CENTRO DE
ESTUDIO DE LOS
RECURSOS
ENERGÉTICOS

Green hydrogen and derivatives: a challenging industry for the Magallanes region

IEEE POWER ELECTRONICS SOCIETY
Powering a Sustainable Future

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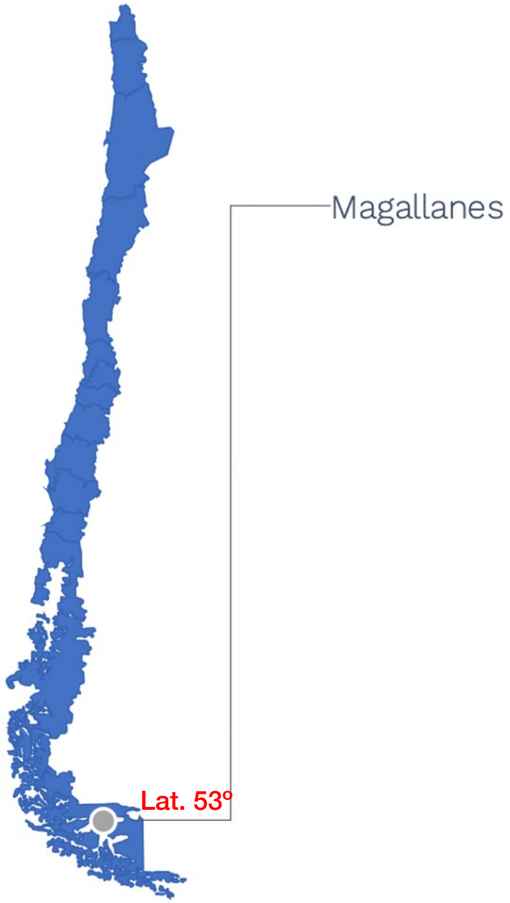
UNIVERSITY OF MAGALLANES (UMAG)



Founded in 1982, it is the continuation of the former Universidad Técnica del Estado, which began its activities in the Magallanes region in 1961.

- 5 faculties.
- 31 undergraduate programs.
- 9 graduate programs (2 PhD).
- ~4250 students.

Mechanical and Electrical Engineering are the foundation programs of the institution, with a **strong link to the industry**.

Central Campus in Punta Arenas.

Our research areas:

- Antarctic and sub-antarctic science.
- Energy and environment.
- Human settlement in high latitudes.
- Human development.

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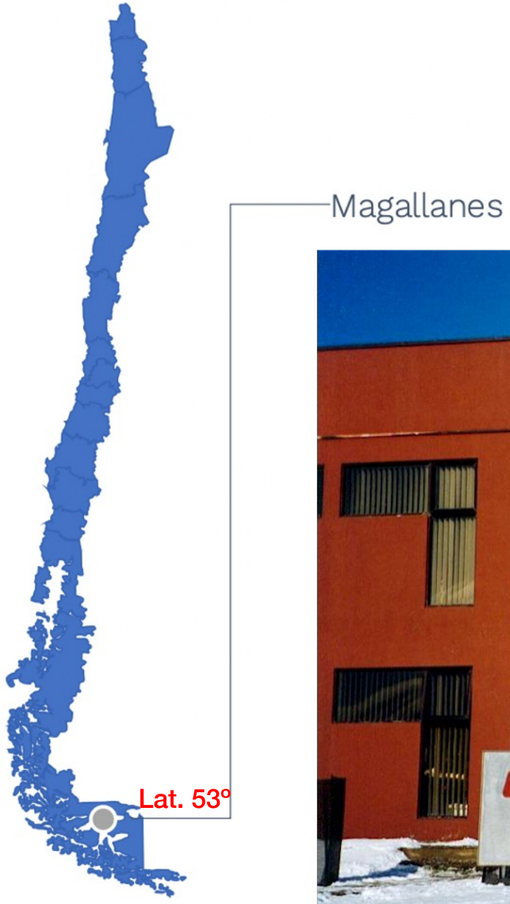
CENTER FOR THE STUDY OF ENERGY RESOURCES (CERE)



CERE was created in 1993 and housed in the Faculty of Engineering of the University of Magallanes.

The center supports the promotion of renewable energy technologies, rational use of energy in residential, public and commercial areas, also assists political decision-makers in the national and local discussions in the most important issues on matters related to energy policy and planning.

Currently, CERE develops applied research projects in 5 areas: Wind, Solar Photovoltaic, Biomass and Biofuels, energetic efficiency and evaluation of green hydrogen and derivatives production opportunities.

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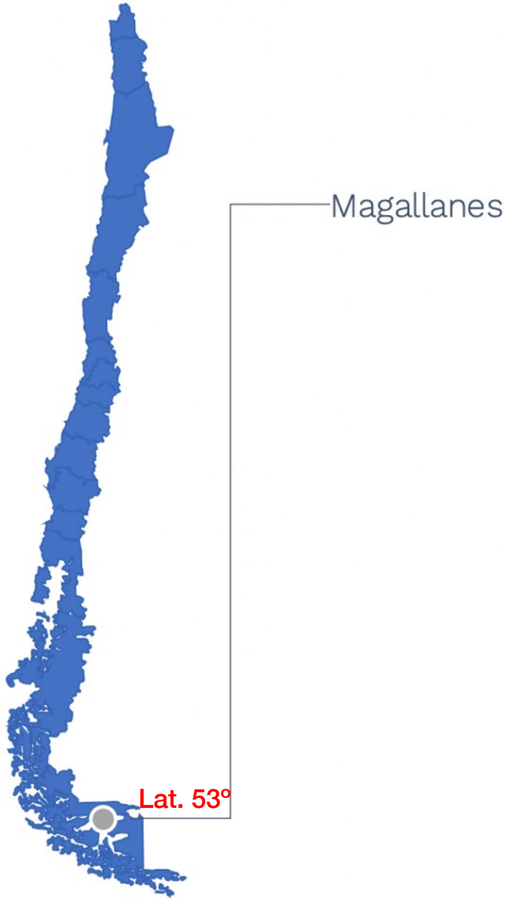


RESEARCH AREAS

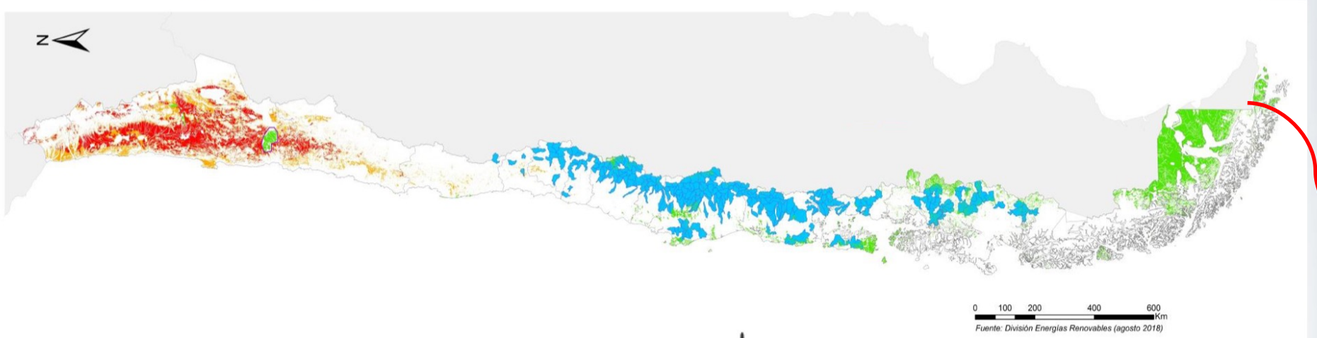
1 **Energetic Efficiency**
- Buildings
- RPC areas
- Ilumination
- Heating
- R&D

2 **Renewable Energies**
- Wind
- Solar
- Biomass - Biofuels
- Marine energies
- Green Hydrogen and derivatives

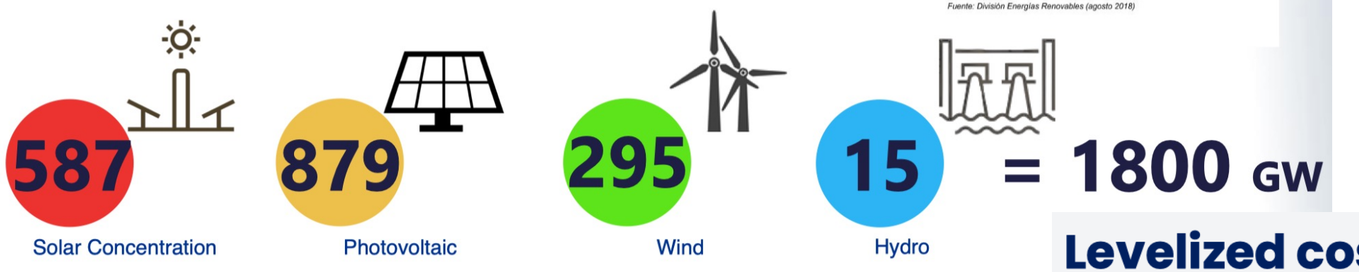
3 **Cross-cuting areas**
- Capacity Building
- Linking with communities
- Public policy studies

Why Chile? Three Main Advantages – The geography

N°1:
The Geography & The Renewable Potential



World class potential wind
LCOE < 25 USD/MWh (Magallanes region)

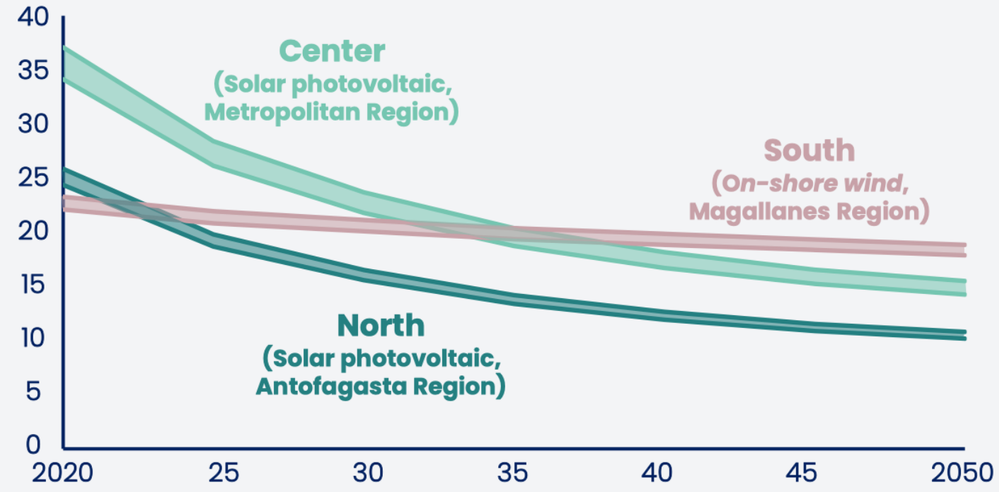


= 1800 GW

"The other aspect related to the Chilean territory is its huge potential of renewables energies"

Levelized cost of renewable electricity (USD/MWh)

Source: McKinsey & Co.



N°1: A country with abundant and quality renewable resources

Capacity factors per country in best areas (%)

Source: Ministry of Energy of Chile, McKinsey & Co

		Chile	Australia	Saudi Arabia	USA	EU
Solar PV		37%	~30%	~30%	~25%	20-25%
Wind	Off shore	>75%			40-45%	50-55%
	On shore	70-75%	30-35%			

If a comparison is made considering capacity factors per country in best areas, you can see that Chile has a clear advantage.

The National Hydrogen Strategy

This document establish:

-Develop a clear, stable, and coherent regulation on markets

-Reduce uncertainty and accelerate projects.

-Streamline permitting to accelerate deployment of technologies.

Advantage N°3: The Mining Sector – the big user

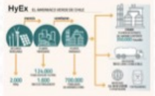
Chile: leading in low-emission mining

World's leading Lithium producer

World's largest low emission copper producer

Long term supply of lithium carbonate/hydroxide	Lithium and copper added value products	Solar energy for continuous electricity supply (mix PV/CSP)	Hydrogen as a fossil fuels substitution
		 	
(Battery grade)	(Cathodes, others)	At average cost of 20 USD/MWh	

Green Hydrogen Projects in CHILE – Public information (+60 projects)



HYEX/ENGIE Y ENAEX
Type of Project: Green Ammonia for Explosives and Export
Source: link

AES ANDES
Type of Project: Green Ammonia for Export
Source: link

ENEL GREEN POWER
Type of Project: Hybrid Plug and play microgrid, Cerro Pabellón Geothermal power plant
Source:Fuente: link

En operación

North Atacama Desert

GNL Quinteros & Acciona
Type of Project: H2 production to blend in natural gas pipelines
Source: link

Gasvalpo & Busso Group
Type of Project: H2 production to blend in natural gas pipelines
Fuente: link

AngloAmerican
Type of Project: FC Forklift
Source: link

En operación

Walmart-Engie
Type of Project: FC Forklift
Source: link

Center

HIF/Siemens
Type of Project: e-fuels for Export.
Source: link

HNH/AustriaEnergy
Type of Project: ammonia production from green Hydrogen
Source: link

Total EREN
Type of Project: ammonia production from green Hydrogen
Source: link

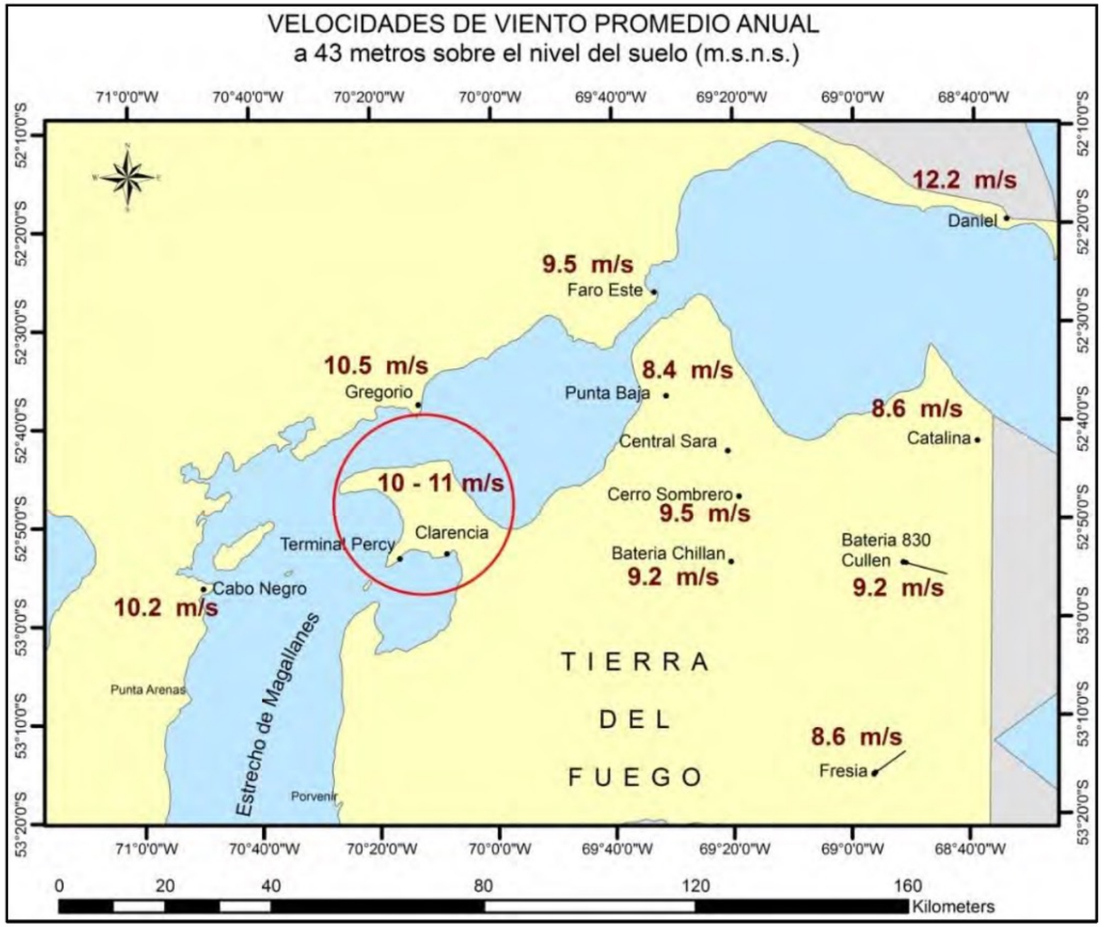
South Patagonia

Fuente: Corfo 2021

Green hydrogen projects in southern region of Chile

Torres del Paine National Park, Magallanes region

Why Magallanes ?



Annual mean wind velocity (source CERE 2014)

World class potential wind
LCOE < 25 USD/MWh (Magallanes region)

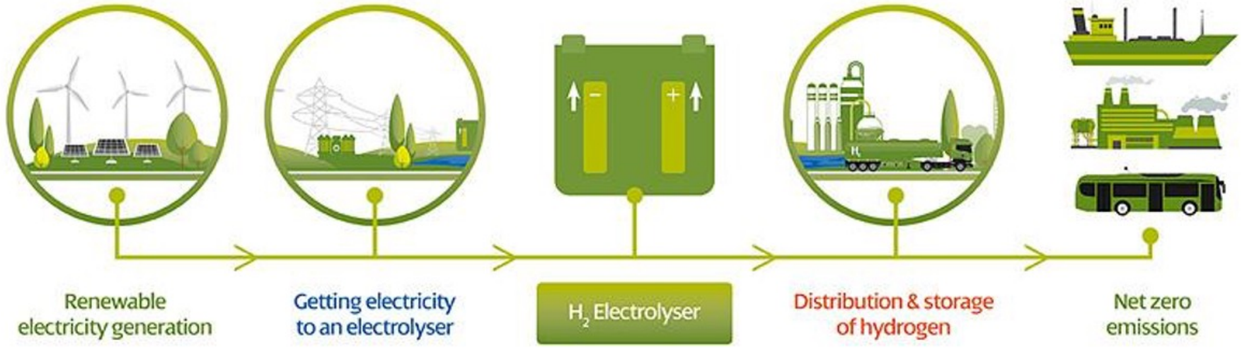
Wind park Vientos Patagónicos: Power 10,35 MW

Capacity factor
(52 - 54%)

H_2

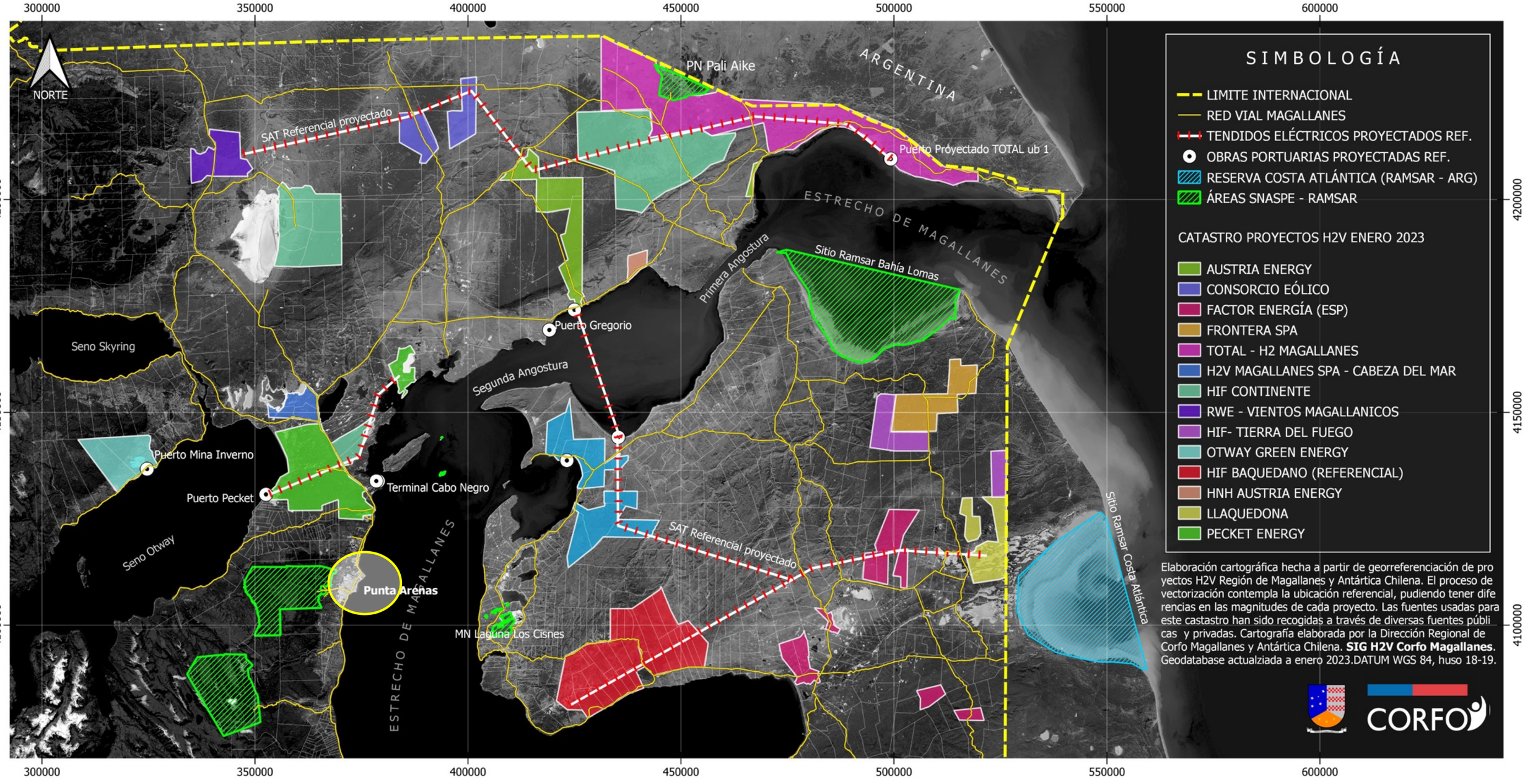
Wind park Cabo Negro: Power 2,5 MW
(operating since 2015)

What is green hydrogen



Production cost of green hydrogen depend strongly of the renewable electricity cost (60% - 70%)

Green H_2 and derivatives (14 projects in Magallanes region)



Production expectations of green H_2 and derivatives in Magallanes

Magallanes region could host 6 projects that are known to be planing to begin exports this decade

Magallanes

TOTAL eren — 2025

Green ammonia for export project. Already has secured land and at the moment the environmental baselines are being defined.

HIF / SIEMENS energy — 2024

Green methanol and green gasoline production from wind power and captured CO2 for export to German offtakers Porsche and Mabanaft. Pilot phase begins operations in 2022. Export terminal for the pilot is secured.

AustriaEnergy — 2026

Green ammonia for export project. Already has secured land and has an offtake MoU with Trammo. Export terminal is not clear.

2028 — CWP GLOBAL

Green ammonia plant in development. Land and export terminal not clear.

2030 — Sociedad de Inversiones Albatros / alfanar

Green ammonia plant in development. Export terminal is not clear.

TEG TRANSITIONAL ENERGY GROUP / HAURA ENERGY

Green ammonia for export project. At the moment, the environmental baselines are being defined at the Tierra del Fuego island.

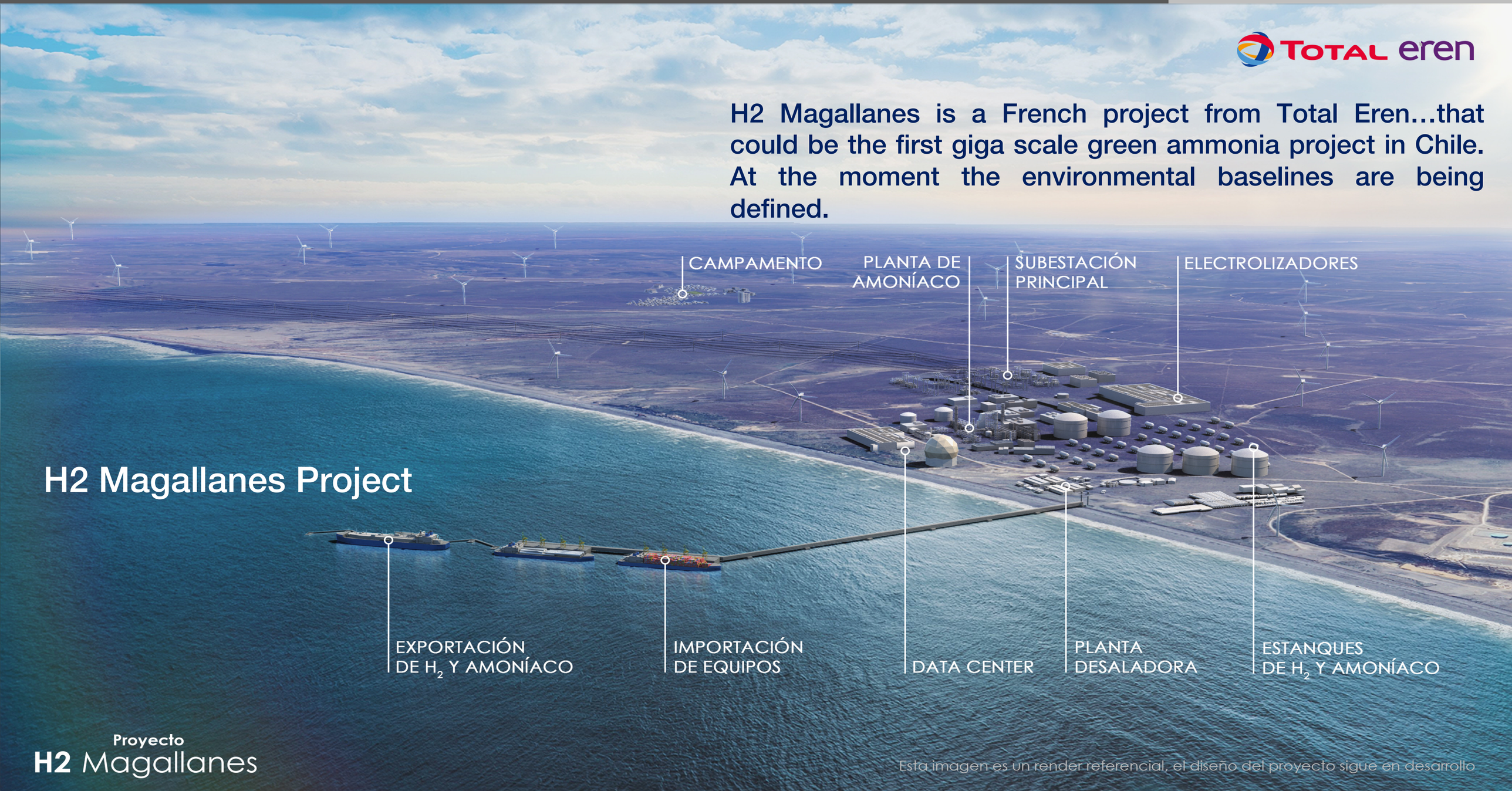
- If only first commercial phase is developed in each one of these projects, we will have 12 GW of wind power
- At the present, Chile has only 6 GW of wind power
- Most projects are to produce green ammonia.

Green hydrogen and ammonia production from wind power (Austria)

Green ammonia production project

Green hydrogen and ammonia production from wind power (France)

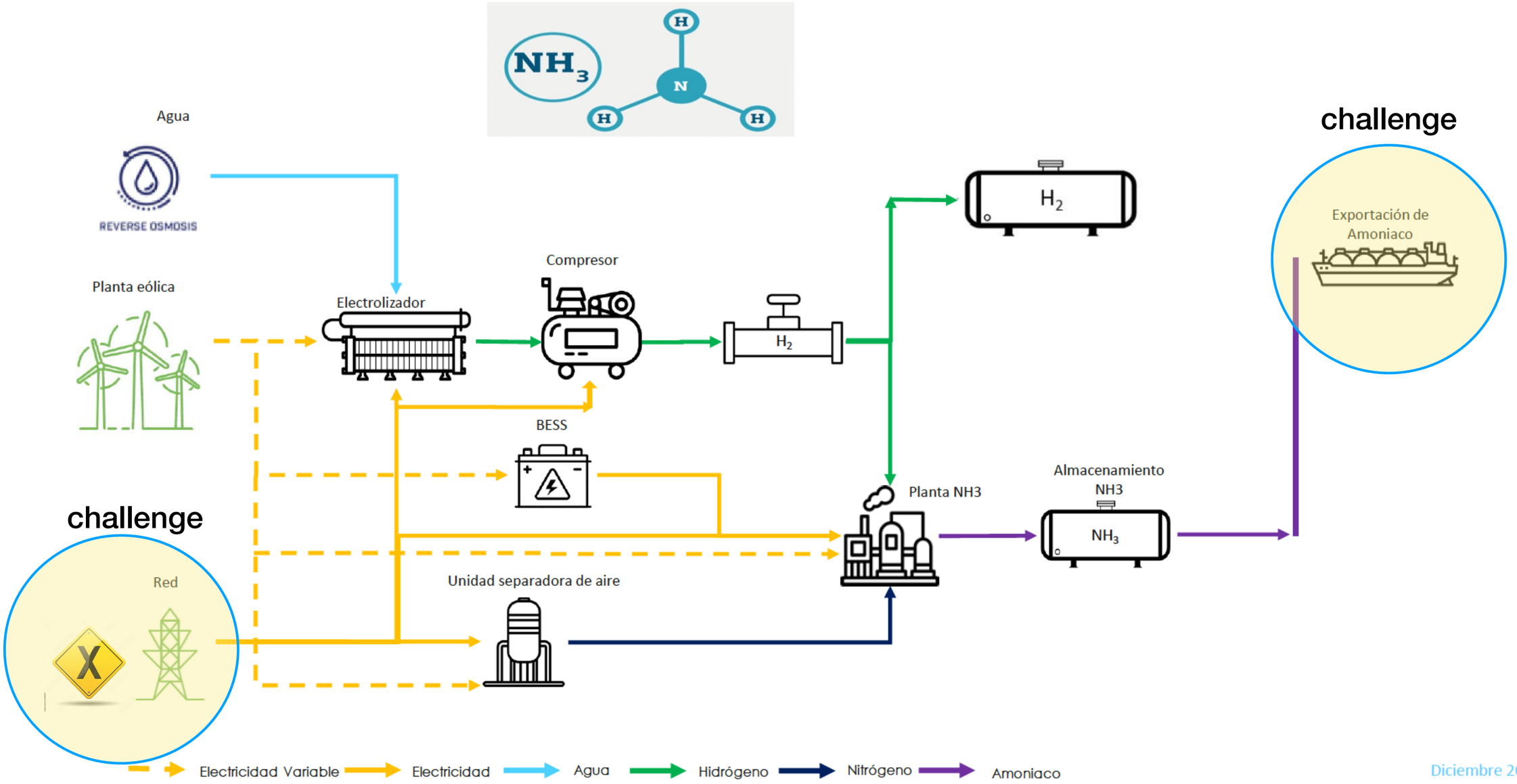
H2 Magallanes is a French project from Total Eren…that could be the first giga scale green ammonia project in Chile. At the moment the environmental baselines are being defined.



Proyecto
H2 Magallanes

Esta imagen es un render referencial, el diseño del proyecto sigue en desarrollo

Transforming wind power to green ammonia in Magallanes region



Diciembre 2020

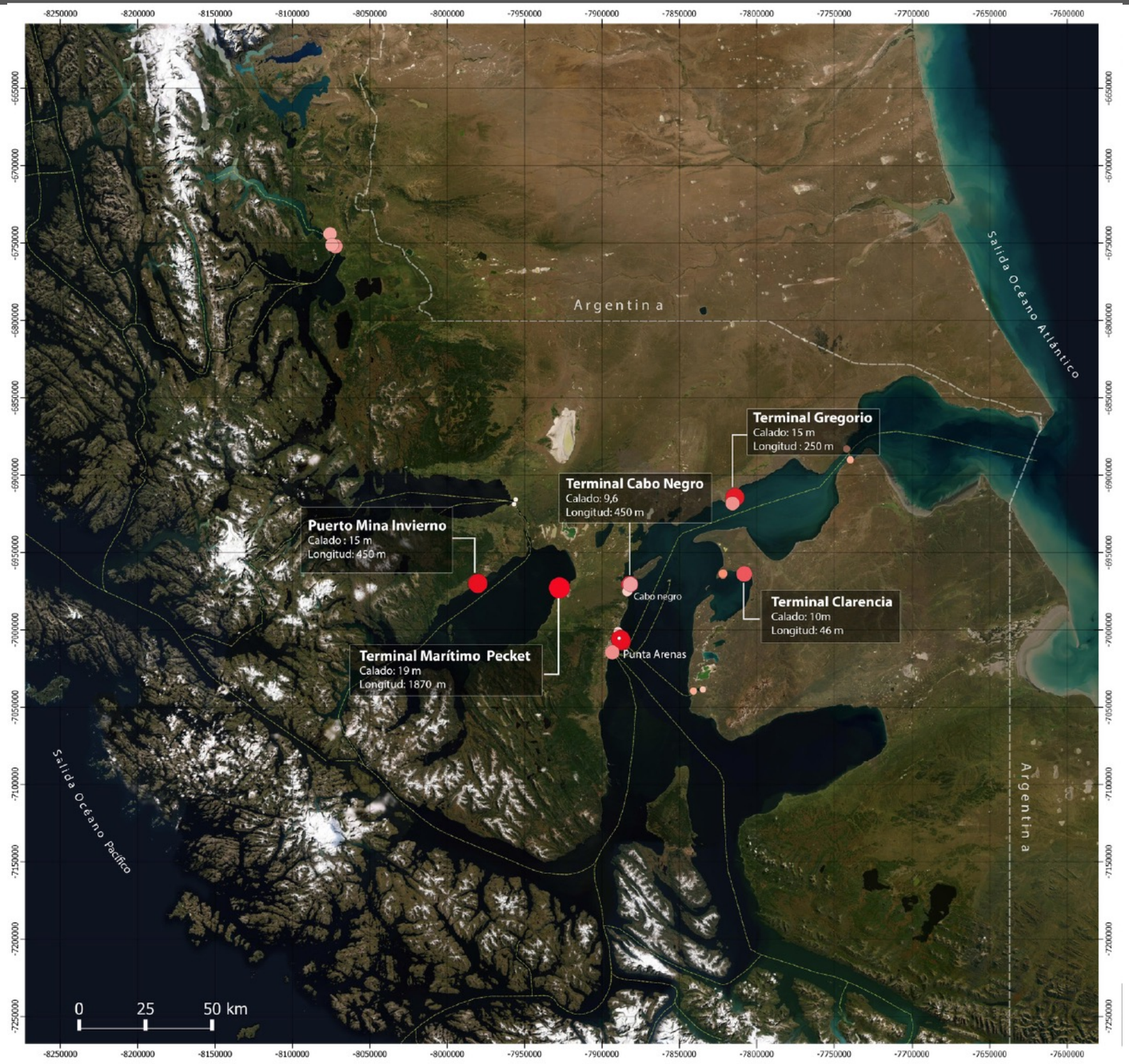
Existence of transport network – (infrastructure challenge)

Existence of gas transport infrastructures in the same area due to former economic activities related to oil&gas.

Challenge: 500 kms of pipeline unused by Enap could be a network for transport renewable ammonia to the export terminals.

Fuente: Corfo Regional)

Existence of port infrastructures (adaptation challenge)



Terminal associated with industries of:

- Oil and gas
- Methanol
- Coal mining

Developing the infrastructure necessary to transport and export ammonia derivatives in the Magallanes Region, presents substantial challenges.

Existence of port infrastructures (adaptation challenge)

ENAP’s port development plan (source Enap)

H2V Magallanes association (coordination challenge)

Creation of the green hydrogen association in Magallanes (March, 2023)

Union of green hydrogen producers with presence in the Magallanes Region that will seek to create a space for coordination and dialogue with local actors to promote the sustainable development of this key industry for the energy transition.

HIF Global	
TEG Chile	Inglaterra
Total Eren	
EDF Andes	Francia
EDF Renewables	
HNH Energy	Austria
ENAP	Chile

Generation of local demand: economical challenge

- Current economical model of the renewable hydrogen and ammonia industry is oriented to the exportation.

Challenges

- To produce local value in the communities and regions where hydrogen or ammonia is developed.
- Enable the development of manufacturing and services to capture increased shares of the market value domestically.

Social and environmental challenges

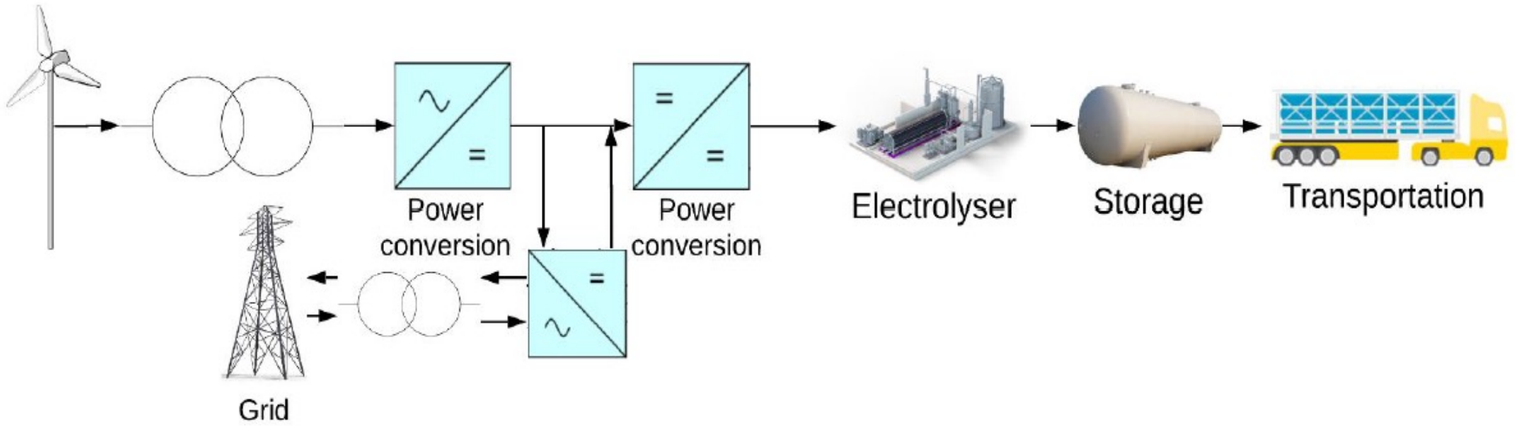
Challenges

- A social impact assessment, similar to Environmental Impact Assessment should be conducted to evaluate the local capacity building potential.
- Understand the communities concerns, aspirations and expectations.
- To prepare the city, towns and communities for the arrival of so much equipment and personnel.

