



# CHILE, GREEN HYDROGEN

An energy source for a zero  
emissions planet



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InvestChile  CORFO 

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# OVERVIEW OF CHILE

# ABOUT CHILE

## Basic figures

GDP 2019	US\$294 bn
Exports	US\$69.7 bn
Imports	US\$65.5 bn
Population	18 million
GDP p/capita (PPP)	US\$22,975 (N°1 in LatAm)
Reference interest rate	0.5%
Inflation 2019	3.096% (average 2000-2018: 3.2%)
Foreign direct investment inflow	US\$18 bn (annual average past ten years)
VAT	19%

## Robust foreign direct investment regime

- Non-discrimination: Foreign companies based in Chile have the same rights and responsibilities as Chilean companies (national treatment).
- Free flow of capital and profits: Chilean legislation permits the entry and repatriation of capital without cost or constraints other than procedural formalities.
- Pro-business environment: Simple tax structure/ease of setting up a company.
- Commitment to boosting investment: Government pro-investment agenda.





# WHY CHILE?

## ON-GOING LEADERSHIP

When it comes to Foreign Direct Investment- FDI, we are leaders in Latin America.

Our competitive edge and solid economic foundation makes us OECD's first South American economy. We are a nation that breathes a dynamic business culture and displays the highest GDP (PPP) per capita in South America.

Since 1998, and every year since, Chile is the WEF's most competitive nation of Latin America!

### Quality of Governance - WGI\*



\*World Governance Indicators 2020 - World Bank

## Chile

# 1 Business Environment Ranking

EIU 2019 - 2023

# 1 Best Country for Business

Forbes 2019

# 1 Economic Freedom

Heritage Foundation 2020

## SOPHISTICATED TALENT

We are the regional talent magnet.

Our economy has global-minded talent. With competitive costs and highly-skilled professionals, we are prepared for the challenges brought by the new economy. Positioned as Latin America's leader in education.

- 30 of the region's 150+ best universities (Times Higher Education 2019).
- +1,268,000 university students & +244,000 annual graduates (Ministry of Education of Chile 2019).
- Between 2009 & 2019, applications for temporary employment visa have risen 34% annually. In the case of subject-to-employment visas, the annual increase is 93%.
- Chile facilitates the arrival of overseas IT professionals and specialized technicals for the global services sector with a **Visa Tech - Talent Attraction Program** (launched in July 2017).
- From 2017 to 2019, InvestChile processed 220+ permits.

## VIBRANT ENTREPRENEURIAL ENVIRONMENT

We are internationally recognised for our pioneering entrepreneurial ecosystem.

Our country breeds professionals and skilled-workers that are fearless when it comes to tackling new challenges. Ranked 1<sup>st</sup> in LatAm & 19<sup>th</sup> internationally in the 2019 Global Entrepreneurship Index (Global Entrepreneurship & Development Institute- GEDI)

Launched in 2010, Start-Up Chile is known as 'The Revolutionary Startup Accelerator'

(Forbes 2018).

It has effectively backed 1,600 companies from 85 countries, creating US\$ 1,4 billion in net value assets.

## Chile Top 1 in LatAm

on the 2020  
Global Talent  
Competitiveness Index

Source: INSEAD, Adecco, Google - HCLI.



**+500,000**  
enterprises created in 5  
years with the *company-  
in-a-day-system*  
(2013-2019)

***That is +200 per day!***

Source: Ministry of Economy



**“Most  
innovative  
country**

**for early stage  
entrepreneurs”**

Source: WEF 2019-2020 Global  
Entrepreneurship Monitor

## A LATIN AMERICAN HUB

**We are globally connected and globalization-committed.**

Perched on the world economy, we have signed more Free Trade Agreements than anyone on the planet.

Ours, is a country where we have turned distance into a non-issue. Integration and technology have allowed us to become an entrance door to the Pacific Alliance.

- Free trade agreements with 65 countries.
- International agreements and treaties to avoid double taxation with 33 economies.
- We have special trade tariffs with 88% of global GDP.
- Access to 4.9 billion consumers.





# CHILE, THE WORLD'S **GREEN ENERGY** CAPITAL

## 3.1 GREEN ENERGY

### We are developing today the energy for tomorrow.

We are a natural laboratory for the energy of the future. Our country has a unique environment accompanied by state-of-the-art policies and incentives for the development of new sustainable energy technologies.

**Privileged Environment.** We have the best conditions for solar energy production in the world; including 4 thousand hours of sunshine per year in our northern regions and the highest levels of solar radiation found anywhere on the planet.

Optimal wind energy potential and operative wind farms are found all over Chile (Antofagasta, Coquimbo, Biobío, Los Lagos and Magallanes).

The capacity factors of wind power plants located on-shore in the Magallanes Region are equivalent to those found in power plants located off-shore in the North Sea, with lower investment and operational costs.

Our coastline extends over 4,000 kilometres and provides the perfect conditions to develop marine energy.

The rivers of the centre and south of the country. The Andes mountain range contains important geothermal energy reserves while Chile’s densely forested southern regions are a source for biomass fuel.

**Cutting-Edge.** We are a clean energy leader. Public and private energy sector investments focus on diversifying the generation matrix.

Our goal is to become a ‘carbon neutral’ country by 2050, as well as to be recognized as a key producer & exporter of green hydrogen. The world’s future natural energy laboratory.

Chile’s solar and wind capacity has increased ten-fold over the past 7 years. Renewables are poised to become our dominant source of power: a public-private agreement to phase out coal power plants by 2040 will open up new opportunities.

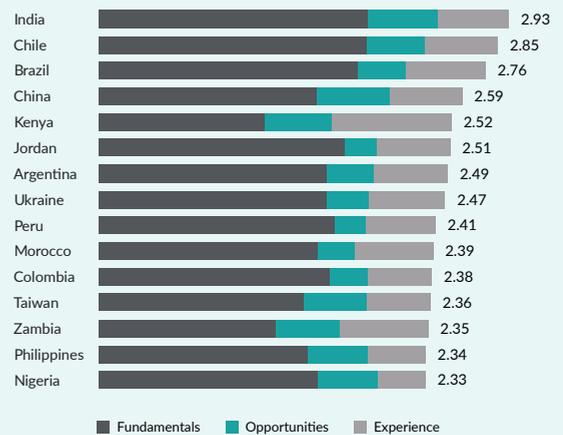
### Chile: Top 1 LatAm Top 2 worldwide

In Renewable  
Energy investment &  
Solar Generation



Source: Climatescope -Bloomberg NEF 2019

### Climatescope score of top 15 countries out of 104



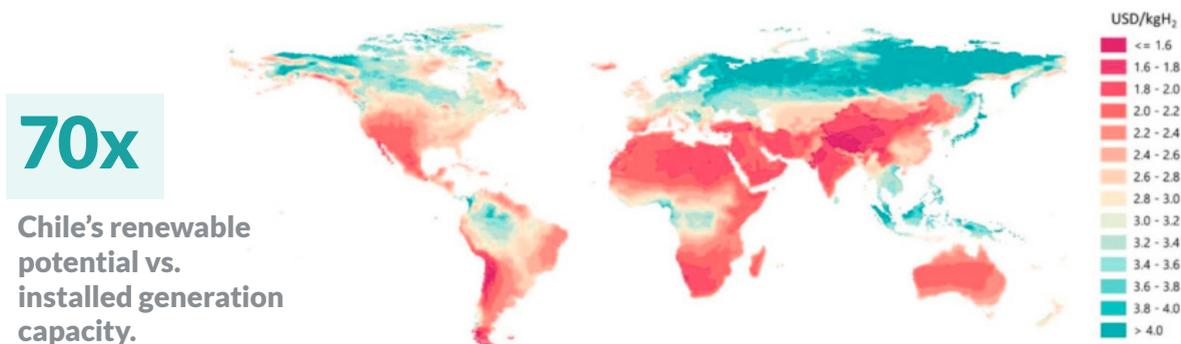
Source: Climatescope

## 3.2 RENEWABLE ENERGY POTENTIAL

The potential for the growth of renewable energies in Chile is equivalent to 70 times the country's present installed generation capacity.

### Best renewable energy potential in the world

Estimated cost of hydrogen based on wind and solar potential



(Source: The Future of Hydrogen, IEA, 2019)

**Chile has the world's best radiation for the generation of solar energy**, which can be used to produce green hydrogen (with capacity factors of CF>40% assuming 15% annual technical losses).

**The north of Chile has a solar potential** of 1,260 GW for photovoltaic systems and 550 GW for concentrated solar power (CSP), giving a total of 1,800 GW, considering only plant factors of CF>30% and assuming a conservative 20 MW/km<sup>2</sup> for land use.

**Some of the world's greatest wind** potential is to be found in the Magallanes Region where there are places with CF>60%. Together with the Region's hydrocarbons exploration and production industry and associated infrastructure and human capital, this makes Magallanes a destination with high development potential, equivalent to seven times the annual output of the country's entire electricity system. There are onshore sites where plant factor reaches 70-80%. The

region's potential could translate into an annual output of some 10 million tonnes of green H<sub>2</sub>.<sup>[1]</sup>

**The wind potential of Chile's** five most northerly regions reaches 14.5 GW, considering only plant factors of CF>30% and 10 MW/km<sup>2</sup> for land use. This includes 11.5 GW inland from Taltal. In central-northern and central-southern Chile, there are various locations with wind potential with CF>40%, including some 23 GW that has been identified in the Biobío, Araucanía, Los Ríos and Los Lagos Regions (including the Island of Chiloé).

[1] Assuming an electrolytic conversion efficiency of 60% and calorific power of 33.3 MWh/tonne H<sub>2</sub>. Subsequent efficiency losses due to compression or conversion to another vector of transport are not taken into account.

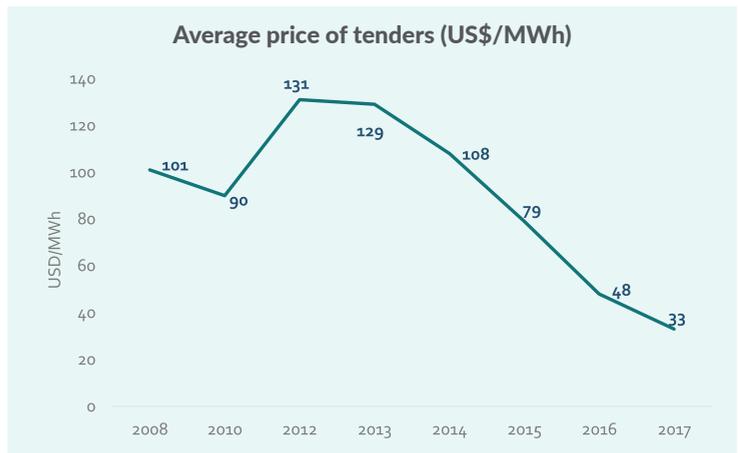
### 3.3 RENEWABLE ENERGY COSTS

Chile’s great NCRE potential makes it very competitive as regards estimated green hydrogen production costs, which could come in at less than US\$1.6/kgH<sub>2</sub> and even as low as US\$1.4/kgH<sub>2</sub> by 2030, according to the Hydrogen Council (Path to Hydrogen Competitiveness: A Cost Perspective, 2020).

**Tenders for supply of regulated clients resulted in price reduction**  
due to renewable energy potential + cost decreases

**80%**

Reduction in solar energy costs since 2010



### 3.4 AVAILABLE RESOURCES

#### Availability of land for development

Chile has important extensions of land that are optimal for the development of renewable energy projects. Many of these sites are owned by the state of Chile and are administered by the Ministry of National Assets, which makes them available for potential development through public bids, using different instruments such as their direct sale and, principally, fee-paying concessions. For further information, see <http://licitaciones.bienes.cl/>.

#### Availability of water resources

In the case of the water resources required for electrolysis, there are important watercourses in the south of Chile while, in the north, desalination plants are being built. At present, almost 6,000 liters per second is produced through desalination and, by 2025 the figure is expected to increase by 160%.

### 3.5 ESTIMATED POTENTIAL COSTS OF GREEN HYDROGEN PRODUCTION

According to the International Energy Agency (2019), Chile is among the countries with the world's lowest estimated potential costs for the production of green hydrogen. The cost of electricity represents between 45% and 75% of hydrogen production costs.

McKinsey & Co estimates that Chilean green hydrogen will cost US\$2.9/kg in Japan/South Korea and US\$2.5/kg in the United States by 2030, underlining Chile's competitiveness compared to other potential exporters.

### 3.6 NATIONAL GREEN HYDROGEN STRATEGY

#### National Green H2 Strategy



**Green Hydrogen Strategy developed through a participatory process:** political leaders, experts, academia and citizens



**Promotion of pilot projects:** follow-up of more than 15 pilot projects



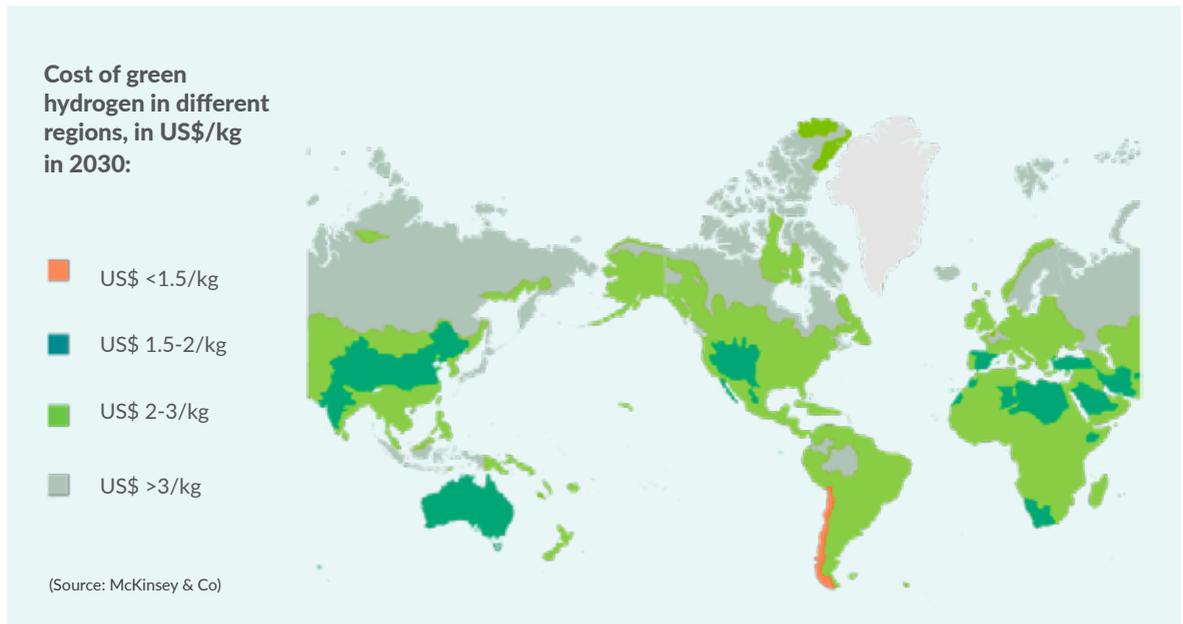
**Regulation:** identification of gaps and their closure

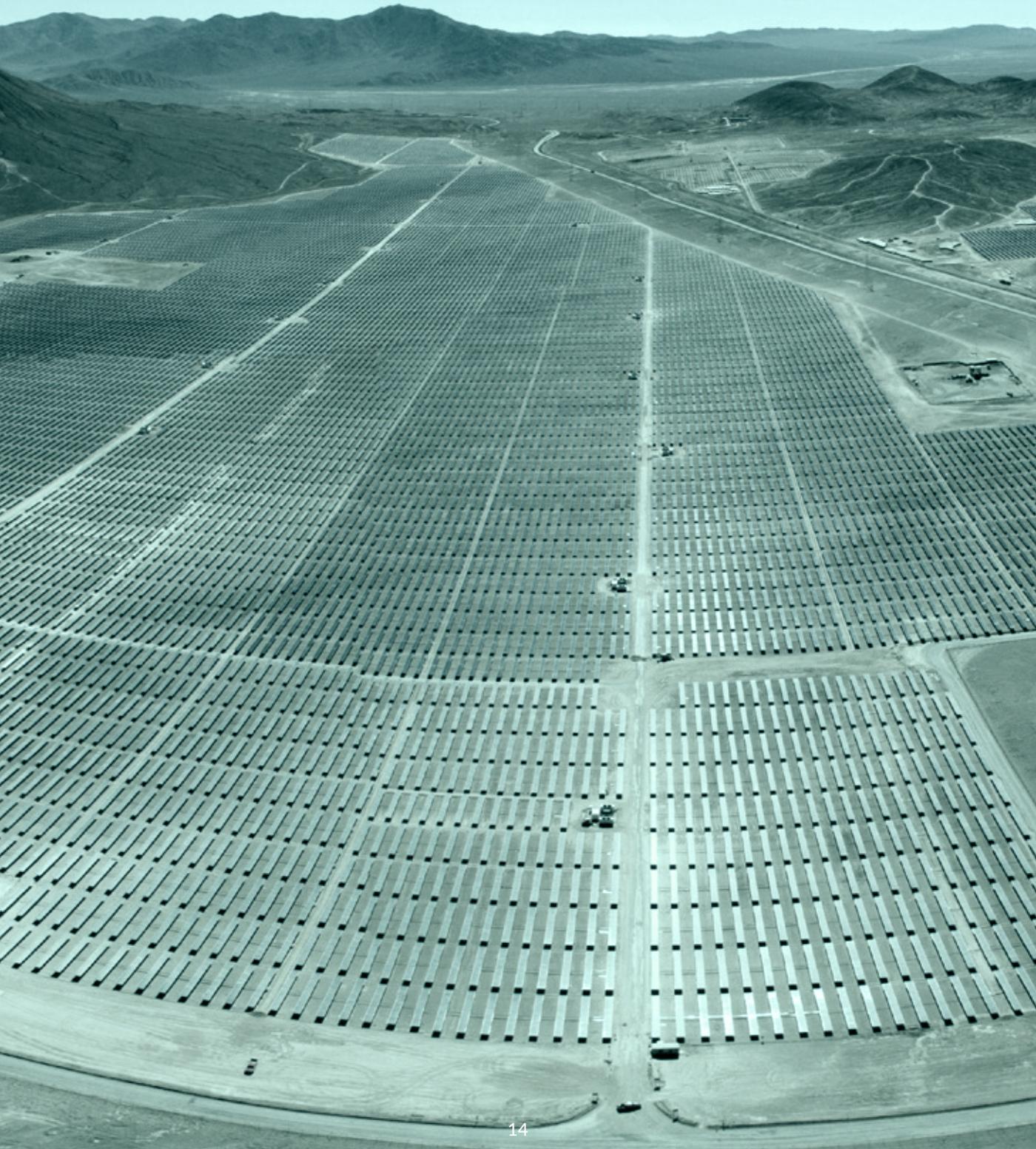


**International Cooperation:** European Union, United States, Japan, Australia, Singapore, UK and others

## Chile tipped to be the world's most competitive producer

Cost of green hydrogen in different regions, in US\$/kg in 2030:







## 3.7 CURRENT INITIATIVES

**Chile is already working on testing for hydrogen. With the support of the government's Economic Development Agency (CORFO), the following projects are being implemented:**

### **a) Clean Technologies Institute**

This institute will provide infrastructure, testing facilities and trained personnel with a strong focus on the development, scaling and adoption of technological solutions. It will receive financing of US\$193 million over ten years, with 30% co-financing, and bids are currently being evaluated prior to awarding a contract.

The project will focus on three areas of interest:

- Solar energy: Solar electricity, solar heating and hydrogen (solar fuel)
- Sustainable mining: Energy sustainability and carbon footprint reduction, new low-emission metallurgical mining processes, traceability of GHG emissions and sustainability of non-metallic mining that extracts minerals from salt flats
- Advanced lithium and other mineral materials: Innovations in advanced materials based on lithium, salts and other strategic minerals.

### **b) HYEX**

This pilot project focuses on the production of green ammonia for use in producing ammonium nitrate, a key element for mining blasting processes. Engie and Enaex are leading this project, which will operate based on 2,000 MW of renewable energy to power a 1,600-MW plant to produce green hydrogen through electrolysis

of water. Ammonia for mining operations will then be obtained from the hydrogen and nitrogen in the air.

### **c) HYDRA**

This project seeks to develop CAEX mining trucks with fuel cells.

Chile aims to promote the mass use of green hydrogen in mining and this project was one of the winners in the 2020 version of CORFO's Innova High Technology Program. CSIRO Chile, Engie and the Mining3 research center are leading this initiative to design and manufacture a new power train that will enable mining vehicles to operate using only green hydrogen.

### **d) Dual Hydrogen-Diesel Engines for Mining Trucks (CAEX)**

A consortium led by Alset Global GmbH, the Catholic University of Chile, CAP, Anglo American, BHP and the University of Santiago is working to develop a prototype of a mining truck powered by a dual hydrogen-diesel engine and equipped with a hydrogen storage system. It will be tested in real mine conditions. This will reduce the mining industry's need for fossil fuels and the CO<sub>2</sub> footprint of mining products. Earlier experimental developments with diesel engines running on dual hydrogen-diesel fuel have shown that up to 97% of the diesel can be replaced by hydrogen when the truck is idle and or partially loaded and between 40% and 70% when it is fully loaded.



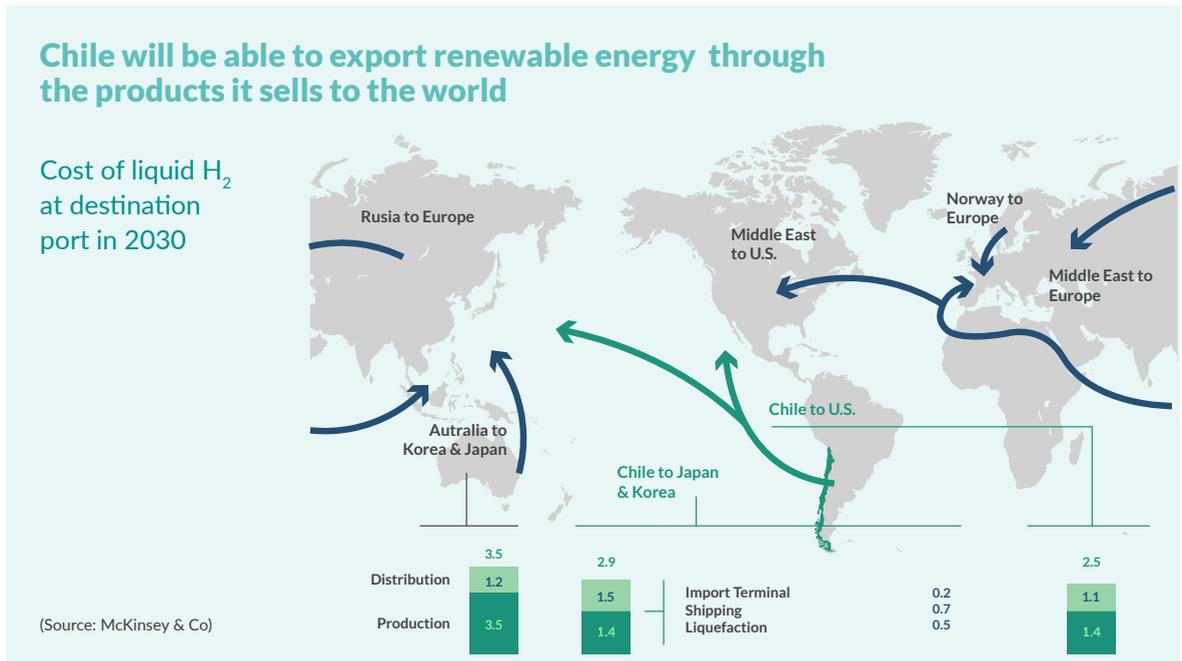
# OPPORTUNITIES

## 4.1 CHILE AS A GREEN HYDROGEN EXPORTER

Foreign investors are invited to install pilot projects for the production of green hydrogen and its export to the rest of the world and, particularly, to markets in Asia and North America.

### Chile Offers

- Unparalleled renewable resources in the Atacama and Patagonia make Chile the cheapest place to produce green hydrogen and its derivatives in the world.
- We have a domestic market of applications that include heavy duty and mining trucks, blending into networks, grey ammonia and hydrogen replacement, among others, that will add up to a market size of 6 billion USD and 3.5 million tons of green hydrogen a year by 2040. We will start developing this sector with GW scale projects by 2025, to then scale up and start exporting to the world.
- Considering the magnitude of future global demand for hydrogen and its derivatives to meet decarbonization targets, this represents an opportunity for Chile with the potential to grow into a US\$ 35 bn industry by 2050 -equivalent to today's mining industry in the country-.
- Chile can become one of the top five green hydrogen producing and exporting countries in the world. We are well positioned to supply Japan, Korea, China, Europe and the U.S.A.
- The Chilean government is committed to supporting the hydrogen industry development and will play an active role to solve barriers in critical areas such regulatory framework, reducing financial barriers, value chain support, infrastructure development, and talent and knowledge growth. Dedicated task forces will attract and facilitate the long-term investments necessary to scale-up green hydrogen.



“Countries categorized as hidden champions, **like Chile**, typically demonstrate fundamentally **unexplored renewable energy potential framework and sufficiently strong institutions** - that are often underestimated in the general perception of latin american countries.”

“Power to x could readily become a serious topic if facilitated appropriately. These countries may well be in the **lead in the market penetration phase**, fostering the development of power to x technology.”

*World Energy Council, 2018)*



# Let's make your next project happen!

We are the government agency responsible for promoting Chile's reputation in the global market as a key destination for FDI & as the Latin American Hub for Global Business.

We are **the bridge between your interests and the business** opportunities our country offers, providing tailor-made and individually-focused assistance to facilitate your landing.



we advise / we connect / we support

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