

# The Future of CH<sub>2</sub>LE: Green Hydrogen !



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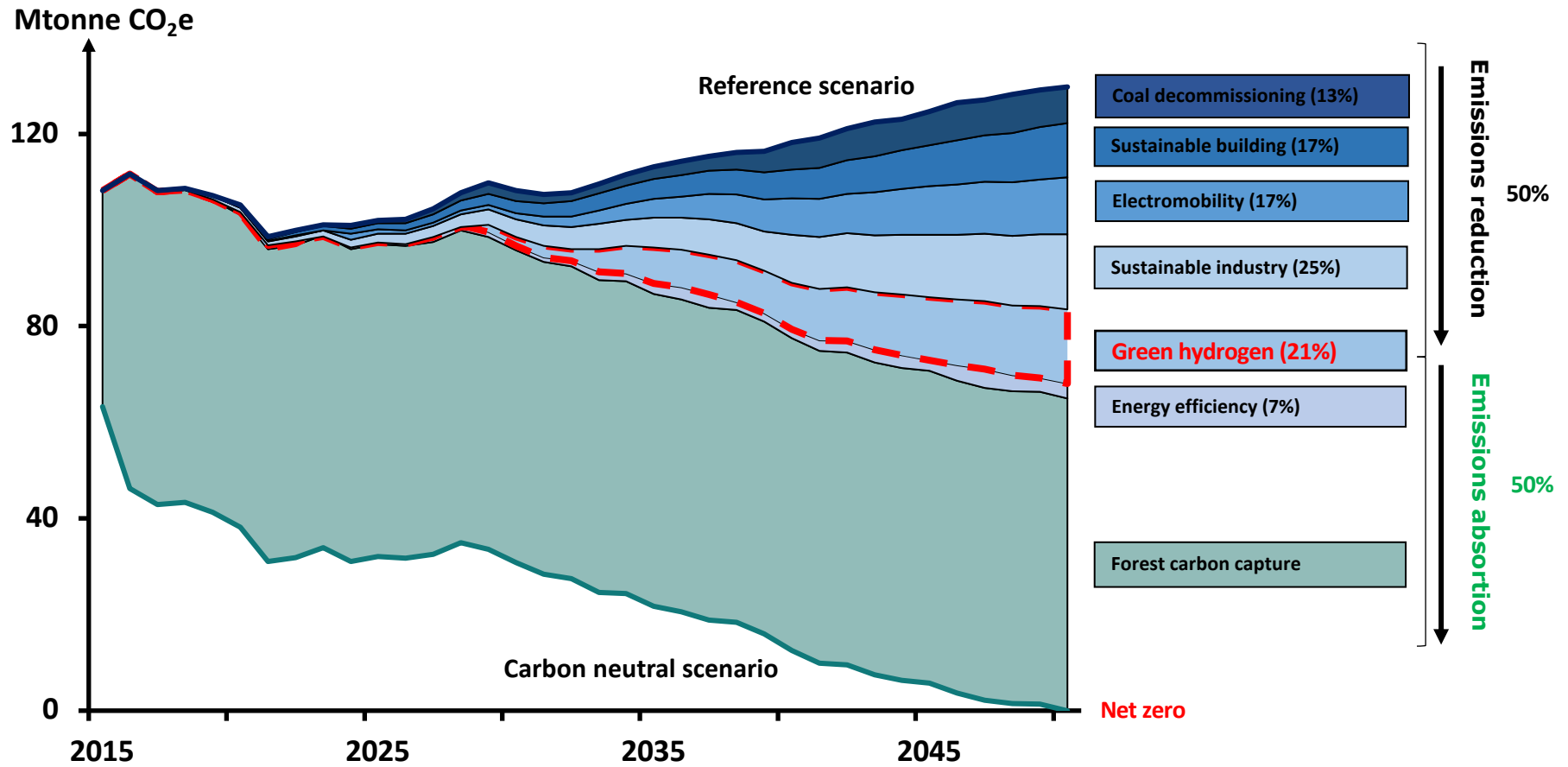
Santiago, 9 August 2021

# **1. Chile's Green Hydrogen Strategy**

**(Source: Mins. of Energy and Mining of Chile, July 2021)**



# Green hydrogen: the key to attain zero net GHG emissions



Sources: Ministries of Energy and Mining of Chile (July 2021).

