Chile’s Green Hydrogen Strategy and investment opportunities

June, 2021
We are facing a climate crisis

Global warming referenced to 1850-1900 (°C)
Source: IPCC. (2019). Special Report: Global Warming of 1.5°C.

Energy production and use are at the heart of the challenge

Global greenhouse gas emissions by sector
Alongside the world, committed to reach carbon neutrality
We are retiring all coal power plants by 2040. 50% will be closed by 2025.

In 2021: We are doubling our solar & wind capacity.

+ 6 GW

Equivalent to 25% of power system size.
MINISTERIO DE ENERGÍA
The time for hydrogen has arrived

Almost 90% of global GDP has put forward hydrogen support policies or initiatives

Source: LBST, Hydrogen Council

Global energy demand supplied by hydrogen (PWh)

18% of final energy demand

- Power generation and storage
- Transportation
- Heating and residential uses
- Industry
- New uses
- Existing uses

MINISTRIES OF ENERGY AND MINING | 6
Hydrogen applications are reaching maturity: transport is the next wave


1. Defined as >1% of segment sales
The power of green hydrogen

An industrial gas used widely for more than a century, elemental hydrogen (H₂) can be produced today from water with increasing scale and efficiency. In green hydrogen production, water can be separated into its constituents, hydrogen and oxygen, using renewable power.

Historically, it has been produced from fossil fuels in processes that emit greenhouse gases. It has mostly been used in chemical industries and for the refining processes of crude oil.

It is a means for using the inexhaustible renewable energy found in various forms on the planet. It functions as an energy carrier that emits no greenhouse gases when used. It can replace the use of fuels in the production of electricity, heat, and multiple materials.

Source: adapted from Siemens, Power-to-X

Decarbonization potential of green hydrogen

Renewable power

Water

O₂

H₂

Green hydrogen

Fossil fuels

CO₂

H₂

Grey hydrogen

Grey hydrogen

Renewable power

Turbines, engines, fuel cells

Green hydrogen

Electrolysis

Boilers and gas grids

Green synthetic fuels

Substitute for grey hydrogen

Substitute for grey hydrogen

Substitute for grey hydrogen

Boiling and cooling

Other industries

Steel

Ammonia and green fertilizers

Chemical industry

Petrochemical industry

Agriculture

Transportation

Fuel cells, dual combustion

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The green hydrogen economy is building momentum

240 Announced projects

- 97 Large-scale industrial usage: refinery, ammonia, power, methanol, steel and industry feedstock
- 55 Transport: trains, ships, trucks, cars and other hydrogen mobility applications
- 47 Integrated H₂ economy: cross-industry, and projects with different types of end-uses
- 17 Giga Scale production: renewable H₂ projects > 1 GW and low-carbon H₂ projects >200 kt/year
- 24 Infrastructure projects: H₂ distribution, transportation, conversion and storage

Projected electrolyser capacity (GW)

- December 2020: 43.9 GW
- June 2020: 27.5 GW
- December 2019: 12.9 GW

Green hydrogen holds the key to reach net zero

Source: Ministry of Energy
Green Hydrogen

CH$_2$LE

“I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable”

Jules Verne, 1874
Our renewable potential amounts to 70 times our current capacity.

Potential (GW)

- CSP: 587
- Photovoltaic: 879
- Wind: 295
- Hydro: 15
Thanks to its unique renewable resources and geography

Capacity factors per country in best areas (%)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Solar PV</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Wind</strong></td>
</tr>
<tr>
<td>Off shore</td>
</tr>
<tr>
<td>On shore</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Solar PV</th>
<th>Wind Off shore</th>
<th>Wind On shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chile</td>
<td>37%</td>
<td>&gt;75%</td>
<td>70-75%</td>
</tr>
<tr>
<td>Australia</td>
<td>~30%</td>
<td>~30%</td>
<td>30-35%</td>
</tr>
<tr>
<td>Spain</td>
<td>~30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>~25%</td>
<td></td>
<td>40-50%</td>
</tr>
<tr>
<td>EU</td>
<td>20-25%</td>
<td>50-55%</td>
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</tr>
</tbody>
</table>

Our narrow territory (average 180 km width) ensures proximity of production points to maritime ports.

