

Business opportunities of Hydrogen and Geothermal Power Generation for Decarbonization in LAC region

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Context

2021

IDB financed a record amount of US\$4.500 million in activities related to CC
Represent 30% of the Bank's total annual approvals

Since January 1, 2023, the IDB has evaluated the alignment of all its operations with the objectives of the Paris Agreement

Jan 2023

The IDB emphasizes the integration of resilience in infrastructure investments to adapt to climate change at a lower cost.

- In 2015 -2019 investments in resilience represented 5% of regional GDP.
- For every dollar invested in resilient infrastructure, up to 4 in economic benefits are generated. (WB 2019)

Potential + Operations

In Latin America and the Caribbean (LAC), there is an estimated potential for **geothermal resources of between 15GW to 50GW**, with 1.8GW of electricity generation already installed, with prices ranging between US\$0.07/kWh and US\$0.12/kWh

MEXICO

2019 PGM:
BID US\$ 53.4 M,
CTF US\$ 51.5 M

EL SALVADOR

1994 Berlin:
BID US\$ 215 M

NICARAGUA

2016 Cosigüina:
BID US\$ 23 M,
CTF US\$ 17 M

COSTA RICA

2015 Borinquen:
BID US\$ 200 M, JICA US\$ 645 M
1985 Miravalles:
BID US\$100 M, JICA US\$ 79M

CARIBE ORIENTAL

2015-2019 Sustainable Energy
Facility
for the Eastern Caribbean:
BID US\$ 20 M,
CTF US\$ 19 M,
GCF US\$ 80 M

