CASE STUDY

BUSINESS MODELS FOR GREEN HYDROGEN IN LATIN AMERICA

1. PROTIUM BY HEVOLUCIÓN IN COLOMBIA

This publication is part of the activities of the project "Advancing a Regional Approach to the Green Hydrogen Economy in Latin America and the Caribbean" (H2 ¡Vamos! / H2 Go!), an initiative led by the United Nations Environment Programme (UNEP) and funded by the Green Climate Fund. The project aims to strengthen regional capacities to promote a just, inclusive, and sustainable green hydrogen economy.

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1. EXECUTIVE SUMMARY

The Protium Project, developed by the company Hevolución in the department of Antioquia, Colombia, represents one of the country's first operational green hydrogen plants [1]. Launched in December 2023 and currently in its commissioning phase, the project aims to lay the foundations for a national hydrogen economy by producing 1,000 kilograms of green hydrogen per day through electrolysis powered by renewable energy sources [1].

This hydrogen is liquefied in the form of ammonia to facilitate its transportation and storage, for both domestic consumption and export. Among the most relevant uses of the generated ammonia is the production of green fertilizers—a strategic sector for Colombia given its strong agricultural activity.

The plant has an installed electrolysis capacity of 2.3 MW and operates with zero emissions, marking a milestone in the country's energy transition [2]. Although it does not produce fertilizers directly, Hevolución collaborates with clients in the agro-industrial sector who use green ammonia as a raw material. This connection positions the project as a key model for future green hydrogen applications in agriculture.

2. BACKGROUND AND CONTEXT

The Protium Project, developed by the company Hevolución in the department of Antioquia, Colombia, represents one of the country's first operational green hydrogen plants [1]. Launched in December 2023 and currently in its commissioning phase, the project aims to lay the foundations for a national hydrogen economy by producing 1,000 kilograms of green hydrogen per day through electrolysis powered by renewable energy sources [1].

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3. PROJECT DESCRIPTION

The Protium Project is a green hydrogen production plant located in Antioquia, Colombia, developed by the company Hevolución [1]. Since December 2023, it has been in the commissioning phase, aiming to begin continuous operation throughout 2024 [1].

Its electrolysis system has a capacity of 2.3 MW, enabling the daily production of approximately 1,000 kg of green hydrogen using electricity from renewable sources [2]. The hydrogen is transformed into ammonia through synthesis processes, facilitating its transportation and subsequent use in industrial and agricultural applications.

Although Hevolución is not directly involved in fertilizer manufacturing, it has identified key clients in the agro-industrial sector that use ammonia as the basis for green fertilizers [1]. This makes the project a critical link in Colombia's agricultural sector transition toward cleaner production.

Beyond environmental benefits, the Protium Project aims to generate positive social and economic impacts in the region by promoting skilled employment, training in new technologies, and positioning Colombia as a regional leader in the hydrogen value chain

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4. USE OF TECHNOLOGY

The Protium Project employs cutting-edge technologies to produce green hydrogen from renewable sources, with the goal of using it as feedstock for green ammonia synthesis. Below are the main technological stages involved:

1. Green Hydrogen Production

Hydrogen is generated through a water electrolysis process, using an alkaline electrolyzer powered by renewable electricity. The plant has an installed capacity of 2.3 MW, allowing for the daily production of up to 1,000 kg of hydrogen [2].

- **Electrolysis:** Water is split into hydrogen and oxygen using an electric current. The process is emission-free if powered entirely by renewable energy [4].
- **Water consumption:** Purified water is used as the raw material for electrolysis, with controls in place to minimize consumption and losses.
- **Emissions control:** By operating on clean electricity, the process does not generate direct CO2 emissions [4].

2. Conversion to Green Ammonia

To facilitate storage, transportation, and commercialization, the produced hydrogen is converted into ammonia through a catalytic synthesis process using atmospheric nitrogen. This chemical form is more stable and especially relevant in sectors such as fertilizers [5].

