GREEN HYDROGEN

AN INNOVATIVE ENERGY FOR CHILE

INTRODUCTION

Hydrogen is a colorless, odorless, and highly reactive gas found in all components of living matter and many minerals and is also the most abundant component of the universe. It can be used as energy by its characteristics. Namely, Chile is one of the pioneers with a future plan for hydrogen, in this case, green.

There are three types of hydrogen, gray hydrogen, produced from hydrocarbons such as natural gas, methane or other gases, blue hydrogen that is obtained in a similar way to gray hydrogen, but carbon capture and storage technologies are applied, turquoise hydrogen that comes from natural gas treated by a pyrolysis process[1], but that it is not exempt from emissions. Finally, the green hydrogen is obtained through the electrolysis of water using renewable energy, this through an apparatus called an electrolyzer [2] that breaks the water molecules into hydrogen and oxygen and then through another device called Fuel Cell[3], performs the reverse process that makes the electrolyzer, thus obtaining this green hydrogen.

This type of energy is peculiarly feasible in a country like Chile, both for its technological development and geographical location. To obtain green hydrogen, it is necessary to perform and develop renewable energies such as solar energy and wind energy in Chile. In fact, the national government is committed, through its ministry of energy, to produce the cheapest fuel on the planet in 2030, to be among the first three exporting countries of green hydrogen by 2040, and have 5GW of electrolysis capacity to replace fuels such as Diesel, which implies doubling the capacity of the country concerning the production of solar and wind energy for 2025.

All this to lead Chile to be the leading country of this type of energy, both for local use, its implementation is heavy industry such as mining or the area of agriculture, and with this reduce the carbon footprint as the export of green hydrogen and its derivatives, such as ammonia, methanol and synthetic fuels.

The development of this innovative energy could mean a very favorable economic impact for the country and, of course, an invaluable contribution to the relationship of the human being with the environment, so we are already working on the conglomerate

[1] *Pyrolysis is the chemical decomposition of organic matter and all types of materials, except metals and glass, caused by heating to high temperatures in the absence of oxygen.*
[2] *An electrolyzer is a device used to separate oxygen and hydrogen molecules contained in water.*
[3] *Fuel cell, also called fuel cell or fuel cell, is an electrochemical device in which a continuous flow of fuel and oxidant undergo a controlled chemical reaction that results in products and directly supplies electrical current to an external circuit.*

necessary to make this possible, and that the conditions for the use and democratization of green hydrogen are developed.

REGULATIONS

From the National Congress of Chile, the proposal on green hydrogen for the future development of the country has been taken with real seriousness, to the point that you can download on the page of the Senate of Chile the document HsV Green Hydrogen Initiative[4], which in the section of legislative and regulatory proposals is typified:

***1. PL for R&D in green hydrogen*:** The H2V Initiative of the Commissions on Future Challenges, Science, Technology and Innovation and Mining and Energy of the Senate of the Republic proposes to promote various financing mechanisms for pilot projects in the demonstration phase. Thus, the different stages of the projects that could be generated are differentiated: pilot project, commercial project and demonstration project.

The Initiative proposes to formulate bills that allow to expand the range of financing possibilities of these projects in their early stages of life, in order to generate a green hydrogen market.

Thus, it is suggested to legislate to obtain funds from international cooperation, public-private agreements (PPPs), other forms of money-raising such as associative strategies between universities, technical training centers, local governments and other actors, as well as the establishment of royalties. It is suggested to modify the law of donations so that projects related to green hydrogen are prioritized.

By having this type of approach, which contemplates public-private cooperation, we have a good indicator of the integrative vision of the proposal so that it effectively generates a market in the participation of all actors and the management of the project's phased scheme, which will allow greater transparency and generate a broad sense of ownership and positive incentives concerning H2V, so that an important conglomerate is being developed for this innovative energy.

2. PL on Electromobility: The Initiative proposes that electromobility not only be limited to mining trucks but also open niches with a broad view: public

[4] *H2v Green Hydrogen Initiative. Commission challenges of the Future, Science, Technology and Innovation and Commission on Mining and Energy of the Senate of the Republic.*

transport, aquaculture sector, agribusiness, even boats to promote eco-tourism. Chile has many fronts available for piloting from the salmon and aquaculture industry. When legislating, priority should be given to public transport and freight transport.

In mining, advances in medium-power vehicles would be especially important. Other vehicles, such as intercity buses, could leave a lot of know-how in the country. Trains are also a good option due to the geographical characteristics of the country.