COLOMBIA

2016 CTF US\$ 10 M

BOLIVIA

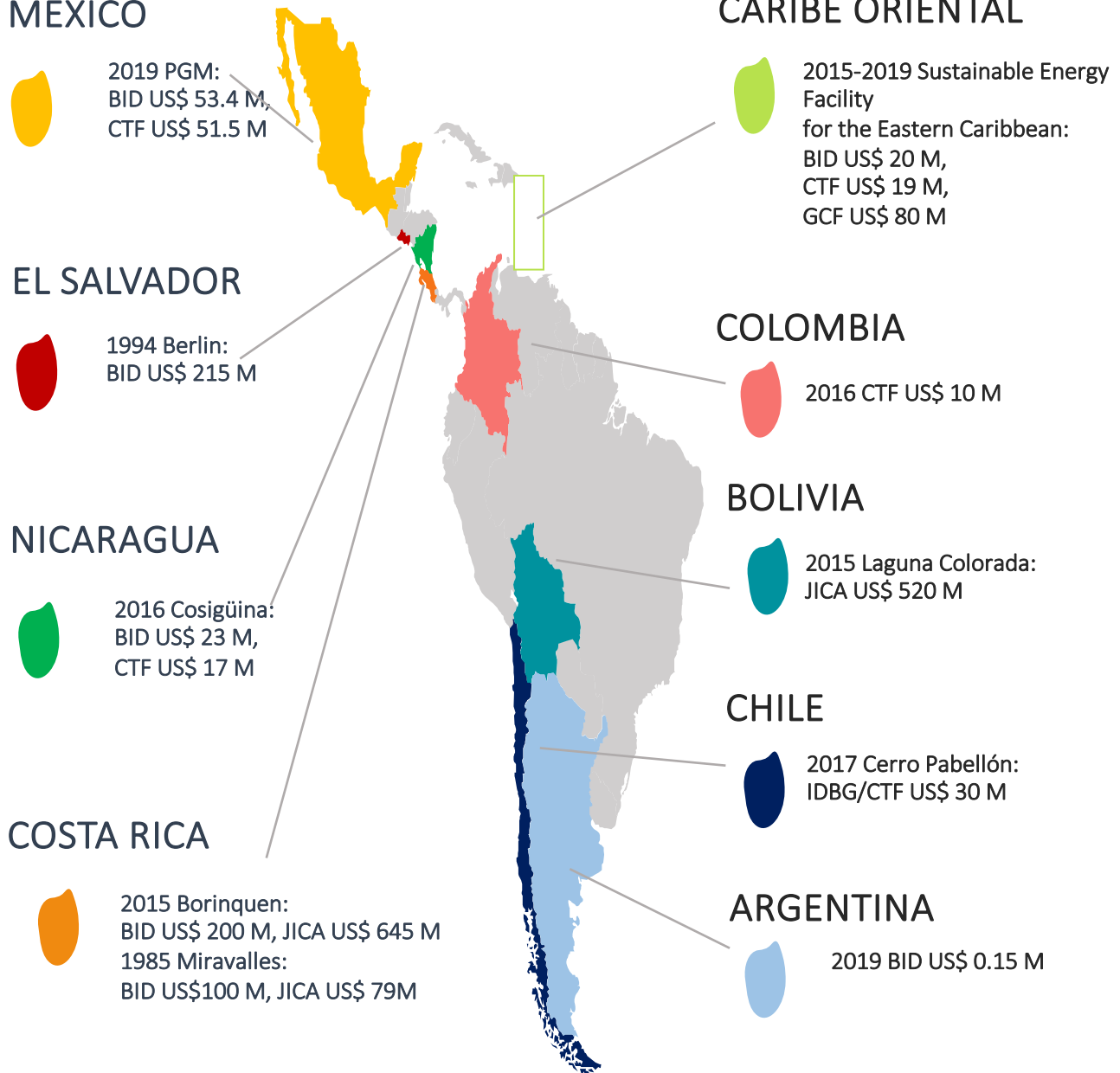
2015 Laguna Colorada:
JICA US\$ 520 M

CHILE

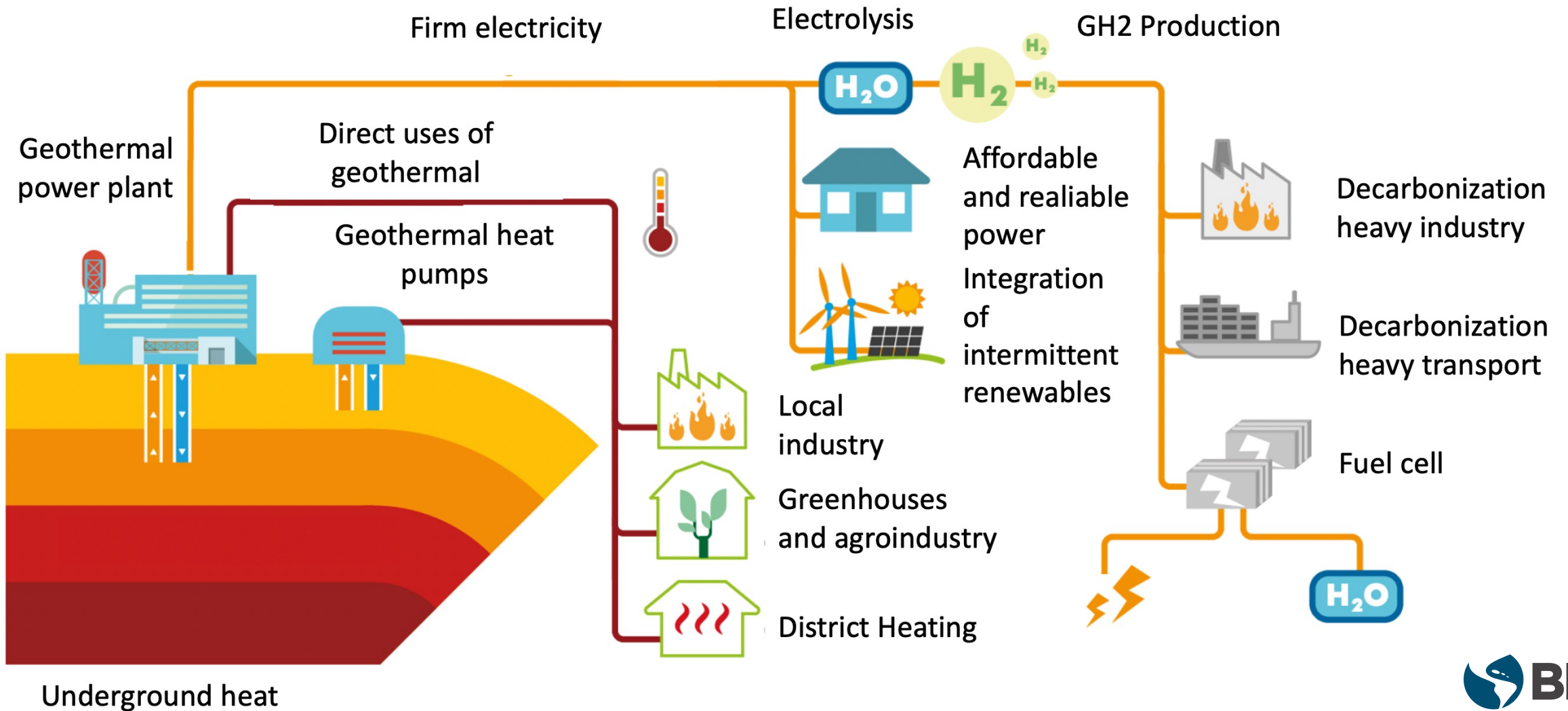
2017 Cerro Pabellón:
IDBG/CTF US\$ 30 M

ARGENTINA

2019 BID US\$ 0.15 M




Geothermal energy for industry decarbonisation



Financial mechanisms to foster geothermal energy in LAC

Chile



MIRIG

- Blended loan
- 💡

Mexico



- CEA
- Insurance
- 💡
- PGM
- Contingent grant + soft loan
- 💡

Eastern Caribbean



SEF

- Contingent recovery grant + soft loan
- 💡

Argentina



- Domuyo Project 100MW
- Phase 1 - 3wells + Power plant + Transmission line

Colombia



Geothermal PWR2X

- Contingent recovery grant + loan
- 💡 + 🗑️

LAC



GEO+

- Equity
- Soft loans
- 💡 + 🗑️ + 📱 + 🚶

Executed

Current execution

Preparation

Chile

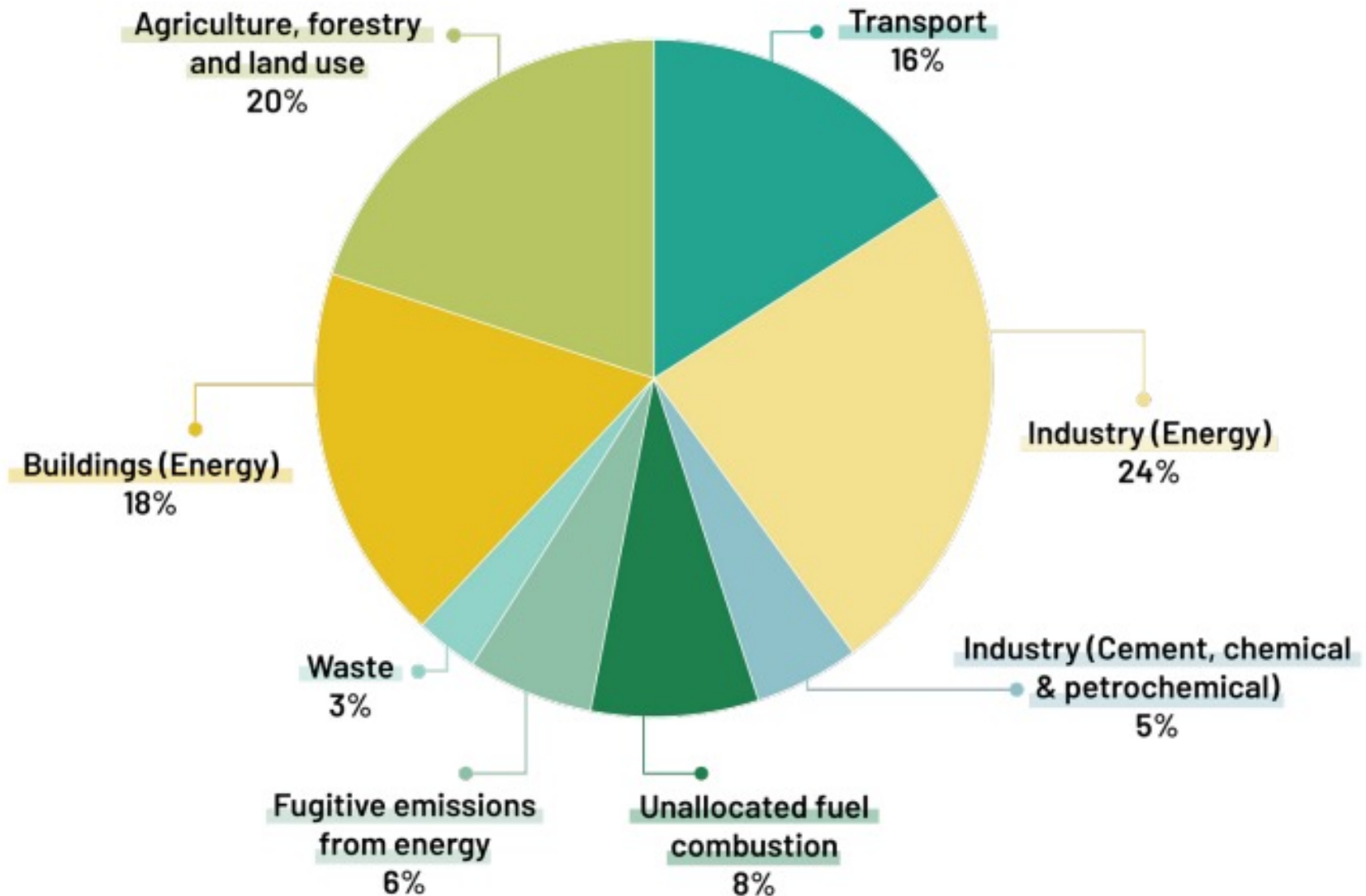
MIRIG - Cerro Pabellón



Hydrogen: Almost 50% of the total GHG from hard-to-abate sectors

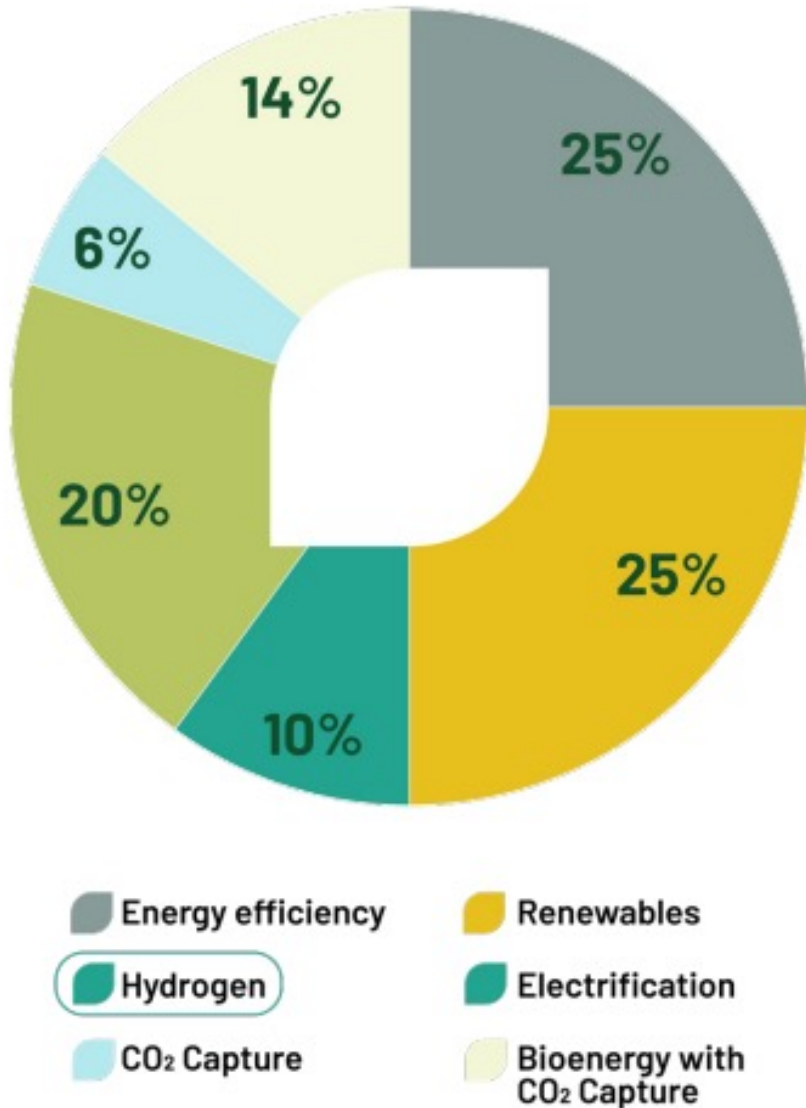
