confident, actually guaranteed, to establish a niche market for biogenic green CO_2 that will stand out from the food grade CO_2 currently available, the latter generally being of fossil origin, as a by-product of the manufacturing industry, including ethanol production, the fertilizer industry (ammonia), hydrogen production processes, and natural wells.

BACKGROUND

Disposal of waste from "blue bins" (municipal solid waste - MSW)

We would now like to stress the critical environmental critical importance and practicality of our action. As an illustration, examples of particular significant importance are our process supply: either the elimination of piles of mixed-paper, municipal solid residues from blue bins, deconstruction wood N^{o}. 2 (reclaimed wood) from public landfills, MSW centers sorting, and eco-centers. All this supports the government's desire to solve the problems by creating renewable energies, much better than standard landfill, as has unfortunately occurred too often in the past, and that over many decades.

Disposal of mixed papers

India has followed China's lead in tightening the rules to reject mixed-paper bales with more than 1% contamination. To the rescue and helping a new use of these bales without takers anymore, the H_2 V process is efficient in treating such residues, namely cardboard boxes, newspapers, circulars and others, and that up to 8% contamination levels. H_2 V is here providing a national solution with immediate benefits for supporting energy transition.

Elimination of non-recyclable plastics

In Europe, 37% of plastics are non-recyclable. While we do not have an exact figure for Canada, it is probably of the same order of magnitude; the content of urban solid residues being very similar in societies of similar economic development. As long as the legislation is adapted to transform these non-recyclable plastics, H_2 V would be able, through its omnivorous process, to convert these plastics into hydrogen, with an even better conversion rate than woody biomass. This would clean up municipal landfills. California, considered a pioneer state in the fight against climate change, authorizes such use of non-recyclable plastics. Recently in California, a project similar to the H2 V project at Bécancour was announced, which, moreover will use the same technology as H_2 V. The supplier of the Californian project being OMNI CT, the technological supplier of H_2 V.

Elimination and use of fresh and buried bark

Including, among others, sawdust, compressed wood products, as well as wood from silvicultural work or from logging, such as trunks, branches, planers, trimmings, shavings, scraps, crowns, short sections, slash, waste wood referred to in article 94 of the Forest Act (RSQ, c. F-4.1) and wood intended for or coming from landfill sites in Quebec, as well as wood fiber residues, paper and cardboard rejected by sorting centers and intended for landfill can be eliminated by the H_2 V process and converted into hydrogen.

Biomass in general

Regarding the biomass available in Canada, it is important to stress that considerable quantities of biomass are available, biomass essentially unused at present. We are talking of about 20 million tons of forest logging residues, 51 million tons originating from natural disturbances, not taking-into-account, according to the International Energy Agency evaluation, 21 million tons of agricultural residues and 58 million tons of manure. A large part of this biomass would eventually be usable and the H_2 V omnivorous process is suited to treat them.

HOW TO ACCELERATE THE DEVELOPMENT OF A SUSTAINABLE HYDROGEN CARBONEUTRAL ECONOMY

H_2 V believes that it is necessary to serve the export markets, mainly those which are currently located and developed in the Atlantic seaports of the European Union

Deep-water ports and terminals located in the estuary of the St. Lawrence River or those established on the country east coast (Saint-John, NB, Halifax, NS, and others) should be equipped with storage tanks to store, before export, bio hydrogen stabilized by being captured within an organic molecule. The organo-chemical capture process, as a type of hydrogenation, is known by the acronym LOHC for Liquid Organic Hydrogen Carrier.

Several processes exist, but the most advanced comes from a German company with which H_2 V has a business relationship. It uses a toluene-based organic molecule made. The release of hydrogen, a simple dehydrogenation process, then takes place at destination in importing countries. Other tankers will ensure the return of the organic toluene-based molecule to the H_2 V plant. The molecule is recyclable over nearly a thousand cycles; which guarantees H_2 V a safe and economical transport over long distances.