# CH<sub>2</sub>LE

National Green Hydrogen Strategy

Published November 2020

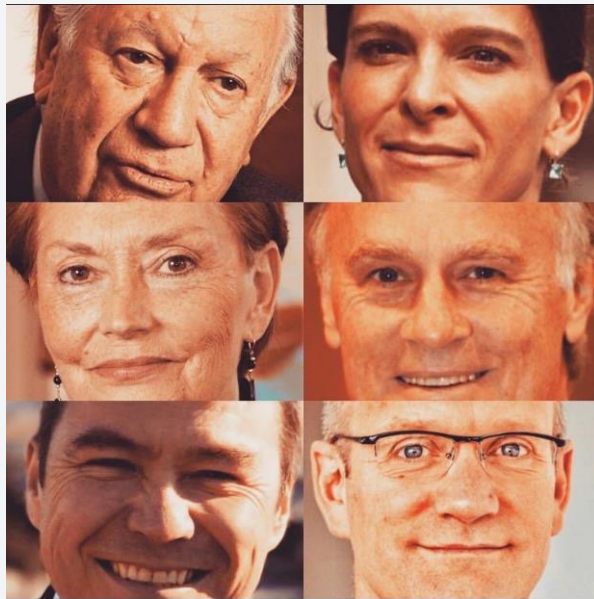
*"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable"*

*Jules Verne, 1874*



# A long-term strategy with broad political support

## Advisory board



**Ricardo Lagos**  
Former President of Chile  
**Vivianne Blanol**  
Former Head of Energy Regulator  
**Marcelo Mena**  
Former Minister of the Environment

**Jeannette von Wolfersdorff**  
Economist  
**Klaus Schmidt Hebbel**  
Former Chief Economist of the OECD  
**Gonzalo Muñoz**  
COP25 High Level Climate Action Champion

## Green hydrogen 'ambassadors'

### 1. Minería

Identificar y desarrollar formas de financiación pública y privada, nacional e internacional, para la industria del hidrógeno verde. Promover eventos de networking de incentivos que fomenten la obtención del financiamiento necesario para esta industria bajo en carbono.



**MARCELINA**  
Directora de Estrategia de Hidrógeno Verde  
Ministerio de Minería



**FRANCISCO CASTRO**  
Director de Política Energética  
Ministerio de Energía

### 2. Transportes

Generar interés y voluntad en el ámbito gremial y a nivel privado del sector transporte de incorporar el hidrógeno verde en sus flotas, como combustible alternativo, en sus operaciones.



**PEDRO PABLO KUCZYNSKI**  
Director de Políticas Energéticas  
Centro de Estudios de la Energía



**JOSEFINE MONTENEGRO**  
Directora de Políticas Energéticas  
Ministerio de Energía

## El transversal grupo de embajadores del HIDRÓGENO VERDE

Un mensaje de PEDRO PABLO KUCZYNSKI

Desarrollar un ecosistema necesario para impulsar el hidrógeno verde en Chile. El hidrógeno verde es una tecnología que está en su infancia, pero que tiene un potencial enorme. Para poder aprovecharlo, necesitamos un ecosistema que permita conectar a los actores clave: desde el sector privado hasta el gobierno, pasando por la academia y la sociedad civil. Este grupo de embajadores tiene el objetivo de impulsar avances en cada uno de estos ámbitos. En particular, el Ministerio de Energía, dirigido por Juan Carlos Jobet, tiene un gran rol en este proceso. El objetivo es generar un espacio de diálogo y colaboración entre todos los actores involucrados. Este grupo de embajadores tiene el objetivo de impulsar avances en cada uno de estos ámbitos. En particular, el Ministerio de Energía, dirigido por Juan Carlos Jobet, tiene un gran rol en este proceso. El objetivo es generar un espacio de diálogo y colaboración entre todos los actores involucrados.

### 3. Petróleo y gas

Apoyar posibles acuerdos y transacciones de transición energética entre el sector privado y el gobierno, con el fin de reducir la dependencia de combustibles fósiles.



**LORETO SILVA**  
Directora de Políticas Energéticas  
Ministerio de Energía



**DANIEL FERNÁNDEZ**  
Director de Políticas Energéticas  
Ministerio de Energía

### 4. Exportación

Generar contratos de compra de hidrógeno verde y sus derivados en mercados internacionales, con el fin de reducir la dependencia de combustibles fósiles.