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Green and low-carbon hydrogen could address the **decarbonization** in the hard-to-abate sectors like **industry and transport** (together contribute to nearly 50% of the total GHG emissions)



Pathways to reduce GHG emissions

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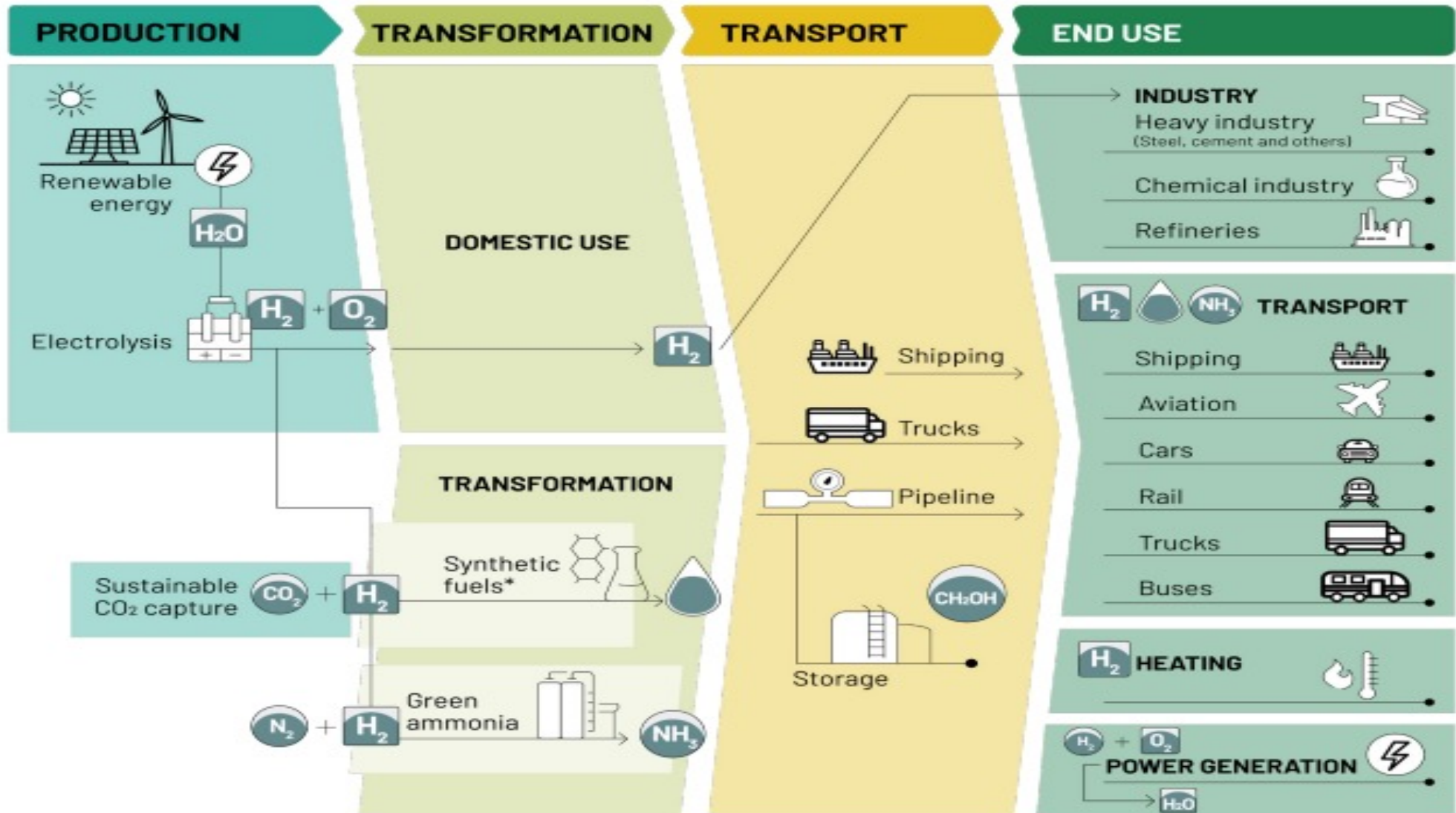


To reach **net-zero emissions by 2050**, six **decarbonization pathways** have been identified. These pathways can be categorized into four key measures: (I) enhancing energy efficiency; (II) electrifying processes through renewable energy sources; (III) implementing carbon capture, utilization, and storage (CCUS), including bioenergy capture; and **(IV) leveraging green hydrogen and low-carbon hydrogen (GLCH).**

Source: Own elaboration based on information from IRENA (IRENA, 2022a)

Green Hydrogen Value Chain

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Source: Adapted from IRENA (2020), Green Hydrogen A Guide to Policy Making.

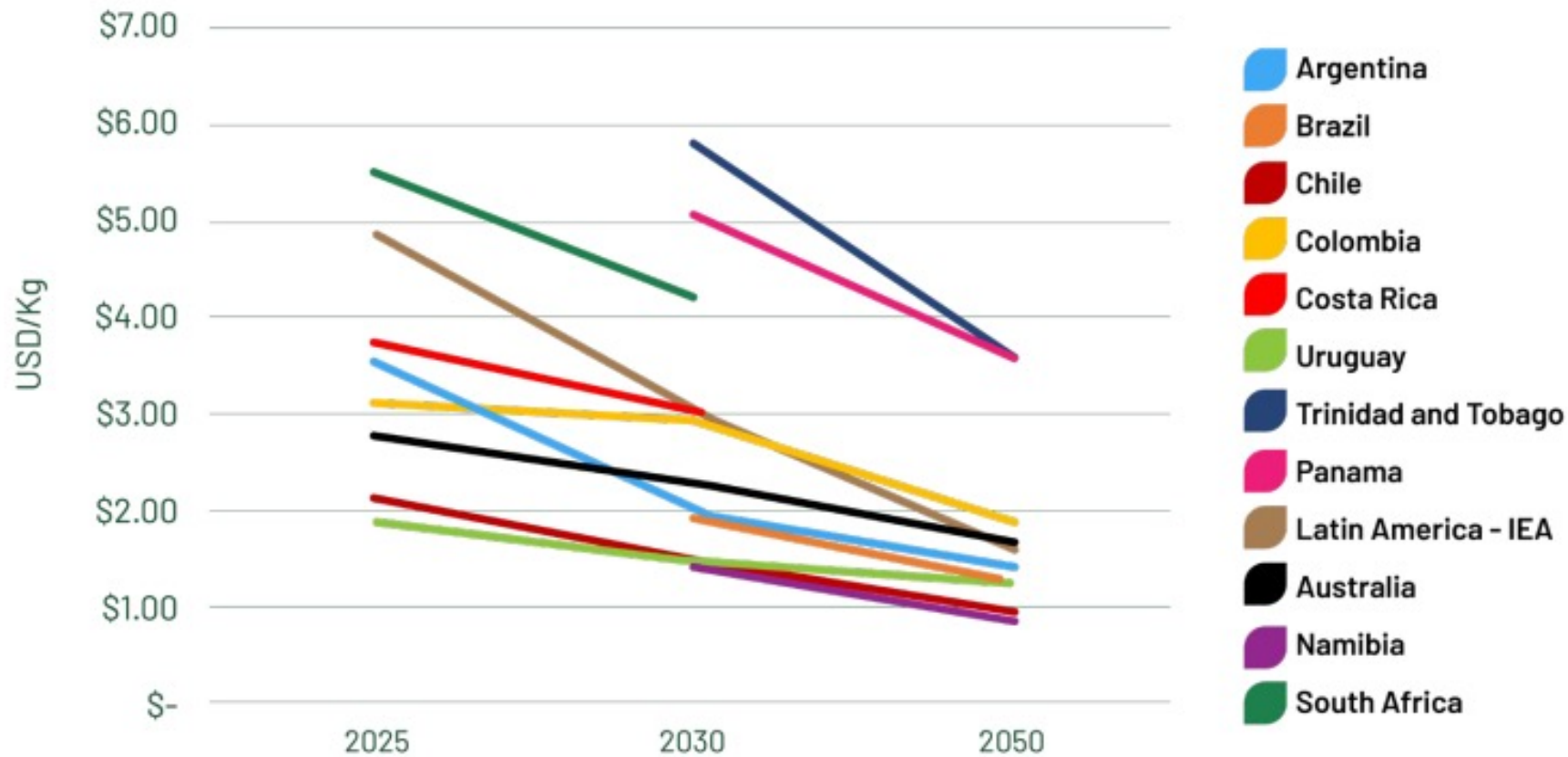
Activities in 15 countries

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Bien Publico Regional (BPR)

LAC can be competitive in comparison with other regions

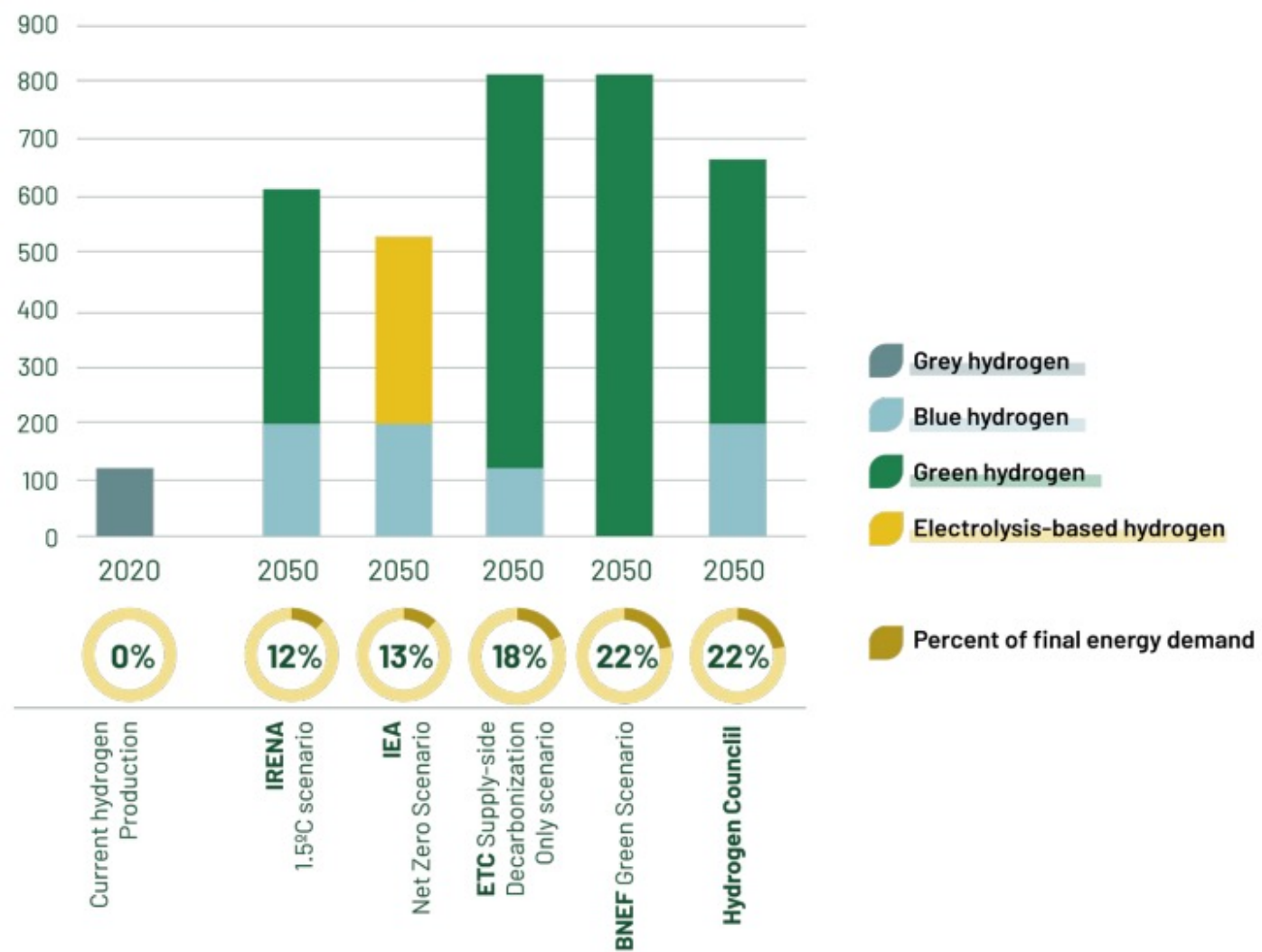


LCOH is projected to **decrease in most countries by 2030 and 2050**. By **2050**, the prices are expected to be below **US\$2/kg in many countries**, aligning with other countries aspiring to become hydrogen exporters, such as **Namibia and Australia**

Global green hydrogen demand in 2050 will be 5 to 8 times the current grey H2 demand

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Hydrogen production (Million tonnes)

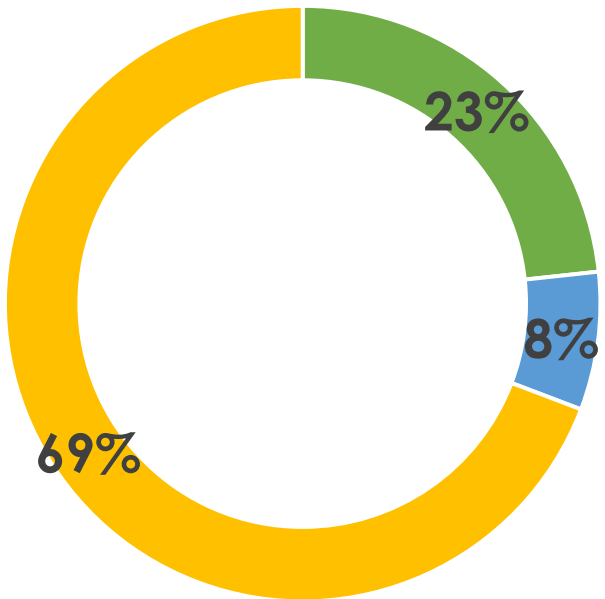


The Levelized Cost of Green Hydrogen Will Fall as Global Demand for GH2 Rises

At least 69% of cost LCOH is power

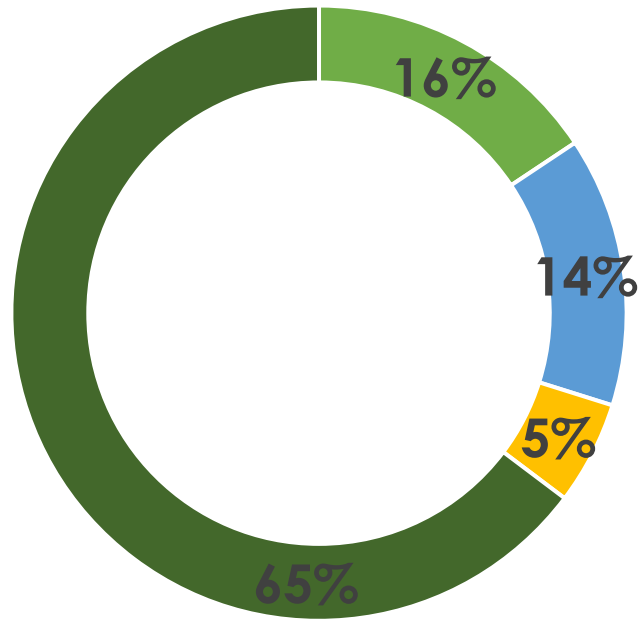
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LCOH