Latest estimations put Chile around 1 USD/kg by 2030

Levelized cost of production (USD/kg H₂)

Levelized cost of production by 2030 (USD/kg H₂)

Does not consider conditioning, transport, storage nor distribution costs

Potential for a 160 Mtonne yearly green hydrogen production according to IEA

Despite distance to markets, Chile remains on top

Cost of liquid $\text{H}_2$ at port of destination, 2030 (USD/kg $\text{H}_2$)

<table>
<thead>
<tr>
<th>Destination</th>
<th>Cost (USD/kg $\text{H}_2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia to EU</td>
<td>2.0</td>
</tr>
<tr>
<td>Norway to EU</td>
<td>1.9</td>
</tr>
<tr>
<td>Middle East to US</td>
<td>2.2</td>
</tr>
<tr>
<td>Middle East to EU</td>
<td>1.9</td>
</tr>
<tr>
<td>Australia to K/J</td>
<td>2.7</td>
</tr>
<tr>
<td>Chile to K/J</td>
<td>2.2</td>
</tr>
<tr>
<td>Chile to US</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Distribution: 1.0
Liquefaction: 0.6
Shipping: 0.6
Production: 1.7

Renewable energy carriers considered by developers and investors:
- LH2: Liquid hydrogen
- NH3: Green ammonia
- CH3OH: Green methanol / eFuels
- Cu: Green copper and other green exports

Addressable market for Chile will reach 47 BUSD in 2030, mainly driven by EU and USA

### Table: Total addressable market for Hydrogen and derivatives – USD Billion

<table>
<thead>
<tr>
<th></th>
<th>Europe</th>
<th>United States</th>
<th>Asia²</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrogen</strong></td>
<td>$0</td>
<td>$5</td>
<td>$2</td>
<td>$7</td>
</tr>
<tr>
<td><strong>Ammonia</strong></td>
<td>$0</td>
<td>$0</td>
<td>$3</td>
<td>$3</td>
</tr>
<tr>
<td><strong>Synfuels³</strong></td>
<td>$17</td>
<td>$17</td>
<td>$14</td>
<td>$35</td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>$2</td>
<td>$1</td>
<td>$1</td>
<td>$3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$18</td>
<td>$23</td>
<td>$5</td>
<td>$47</td>
</tr>
</tbody>
</table>

1. Considers Chilean product competitiveness vs. local production and export competitors
2. Japan & Korea
3. Synkerosene (jetfuel), Syndiesel & Syngasoline

We have set clear goals to lead in the green hydrogen economy

**2025**

- **5 BUSD**
  - Top destination for green hydrogen investment in LATAM

- **5 GW**
  - Electrolysis capacity operating and under development

- **200 ktonne/year**
  - Production in at least 2 hydrogen valleys in Chile

- **2.5 BUSD/year**
  - Leaders in export of green hydrogen and derivatives

- **<1.5 USD/kg**
  - The cheapest green hydrogen on the planet

- **25 GW**
  - Leaders in production of green hydrogen via electrolysis

**2030**
And we have defined an action plan to cover 8 key fronts

1. **Strategy and targets**
   Establish a vision and mission to align public and private stakeholders.
   Drive action and commitment by investors, developers, regulators, and civil society towards defined goals.

2. **Regulation and permits**
   Develop a clear, stable, and coherent regulation on markets and safety issues, so uncertainty is reduced and projects are accelerated. Streamline permitting to accelerate deployment of technologies.

3. **Coordination and alliances**
   Reduce market failures: information asymmetries, high transaction costs, barriers for new entrants. International cooperation to overcome technological capability gaps, commercial, regulatory and cultural challenges together.

4. **Value chain development**
   Enable the development of manufacturing and services to capture increased shares of the market value domestically.

5. **Incentives and financing**
   Help in bridging the remaining cost gap relative to fossil solutions, especially reducing the cost of capital.

6. **Infrastructure**
   Plans for developing adequate and coordinated port, electrical, and distribution infrastructure to foster the growth of hubs.

7. **Research & development**
   Deploy technologies and solve local implementation issues, in order to reduce costs, unlock markets, and increase competition in the sector.

8. **Human capital**
   Develop local talent and technical capabilities to accelerate project deployment and generate green jobs.
This opportunity will unveil in 3 distinct waves

The first wave will include domestic usage with existing large energy or hydrogen demand. The shorter-term opportunities are replacing imported ammonia for local production, and replacing grey hydrogen used in oil refineries. The use of green hydrogen for heavy and long-distance transportation also becomes attractive for fleets and machinery operating in concentrated zones.

The start of export activities and extended local uses will be seen before the decade is over. A clear opportunity for green ammonia exports exists in the medium-term, as well as for the first hydrogen exports. A more competitive production of green hydrogen will also replace an increasing share of liquid fuels in land transportation, whereas blending into grids becomes economical.

New export markets open in the long-term, enabling a massive scale-up of production. Fuels derived from green hydrogen will be key to decarbonize the shipping and aviation sectors, both in domestic and international routes. Export markets will continue to grow as other nations take action to deeply decarbonize their economies.

Wave I: Local applications will ramp up demand and activate an industry

We will accelerate the deployment of green hydrogen in 6 prioritized applications to build local supply chains and acquire experience.

Public action will kickstart the local hydrogen industry by incentivizing production and create a tangible demand for this clean element and its derivatives. Uses with the earliest economic breakeven and largest concentrated demand will be targeted first. These actions will generate know-how, develop talent, deploy infrastructure, and attract financing. In doing so, the country will be better positioned to tap into export markets.

<table>
<thead>
<tr>
<th>Application</th>
<th>Total potential market¹ (BUSD by 2050)</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil refineries</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining haul trucks (CAEX)</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy-duty trucking</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long-range buses</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blending into gas grids (up to 20%)</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>


1. Annual sales. Considers the full transition to hydrogen of the energy demand in each application.
In 6 months, we have achieved 5 key milestones for hydrogen

**50 MUSD**

First call for financing green hydrogen projects
- Funding round for 10+ MW electrolizer facilities

**International outreach**

MoUs for collaboration and co-leadership of MIH2
- MoUs with Singapore and Port of Rotterdam

**265 MUSD**

Clean Technologies Institute
- Open Innovation platform for clean energy and mining technologies

**Fast-track piloting**

3 guides for H2 tech in production, mining, and transport
- Streamlined approval processes for pilot initiatives

**Energy Efficiency Law**

Energy efficiency standard for vehicles
- Hydrogen and battery electric vehicles count x3.
- Accelerated depreciation.
40+ projects have sprung in Chile already

**Atacama Hydrogen Hub Project**
Large-scale electrolysis facility with export potential and hydrogen fuel cell powered freight train

**HyEx Project**
Green ammonia production in the north of Chile for domestic and international consumption, replacing ENAEX ammonia imports

**Quintero Bay H\(_2\) Hub Project**
Production of green hydrogen in the central zone of Chile, close to potential offtakers

**Green Steel Project**
Green hydrogen blending into CAP’s blast furnaces to reduce consumption of coke and eventually replace it entirely in their production of steel

**HHN ENERGY Project**
Large scale green ammonia production in Magallanes for export

**HIF Project**
Industrial-scale plant in Magallanes that will produce synthetic climate-neutral fuels for export

**Source:** Ministry of Energy
HIF is expected to yield the world’s first industrial-scale plant that will produce synthetic climate-neutral fuels for export.

**PRODUCTION**
A wind plant will power an electrolyser which will produce green hydrogen. This will be combined with captured carbon dioxide to produce synthetic methanol. A portion of this methanol will be converted into synthetic gasoline (eGasoline).

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**
HIF

**PARTNER COMPANIES**

- **SIEMENS ENERGY**: Co-developer and technology provider.
- **ENEL**: Renewable power developer.
- **ENAP**: Chilean National Oil company. Infrastructure provider.
- **GASCO**: Co-developer and offtaker.
- **PORSCHE**: Co-developer and offtaker.

Siemens received an **8 million euros grant** from the German Federal Ministry for Economic Affairs and Energy to develop this project.

**OFFTAKE**

PORSCHE is planning to use the eGasoline from Chile in pilot projects. These include using eGasoline in Porsche’s Experience Centers and sports cars.

**STATUS**

Pilot phase is in a detailed engineering state and was recently approved by the Environmental Assessment Service. Further permits must be obtained.

Phase I is currently in development and the environmental assessment is being prepared.

**PROJECTIONS**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Year</th>
<th>m $^3$ eGasoline per year</th>
<th>USD investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot</td>
<td>2022</td>
<td>131</td>
<td>45 million</td>
</tr>
<tr>
<td>Phase I</td>
<td>2024</td>
<td>70,000</td>
<td>755 million</td>
</tr>
</tbody>
</table>

**LOCATION**

HIF is an SPV owned by Desal.

**HIF** is expected to yield the world’s first industrial-scale plant that will produce synthetic climate-neutral fuels for export.

**HOW IT WORKS**

Wind energy + Well water + Desal. water → Green hydrogen + CO$_2$ captured from the air → eMethanol → eGasoline → Applications

**Contact details:** Clara Bowman
General Manager, AME
bowman@ame.cl
HyEx seeks to produce green ammonia in the North of Chile for domestic and international consumption, replacing imports.