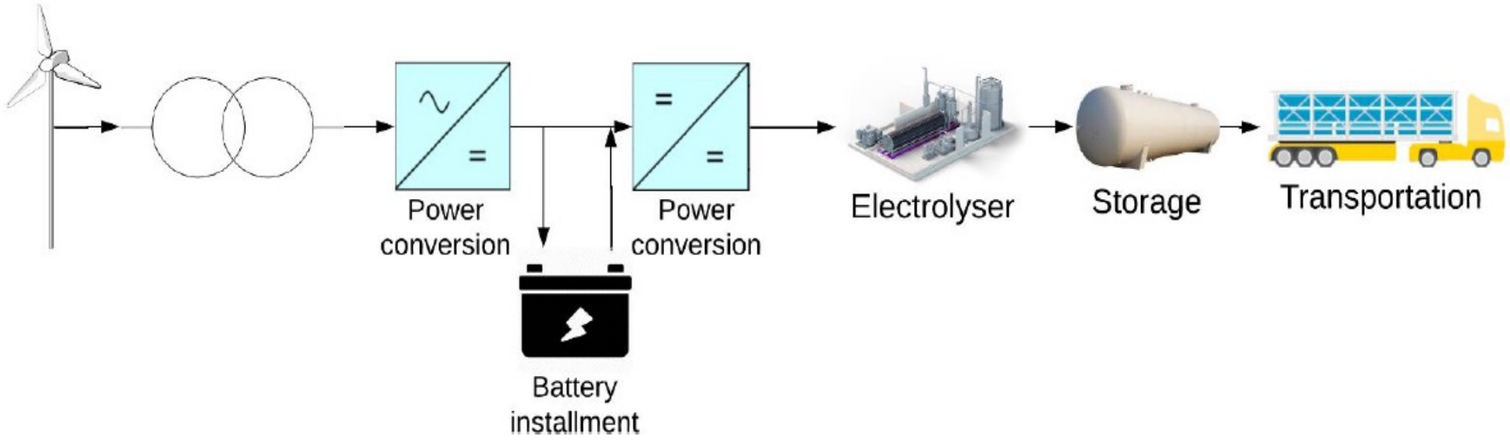
Developing wind farms in harmony with nature and ecosystems (land uses, migratory routes, Ramsar sites, etc..)

Mitigation of environmental impacts of desalination processes through use of the different brine management techniques.

Big scale wind farms operating in off grid mode – technical challenge



H2 production assisted by grid



H2 production assisted by BESS

• One of the main gaps lies in the operation, reliability and stability of the internal electrical systems; in other words, in keeping the production plant in operation, given that due to its location and size, the project would operate as an electrical island and this situation could affect the LCOAs.

- The power requirement for the electrolysis process must be quite stable for avoid shutdowns preserving the lifetime of the electrolyzer and maintain a high degree of hydrogen purity.
- The design of wind farms to feed the electrolysis process must include some technical solutions to deal with the intermittences of the renewable energy.
- A back-up energy source must be incorporated due to the the absence of an electrical grid that can absorb periods of low wind generation.
- The back-up could consist of hydrogen fuel-based electrical generation or a battery energy storage system (BESS), because it is looking for the projects that are completely renewable.

Local capabilities gaps for the green hydrogen and derivatives

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

Given this is a new industry, it is crucial to work in a forward-looking manner, to provide training and build networks with the study centers that will provide the technicians and professionals that will be needed.

HIF pilot project under operation.... (March, 2023)

First batch of e-fuel, made from green hydrogen and captured CO2, heading from Chile to UK for Porsche testing

The first 2,600 litres of e-gasoline manufactured from the landmark Haru Oni project in southern Chile is now on its way across the Atlantic on a 16,800km journey to eastern England, where it will be tested by Porsche (Refinery Haltermann Carless).

HIF pilot project under operation…. (October, 2023)

Punta Arenas, October 6th, 2023.- HIF Global, the world´s leading eFuels company, and the Chilean gas company Empresas GASCO, today announced the first production of carbon-neutral liquefied gas (“eLG”) generated with renewable energy from the strong winds of the Magallanes Region, at the Haru Oni eFuels facility in southern Chile.

Collaboration agreements with developers

Collaboration agreement between University of Magallanes and Highly Innovative Fuels Company (HIF)

Collaboration agreement between University of Magallanes and Total Eren Company

First synthetic fuel laboratory of Chile installed in UMAG

Lab was funded by
Highly Innovative Fuels Company (HIF)
800.000 USD

- Built next to existing laboratory of solid fuels
- 1 M USD Investment for liquid and gas fuels
- In collaboration with HIF and Gasco
- The laboratory serves HIF pilot plant
- It is available for other R&D endeavours.
- The facility with all its equipment will belong to UMAG in 4 years.

Conclusions

- Many opportunities open up to economies with large industrial infrastructure and availability of renewable resources, such as Chile or Brazil.

- There are still many challenges that need to be overcome in the territories to realize the opportunities.


Thanks…