In the agricultural sector, demonstration plant developments can be made, providing complementary services that improve the value of the products that are being produced in agribusiness (from improving technology for tractors to using storage for renewable energy sources in the winter). A bill in this area could set quotas for hydrogen vehicles in future tenders, for example 5% of new buses.

It is interesting to think of a connected country thanks to green hydrogen and where its primary industry is mobilized by it. What should then be taken as north is the integral development of energies such as solar and wind power since these energies can be used to produce H2V. On the other hand, this project must be carried out with a lot of observation so that, to the extent that such an essential step as the replacement of fossil energies takes place, the project is not only thriving. Still, it does not become an obstacle for any Chilean and instead stands out for its possibilities and comparative efficiency.

3. PL of Energy Efficiency: The entry into force of the energy efficiency law is necessary to allow the Ministry of Energy to regulate by legal means such as decrees and regulations, especially the aspect of safety in the production, use and transport of green hydrogen.

The safety aspect is decisive in this project, so guaranteeing the use, production and transport is a very positive aspect of the proposal. However, it should be focused on this allowing the Ministry of Energy to be an instrument to facilitate citizens' efficient use of H2V and not act as an obstacle.

4. PL Diesel Regulation: The most significant competitor associated with hydrogen in electromobility is not liquefied gas but Diesel, despite its socio-environmental impacts.

Its economic advantages must be eliminated in order to strengthen the green hydrogen industry.

This point is somewhat disturbing. While H2V is an important project that can transform Chile, this transformation must occur by proving that this technology is better and more efficient than other competitors, such as Diesel. Suppose the state acts in an interventionist manner to limit the use of Diesel. In that case, more could be affected than benefited.

5. Specific bills for the mining sector: Emissions from the mining sector are particularly high, so it is imperative to change the regulations that allow this sector to enjoy an indirect subsidy on Diesel, while not paying an emissions tax. In this area, there is a huge demand potential for green hydrogen.

Although the emissions from the use of Diesel are high, it is also true that it is this product that keeps the mining sector going, so the process of replacing Diesel with H2V must also be done thinking about the success of the industry and all the workers who depend on it both directly and indirectly.

6. Freight transport regulation: Long-distance freight transport is a crucial sector that could be regulated in the country to favor the use of hydrogen. Other countries have been identifying the routes with the highest traffic to focus on installing road charging electrolyzers, to begin with the projects with the greatest financial viability and demand.

Instead of favoring freight transportation through regulation, what must be done is that the incentives for the use of H2V are much greater than those of its competitors to promote a greater and more efficient use in the transport sector.

7. Regulation of airport and port vehicles: Much of the machinery used in ports and airports could move towards hydrogen. Green hydrogen is an opportunity to take out of circulation several vehicles that are very polluting today. A bill could promote the modernization of motor vehicles used in ports and airports.

While modernization is necessary for the progress of countries, and concerning H2V in Chile means an element that has the potential to renew everything where it is developed, it will be essential to evaluate how the State will "take out of circulation" other vehicles, so that this is as efficient as possible minimizing damage to individuals.

However, the Ministry of Energy has also specified a strategy[5], of which six pillars stand out:

1. Mission-oriented policy: The State will be a facilitator, coordinator and promoter of the mission to establish this new industry with multisectoral efforts.

2. Balanced use of resources and territory: The development of the hydrogen industry will be consistent with its social and environmental surroundings, incorporating best practices and dialogue.

3. New clean export economy: Hydrogen will enable a new Chilean export economy based on clean energy and products with a low carbon footprint.

4. Efficient route to a zero-emission country: Our country is committed to the transition to carbon-neutrality. Hydrogen will play a leading role.

5. Green hydrogen as an engine for local development: The projects and industry of this clean fuel will generate poles of investment, innovation and local activity

6. International openness: International openness will develop the national and global green hydrogen economy at the speed that the planet requires.

All these pillars act in unison to develop the conditions to make H2V the primary driver of Chile for 2030, which will be accompanied by legislation that promotes this ambitious initiative. Taking all these elements into account, the State apparatus is focused on achieving its goals, which makes us confident in the future.

INTERNATIONAL COMPARISON

With great determination, Chile has set ambitious goals concerning H2V. Under the leadership of Biminister Juan Carlos Jobet, which has brought together all social, political and business sectors, seeks to build a future with a smaller carbon footprint and thus be able to produce the cheapest fuel on the planet by 2030 and be among the leading exporters of this product by 2040. In this sense, 50 million dollars have already been earmarked for projects, and even greater resources are planned for the future.