The interest is multiple when considering many Californian counties. In this case, the mode of transport by rail is just as safe and economical as by sea because of the LOHC process. It does look quite promising. Extensive use of tank cars will require new infrastructure.

We suggest that H_2 V and Export Development Canada work closely together to strategically manage the first large-scale overseas or continental markets specializing in the import of green hydrogen. Economically, this will make it possible to exceed the critical threshold level and significantly reduce costs. As a result, the production of blue and green hydrogen would support one another, so that the production of blue hydrogen would too accelerate the economy of hydrogen in all colors and thus reduce the cost price of this energy vector.

In Canada, rather than building a dedicated infrastructure, an adaptation of the current natural gas distribution networks would be possible to transport diluted green hydrogen. The question arises as to whether or not the pipes could accept up to 20% zero-emission green hydrogen. We must salute here the Evolugen project in Gatineau

(Quebec), which is a first introductory project to this potential for decarbonising in part natural gas. It is the first company to have worked on the subject. The ramp-up would be gradual and thus manageable, even for such a potential market which is considerable.

CANADA – GERMANY

A Canada-Germany MOU agreement was signed on March 16, 2021, on the sidelines of the “7th Berlin Dialogue on Energy Transition”, an international conference.

The Memorandum of Understanding between Natural Resources Canada and the Federal Ministry of Economic Affairs and Energy of the Federal Republic of Germany establishes a partnership in energy matters, notably on GREEN HYDROGEN.

The Canadian Press release mentions that "The two countries may not, however, fully agree on the source of this hydrogen: Canada has been focusing for some time on what is called blue hydrogen." …. "This fuel is generally derived from natural gas and associated with a technology to capture the carbon emitted during its production, which makes it more politically acceptable in the western provinces, which have abundant reserves. of natural gas. "

In our development strategy, the positioning of H_2 V for 2024 is to contribute to the orientation of the transition to integral hydrogen systems and to hydrogen-fuel cell systems, to promote the use of organo-chemical capture and release technology (our partner firm is Hydrogenious LOHC Technologies GmbH), for a market with high added value and considerable potential.

H_2 V focuses its development strategy on close market outlets. The most promising are in the European Union, i.e. the ports of Rotterdam, NL, Zeebrugge, BE, Antwerp, BE, and those of Hamburg, Hanover and Kiel located in Germany.

These port authorities are presently building hubs for the import of GREEN HYDROGEN from across the Atlantic, from the Maghreb countries to some from the Middle East, in particular from Saudi Arabia.

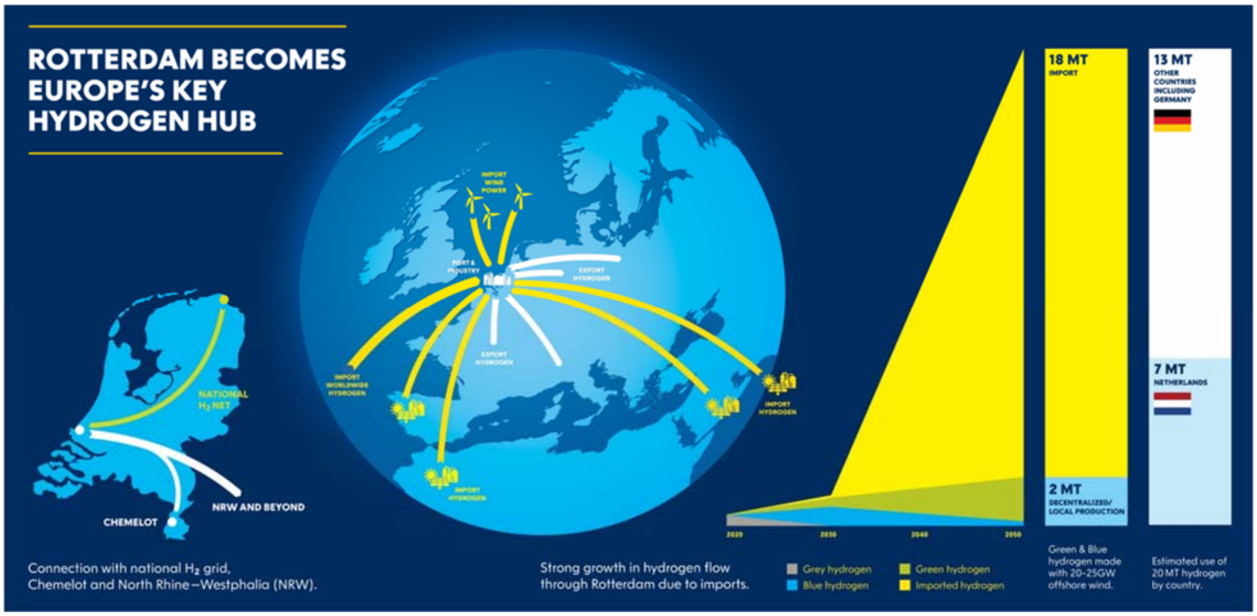
Here let us pay attention to Canada’s trade deficit with Germany, which stands at C $ 10.8 billion (2020).