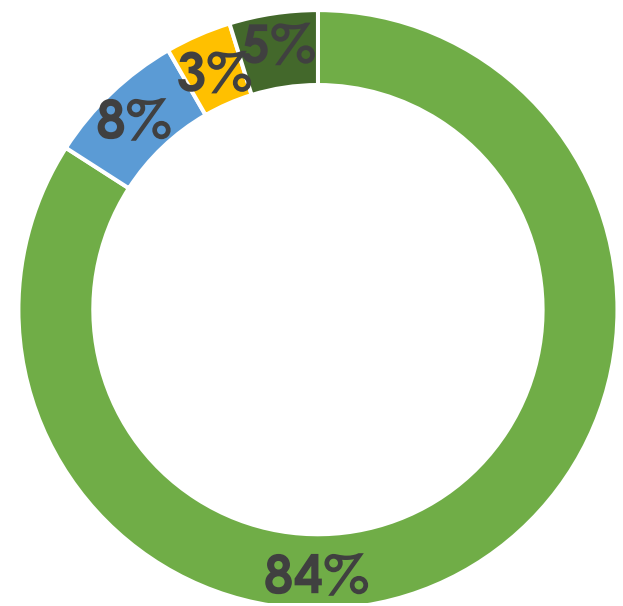
■ CAPEX ■ OPEX ■ Electricidad

LCOA



■ CAPEX
 ■ Costos OPEX
 ■ Costo de la energía de síntesis

NH₃ cost from La Guajira to Germany



■ LCOA de producción
 ■ Ducto
 ■ Almacenamiento
 ■ Transporte marítimo

33% of Europe and Asian demand could be supplied by LAC

140 Mt/year

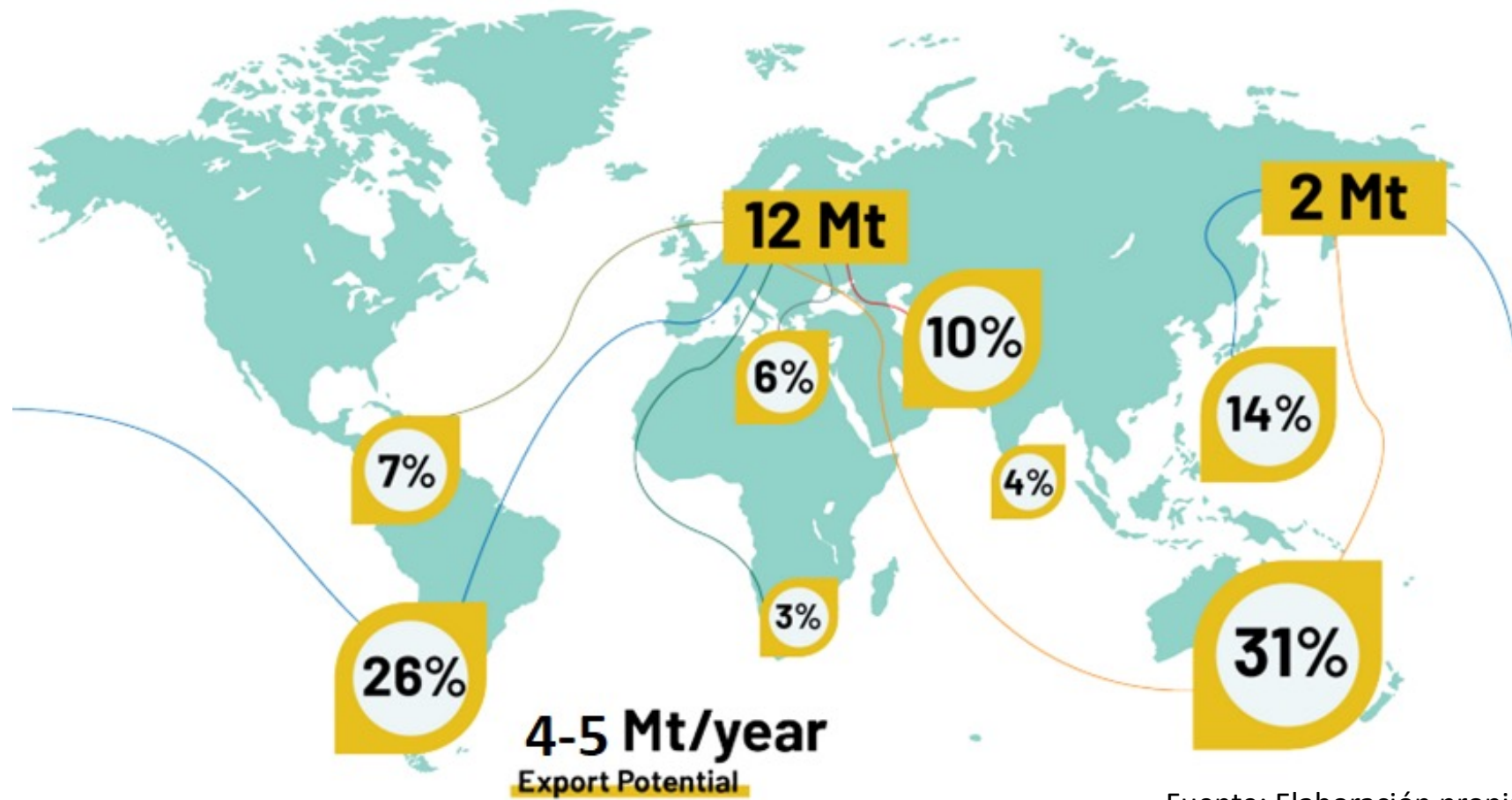
Is the expected global demand for 2030.

10%

Of the international trade of H2 will be demand from Europe (12 Mt) and Japan and South Korea (2 Mt).

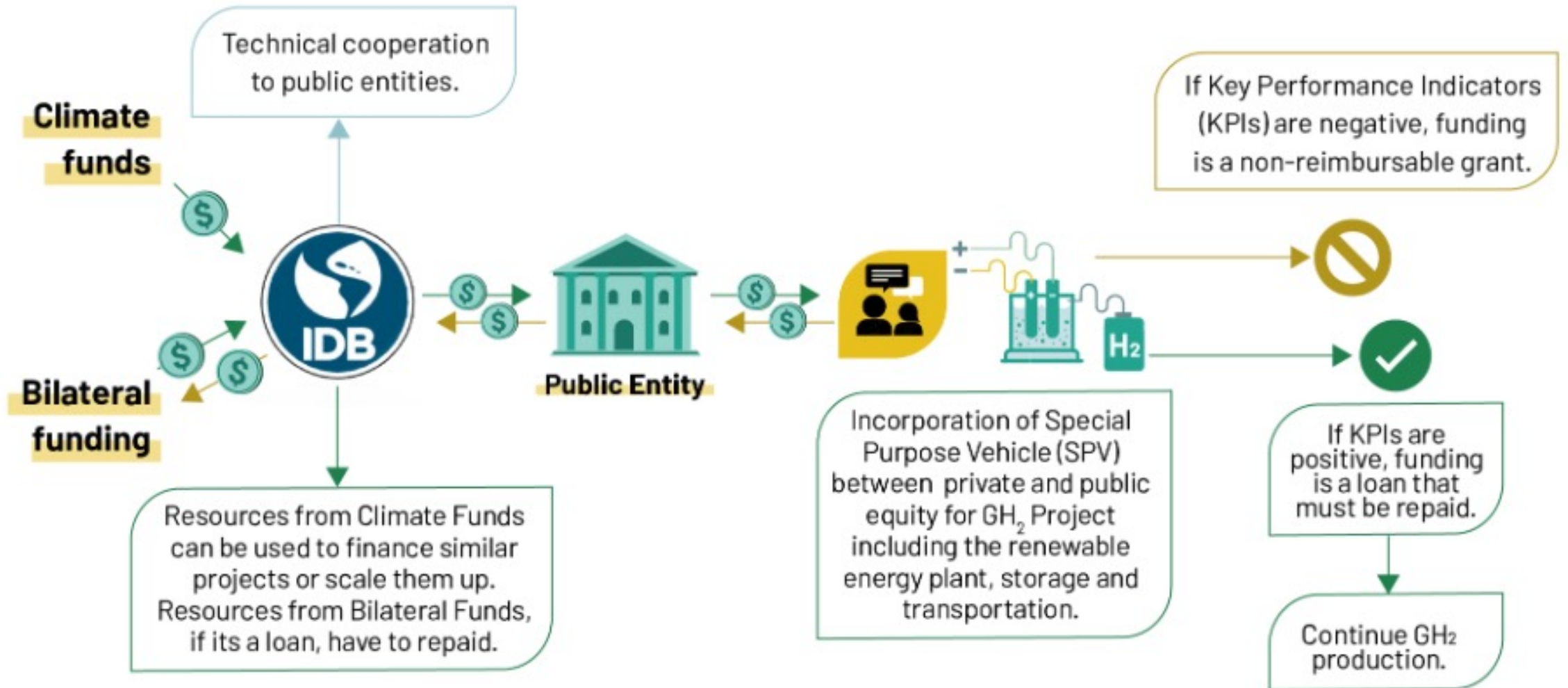
26%

Is the export of the Southern Cone.