**EDUARDO FREI**  
Director de Políticas Energéticas  
Ministerio de Energía



**DAVID GALLAGHER**  
Director de Políticas Energéticas  
Ministerio de Energía

### 5. Educación y ciudadanía

Crear y difundir mensajes clave para la ciudadanía y sectores privados, con el fin de generar un ecosistema que permita conectar a los actores clave: desde el sector privado hasta el gobierno, pasando por la academia y la sociedad civil.



**JAVIERA PAREDA**  
Directora de Políticas Energéticas  
Ministerio de Energía



**PABLO CORTAZAR**  
Director de Políticas Energéticas  
Ministerio de Energía

### 6. Financiamiento e incentivos

Identificar y desarrollar formas de financiación pública y privada, nacional e internacional, para la industria del hidrógeno verde. Promover eventos de networking de incentivos que fomenten la obtención del financiamiento necesario para esta industria bajo en carbono.



**AXEL CHRISTENSEN**  
Director de Políticas Energéticas  
Ministerio de Energía



**ANDRÉS PÉREZ**  
Director de Políticas Energéticas  
Ministerio de Energía



**CAROLINA NÚÑEZ**  
Directora de Políticas Energéticas  
Ministerio de Energía

### 7. Encadenamiento económico y pymes

Promover la integración de empresas y capacidades locales dentro de la cadena de valor del hidrógeno verde, incluyendo la promoción del emprendimiento en el área y la identificación de oportunidades en las que puedan participar las pymes.



**EDUARDO BITRAN**  
Director de Políticas Energéticas  
Ministerio de Energía



**Diego Riquelme**  
Director de Políticas Energéticas  
Ministerio de Energía

### 8. Valor local y comunidades

Identificar y promover mejores prácticas de desarrollo comunitario en torno al hidrógeno verde, con el fin de reducir la dependencia de combustibles fósiles.



**NICOLÁS BORREGO**  
Director de Políticas Energéticas  
Ministerio de Energía



**MARÍA ELENA ARIZ**  
Directora de Políticas Energéticas  
Ministerio de Energía

### 9. Capital humano

Generar oportunidades educativas para la formación, capacitación y promoción de la fuerza de trabajo en el sector del hidrógeno verde, con el fin de reducir la dependencia de combustibles fósiles.



**ROSARIO NAVARRO**  
Directora de Políticas Energéticas  
Ministerio de Energía



**EDWIN FLETT**  
Director de Políticas Energéticas  
Ministerio de Energía

Sources: Ministries of Energy and Mining of Chile (July 2021).



# 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.








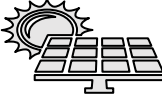





## 8 Human capital

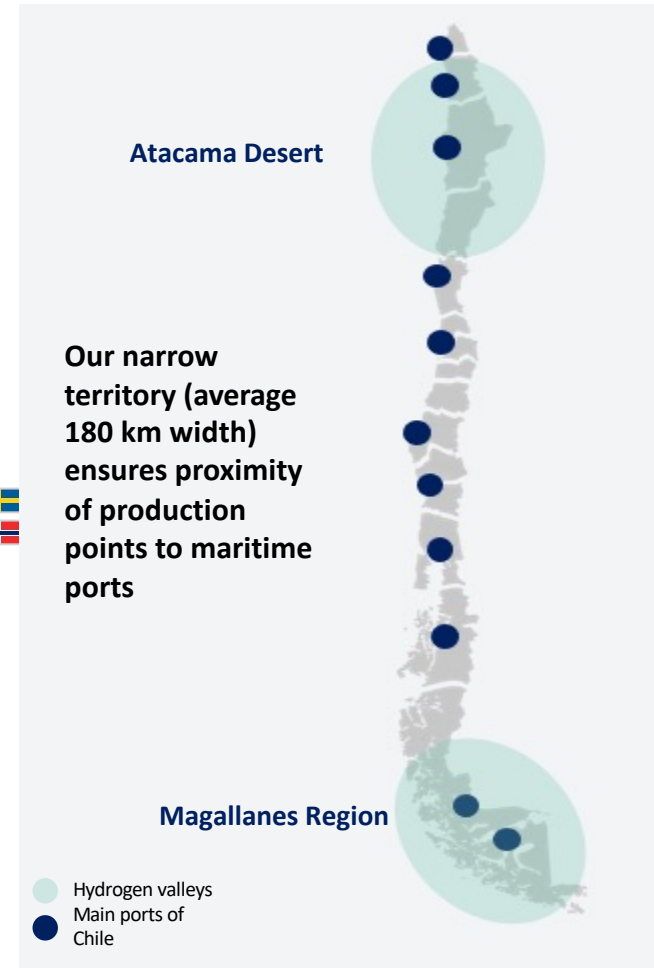
Develop local talent and technical capabilities to accelerate project deployment and generate green jobs.

Sources: Ministries of Energy and Mining of Chile (July 2021).

# Chile is poised to become the leading producer of green H2

## Capacity factors per country in best areas (%)

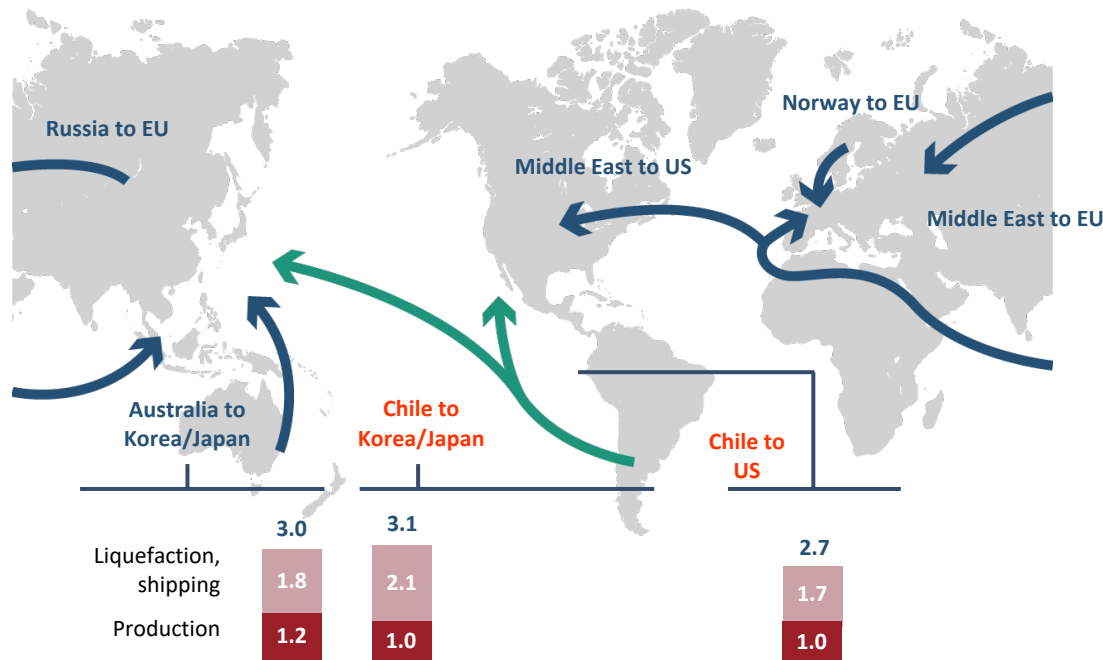
					
<b>Solar PV</b>					
	<b>37%</b>	~30%	~30%	~25%	20-25% 
<b>Wind</b>					
Off shore 	<b>&gt;75%</b>			40-45%	50-55%   
On shore	<b>70-75%</b>	30-35%		40-50%	



Sources: Ministries of Energy and Mining of Chile (July 2021) and McKinsey & Co.

# Despite distance to markets, Chile remains competitive in H2

Cost of liquid H<sub>2</sub> at port of destination, 2030  
(USD/kg H<sub>2</sub>)



Renewable energy carriers considered by developers and investors

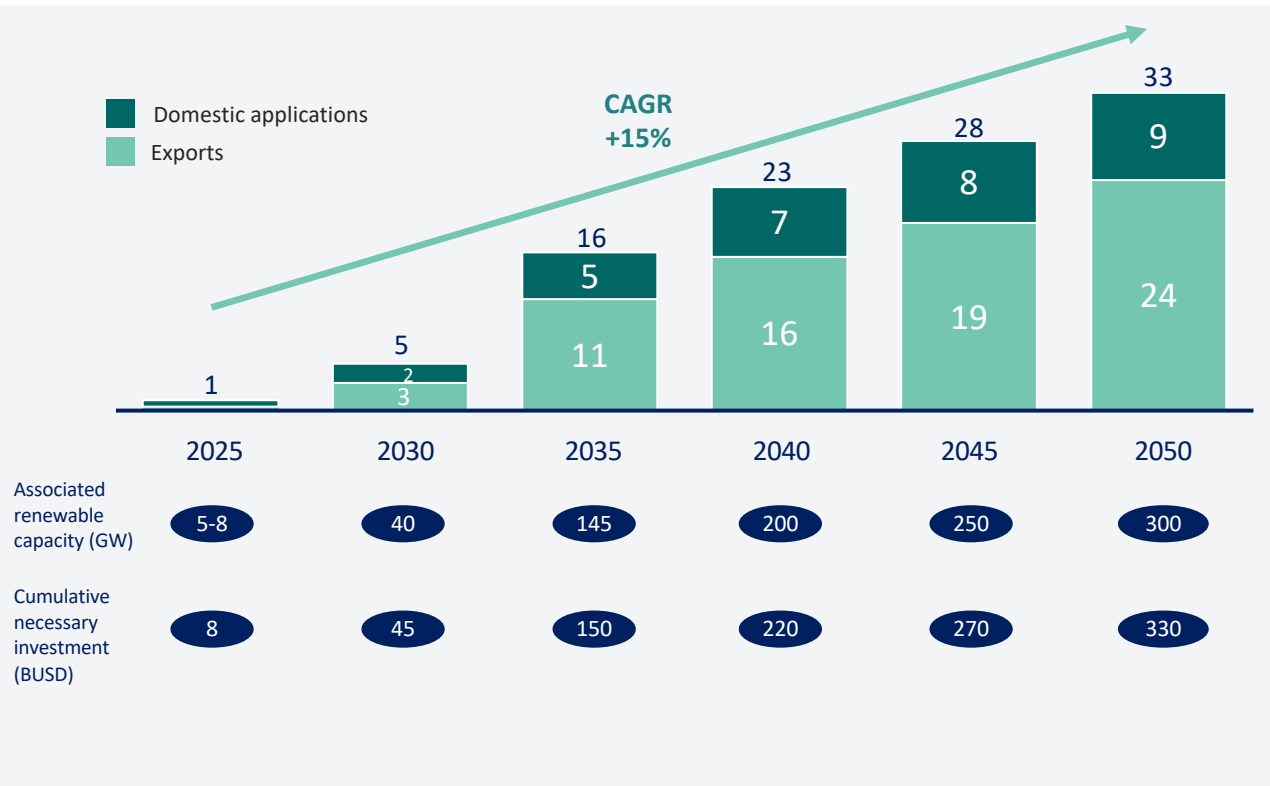
- LH<sub>2</sub>** Liquid hydrogen
- NH<sub>3</sub>** Green ammonia
- CH<sub>3</sub>OH** Green methanol / eFuels
- Cu** Green copper and other green exports

Sources: Ministries of Energy and Mining of Chile (July 2021) and McKinsey & Co.



# A unique opportunity: green hydrogen could be a clean industry as big as our mining sector

## Projection of Chilean markets for green hydrogen and its derivatives, 2025 - 2050 (BUSD)



The competitiveness of Chile in renewable energy production and the global need for clean energy carriers will open the door to the creation of an economic sector that could rival the size of the Chilean mining sector

If timely and effective action is taken, the use of green hydrogen in domestic applications will generate an industry prepared to compete in international export markets. Investment in green hydrogen will lead to significant national capabilities and the creation of dynamic economic ecosystems throughout the country

Sources: Ministries of Energy and Mining of Chile (July 2021) and McKinsey & Co.

# We have set clear goals to lead the way

## 2025



Top  
destination for  
green hydrogen  
investment in  
LATAM

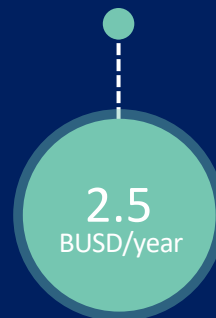


Electrolysis capacity  
operating and under  
development

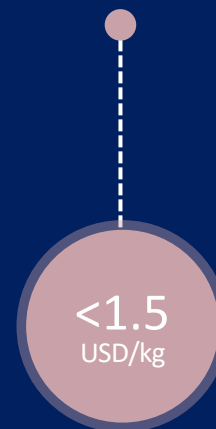


Production in at  
least 2 *hydrogen*  
*valleys* in Chile

Leaders in  
export of green  
hydrogen and  
derivatives



The cheapest green  
hydrogen on the  
planet



Leaders in  
production of  
green hydrogen  
via electrolysis



## 2030

Sources: Ministries of Energy and Mining of Chile (July 2021).

# 40+ projects have already sprung in Chile



**+15**

USD billion projected investment by 2030



**+1,200**

kTonne H<sub>2</sub> projected yearly production by 2030



**+500**

kTonne H<sub>2</sub> projected yearly local consumption by 2030



**+15**

Projects have already defined their operations start date

## Atacama Hydrogen Hub Project

Large-scale electrolysis facility with export potential and hydrogen fuel cell powered freight train

## 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

## HIF Project

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

## HyEx Project

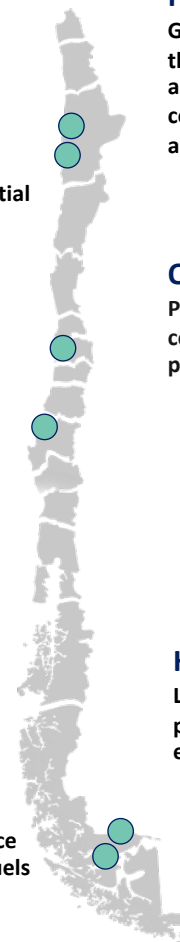
Green ammonia production in the north of Chile for domestic and international consumption, replacing ENAEX ammonia imports

## Quintero Bay H<sub>2</sub> Hub Project

Production of green hydrogen in the central zone of Chile, close to potential offtakers

## HNH ENERGY Project

Large scale green ammonia production in Magallanes for export



Sources: Ministries of Energy and Mining of Chile (July 2021).

## **2. The HIF Project**

**(Source: J.J. Gana: “HIF Project Overview”, June 2021)**



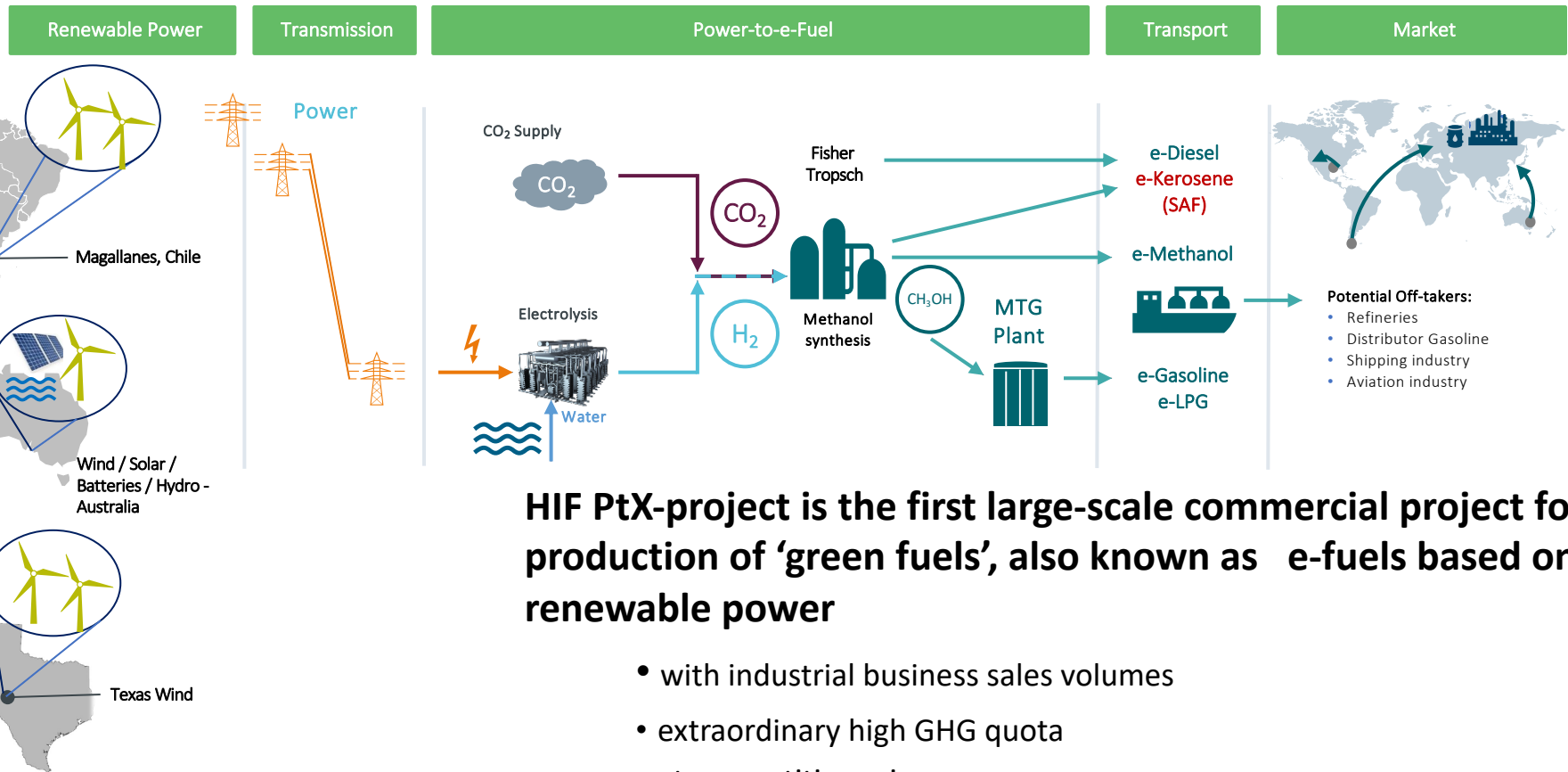
# The HIF Project



- **Electrification is not enough**; a solution is needed to **replace fossil fuels** with renewable energy
- HIF, a subsidiary of AME (the fifth largest IPP company in Chile) has been developing a project since 2016 to take advantage of one of the **world's best wind resources located in the south of Chile**
- HIF's vision is to be the world's first **internationally based, industrial scale, carbon neutral e-fuel company**
- HIF's project in Chile adopts a phased approach: a demonstration plant, to start operation in 2022, a first commercial scale plant operation in 2024, and successive phases of world scale commercial plants starting in 2026
- In mid 2020, HIF initiated development of similar large-scale e-fuels projects in Australia and Texas, with targeted COD in 2024.

Source: J.J. Gana: "HIF Project Overview" (June 2021).

# e-fuel Production Process



**HIF PtX-project is the first large-scale commercial project for production of 'green fuels', also known as e-fuels based on renewable power**

- with industrial business sales volumes
- extraordinary high GHG quota
- at competitive prices
- high up-scaling capability

Source: J.J. Gana: "HIF Project Overview" (June 2021).



# Chile: the world's best renewable resource

World's best  
onshore wind  
resource

- HIF has signed long term leases for over 200,000 ha of the best renewable energy resources the world has to offer. The tip of South America enjoys the world's best onshore wind conditions due to the Coriolis effect
- Plant factors in the range of 70%: low expected energy prices, \$0.01 – 0.02 /kWh
- Constant wind profile allows to have nearly continuous operation
- Location of extensive grazing lands, with a long history of petroleum exploration and production, well removed from sensitive tourism locations or nature reserves
- Direct electrical connection to the chemical plant, no need to be connected to the main grid, which allows for significantly lower transmission costs

Leveraging of  
existing  
infrastructure

- Lease in final negotiation with ENAP for construction of commercial facilities in the Cabo Negro port area to provide access to existing under-used port infrastructure
- Medium sized town (Punta Arenas) able to provide qualified workforce, accommodation, and services
- Potential to capture CO2 from nearby industrial facilities

Access to  
markets

- Chile is an investment grade country
- Free trade agreements in place with most export destinations
- Low-cost export to Europe (US\$40/tonne of gasoline), with access to export to Pacific markets without needing to pass through the Panama canal
- Strong track record for attracting international investment in mining and energy sectors: high liquidity, attractive margins
- Government and broad political support for development of hydrogen-based exports