Speech by Mr. Allard CASTELEIN, President and CEO, Port Authority of Rotterdam

https://www.portofrotterdam.com/en/news-and-press-releases/making-rotterdam-europes-hydrogen-hub

“*Together with parties in various countries, we are examining the possibilities of setting up import chains for hydrogen. This is being done with Morocco, Portugal, Iceland, Oman, Uruguay and Australia among others - all countries with lots of sun, wind, hydropower or geothermal energy, with plenty of space and situated along the sea*”.

The invitation to join this transition movement is launched! If Canada aspires to a pole position in the massive export of green hydrogen, we must react quickly and take the necessary steps.



INFRASTRUCTURES

Hydrogenation plants by organo-chemical capture

To respond to the invitation to supplying 18 million tons of green hydrogen, the Canadian Government must invest in this type of plants as the dehydrogenation will take place in countries that import green hydrogen.

Computed example: (ICI)

Based on overseas maritime transport for the export of green hydrogen at large European Union scale by tankers - Year of full production of the H2 V plant in Bécancour in 2024.

- Reversible hydrogenation/dehydrogenation LOHC (Liquid Organic Hydrogen Carrier) process.
- **Minimum daily production (10 trains of OMNI CT plasma) from the H_2 V plant from Bécancour:** 137 tons of green hydrogen.
- Roads - maritime corridors: Port of Bécancour (Canada) to the Port of Rotterdam, NL. Distance: 6,075 km (3,280 nautical miles) - Speed 15 knots. Transit time: 9.1 days, plus 3 days in port and 9.1 days return trip for a total of a cycle of 21.2 days.
- Operation on mooring days and in port: a) Unloading of the mixture of green bio hydrogen + LOHC molecule in storage tanks, then b) Loading of the recycled and stored LOHC molecule.
- Oil tankers: the mixture contains 62 kg green hydrogen per ton of LOHC. Which give for 60,000 deadweight tons approximately 967 tons of green hydrogen or the equivalent 7 days of green bio-hydrogen production. For a complete cycle, about 6 tankers are necessary.

- For 120,000 organic carrier deadweight tons, we would have around 1,934 tons of green bio hydrogen, which is the equivalent of 14 days of production at the Bécancour plant. A complete cycle of 3 tankers would be required.
- Dehydrogenation plants could also be installed at major and local customers industrial sites. There would then be an on-site recovery of the LOHC molecule for storage and transfer in a closed loop to the H_2 V plant in Bécancour.
- Pipeline for transport to CN and CP ports and unloading docks.

ENRICHMENT OF GAS NETWORKS

The enrichment of gas networks is based on the "Power-to-Gas" concept.