[5] *National Green Hydrogen Strategy, Chile, energy source for a zero-emission planet. Ministry of Energy, Government of Chile. Santiago de Chile. 2020.*

Similarly, other countries are interested in green hydrogen. One of them is Germany, one of the most innovative countries globally, which plans to approve essential resources for this purpose.

As we can see, Germany with respect to H2V works on the following strategy:

After months of discussion and deliberation, the German government has presented a National Hydrogen Strategy. **A plan endowed with an investment project of more than 9,000 million euros.** The reasons for doing so were many, but the main one is framed in the enormous potential of green hydrogen as the primary sustainable energy of the future.

THE GERMAN STRATEGY WILL REVOLVE AROUND THE FOLLOWING AXES:

1. Adopt a leading position on the road towards reducing emissions and place the development of hydrogen technology as a critical element to meet the decarbonization objectives.
2. Make hydrogen competitive by driving cost reductions with a rapid increase in the international market.
3. Develop a "domestic market" for hydrogen technologies in Germany and pave the way for imports.
4. Establish hydrogen as an alternative energy carrier to enable the decarbonization of more complex sectors.
5. Make hydrogen sustainable as a raw material for industry.
6. Improve the transmission and distribution infrastructure using the existing gas infrastructure in Germany by expanding hydrogen networks or building new ones.
7. Establish international hydrogen markets and cooperation.
8. Understand global cooperation as an opportunity.
9. Develop and ensure a quality infrastructure for production, transport, storage, and hydrogen use while building trust.
10. Constantly improve the framework conditions and assume the current developments.[6]

As we can see, there are similarities concerning the approach proposal about Green Hydrogen. Germany is committing to develop H2V production and the

[6] *Good New Energy, why is Germany going to allocate 9,000 million euros to green hydrogen? Available in: https://cutt.ly/4xWqDqT*

H2V market. Having the aforementioned geographical characteristics in Chile and the commitment that is being made to promote this energy, it gives excellent prospects for the future.

Another country that has an important project concerning H2V is Denmark, which is working on a project of artificial islands where renewable energy is produced. One of these energies is Green Hydrogen.

The Danish government has just confirmed an enormous project that will involve the creation of a series of artificial islands where wind turbines will be installed and where green hydrogen will also be produced with surplus energy.

The project will be installed in the North Sea. It will consist of a series of offshore wind farms located approximately 80 kilometers west of the Jutland coast. A project that is expected to have about 200 turbines in the first phase of the project, which consists of approximately 120,000 square meters, will have an installed capacity of 5 GW, triple the capacity currently installed in Denmark.[7]

These initiatives show the tremendous future potential that European countries see H2V. If all the projections are met, this will be the great energy of the future. However, countries in our region, such as Colombia, also see green hydrogen as an instrument for its future development, especially in the mining sector, an issue that is working in cooperation with Chile.

POSSIBLE SOLUTIONS

Undoubtedly, the entire conglomerate destined to make green hydrogen the primary fuel of Chile can give us great expectations for the future. The organization and integration of all sectors of society can go all right, and great success can be realized. The possibilities of using green hydrogen both in mining and individuals' use can effectively put Chile at the forefront of H2V use by 2030.

For all this to be possible, it would be essential to emphasize that the success of green hydrogen will be seen when green energies such as solar and wind developed in the country can create enough H2V to supply the demand and at a competitive price.

[7] *Electric cars forum. Denmark will build huge artificial islands whereIt will produce renewable energy and green hydrogen, Available in:* https://n9.cl/ilxul

However, this must be the result of its proven effectiveness compared to that of other fossil fuels, and not of the irruption of the State against people if they are not satisfied with this energy.

In addition, the political commitment of future efforts will be decisive to achieve the objectives and succeed in the end.

CONCLUSIONS

Green hydrogen has the potential to generate in Chile an energy revolution and effectively turn this country into one of the countries with the lowest carbon footprint in the world. Its geography and technological development allow us to set goals for adapting H2V to all productive sectors of society in the coming decades.

The legislation that is developed to achieve Chile's success as a producer of green hydrogen must have the appropriate incentives, not to be an obstacle but a point of support for this purpose. This will depend on whether the ambitious but achievable goals can be realized optimally.

Meanwhile, it should be noted that all initiatives to make H2V the main fuel of Chile, both industrial and private use, are being well directed by Biminister Juan Carlos Jobet, the leader of the energy revolution in Chile.

Everything seems to indicate that Chile will succeed in using Green Hydrogen. This effort is worthwhile for the economic future and in the country's relationship with the environment. It remains to be seen how the national strategy is concretized and how we adapt to this innovative energy.

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PUBLISHED BY: