大成 DENTONS

Green Hydrogen in Chile

Grow | Protect | Operate | Finance

大成 DENTONS

Chile, a country with abundant renewable energy resources

Chile in numbers

- Territorial area: The continental territory has an area of 755,776.4 km^2, and the Antarctic territory has an area of 1,250,257.6 km^2.

- Territorial length: From north to south, Chile spans over 2,653 miles / 4,270 km. Chile has 6,435 km / 4,000 miles of Pacific coastline.

- Territorial width: The country has 110 miles / 177 km across from east to west, on average.

- Up to 2022:
  - Population: 19,493,184
  - GDP: USD 301,448 million
  - GDP per capita (current USD): 15.941,34
  - Unemployment: 7,8%
  - Inflation: 11,2% (in 2022) to 7,6% (in 2023).

Country distribution

- The country's territory can be **administratively** divided into 16 regions, which are shown on the following image.

- Also, the country's territory can be **energetically** divided into three zones:
  1. **North Zone**: from Arica and Parinacota Region to Coquimbo Region.
  2. **Central Zone**: from Valparaíso Region to Los Lagos Region.
  3. **South Zone:** from Aysén del General Carlos Ibañéz del Campo to Magallanes Region and Chilena Antarctic.

- The north and south of the country are the zones with specific interest for the development of green hydrogen, notwithstanding the fact that there are also projects in the center. The following slides will provide a brief overview of each area.

North zone

- Area: 300.604 km^2.
- Population: 2.477.542
- Economic activity: It is characterized by a strong mining industry, a high energy consumption and the existence of port, rail and road infrastructure.
- Geographic features: Desertical area area with high sun exposure. The Atacama Desert is located in this area, with 49,000 m^2 and an average annual rainfall of 0.6 inches.
- Energy potential: Photovoltaic, solar CSP and wind energy. In the initial phase of green hydrogen use, the latter is planned to be used in the mining industry for transportation and for heat production.
- Connected to the National Electrical System (33,218 MG).

Central zone

- Area: 211.380 km^2 .
- Population: 16.674.742
- Economic activity: It is characterized by being the main consumption center of the country, with a strong non-mining industry, mainly agricultural.
- Geographic features: Area with a predominantly mediterranean and temperate climate.
- Energy potential: Photovoltaic and wind energy. Green hydrogen is planned to be used for refinery installations, by-product production and ground transportation.
- Connected to the National Electrical System (33,218 MG).

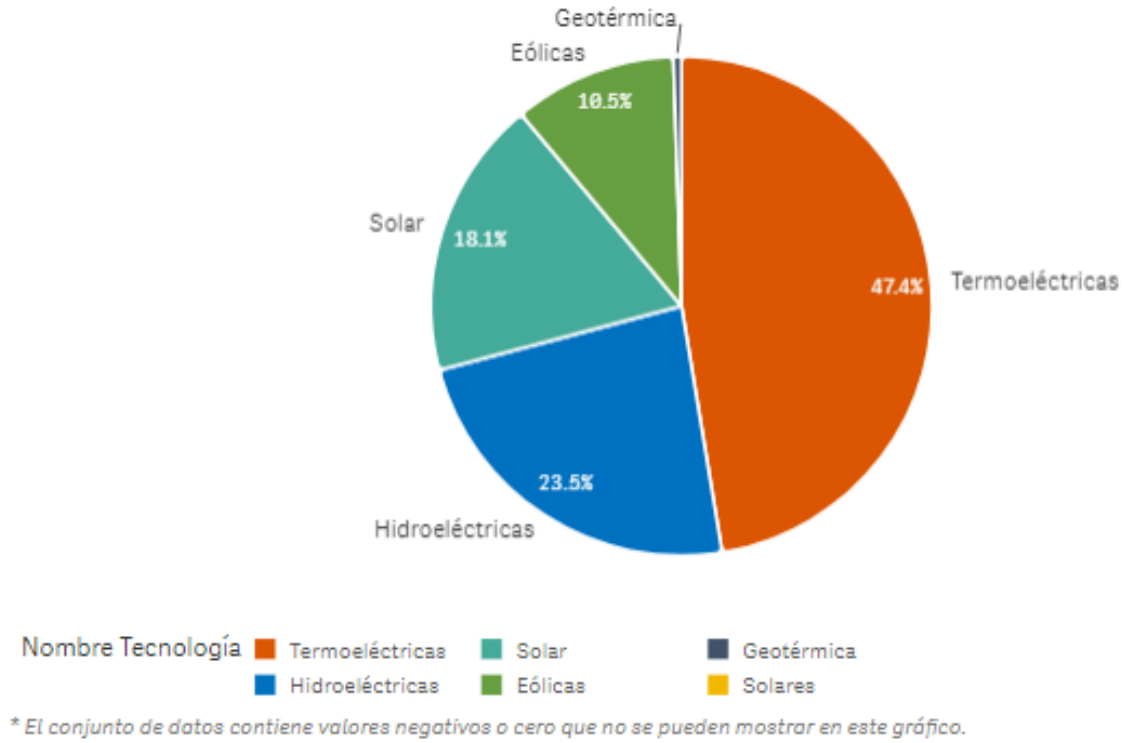
South zone

- Continental area: 240.527 km^2. Antarctica area: 1,264 millones km^2.
- Population: 285.659
- Economic activity: Low industrial development. Economic activity is mainly agricultural.
- Geographic features: The climate is cold and temperate, with abundant cloudiness, windy and with little thermal variation.
- Energy potential: Onshore and offshore wind energy. Magallanes Region has one of the best wind resources in the country, with an estimated potential of 310 GW.
- Not connected to the National Electrical Systema. There are two isolated electric systems: i) The Aysén Electric System (69,8 MW); ii) The Magallanes Electric System (129,3 MW).

Electrical market

- Our legislation recognizes the right of all foreign investors to an equal treatment.
- Chilean regulation splits the energy market into three segments: **generation**, **transmission** and **distribution**.
- Existence of an open and competitive generation market (free market rules), where all electric power assets are privately owned. When a generator decides to connect to the national grid, it becomes subject to dispatch and wholesale market prices regulations.
- Electricity legislation imposes restrictions on vertical integration. No transmission company can participate in the generation or distribution business.
- Accordingly, the participation of generation or distribution companies in the transmission business cannot exceed 8% of the value of Chile's transmission assets.
- The **National Electric System** (SEN) is a unique electrical system that reaches a length of 3,100 km, covering almost the entire national territory, from the city of Arica in the north to the island of Chiloé in the south (North and Central Zone).
- Grid operator **Coordinador Eléctrico Nacional** (CEN) regulates dispatch priority. It attempts to run the system by optimizing it to reach the lowest overall cost possible.

Actual generation distribution of the National Electric System by technology



Grid operation is based on the following principles:

- Preserve the safety of the service.
- Ensure the most economical operation.
- Ensure Open Access to transmission systems.

COORDINADOR ELÉCTRICO NACIONAL

Source: https://www.coordinador.cl/operacion/graficos/operacion-real/generacion-real/

A country with diverse renewable energy resources

Renewable energy potential (GW)

Source: Ministry of Energy

587 GW
Concentrated solar power

879 GW
Solar photovoltaic

15
Run of river hydro

295 GW
On-shore wind

The most powerful solar radiation on the planet is found in northern Chile
Capacity factors of up to 37% can be achieved in monofacial solar photovoltaic plants with 1-axis tracking

Solar generation in the central part of Chile is already more competitive than fossil-powered electricity generation
This renewable potential is located close to large consumption centers, gas grids, and logistical hubs, such as ports and distribution centers

Winds in the far south end of the country are as strong inland as they are off-shore
120-meter-high wind turbines are able to achieve capacity factors of up to 75% on-shore,

Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

NCRE incentives

Generators with installed capacity over 200 MW must certify that 20% of their withdrawals comes from renewable sources.

Green taxes: US$5.0/ton of CO_2 emitted (among others).

. Enable by law to impose rights of ways over surface and mining property.

. Auto dispatch and exempted from paying tolls.

. Aim to turn off all coal fired generation capacity (5.5 GW) by 2040.

PMGD (up to 9 MW): Easier protocols to connect to the grid. Stabilized price regime (average value of PPAs on the market adjusted by long term node price or projection of the spot market prices).


大成DENTONS
Chile, a country with advantages for green hydrogen development

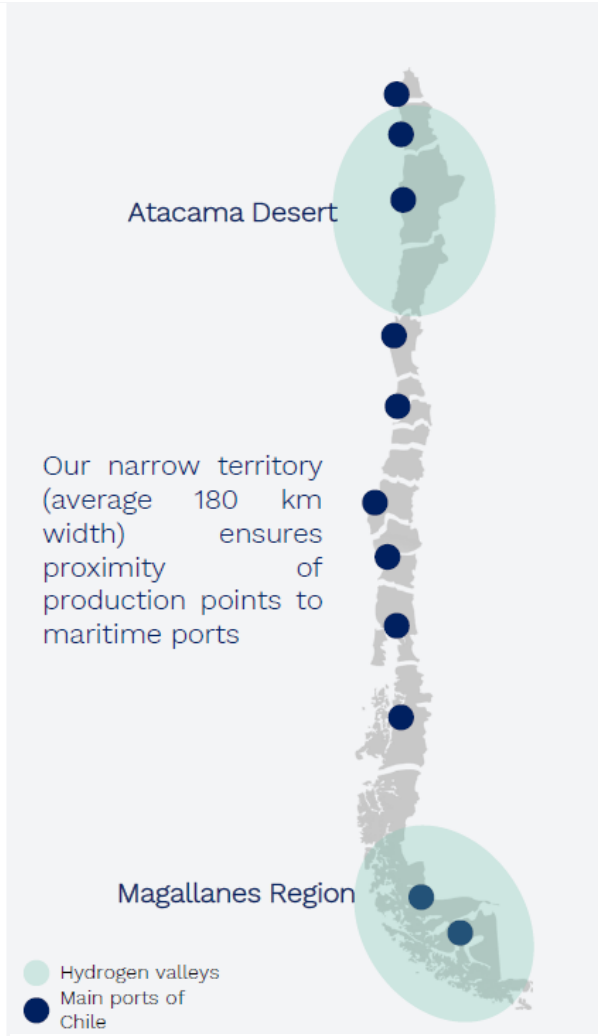
Green hydrogen “H2V”

Chile is poised to become the leading producer of green H_2

Capacity factors per country in best areas (%)

Source: Ministry of Energy of Chile, McKinsey & Co

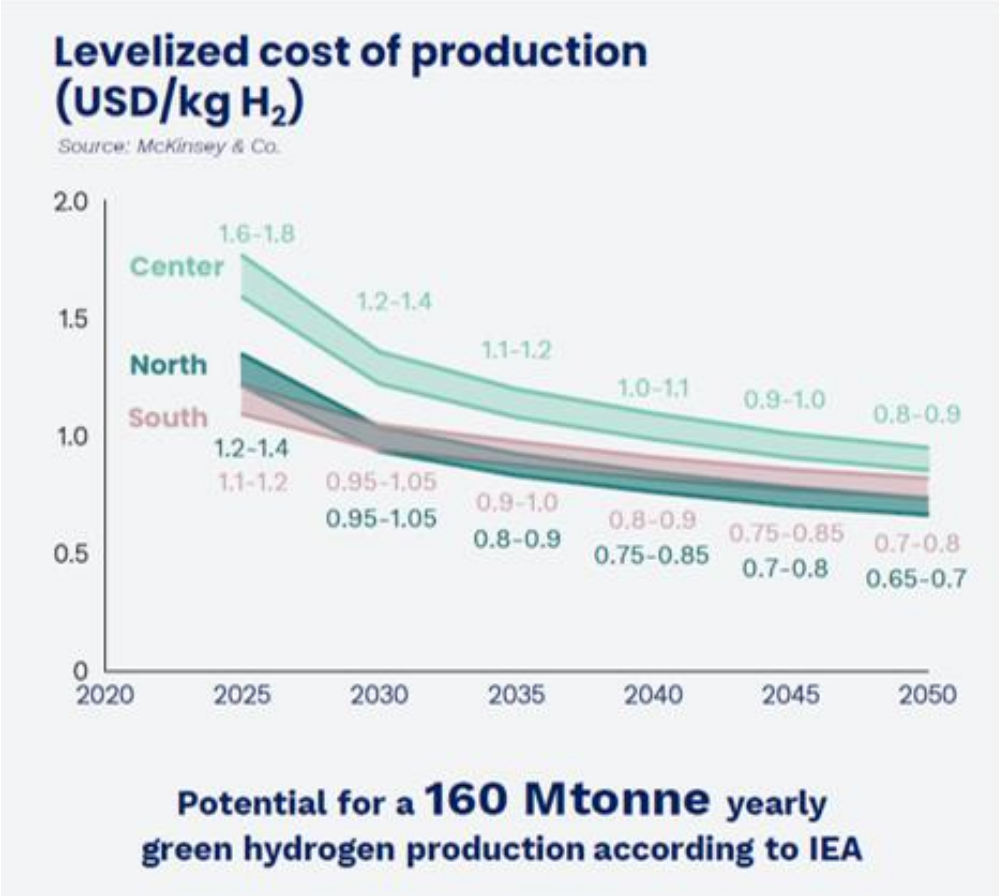
Solar PV		37%	~30%	~30%	~25%	20-25%
Wind	Off shore	>75%			40-45%	50-55%
	On shore	70-75%	30-35%		40-50%	

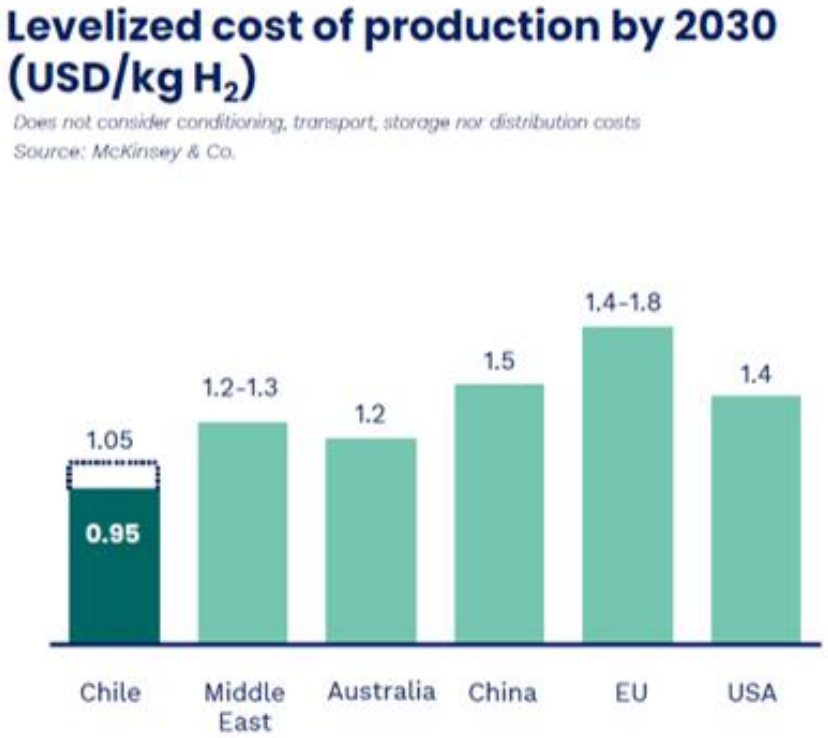


Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

CH2LE

Latest estimations put Chile around 1 USD/kg by 2030



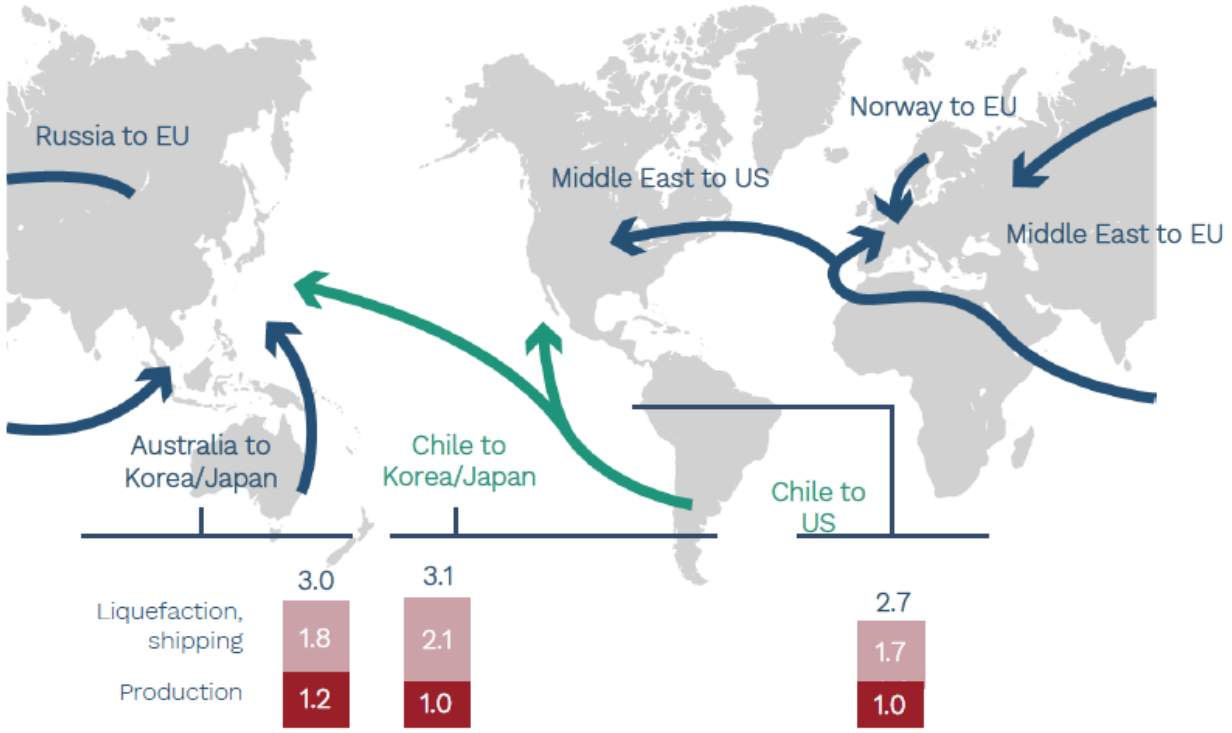


Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Despite distance to markets, Chile remains competitive in H_2

Cost of liquid H_2 at port of destination, 2030 (USD/kg H_2)

Source: McKinsey & Co.



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

Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

National Green Hydrogen Strategy in Chile

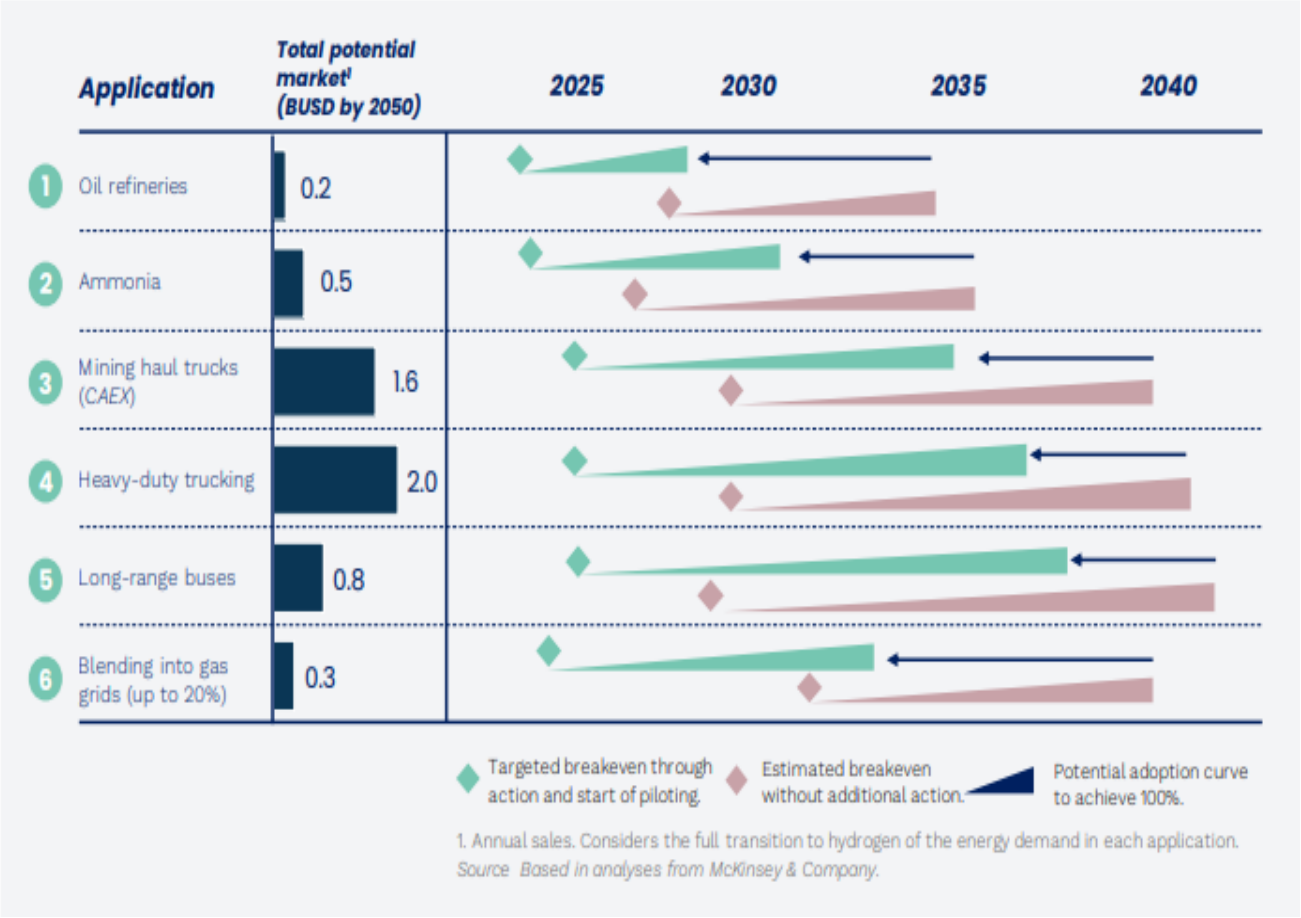
- In accordance with the commitment adopted by Chile at COP 25 to become carbon neutral by 2050 and due to the conditions previously indicated, in November 2020 the **Chilean government launched the green hydrogen national strategy,** which seeks to place Chile among the world's leading producers of this renewable fuel and its derivatives.

- The strategy aims to turn Chile into **the world's cheapest producer of green hydrogen** and convert Chile from an extractivist country of non-renewable resources to one that produces clean and renewable fuels and their derivatives. The strategy has been divided into three stages:

Wave 1: 2020-2025

Domestic ramp up and export preparation

- In order to establish local supply chains, the aim is to accelerate development in 6 priority applications indicated in the following image.
- These applications will focus on a first break-even point and will have an assured tangible demand.
- The objective of these applications will be to generate industry know-how, develop talent, deploy infrastructure and attract financing, to ensure access to export markets abroad in the subsequent stages.



Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

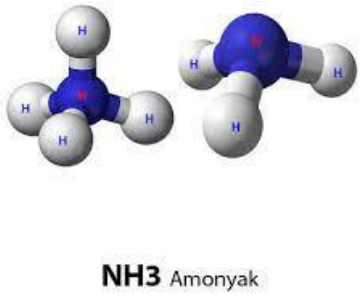
Wave 2: 2025-2030

Becoming a key player in export market

- Based on local use of green hydrogen applications, the country will scale up green hydrogen generation and become a key player in export markets.

- A green ammonia production and export industry will be boosted through the support of GW-scale consortiums. Along with the above, the Government will work to negotiate purchase and investment commitments to secure hydrogen and ammonia exports.

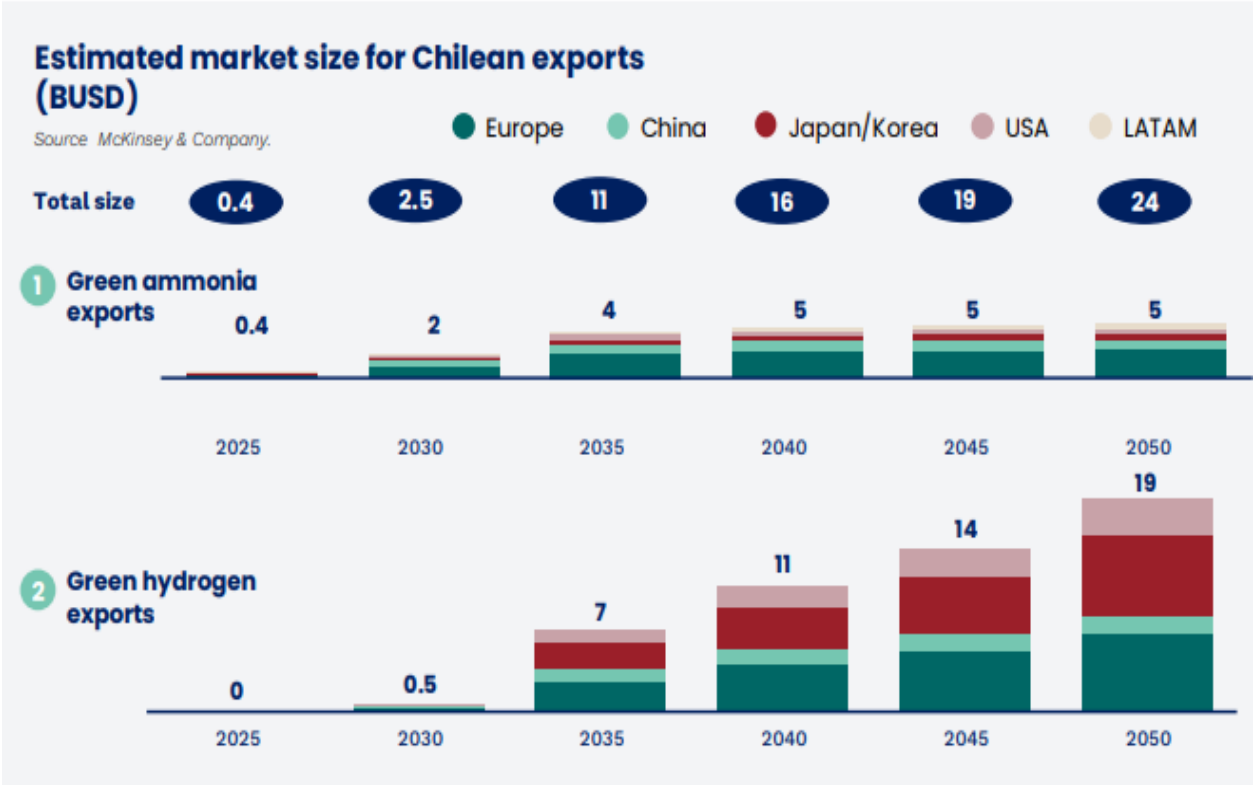
- Finally, in order to boost exports, the "green color" of the products produced in Chile will be certified. In this way, for example, Chile will become the world's leading producer of green copper.



Wave 3: 2030 - Onward

Becoming a large-scale exporter

- Boost the synergies and the economies of scale to expand production of clean fuels and its derivatives.
- Considering that other countries will also decarbonize, the products to be exported from Chile will enter a diversified clean fuels export market.
- In this way, for example, the products exported from Chile will have a strong impact on the aviation, rail and marine transportation industry.



Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Summary of the waves of the strategy

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.

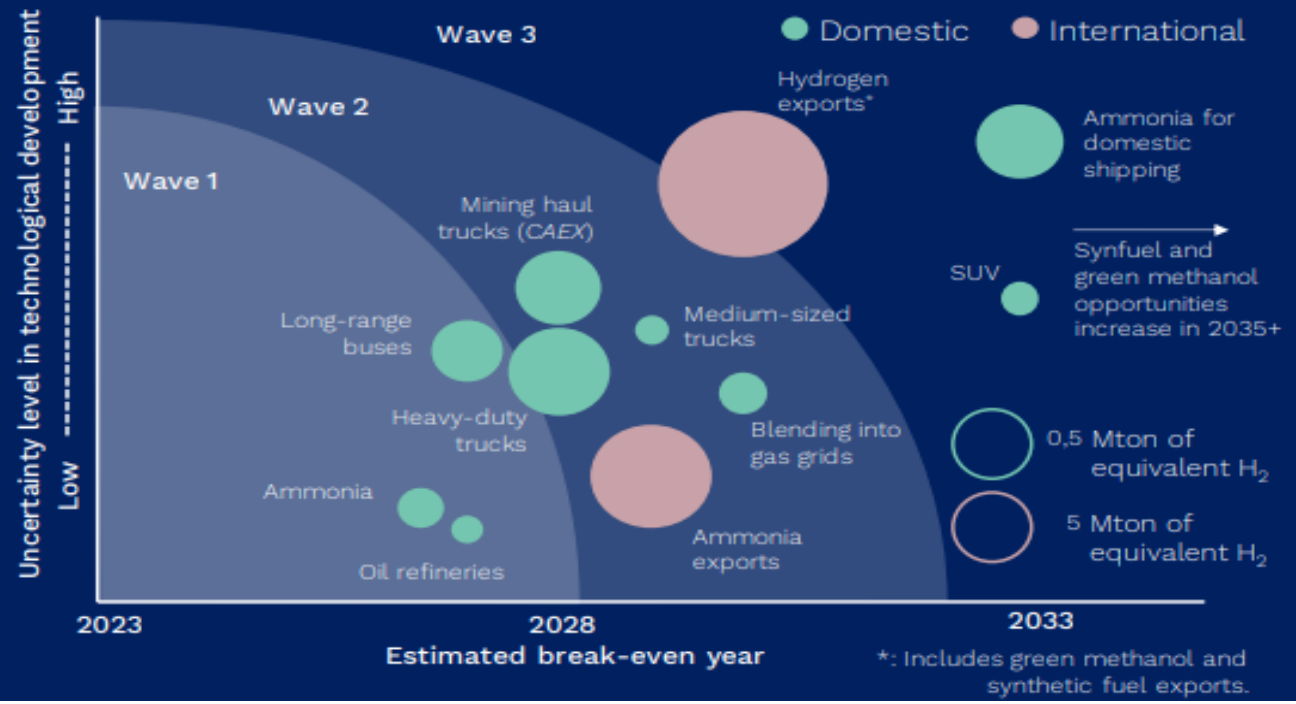
The start of export activities and extended local uses will be seen before the decade is over.
A clear opportunity for green ammonia exports exists in the medium-term, as well as for the first hydrogen exports. A more competitive production of green hydrogen will also replace an increasing share of liquid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

Projected development of green hydrogen applications

Uncertainty level, market size, and estimated year of breakeven for some applications of hydrogen in Chile. Does not consider carbon price. List of applications not exhaustive.

Source Based on analysis by McKinsey & Company.



Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Goals of the strategy

Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Pillars of the strategy

In order to achieve these goals, the strategy is based on the following pillars:

Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Pillars of the strategy

Mission-oriented policy

The State should guide and coordinate the joint action of various sectors, providing clear signals for private initiatives and eliminating regulatory, financing and technology barriers.

Balanced use of resources and land

The industry shall be developed in harmony with its surroundings, with attention to the local communities, activities and water use.

New economy based on clean exports

The country will have an open export vocation for the supply of clean products that the planet requires for a global energy transition.

Efficient pathway to a net-zero country

An efficient transition from fossil fuels to clean systems requires the use of hydrogen and its derivatives.

Green hydrogen as a catalyst for local growth

The state, together with the private sector, should promote projects that are harmoniously integrated into the country, prioritizing the creation of value and local growth.

Open to the world

The country must cooperate with public and private international stakeholders to scale up global green hydrogen markets.

Action plan of the strategy

Promotion of domestic and export markets

Set up a Public-Private Agreement for Hydrogen in Mining and Transportation, alongside key public and private stakeholders to define specific barriers and actions to be carried out to accelerate the adoption of hydrogen in these sectors.

Promote studies and coordination initiatives jointly with countries that declare themselves as net hydrogen importers to promote commercial initiatives for export-import.

Exchange experiences and formulate collaborative initiatives to bolster the deployment of green hydrogen production and use in Chile through bilateral and multilateral agreements.

Study and promote the establishment of international certification systems for carbon footprint and guarantees of origin of green hydrogen.

Explore the impact of tax mechanisms in promoting the investment of green hydrogen projects.

Enable and promote the access to international and local financing with multilateral private and public actors of early projects.

Standards, safety, and piloting

Modify Law DFL 1 from 1979 and Law DL 2.224 to define hydrogen as an energy carrier and, thus, allow for by-laws to be emitted to regulate safety issues along its value chain.

Communicate about the request process for dedicated authorizations from the Superintendency for Electricity and Fuels, as well as communicate procedures and conditions to carry out piloting in various applications.

Review and update power market regulation to effectively allow the participation of hydrogen technologies in the provision of various services, including energy, capacity, and ancillary services.

Social and local development

Communicate knowledge of green hydrogen to the general public with a focus on environmental and safety opportunities and challenges to generate increasing trust in its use.

Analyze and promote reconversion and/or reutilization of infrastructure of coal power plants for the production and utilization of green hydrogen.

Review land use regulations applicable to the green hydrogen value chain and review associated permitting processes to identify and reduce potential barriers to its development.

Study key infrastructure needs associated with each region to identify opportunities for local development.

Capacity building and innovation

Prepare diverse groups of public servants, such as regulators, evaluators, overseers, and others, on the implications of green hydrogen development on their fields of action.

Elaborate a plan to prepare emergency response teams, including firefighters, paramedics, and others.

Horizontally communicate through industry and academia the results and lessons learned in publicly funded R&D initiatives, such as technological development consortiums.

Identify and connect stakeholders that develop research and development activities to promote collaborative innovation on solutions that address local challenges prioritized for the country.

Source: https://energia.gob.cl/sites/default/files/documentos/green_h2_strategy_chile.pdf.

Main advances made by the state

Chile's agreements with World Bank and Inter-American Development Bank (BID) to promote green hydrogen projects.

- World Bank: In order to contribute to the development of the green hydrogen industry in Chile, a loan of **US$150 million** was agreed in a first instance, and a **US$200 million** loan for a second instance.
- BID: For the implementation of the green hydrogen industry support program in Chile, a performance-based investment loan of up to **US $400 million** was agreed upon.

Elaboration of guidelines by state institutions to facilitate the application for sectoral permits for the development of green hydrogen projects.

- Support Guide of the Superintendency of Electricity and Fuels (SEC) for the request for authorization of special hydrogen projects.
- Technical document with evaluation criterias for green hydrogen projects prepared by the Environmental Assessment Service (SEA).
- Guide for the approval of green hydrogen pilot projects in mining, prepared by the Ministry of Energy, the Ministry of Mining and the National Geology and Mining Service (SERNAGEOMIN).

Elaboration of regulations for the implementation of green hygrometer projects.

- Enaction of Law Nº 21.305 of **Energy Efficiency that defines hydrogen as a fuel and allows the Ministry of Energy to regulate its use, in addition to establishing tax benefits for zero-emission cars, including those that use hydrogen**.
- Modification of Decree Nº 122/1991 of the Ministry of Transportation and Telecommunications that establishes dimensional and functional requirements for vehicles providing public transportation services.
- Modification of Decree Nº 43/2016 of the Ministry of Health establishing the Regulation for the storage of hazardous substances.

Main challenges for the development of green hydrogen projects in Chile

Rise in the price of EPC contracts:
EPC contracts are no longer willing to take risks as they used to.

Water scarcity:
In view of the country's water shortage, to produce green hydrogen, desalinated water (obtained at low cost) will probably have to be used.

Land Use:
Due to the extensive land use required for green hydrogen projects, they could face opposition and a ruling from the authority will probably be required.

Lack of legislation:
In order to provide transparent signals to private investors and reduce market uncertainty, the production, storage and transportation of green hydrogen and its derivatives should be regulated.

Human capital:
For the scale industry that the country wishes to develop, a large number of specialized professionals are required at different levels of the value chain.

Logistics:
For the development and construction of green hydrogen projects, it will be necessary to improve existing infrastructure in roads, ports and accommodation facilities.

Main benefits and challenges of green hydrogen: North Zone

Benefits

Photovoltaic, solar CSP and wind energy potential.

Strong mining industry that:
1. Guarantees a significant consumption of green hydrogen.
2. Offers an important industrial infrastructure for the development of green hydrogen.

High human capital specialized in mining that can be upgraded for the green hydrogen industry.

Robust energy, port and road infrastructure. The local transmission system is connected to the National Electric System (33,218 MW).

Challenges

Transmission system congestion problems affecting the profitability of renewable energy generation.

The unemployment rate is low, so in order to develop green hydrogen projects it will be necessary to bring in labor from other parts of the country.

Main benefits and challenges of green hydrogen: South Zone

Benefits

Wind energy potential. Magallanes Region has one of the best wind resources in the world, with an estimated potential of 310 GW.

Low population density that benefits the location of energy projects.

In Magallanes Region there are important tax incentives for private investment, established mainly by the Navarino Law, the Austral Law and the Tierra del Fuego Law, among others.

Challenges

Remote area connected to the rest of Chile only by air or sea and not connected to the national electricity system, a condition that must be considered for the development of renewable energies.

Not connected to de National Electric System. There are two isolated electrical system in this zone: i) Aysén (69,8 MW); ii) Magallanes (129,3 MW).

Low population density and lack of specialized human capital, relocation and specialization of personnel will be required.

Lack of roads, ports, industrial infrastructure, landfills and waste management.

Green Hydrogen Projects currently under Development in Chile (among others)

Source: https://h2news.cl/2022/01/10/con-60-proyectos-chile-apuesta-a-exportar-mas-hidrogeno-que-cobre/

Dentons key contacts

Enrique Benítez Urrutia
Partner, Chile
Energy, Environment and Natural Resources
enrique.benitez@dentons.com

Pauline Chiffelle Horsel
Partner, Chile
Litigation, Energy
pauline.chiffelle@dentons.com

Marisol Ceballos
Partner, Chile
Energy, Corporate
marisol.dentons@dentons.com

Daniel Cristi Le-Fort
Senior Associate, Chile
Energy, Real estate
daniel.cristi@dentons.com

Constanza Kulikoff Leiva
Associate, Chile
Energy
constanza.kulikoff@dentons.com

大成 DENTONS

Thank you

Dentons is designed to be different. As the world's largest global law firm with 21,000 professionals in over 200 locations in more than 80 countries, we can help you grow, protect, operate and finance your business. Our polycentric and purpose-driven approach, together with our commitment to inclusion, diversity, equity and ESG, ensures we challenge the status quo to stay focused on what matters most to you. www.dentons.com.