**PRODUCTION**

Using renewable energy and desalinated water, the project will produce green hydrogen through an electrolysis process. Hydrogen will then be combined with nitrogen, captured from the air, and through Haber-Bosch process will produce green ammonia. During the pilot phase, all production will be sent by truck to ENAEX’s plant, replacing some of its current imports. The second phase considers large scale ammonia production for ENAEX consumption, export and additional applications.

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**

ENGIE has a partnership with ENAEX, which will utilize 350,000 tonnes of ammonia per year for its ammonium nitrate Prillex plant, replacing the current grey ammonia import. Remaining production will be commercialized in local markets for mining applications and fertilizer production, as well as exported to international offtakers.

**ENGIE** is a global reference company in low-carbon energy and services, having a Business Unit dedicated to renewable hydrogen since 2018. The current portfolio of renewable H₂ projects under development and in construction is over 30 projects in 10 countries over four continents.

**ENAEX** is the main ammonium nitrate producer and supplier of comprehensive rock fragmentation services for the mining industry in Latin America. With over 100 years of experience and presence in 10 countries, ENAEX is actively committed to sustainability.

**STATUS**

A feasibility study of the project is being conducted. An environmental impact study is currently being carried out to be presented to the Chilean Environmental Assessment Service by 2021.

**PROJECTS**

**Pilot**

- **18,000 Tonnes green ammonia per year**
- **200 million USD investment**
- **36 MW Solar energy**
- **2024-2025 expected year for operation start**

**Industrial Plant**

- **700,000 Tonnes green ammonia per year**
- **2,000 million USD investment**
- **2.8 GW Solar energy**
- **2030 expected year for operation start**

**OFFTAKE**

ENGIE has a partnership with ENAEX, which will utilize 350,000 tonnes of ammonia per year for its ammonium nitrate Prillex plant, replacing the current grey ammonia import.

**LOCATION**

Antofagasta Region

Chile

Exportation

**CONTACT DETAILS:**

Asunción Borrás
Sr. VP Bussines Development H2BU, Engie
asuncion.borras@engie.com
GNL Quintero, the largest LNG regasification terminal in Chile located in the Quintero bay, aims to take advantage of its proximity to industrial areas with high energy demand and grey hydrogen consumption to produce green hydrogen for the domestic market.

**PRODUCTION**

Production of green hydrogen in the central zone of Chile, even though facing higher energy prices, could be competitive due to closeness to potential offtakers. This could make hydrogen a competitive alternative to replace fossil fuel consumption and local demand for grey hydrogen, reducing emissions in several industries.

Whether the green hydrogen will be produced with off-grid renewable plants or with green power from the grid is still under study.

**STATUS**

A prefeasibility study for the pilot phase was carried out. The company is currently attempting to form a consortium with local stakeholders: potential offtakers and partners.

GNL Quintero presents strategic advantages such as experience in pipe and on road gas transport and access to gas grids, transmission lines and port infrastructure.

**PROJECTIONS**

- **2 MW** firm PPA
- **8 MW** variable PPA

Replacing ~1% of the whole hub’s energy needs

- 2.6 USD/kg LCOH
- **430 Tonnes of green hydrogen per year**

**POTENTIAL OFFTAKERS IN THE HUB**

- **GasValpo**: Local gas distributor
- **ENAP**: National Oil Company. Owns a refinery in Quintero.
- **EPV+TPS**: Valparaiso Port operators
- **Melón**: Cement producer
- **Codelco**: National Copper Company. Owns a refinery in Ventanas.
- **Enex+Cope**: Fuel distributors; interested in mobility projects.
- **Buses**: Several bus companies operate in the area.

**HOW IT WORKS**

- Renewable energy contract
- Energy from the grid
- Green hydrogen
- Blending into gas pipelines
- Oil refinery
- Mobility
- Furnaces

Contact details: Alfonso Salinas
Sustainable Development Manager, GNL Quintero
alfonso.salinas@gnlquintero.com
The HNH Energy project aims to produce green ammonia on a large scale in Magallanes for export, leveraging abundant wind resources present in the region.

**PRODUCTION**

Wind energy is used to power an electrolysis plant, which uses desalinated water to obtain oxygen and hydrogen. Hydrogen will then be combined with nitrogen captured from the air through the Haber-Bosch process, to produce green ammonia. The project also contemplates the construction of port infrastructure for export.

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**

AUSTRIAENERGY focuses on utility scale energy project development, construction, operation and management, with close to 1 GW developed in Chile, thereof 300 MW in operation and close to 300 MW under construction. It is a partner in the project and the developer.

ÖKOWIND, his partner, is dedicated to the development and operation of wind, hydro and solar power plants with over 100 MW installed capacity and over 500 MW in development in Europe.

**OFFTAKE**

Trammo DMCC, a subsidiary of Trammo, Inc., a global company that markets, trades, transports and distributes key raw materials used in industrial processes and fertilizer production announced an MoU highlighting the purchase the entire output from this project.

**STATUS**

The project is in a conceptual engineering development stage and holds a lease over the terrain. Wind capabilities are being measured and environmental baselines are being defined.

**PROJECTIONS**

- Wind energy installed capacity: 1,800 MW
- Tonnes green ammonia per year: 850,000
- Tonnes of green hydrogen per year for ammonia production: 150,000

**LOCATION**

Chile

Exportation

**WHAT IT WORKS**

Wind energy + Desal. water → Green hydrogen + Nitrogen captured from the air → Green ammonia

**CONTACT DETAILS**

Helmut Kantner
Managing Director, AustriaEnergy
helmut.kantner@austriaenergy.com
Taking advantage of strong winds and solar radiation in Chile, the project aims to produce green ammonia on a large scale for export and maritime transportation fueling.

**PRODUCTION**

Using renewable energy and water from a desalination plant, the project will produce green hydrogen through an electrolysis process, which combined with nitrogen captured from the air will be used to produce green ammonia.

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**

AES CHILE

**PARTNER COMPANIES**

AES ANDES is a subsidiary of AES Corporation, a global energy company with over 5 GW of installed capacity. For over 2 years, the company has been developing ammonia related initiatives in countries such as Brazil, Argentina and Colombia, as well as Chile.

AES ANDES has a (BBB-) credit rating and over 3.5 GW of installed capacity in Chile. It is a partner in the project and will be the developer and technology provider.

AES ANDES has signed an MoU with its undisclosed investment grade partner. It is a world-class hydrogen producer and exporter.

In the MoU they have committed 100% of the green ammonia production for maritime fuel and international export for a tenor of up to 30 years.

**OFFTAKE**

Studies are being executed to define the right set up for the desalination and production plants. Target markets are being assessed.

**STATUS**

**PROJECTIONS**

**EXPECTED PRODUCTIONS**

- 800 MW Renewable energy
- 250,000 Tonnes of green ammonia per year
- 50,000 Tonnes of green hydrogen per year for ammonia production

**LOCATION**

Chile

Contact details: Luis Sarrás
Green & Fuels Hydrogen Director, AES South America
lsarras@aes.com
THE ATACAMA HYDROGEN HUB PROJECT

The ATACAMA HYDROGEN HUB project aims to build a large-scale electrolysis facility with export potential in the northern Antofagasta Region.

PRODUCTION

Solar energy is used to power an electrolysis plant, which uses desalinated water to obtain oxygen and hydrogen. The pilot involves an electrolysis facility and a dedicated off-grid solar PV plant to supply a hydrogen powered freight train. Industrial phase contemplates large scale hydrogen production. It is being considered to include the production of ammonia and/or the liquefaction of hydrogen.

PROJECT OWNER AND PARTNERS

PROJECT OWNER

PARTNER COMPANIES

HUMBOLDT HIDROGENO VERDE (H2V) is a company created by Chilean entrepreneurs for the development of hydrogen production, transportation and application projects in the north of Chile. It is the developer of the project.

COMPLEJO PORTUARIO MEJILLONES (CPM), subsidiary of Codelco, Chile’s national copper corporation, is a port located in the Antofagasta Region. It will provide infrastructure for the project.

OFFTAKE

The pilot considers the adaptation of an existing train engine to be powered by hydrogen fuel cells. Negotiations with train operators that provide transport to mining facilities within the region are underway.

The industrial phase considers a large scale hydrogen production and aims to foster efficient supply chains such as shared gas pipelines in collaboration with other players to enable large scale exportation.

LOCATION

Exportation

Atacama Hydrogen Hub

HOW IT WORKS

Solar energy + Desal. water → Green hydrogen → Hydrogen powered freight train → Applications

STATUS

The first phase is in pre-feasibility and conceptual engineering stage. It will request approval from the Environmental Assessment Service during 2021.

18 million USD

Total investment during the first phase

Pilot

PROJECTIONS

Industrial Phase

2022

2030

110 kton green hydrogen per year (metric tons)

10 MW electrolysis capacity

gas pipeline in collaboration with players

Contact details: Nicolás Errázuriz
Managing Partner, Four Trees Merchant Partners Inc.
nerrazuriz@fourtreescapital.com
Leveraging their expertise in power generation and hydrogen technologies, Aker and Mainstream have joined forces to develop a large-scale green ammonia project in Chile.

**PRODUCTION**

Using renewable energy and water from a desalination plant, the project will produce green hydrogen through an electrolysis process, which combined with nitrogen captured from the air will be used to produce green ammonia.

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**

**PARTNER COMPANIES**

AKER Clean Hydrogen (ACH) and MAINSTREAM Renewable Power (MRP) are subsidiaries of AKER Horizons, a company dedicated to incubating and developing companies that solve fundamental challenges to sustainable existence.

ACH is a developer and operator of clean hydrogen production at an industrial scale. With a proven execution model and unique end-to-end asset integration and optimization capabilities.

MRP is one of the major renewable players in Chile and has a worldwide pipeline of 12.1 GW of wind and solar energy projects, with over 1.4 GW under construction and 1.1 GW in operation.

**HOW IT WORKS**

Wind energy + Solar energy + Energy from the grid + Desal. water → H₂ + Nitrogen captured from the air → Green hydrogen → Green ammonia → Applications

**STATUS**

Studies are being executed to define the right set up for the desalination and production plants. Target markets are being assessed.

**FINAL PHASE PROJECTIONS**

3,500 MW Renewable energy

1.3 million NH₃ Tonnes of green ammonia per year

250,000 H₂ Tonnes of green hydrogen per year for ammonia production

**LOCATION**

Chile

North of Chile

**OFFTAKE**

AKER Clean Hydrogen has signed an MoU with its undisclosed investment grade partner.

**PROJECT OWNER AND PARTNERS**

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**Contact details:**

Manuel Tagle
General Manager Latam at Mainstream Renewable Power
manuel.tagle@mainstreamrp.com
HUACHIPATO steel mill (CAP Acero) is part of the integrated iron and steel CAP Group and is the main steel producer in Chile. The company is planning to reduce CO2 emissions from its steel production processes incorporating green hydrogen along its value chain.

PRODUCTION
Production of green hydrogen in the south-central zone of Chile, for blending into CAP’s blast furnaces to reduce consumption of coke and eventually replace it entirely. Additionally, green hydrogen will be used to decarbonize transport – trucks and rail in its supply chain.

Whether the green hydrogen will be produced with off-grid renewable plants or with green power from the grid is still under study.

PROJECT OWNER AND PARTNERS

PROJECT OWNER
The Huachipato steel mill was founded in 1950. Supplies metallurgical, mining, and construction sectors in Chile. Annual revenue: 500 MUSD.

PARTNER COMPANIES
CAP and Paul Wurth, an SMS Group company, signed a Technological Cooperation Agreement on March 17th, 2021, to explore the feasibility of reconverting CAP’s operations to produce green steel.

TECHNOLOGY
Production of Direct Reduced Iron (DRI) through green hydrogen has the potential to dramatically reduce CO2 emissions in the steelmaking industry. Several pilots are under planning in Europe. A 100% green hydrogen steel pilot plant is even set to begin operations in Sweden by 2024.
CWP Global is developing the “H1 Magallanes” project in Chile with the assistance of its regional company H1 America with the target to build a world-scale green hydrogen and ammonia production facility.

**PROJECT CONCEPT**
The project will consist of upstream wind power generation, and downstream green hydrogen & green ammonia production. Ancillary systems will be installed for water desalination, intelligent hydrogen storage, back-up power, ammonia storage and export facilities. The aim is to construct a world-scale ammonia synthesis train which will enable economies of scale and competitive cost.

**PROJECT OWNER / DEVELOPER**
CWP has 15 years of experience from large-scale renewable power generation projects with a successful track record of over $3 US bn of financed assets. CWP Global is part of the Green Hydrogen Catapult initiative.

CWP Global is one of the main shareholders in the 26 GW Asian Renewable Energy Hub project in Australia. This project is one of the most advanced PtX sites in the world in terms of development and permitting - it has received “Major Project Status” recognition from the government and environmental approval for the first phase.

**STATUS**
Feasibility studies are being executed, as well as environmental screening and wind resource assessment.

The projects are expected to start operations in **2028**

**PHASE ONE PRODUCTION CAPACITY**
- **2,200 MW** Wind energy installed capacity
- **1,000,000 Tonnes green ammonia per year**
- **170,000 Tonnes of green hydrogen per year**

This first phase is expected to be expanded in tandem with global market growth.

**OFFTAKE**
CWP Global and its Group team have decades of experience in global commodity trading and are using this know-how to structure long-term bankable ammonia off-take agreements with various partners around the world.
The San Pedro de Atacama project has the ambitious goal of incorporating green hydrogen and renewable energy into existing fossil fuel generation systems in isolated areas such as the one located in San Pedro de Atacama in the north of Chile, with the highest radiation levels in the world.

**HOW IT WORKS**

The project aims to modify the existing isolated power system operated by "Cooperativa Eléctrica de San Pedro de Atacama (CESPA)" to incorporate solar photovoltaic generation, battery storage, hydrogen technologies to provide a high-renewable share power supply to the cultural and tourist hotspot of San Pedro de Atacama.

**PROJECT OWNER**

Chile

**KEY POTENTIAL PARTNER**

CESPA

CUMMINS is a leading company that provides power solutions, working with diesel, natural gas, biogas, battery and hydrogen (production and fuel cells). It is the project owner and developer.

**HOW IT WORKS**

- Solar energy
- Hydrogen production
- Hydrogen storage
- Fuel cell
- LiFePo Battery
- Diesel
- LPG
- Power for San Pedro de Atacama

**STATUS**

The project has completed a pre-feasibility study, where the configuration of the technology mix was optimized with promising results. The study was carried out by HINICIO, a strategic consulting firm focused on sustainable energy, transportation, and hydrogen.

**2022-2023** expected year operation start

**PROJECT DETAILS**

- **143 Tonnes green hydrogen per year**
- **2.2 MW electrolyzer**
- **500 kg hydrogen storage**
- **600 kW fuel cell**
- **1.3 MW Diesel engines**
- **4.2 MW Solar PV plant**
- **2.6 MW LiFePo Battery**
- **$10 million USD investment**

**LOCATION**

The isolated grid owner and operator has still not joined the project.

The clients and beneficiaries would be the residents and visitors of the community of San Pedro de Atacama, who would enjoy a cleaner supply of 24/7 electricity.

The generator and energy distributor would be CESPA, the local utility for the isolated grid.
The HOASIS Project, in the Antofagasta region, promotes hydrogen as a solution that contributes to energy self-sufficiency and supports local development based on a circular economy model.

PRODUCTION

Large-scale production of green hydrogen and oxygen to produce fertilizers, which will be used in reforestation, precision agriculture, waste recovery and creation of synergies with local industries. HOASIS also contemplates the construction of 2,000 Ha of greenhouses to produce local crops and the reforestation of the area from the planting of 100 Ha of tree crops.

PROJECT OWNER AND PARTNERS

TCI GECOMP specializes in renewable energy projects, with more than 1 GW installed in Europe and Latin America. Currently, TCI is expanding its business to develop projects and services related to green hydrogen in Europe, Africa and Latin America.

Offtake

The project considers the formation of a consortium during 2021 and it has identified potential offtakers in the mining and chemical industries, plus nearby utilities running on fossil fuels. HOASIS also considers the production of fertilizers and agricultural products, to support the development of a local ecosystem with positive impacts on the implementation zone.

How it works

Solar energy (from desalination water, energy from the grid)

Green hydrogen

Oxygen

Green ammonia

Transport

Industry

Agriculture

Status

The project is undergoing a pre-feasibility analysis. Lands are being evaluated for acquisition, and the project is in the consortium formation phase.

3,700 million USD

Total investment, starting operation in 2024.

Projections

250,000 tonne NH₃

102,000 tonne H₂

140,200 tonne

Agricultural products per year

Location

Antofagasta Region

Contact details: Mario Gomez
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The project seeks to develop an ecosystem for zero-emission commuting of mining workers from the cities to the mine sites in the Andes Mountains.

PRODUCTION
Solar power will be used to produce green hydrogen by electrolysis. This hydrogen will be stored in a hydrogen refueling station to supply buses for the commute of mining workers.

The project aims to deploy Fuel Cell Electric Buses that can meet the desert conditions such as altitude, extreme temperatures, among others.

PROJECT OWNER AND PARTNERS

PROJECT OWNER:
Air Liquide

PARTNER COMPANIES:
AIRLIQUIDE: Co-developer and technology provider. Hydrogen production and refueling station infrastructure.
ANTOFAGASTA UNIVERSITY: Co-developer. Technical local capacity building.
ATAMOSTEC: Solar energy laboratory. Co-developer. Integration of energy supply and hydrogen production.