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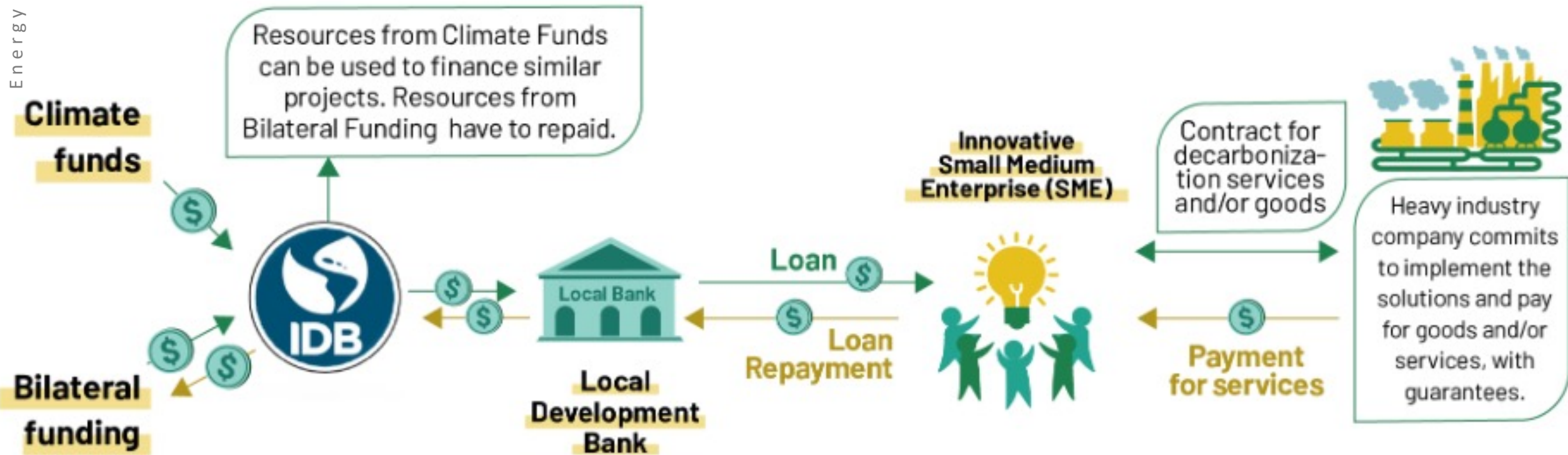
Financing: Contingent recovery grants with SPV



Financing: Decarbonizing Heavy Industry



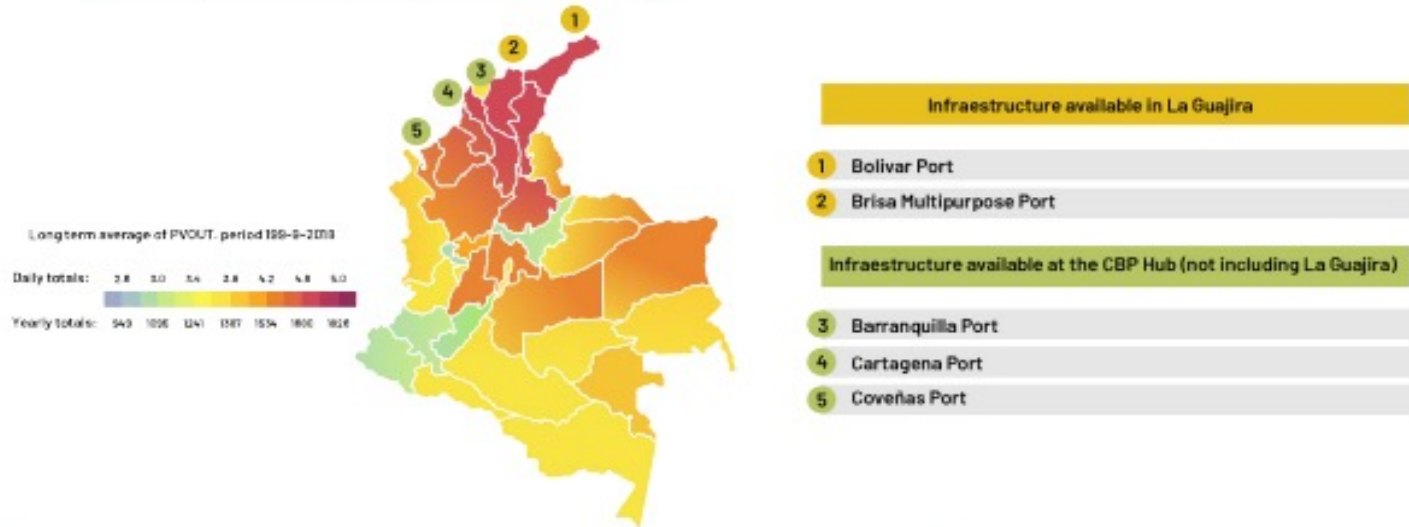
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Source: Prepared by authors

Example of Environmental and social considerations for GH2

LCOH competitiveness of the regions in Colombia (2050)













Comparative Levelized Costs to 2030 Hub Colombia - Guajira



References LAC Region 2030

	Minimums	Maximums	Units
LCOH	\$258	\$348	USD/Ton H ₂
LCOA	\$688	\$858	USD/Ton NH ₃
LCOM	\$911	\$1,088	USD/Ton MeOH

Source: Prepared by authors based on Oxford (2022), Afif et al. (2022), Jain et al. (2022), IRENA (2021), IRENA (2020b), Christensen (2020), Caparrós Mancera et al. (2020), IEA (2019b), Rivarolo et al. (2019), Noh et al. (2019), COSIA (2018) and CSIRO (2016)

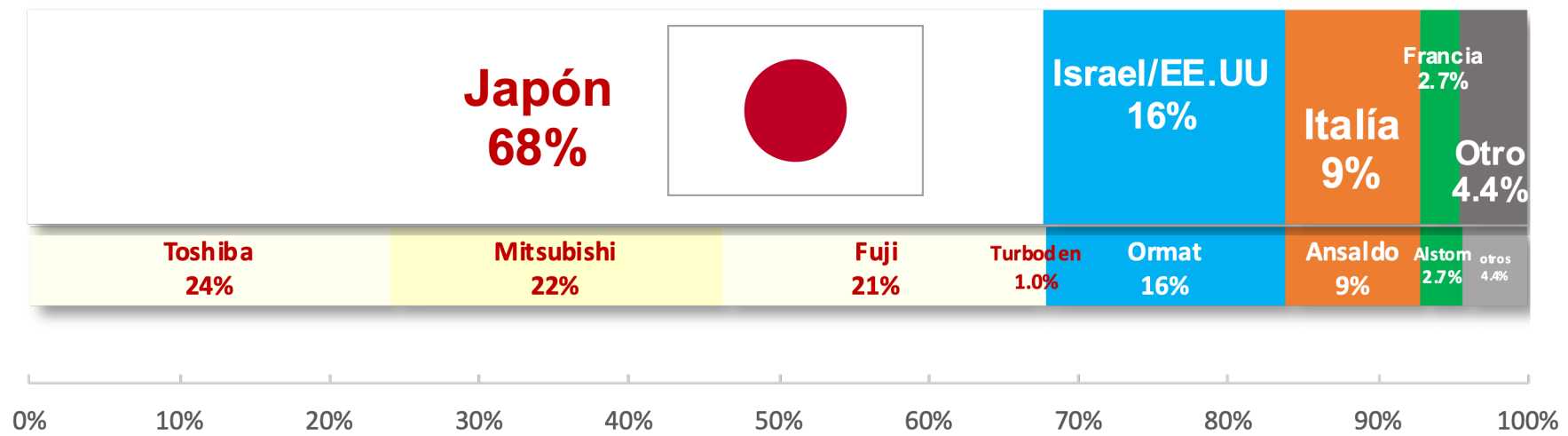
	Attributes	Justification	Certification Category
  	<p>Primary energy source and power production plant information.</p> <p>H2 Production Plant Information.</p> <p>Intensity and scope of GHG measurement.</p>	<p>Present in all hydrogen certification systems worldwide.</p>	<p>LAC Region H2 Certification</p>
     	<p>Positive social impact of the project in surrounding communities / indigenous peoples.</p> <p>Sustainable sources of water.</p> <p>Measures to minimize the environmental impact of the project.</p> <p>Wastewater treatment (brines, when applicable).</p> <p>Compliance with international labor standards.</p> <p>Location and sustainable use of land, that is socially and environmentally harmonious (excluding land conflicts).</p>	<p>Highly relevant for the LAC Region.</p>	
	<p>Production time of H2 with respect to the energy.</p>	<p>Necessary to meet the temporal correlation criteria required by European regulations*.</p>	<p>Certification of H2 exportable to Europe</p>