H_2 V held several successive meetings with stakeholders, and several others are to follow, regarding the potential introduction of a minimum of 20 BCF (billion cubic feet) of biogas in the objective to comply with the demand of Régie de l'Énergie du Quebec.

Natural gas distributors should therefore gradually inject 10% of biogas, that could include hydrogen, into their pipelines by 2030.

The gas distributor Enbridge Inc. has developed a first North American hydrogen storage project using excess electricity that could be subsequently converted into electricity and/or to enrich the gas network. The company is also subject to the 2% content by the "Ontario Energy Board", concerning a mixed biogas content.

H_2 V is following with high interest the recommendations soon to be issued by Natural Resources Canada, the Canadian Gas Association, and CSA International, as they foresee a potential increase of the “2%” enrichment towards 10% or 20% of carbon neutral hydrogen as biogas; in line with what is happening in some European countries.

H_2 V recommends that these tests be accelerated.

INTERNATIONAL MARITIME ORGANIZATION (IMO 2020)

In the maritime sector, the companies Wärtsilä Corporation (Finland) and MAN Energy Solutions ES (Germany) manufacture 70% of diesel engines for maritime transport installed on board ocean-going vessels.

These collaborators contribute significantly to progress in R&D with the objective of using green hydrogen in the power supply of fuel cell applications. These batteries, with an impressive power would be used to replace shore power generators or even (several megawatts, MW), propulsion. These companies are also considering the development of direct or indirect injection systems in main and auxiliary engines. H_2 V is here already working directly with the Hydrogen Research Institute (IRH) of the University of Quebec at Trois-Rivières (UQTR). We trust we have a certain strategic lead in this area.

The reason for Wärtsilä Corp. and MAN Energy Solutions ES to work on these avenues for using green hydrogen is linked to the evolving regulations of the International Maritime Organization (IMO). In fact, as of January 1, 2020, the limit for the sulfur content of fuel oil used by ships has been reduced from 3.50% to 0.50%.

Known as “IMO 2020”, the new content cap is mandatory for all vessels operating outside Emission Control Areas (ECA). These ECA zones, already under a tighter 0.10% limit, are the Baltic Sea, the North Sea, the North America zone, and the Caribbean Sea Zone of the United States.

To promote the use of carbon-free hydrogen, H_2 V has an action plan specifically aligned for Canadian shipowners.

As indicated above, for export, H2 V has a specific interest in the technology of storage and massive transport of green hydrogen by LOHC technology. With this strong positioning, strongly comforted and supported by researchers from the IRH (UQTR), H_2 V has already implemented means to promote privileged access to Hydrogenious LOHC Technologies GmbH from Germany and to SPERA Hydrogen ® from Chiyoda Corporation of Japan.

Breaking news on the Quebec green hydrogen sector

The Quebec government will soon announce the granting of $ 450,000 to UQTR to a hydrogen research chair to support both studies on the production of green hydrogen (by electrolysis and biomass-based), as well as storage, as described above. H_2 V and Innergex are co-financing this chair.

Although the press release is currently under final review and under embargo, let us allow to extract (draft) significant points which support our remarks.

“The Government of Quebec is providing $ 450,000 to the University of Quebec at Trois Rivières (UQTR) to support the development of new catalytic energy materials to make hydrogen. This research project, valued at $ 950,000, will promote the production of clean energy from innovative, high-performance, sustainable and low-cost materials. "

"This project is led by UQTR and carried out in partnership with two Quebec companies: Innergex Renewable Energy and H2 V Énergies. It mainly involves developing green hydrogen manufacturing technologies through innovation in materials science, optimizing production systems, as well as fine-tuning them to produce hydrogen on a large scale. The project will also focus on the development of storage technologies for the efficient distribution of hydrogen over long distances.”