- **Ammonia synthesis:** The Haber-Bosch process is adapted to operate with green hydrogen, eliminating the use of natural gas as feedstock [5].
- **Liquefaction and storage:** The ammonia is stored in liquid form, under controlled temperature and pressure conditions for safety.

3. Logistics and Commercialization

A portion of the ammonia is used in the domestic market, particularly in agro-industrial applications, while another portion is intended for export, depending on the demand from industrial clients [5].

5. VALUE PROPOSITION

The Protium Project, developed by the company Hevolución in Antioquia, Colombia, represents a milestone in the transition toward a more sustainable agro-industrial sector. Its value proposition is based on the production of green hydrogen and its subsequent conversion into ammonia—a key input in fertilizer manufacturing. Unlike conventional processes that use natural gas and generate significant carbon emissions, this project adopts an emission-free approach by powering its electrolyzer with renewable electricity [4].

The initiative significantly reduces the carbon footprint of the fertilizer production chain, offering a tangible alternative for decarbonizing agriculture. Additionally, by liquefying the ammonia produced, the project achieves greater stability for storage and transport, enabling its commercialization both in domestic and international markets. This positions Protium as a dual-impact project: it contributes to national food security through green inputs and opens export opportunities in markets demanding products with a lower environmental footprint [5].

Furthermore, as one of the first initiatives in Colombia to enter the operational phase in the green hydrogen sector, Protium sets an important precedent in terms of technical feasibility, connection with industrial clients, and future scalability. This industrial approach—centered on an intermediate product such as ammonia—enables faster integration with existing sectors, increasing its potential for adoption and replication in other regions of the country [1][2].

6. SIMILAR PROJECTS IN LATIN AMERICA AND REGIONAL ADAPTATION

The Protium Project is framed within a growing interest across Latin America in the development of infrastructure for green hydrogen and its derivatives. In countries such as Chile, Brazil, and Uruguay, initiatives are being implemented that seek to position hydrogen as a key vector in industrial decarbonization [4].

In Chile, projects such as Haru Oni, led by HIF Global, produce e-fuels from green hydrogen, aiming at export. In Brazil, the green hydrogen hub in the Port of Pecém seeks to become an export platform for ammonia to Europe. For its part, Uruguay is moving forward with the Kahirós Project, which uses green hydrogen to decarbonize forestry transportation.

Protium differs by focusing on the production of green hydrogen and its conversion into ammonia as a storage and transport vector, opening opportunities for both local consumption and export. Although not exclusively aimed at the fertilizer sector, the product generated can be used by chemical and agro-industrial industries interested in low-carbon alternatives.

This type of project demonstrates the diversity of hydrogen applications in the region and positions Latin America as an emerging player in the development of green hydrogen value chains.

7. MARKET SEGMENT

The Protium Project is designed to meet a strategic demand in the green hydrogen value chain, with a special focus on its conversion into ammonia as a storage and transport vector. This solution allows for both local consumption and export of the product, expanding the possibilities for industrial hydrogen use in key sectors [5].

The market segments that can directly benefit include:

1. **Chemical and Fertilizer Industry:** The green ammonia produced can be used as an input in the production of nitrogen-based fertilizers, replacing fossil-based alternatives and significantly reducing the carbon footprint of the agricultural sector [5].

2. **Export Market:** The project contemplates the export of green ammonia from Colombia to international markets interested in decarbonizing their industry, particularly in Europe and Asia [5].

3. **Domestic Consumption for Industrial Applications:** Industrial sectors that require hydrogen or ammonia as raw material or energy source could be integrated as national consumers, as regulations and incentives for low-carbon hydrogen use are developed [3].

Protium positions itself as a key player in the construction of a hydrogen economy in Colombia, contributing to the diversification of its productive matrix, attracting foreign investment, and facilitating the energy transition in strategic industrial sectors.