# HIF Demonstration Plant: World Class Project Team



PORSCHE

Porsche: off-taker



AME: owner and lead developer



Green Power

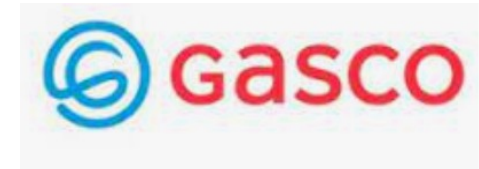
ENEL: partner in wind park and H2 production



Siemens: technology provider and integrator



ENAP: infrastructure and port service provider



GASCO: user of LPG output for I+D and product development

Source: J.J. Gana: "HIF Project Overview" (June 2021).

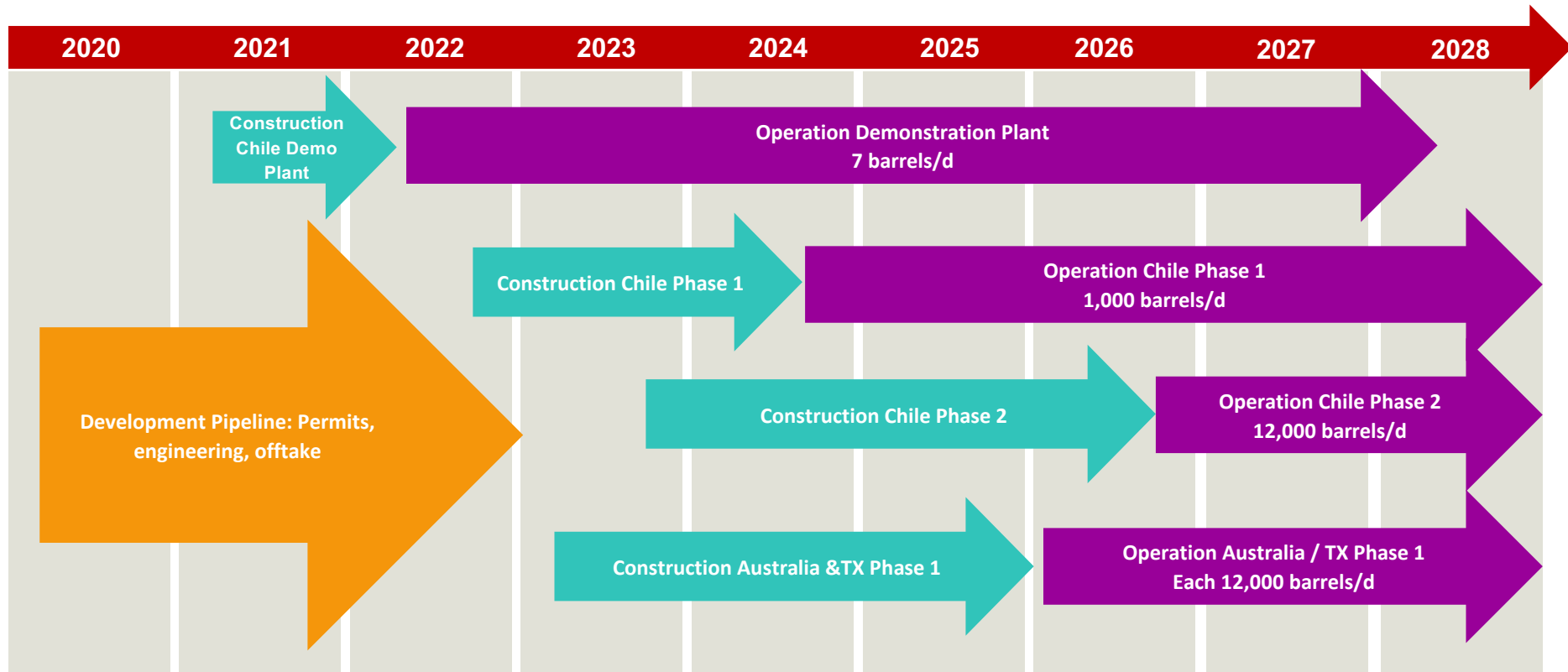


PLANTA DEMOSTRATIVA HARU ONI  
PUNTA ARENAS, REGION DE MAGALLANES, CHILE





# Progressive roll-out of commercial phases



Source: J.J. Gana: "HIF Project Overview" (June 2021).

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