FREIGHT LOCOMOTIVES

To better appreciate the potential of carbon neutral hydrogen market, we may consider the railway industry. In Canada, the railway industry would convert some of its freight locomotives to hydrogen if it were available at an affordable and competitive cost to diesel. One should note that new locomotive engines allow conversion to hydrogen.

The locomotives of the Canadian National (CN) railway company alone consumed more than 1,700 million liters of diesel in 2019[1], with associated greenhouse gas (GHG) emissions of 5.1 million tons CO_2 equivalent.

[1] Canadien National. Carbon Disclosure 2019. https://www.cn.ca/fr/engagement-responsable/environnement/emissions/

Converting all of CN locomotives to hydrogen would require an annual supply of 460,000 tons, roughly ten times the expected production at the H_2 V plant in Bécancour. As a reminder, CN is a leader in the rail industry with fuel consumption per gross ton-mile that is 15% lower than the average for Class 1 railroads.

CN ambitious goal is to reduce the intensity of its GHG emissions (tons of CO2 eq. per TMB or gross ton-miles) by 29% by 2030, compared to 2015 levels, by focusing on its program of excellence in fuel management, increased use of renewable fuels and innovative technologies. By the end of 2019, 8% of this reduction target had been met, and as a result, the carbon-free hydrogen produced by H_2 V clearly represents a GHG reduction opportunity for CN.

Canadian Pacific (CP) is also looking to reduce its carbon footprint.

In 2019, the diesel consumption of CP[2] locomotives reached almost 1,000 million liters of diesel, with associated GHG emissions of 2.94 million tons eq. CO_2. CP has committed to reducing its GHG emissions by 6% from 2017 to 2022. It had reached one-third of this target by the end of 2019. Converting all of CP locomotives to hydrogen would require it only more than five plants as proposed H2 V (263,000 tons of green hydrogen).

SETTING UP OF H_2 V PLANTS IN CANADA

COSTS

The cost of each new 50,000-ton green bio-hydrogen production plant is CAD$ 1 billion. This is a competitive cost compared to any equivalent production of green hydrogen by electrolysis.

BENEFITS

- Innovative industrial process allowing the massive production of green energy at a very competitive prospective cost;
- Availability and use of hydroelectricity for transformation at a much lower power (5.25X less) than electrolysis or proton exchange membrane (PEM) fuel cell technologies;
- Possibility of building several production plants across Canada, notably in Ontario, Manitoba, British Columbia, Newfoundland, and Labrador.
- Combined commercial strategy of national use and export on the world stage, both of the green hydrogen produced and of the industrial process for building H_2 V plants abroad.
- H_2 V carry out its own carbon marketing.

STEPS

For June 2021 to December 2022 period:

- Completing conceptual study (FEED, etc.);

[2] Canadian Pacific. Carbon Disclosure Program 2019. https://www.cpr.ca/en/about-cp-site/Documents/cdp-program-submission-2019.pdf

- BAPE (Office of Public Hearing on the Environment) evaluation;
- Start of construction of the plant and administrative offices;
- Purchasing process equipment.

The plant commissioning will be initiated on the first quarter (Q1) 2024 for first salable production on the second quarter (Q2) 2024.

JOB CREATION

The project will create 1,150 jobs during construction and 100 permanent jobs, mostly technical and high-level professionals.

ECONOMIC IMPACT

The economic benefits are estimated at more than CAD$ 200 million, i.e. CAD$ 131 million at the two levels of government and CAD$ 70 million injected into the regional circular economy.

GREENHOUSE GAS (GHG) REDUCTION

According to our experts, the production of 50,000 tons of green bio-hydrogen represents an annual reduction in GHG emissions of nearly 0.96 million tons of CO_2 or 11% of Canada's target annual reduction (8.76 Mt / year).

H_2 V PROPOSED RECOMMENDATIONS

- Shipbuilding

    That Canada as a country equips itself with a fleet of tankers, sailing under the Canadian flag, of the type shown below (Global Energy Ventures Limited) which can carry up to 2000 tons of compressed green hydrogen.

For federal government to:

- Provide access to funding for hydrogen comprehensive projects such as H_2 V is implementing;
- Respond to infrastructure investment needs;
- Support exports;
- Consider green hydrogen, including green bio-hydrogen, as a reliable energy source;
- Develop a vision and a leadership over the medium and long term;
- Promote known economic opportunities;
- Support, through appropriate measures, the security of the pan-Canadian supply of residual biomass and consider the diversification of supplies, including "non-recyclable" plastics (see Europe and California);
- To assist with appropriate measures in reducing deployment costs, particularly in terms of infrastructure;
- Help for entering the global markets;
- Support the much-needed growth of knowledge, know-how, and scientific activities.

The measures we are proposing should allow Canada to become both a world leader in the hydrogen sector and a leading global net exporter of low carbon intensity hydrogen[3], hydrogen, be it “green or blue”.

H_2 V RESPONSE TO CANADA CHALLENGES

In our view, there can be no complete and successful energy transition without the integration of zero-emission green hydrogen in industry and transport.

To support Canada in this zero-emission approach, the H_2 V project will prove to be a low risk, basically safe venture. Why? Our answers are listed below.

The process does not involve any technological risk; it is set up with a guaranteed performance. OMNI CT technology - used by both the H_2 V project in Bécancour and in the Californian project requires NO SCALING UP.

The massive quantity, or 50,000 tons per year, of carbon-neutral green hydrogen produced by H_2 V at Bécancour will be available in the short term, from the second quarter of 2024.

In our opinion and analysis, it is one of the best chances for Canada to meet its GHG reduction targets.

The project will use certain infrastructures existing in the oil sector.

In addition, H_2 V strategy and plans consist in taking leadership to also support developing countries by enabling access the clean technology of the H^2 V process.

[3] Canada should here benefit in aligning with Europe and consider hydrogen at the level of the carbon intensity of production, and consider the required legislation and measures to be implemented.

It is in line with Canada's foreign policy, and Canada is a country recognized for such foreign policy, i.e. helping and contributing to the development of such countries. H_2 V will contribute to the Canadian foreign policy in a sustainable and profitable economic approach.

ADVANTAGES OF THE H_2 V PROCESS OVER THE PROCESSES OF WATER ELECTROLYSIS SYSTEMS OR PEM (Proton Exchange Membrane)

The main advantage is undoubtedly the fact that the H_2 V process requires FIVE COMMA TWENTY-FIVE (5.25) times less electricity consumption than water electrolysis-based technologies to produce an equivalent ton of green hydrogen.

The massive production of hydrogen by electrolysis of water (or PEM) quickly comes up against the availability of hydro-power or solar or wind power. We will not enter into here the arguments on the topic hydroelectricity surplus, or not, for example in Quebec. In addition, the electricity needs must be guaranteed in the long term and would eventually require colossal capital investments to meet the new demand.

The cost of electricity impacts operating costs and by consequence the unit price of kilo of green hydrogen sold. The operating cost is significantly reduced in the H_2 V process as the necessary energy is provided by the biomass which is converted by gasification. In addition, the cost of supply could even be negative, as in the case of MSW diverted from landfill.

In areas or countries without access to hydroelectricity, the H_2 V concept would only require a small number of photovoltaic solar panels or wind turbines operating on small land areas. In Europe, H_2 V is considering the use of plastics in combination with a reduced electrical power when compared to electrolysis.

No extra water consumption is required when woody biomass is converted. In fact, the H_2 V process recovers water from the biomass by distillation, thus producing more water than it consumes during the converting of MSW or other residual materials.

A planned H_2 V plant will further reduce CO_2 emissions to the atmosphere by avoiding residues decomposition that cause methane emissions, for example in the biodegradation of biomass in Canadian forests. Methane is a GHG with a detrimental effect, depending on the sources, at least 25x times that of CO_2.

Finally, one should remember that, in general, the installed MW cost price for either “onshore” or "off-shore" wind turbines or photovoltaic solar panels is higher than that of large size power plants.

SOLID URBAN WASTE + BURIED RESIDUAL BIOMASS: A HOT POTATO

Biomass gasification is a promising pathway that offers an immediate market outlet. Biomass to produce hydrogen proves to be a much interesting avenue in the fight against climate change. The BIOMASS converting process chosen by H_2 V allows a neutral emission balance as it does not increase the atmospheric concentration of CO_2. The carbon dioxide is captured during the production of green hydrogen as a biogenic co-product. Remember also that the IEA only considers the emission of fossil CO_2 as GHG, which is not the case with the H_2 V project, the CO_2 being here BIOGENIC, from sustainable, renewable biomass. And moreover, it is sold on the market: therefore, the overall process is ZERO GHG EMISSION[4].

By combining the elimination of waste from the blue bins, the transformation of non-recyclable plastics, the conversion of mixed papers, and of deconstruction wood, the H_2 V alternative appears not only an optimal but an essential solution.

In our opinion, no mode of hydrogen production is imposed, nor should be imposed. The diversity of hydrogen production methods offers opportunities for many industries and stimulates research. The biomass option is another powerful tool that we promote in the production of green hydrogen.

The H_2 V process relies on patented, proven, and validated technology. It judiciously addresses the challenges of eliminating, if not reducing, landfill sites by producing hydrogen from the wastes, from the "junk" produced by our society. It contributes significantly to cleaning the environment!

With a need for 730,000 tons of annual biomass to be treated, our project heralds the start of a process of cleaning than phasing out landfills: a new era.

CONCLUSION

Presently, considering the present state of the H_2 V project, our two important key “bring-home” messages are:

- The benefits of green hydrogen production and use will not be visible until a **massive industrial phase** is initiated, is set in motion: it is what we are proposing and what we will achieve with some support from the governments.
- A consequent local distribution and use of green hydrogen as well as a significant international export of hydrogen will only take place if initiatives such as H_2 V and others, are supported by a clear determined political will.

Respectfully submitted, this May 7, 2021,

Normand Goyette, President and Chief Executive Officer, H_2 V Énergies Inc.

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[4] Life Cycle Analysis (outside construction, even shows a negative GHG value

APPENDIX - TECHNOLOGY INFORMATION ON H_2 V PROCESS AT THE BÉCANCOUR PLANT

The industrial process implemented by H_2 V consists of the conversion of municipal solid (MSW) and residual biomass into hydrogen-enriched syngas using OMNI Conversion Technologies GPRS™ technology.

The industrial process includes a first conversion step of residual materials and biomass, followed by a plasma treatment as a refining process; it allows for the obtention of very pure products, green bio-hydrogen and carbon dioxide.

In a way, H_2 V could be considered as "the introducer" of the biomass conversion process to produce hydrogen on the markets, since – notwithstanding the recent Californian announcement - it is a "world first". Indeed, we plan for our factory to be built before that of California. Our strategy is to put forth, to promote our process, advantages and benefits, in order to establish any customized installation model with the customer.

The technology, patents, P&ID (Piping & Instrumentation Diagram) and engineering plans of the process technology have been analyzed and evaluated by an independent engineering firm, namely Black & Veatch (BV) which has globally recognized expertise in the domain. The report, available on request, includes technology flow diagrams as well as an overview and detailed analysis of the various process stages. A very conservative start-up estimate calls for 92% production in the first year, then 95% and above, of nominal production value after 3 years of operation.

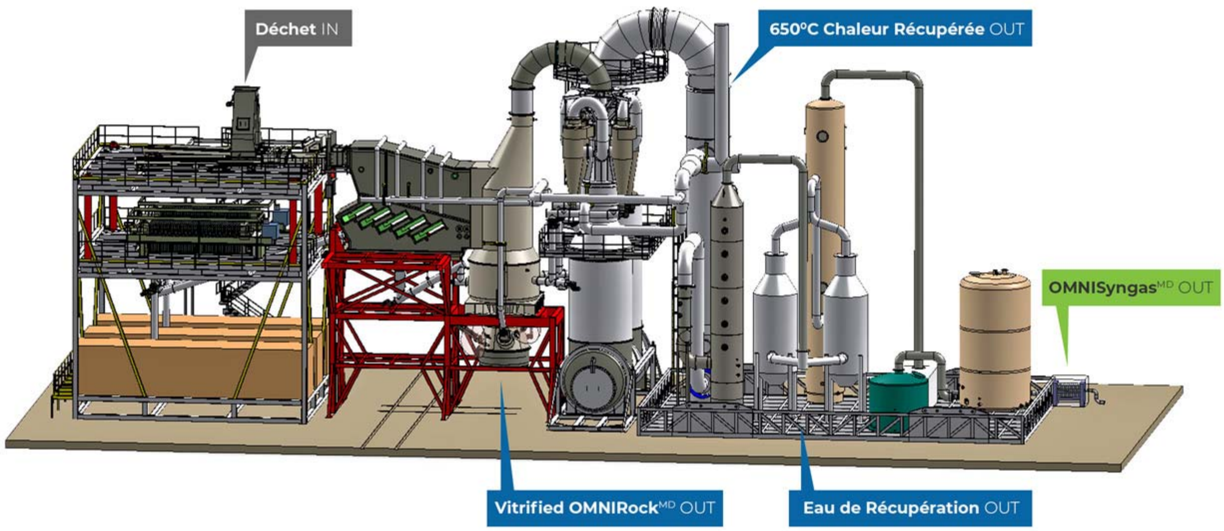
The technology is also recommended as having the best technical and economic value by H_2 V partners and consultants, namely SNC-Lavalin, GAAMA, and the Ultragen Group. It has also been evaluated by Dr. Patrice J. Mangin, director of the Institute of Innovations in Ecomaterials, Ecoproducts and Ecoenergy, associate member of the Hydrogen Research Institute (IRH, UQTR), as well as by Dr. Daniel M. Kammen and Dr. Dan Sanchez, both professor emeritus at the California Berkeley University.

The detailed engineering of the OMNI CT part is completed. For the Balance of Plant (BOP), detailed engineering is in progress and/or finalized at ± 10% (Front-End-Loading Level 3).

The technological innovation provided by H_2 V constitutes a sustainable solution perfectly aligned with the visions and missions of both the Ministry of the Environment and the Fight against Climate Change (MELCC) of Quebec and Environment and Climate Change Canada (MECC), namely the achievement of the energy transition targets of both federal and Quebec governments.

The production process has been extensively tested and validated by OMNI CT on a 135 tons per day demonstration plant from 2007 to 2014. Considering that each modular conversion train or unit treats 200 tons per day (tpd) of material (biomass), there is no risk - ZERO RISK – of scaling up. Ten multiple 200 tpd units are thus assembled without any additional scaling-up steps. The system is adaptable to a varied composition of materials and humidity; it is an “omnivorous” process.

Basically, the production process at the Bécancour plant involves the stages of supplying the reactors with biomass as linked to the supply chain; a system for converting biomass into syngas and integrated refining (ICARS or Integrated Conversion) and Refining System; a gas cleaning and separation system for the production of green hydrogen and food grade carbon dioxide, completed by the melting and vitrification of the solid residue. A diagram of the synthesis gas production process is shown below. The entire production process has been analyzed by SNC-Lavalin.



For the similar project announced in California see:

https://www.businesswire.com/news/home/20210421006131/en/OMNI-CT-Brings-First-of-Its-Kind-Waste-to-Hydrogen-Product-to-Market-in-the-Fight-Against-Climate-Change