8. KEY ACTIVITIES

The development of the Protium Project has followed a set of strategic stages from its conception to its current commissioning phase, allowing for a structured implementation. The following phases have been defined based on public information and official communications from the company Hevolución [1]:

PHASE 1: PLANNING AND INITIAL DEVELOPMENT (2022 – MID-2023)

During this stage, the conceptual engineering of the project was carried out, the site in Antioquia was selected, and the technologies were chosen. In addition, financial structuring and the search for commercial partners began, including potential buyers of green ammonia.

PHASE 2: CONSTRUCTION AND EQUIPMENT INSTALLATION (SECOND HALF OF 2023)

This included the installation of the electrolysis system with a capacity of 2.3 MW (electrical), enabling the production of up to 1,000 kg of hydrogen per day. Infrastructure was also developed for subsequent liquefaction, storage, and conversion into ammonia [2].

PHASE 3: COMMISSIONING AND TESTING (DECEMBER 2023 – PRESENT)

The project entered its commissioning phase at the end of 2023. This phase includes integration and efficiency testing of the electrolysis system, as well as process adjustments to ensure the quality of the final product [1].

PHASE 4: COMMERCIAL OPERATION AND EXPANSION (EXPECTED FROM 2024)

The plant is expected to begin commercial operation throughout 2024. In parallel, an expansion of the electrolysis capacity is projected, along with the development of supply agreements with international and local clients—especially in the fertilizer sector [1][5].

These phases reflect the progressive implementation approach adopted by Hevolución to ensure the technical, operational, and commercial viability of the Protium Project.

9. KEY PARTNERS

The Protium Project is led by Hevolución, a Colombian company dedicated to developing clean energy solutions and green hydrogen vectorization. The company has been responsible for the design, implementation, and operation of the plant [1].

Some relevant stakeholders in its development and potential scaling include:

- **Hevolución:** Project developer and owner. Leads the engineering, operation, and commercialization of hydrogen-derived products.
- **Industrial clients:** Although not publicly identified, Hevolución has stated that negotiations are underway with companies interested in using ammonia for industrial processes, including fertilizers [1].
- **Government of Colombia:** Through the Ministry of Mines and Energy and the Ministry of Commerce, Industry and Tourism, the country actively promotes the Hydrogen Roadmap and the adoption of technologies for the energy transition [3].
- **Private investors and strategic partners:** Hevolución has expressed the intention to scale the project through international partnerships, particularly within the framework of positioning Colombia as an exporter of green ammonia [1].

The role of these partners is key to ensuring the sustained operation and expansion of the project, as well as its positioning within Colombia's national green hydrogen strategy.

10. RESULTS AND BENEFITS

The Protium Project represents a significant advance in the production and use of green hydrogen in Colombia, with a particular emphasis on its transformation into ammonia for industrial applications. Although it is still in the commissioning phase, it is already possible to identify expected benefits in environmental, economic, and strategic areas.

1. Environmental Benefits

The plant uses renewable electricity to power the electrolyzer, allowing for hydrogen production without carbon emissions. This positions the resulting ammonia as a green alternative to its conventional counterpart, whose process generates high CO_2 emissions [4].

2. Economic Benefits

Local production of green ammonia has the potential to reduce dependency on imported inputs in sectors such as fertilizers, increasing supply chain resilience. It also opens opportunities for exporting ammonia under international sustainability standards [5].

3. Strategic Relevance

Protium is one of the first commercial-scale green hydrogen production projects in the country. Its development helps validate the technical and commercial model for Colombia's hydrogen industry, supporting the national energy transition roadmap [3].

In the medium term, the experience gained from the project may serve as a basis for new investments and similar developments in other energy-intensive industrial sectors.

11. COST STRUCTURE

Due to the private nature of the Protium Project, no official public data is available regarding its detailed cost structure. However, based on market information and comparable projects, it is possible to identify the main cost components involved in a plant of this nature [4].

1. Initial Investment (CAPEX)

- **Electrolysis system:** Acquisition and installation of an alkaline or PEM electrolyzer with the capacity to produce up to 1,000 kg of hydrogen per day.
- **Electrical infrastructure:** Integration of the system with available renewable energy, including connections and control systems.
- **Liquefaction and ammonia conversion unit**: Equipment for converting hydrogen into ammonia, including reactors and refrigeration systems.
- **Storage and distribution:** Pressurized or cryogenic tanks for the safe storage of hydrogen and ammonia.
- **Civil and auxiliary works:** Site construction, industrial safety systems, and process control infrastructure.

2. Operating Costs (OPEX)

- **Electricity:** The main input for the electrolysis process.
- **Deionized water:** Used in the electrolysis process.
- **Equipment maintenance:** Periodic technical servicing.
- **Operational staff:** Technicians and engineers in charge of operations.
- **Safety and environmental monitoring:** Oversight to ensure regulatory compliance

This structure serves as a general reference. For a precise financial analysis, detailed information directly provided by the project developer would be required [1].

12. FINANCING STRUCTURE

The Protium Project, developed by the Colombian company Hevolución, has been financed primarily with private resources. Although no official figures have been disclosed, it is known that the initial investment came from the company's own capital and strategic partnerships with actors from the energy sector [1].

In Colombia, the regulatory framework offers tax incentives for green hydrogen projects, such as income tax deductions, VAT exemption for certain equipment and services, accelerated depreciation of assets, and exemption from import duties. These benefits, established by Law 1715 of 2014 and its amendments, aim to promote investment in renewable energies and have been leveraged by projects like Protium [6].

Additionally, the Colombian government, in collaboration with international entities such as GIZ and the European Union, has developed pilot programs to finance green hydrogen projects. These programs include the structuring of dedicated funds and financial products to support initiatives across the green hydrogen value chain [6].

> ***Although Protium has been financed mainly with private capital, the favorable environment in Colombia—through incentives and support programs—has facilitated the project's economic viability. It is expected that in future stages, the project may access additional financing through these mechanisms, especially considering its export potential and contribution to industrial decarbonization.***

13. REVENUE SOURCES

The Protium Project's business model is primarily based on the commercialization of green hydrogen and its derivatives, with a focus on green ammonia. The production plant aims to serve both the domestic market and export opportunities, positioning Colombia as a relevant player in the international supply chain of low-carbon products [5].

One of the main identified revenue sources is the sale of green ammonia to industrial companies seeking to replace fossil-based inputs in their processes. While Hevolución does not produce fertilizers directly, ammonia can be used as a key input in their manufacture, opening a commercialization pathway toward agro-industrial companies [1].

Additionally, the project may generate future income through:

- Offtake agreements with local or international companies interested in securing long-term supply contracts.
- Exports of green ammonia, leveraging Colombia's strategic location and its expanding port infrastructure [5].
- Carbon credits in voluntary or regulated markets, thanks to the emissions reductions associated with green hydrogen production and use [4].
- Government incentives or tax benefits, which, while not direct revenue, reduce operating costs and improve net profitability [6].

This revenue model reflects a strategy oriented toward economic sustainability, combining industrial product sales with benefits tied to decarbonization.

14. LESSONS LEARNED

Although still in the commissioning phase, the Protium Project already offers valuable insights for future green hydrogen developments in the region:

1. Importance of early integration of the value chain:

From the initial design stage, the project considered not only hydrogen production but also its conversion into derivatives such as ammonia and its connection with export markets. This comprehensive vision helps ensure the project's technical and commercial viability [5].

2. Role of the regulatory framework:

Existing tax incentives in Colombia have been key in structuring the project's economic model, demonstrating the direct impact of public policy on the feasibility of emerging hydrogen initiatives [6].