HOW IT WORKS

STATUS
Pilot project is under development working on a pre-feasibility study.

10 million USD
Est. investment of the pilot phase

2022
Expected start of operations

PROJECTIONS

Pilot
48 Tonnes of green hydrogen per year
10 million USD investment

Second Phase
1.2 MW Solar energy
1-3 Buses under operation

Third Phase
2023
2025

LAND AND RESOURCE

The 1.2 MW solar plant called Lalcktur belongs to CDEA.

It was constructed for research purposes and is already in operation.

OFFTAKE

The H2 SOLAR project is looking for a vehicle supplier partner to develop the pilot and for mining companies that would be willing to decarbonize their Scope 3 emissions.

LOCATION

Antofagasta Region
**Selknam** will use the strong winds in Tierra del Fuego island, with over 60% measured capacity factor, to produce green ammonia for export.

**Production**

Wind energy is used to power an electrolysis plant to obtain oxygen and hydrogen. Hydrogen will then be combined with nitrogen captured from the air through a Haber-Bosch process, to produce green ammonia.

The project is located on Tierra del Fuego Island and contemplates reusing ENAP existing facilities such as pipelines and the Clarenzia port for export.

**Project Owner and Partners**

**Project Owner**

Sociedad de Inversiones Albatros Ltda.

**Partner companies**

**Albatros** has been involved in the real estate market in the Magallanes region for over 30 years and is committed to the promotion of renewable energies and energy efficiency. The company holds possession of over 20,000 hectares of land in Tierra del Fuego.

**Alfanar** is engaged in manufacturing a wide range of low, medium and high voltage electrical products, EPC solutions for conventional and renewable power plants worldwide and engineering services. It will contribute as developer, investor and EPC contractor.

**Enap** is the Chilean National Oil company. Their participation in the project is under negotiation.

**How it works**

Wind energy + Well water + Desal. water → H₂ + N₂ → Green hydrogen + Nitrogen captured from the air → Green ammonia → Applications

**Status**

The project counts with conceptual engineering and prefeasibility study developed by Engie Impact.

**Projections**

- **1,500 MW**
  - Wind energy
- **700,000 NH₃**
  - Tonnes of green ammonia per year
- **135,000 H₂**
  - Tonnes of green hydrogen per year for ammonia production

**Land and resource**

- **20,000 hectares** of land are in control of the company
- **Over 60% wind capacity factor** has been obtained by 3 measuring towers operating for over one year

**Offtake**

The SELKNAM project is looking out for partners to establish offtake agreements.

**Location**

The project is located in the Magallanes region of Chile.
The HYDRA project aims to decarbonize the mining sector by developing fuel cell + battery power trains to retrofit mining haul trucks and replace diesel consumption.

**THE PROJECT**

The Hydra project considers replacing the internal combustion engine of large capacity mining haul trucks (>200 tonnes) with a hybrid system of hydrogen fuel cells and batteries. This will replace about 3,000 liters of diesel consumption per truck per day, equivalent to a daily hydrogen consumption of up to 1 metric ton.

**PROJECT OWNER AND PARTNERS**

**PROJECT OWNER**

**PARTNER COMPANIES**

A consortium is being set up with partners along the value chain.

**ENGIE** is a global reference company in low-carbon energy and services, having a Business Unit dedicated to renewable hydrogen since 2018. The current portfolio of renewable H₂ projects under development and in construction is over 30 projects in 10 countries over four continents. **ENGIE** is also developing a mining project in South Africa (Rhyno Project).

**MINING3** is a mining research organization led by the global mining industry to develop and deliver transformational technology to improve the mining industry’s productivity, sustainability, and safety.

**OFFTAKE**

A key pillar for the development of the HYDRA Project is the early engagement of mining companies and OEMs, as they will be the end users and providers, respectively.

This project has received a subsidy of 330,000 USD from the Chilean Economic Development Agency, **CORFO**, for the development of Phase 2.
Competitive and serious projects are those around which key enabling parties coalesce

- **Project champion**
  Coordinator of parties and liaison with external stakeholders.

- **Electricity provider**
  From existing or new assets, on-grid or off-grid.

- **Financiers**
  Willing to invest in, loan to, and/or subsidize a clean energy project.

- **Engineering and technology**
  Leads technical design, construction, and/or operation.

- **Offtaker**
  Guarantor of consumption or commercialization.

- **Public sector**
  Positive and stable regulatory conditions, reasonable permitting processes

Source: Based on McKinsey&Co.
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Chile’s Green Hydrogen Strategy and investment opportunities