3. Alignment with existing industrial markets:

By focusing its product on ammonia—a widely used input in the fertilizer industry—Protium leverages an existing market that enables faster adoption and more predictable demand [1].

4. Need for long-term private investment:

Hevolución's experience confirms that pioneering clean energy projects require committed investors willing to take on early-stage risks and aim for medium- and long-term returns.

5. Gradual validation through pilots and modular scaling:

Starting with an electrolysis capacity of 1,000 kg/day has allowed for controlled operation, generation of technical insights, and adjustment of the growth strategy according to real demand [1].

15. CONCLUSIONS

The Protium Project represents a significant milestone in the evolution of the green hydrogen industry in Latin America. By integrating electrolysis capabilities with ammonia liquefaction and distribution infrastructure, the project stands out as one of the region's first operational examples focused on hydrogen derivatives for industrial use [4][5].

Although it is still in the commissioning phase, Protium already offers clear signals of green hydrogen's potential as a transformation driver for sectors such as agro-industry, where green ammonia can replace fossil-based products in fertilizer manufacturing—contributing to the decarbonization of the agricultural supply chain [1][5].

With an initial electrolysis capacity of 1,000 kg/day powered by a 2.3 MW photovoltaic plant, the project combines technical feasibility with a strategic approach to scalability and market orientation [2].

Moreover, Protium has been structured within the incentive framework provided by the Colombian government, reinforcing the importance of having regulatory environments that foster the adoption of clean technologies [3][6].

Hevolución's experience offers key lessons on business model design, engagement with industrial clients, technology selection, and infrastructure development for hydrogen derivatives. Its implementation sets a precedent for future investments in the sector, both in Colombia and across the region, consolidating Protium as a pioneering model in the transition toward a green hydrogen-based economy.

16. REFERENCES

[1] La República, “Hevolución desarrollará planta para producir 1.000 kg de hidrógeno a partir de 2023”, 2022. [Online]. Available: https://www.larepublica.co/empresas/hevolucion-desarrollara-planta-para-producir-1-000-kg-de-hidrogeno-a-partir-de-2023-3404792

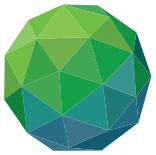
[2] Fenoge, “Mapa de Proyectos de Hidrógeno Verde en Colombia”, 2023. [Online]. Available: https://fenoge.gov.co/documentos-pdf/proyectos/Proyectos_Colombia_Hidrogeno3.pdf

[3] Ministerio de Minas y Energía de Colombia, “El despliegue del hidrógeno avanza desde las regiones”, 2024. [Online]. Available: https://www.minenergia.gov.co/es/sala-de-prensa/noticias-index/el-despliegue-del-hidr%C3%B3geno-avanza-desde-las-regiones-minenerg%C3%ADa-acompa%C3%B1a-construcci%C3%B3n-de-hub-de-hidr%C3%B3geno-de-antioquia/

[4] Agencia Internacional de Energía (IEA), “Global Hydrogen Review 2023”, 2023. [Online]. Available: https://www.iea.org/reports/global-hydrogen-review-2023

[5] ICIS, “Green Ammonia Outlook Latin America”, 2023. [Online]. Available: https://www.marketsandmarkets.com/Market-Reports/green-ammonia-market-118396942.html?gad_source=1&gad_campaignid=401403796&gbraid=0AAAADxY7Sy1gdNf7NrTZt8Pt5sQur_WL&gclid=CjwKCAjwx8nCBhAwEiwA_z__04ADZDz0gsJynaMD6488OFS4oVqJ3cXqGMBhwdNmo-C4MtCSqlOOWxoCqXoQAvD_BwE

[6] UPME, “Incentivos Tributarios para Proyectos de Hidrógeno Verde o Azul”, 2024. [Online]. Available: https://www1.upme.gov.co/Incentivos/Paginas/Incentivos-tributarios-HidrogenoVA.aspx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