Investment opportunities

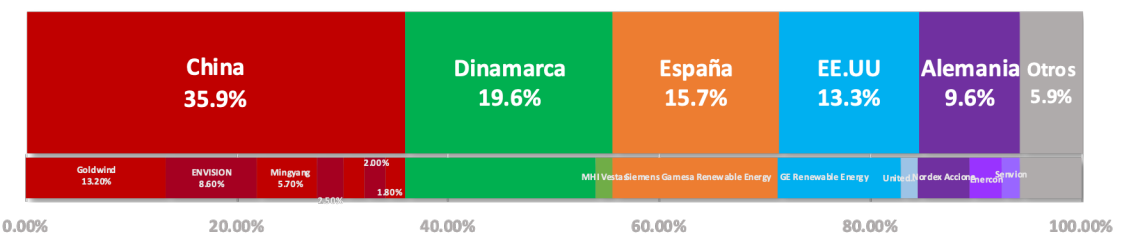


Japanese Equipment and services

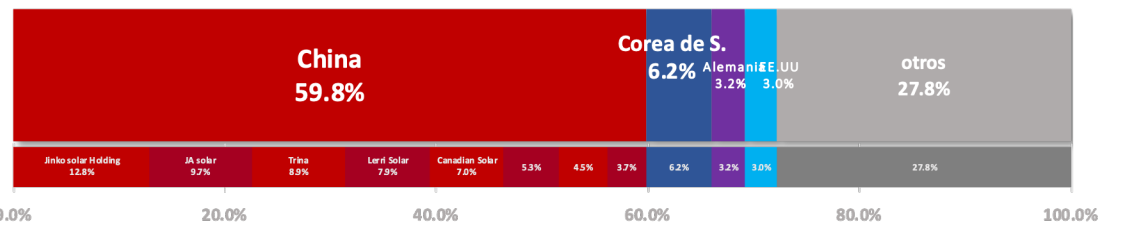
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Geothermal turbine market (2021)



Wind turbine market(2019)



PV modules (2018)

Japan has over 50 years of experience in geothermal energy and nearly a century of direct applications beyond bathing. Japanese equipment and services hold high value within the LAC region, offering numerous business opportunities.



Japanese equity investment

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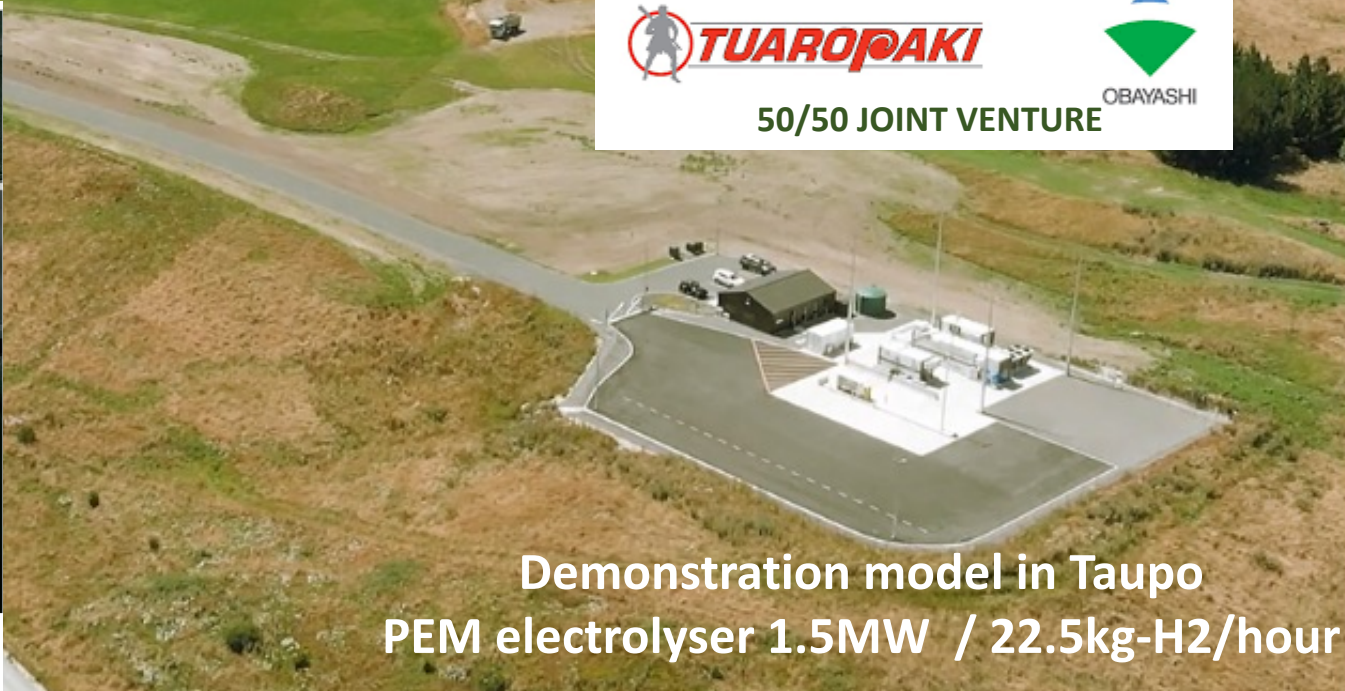
Mokai Geothermal Power Plant
166MW

Halcyon
Power



Tuaropaki Trust CEO Steve Murray (left), Minister of Energy and Resources Megan Woods, Tuaropaki Trust chairwoman Gina Rangī and Japanese Ambassador Koichi Ito. Photo / Matt Jordan - Jordan Creatives

A white rectangular box containing the logos for TUAROPAKI and OBAYASHI. The TUAROPAKI logo features a stylized figure in a red circle next to the word 'TUAROPAKI' in red. The OBAYASHI logo is a green diamond shape with a blue triangle on top, next to the word 'OBAYASHI' in blue. Below the logos, the text '50/50 JOINT VENTURE' is written in black.



Demonstration model in Taupo
PEM electrolyser 1.5MW / 22.5kg-H2/hour

Japanese early development

Rantau Dedap

PT Supreme Energy Rantau Dedap
Geothermal Independent Power Project
Indonesia

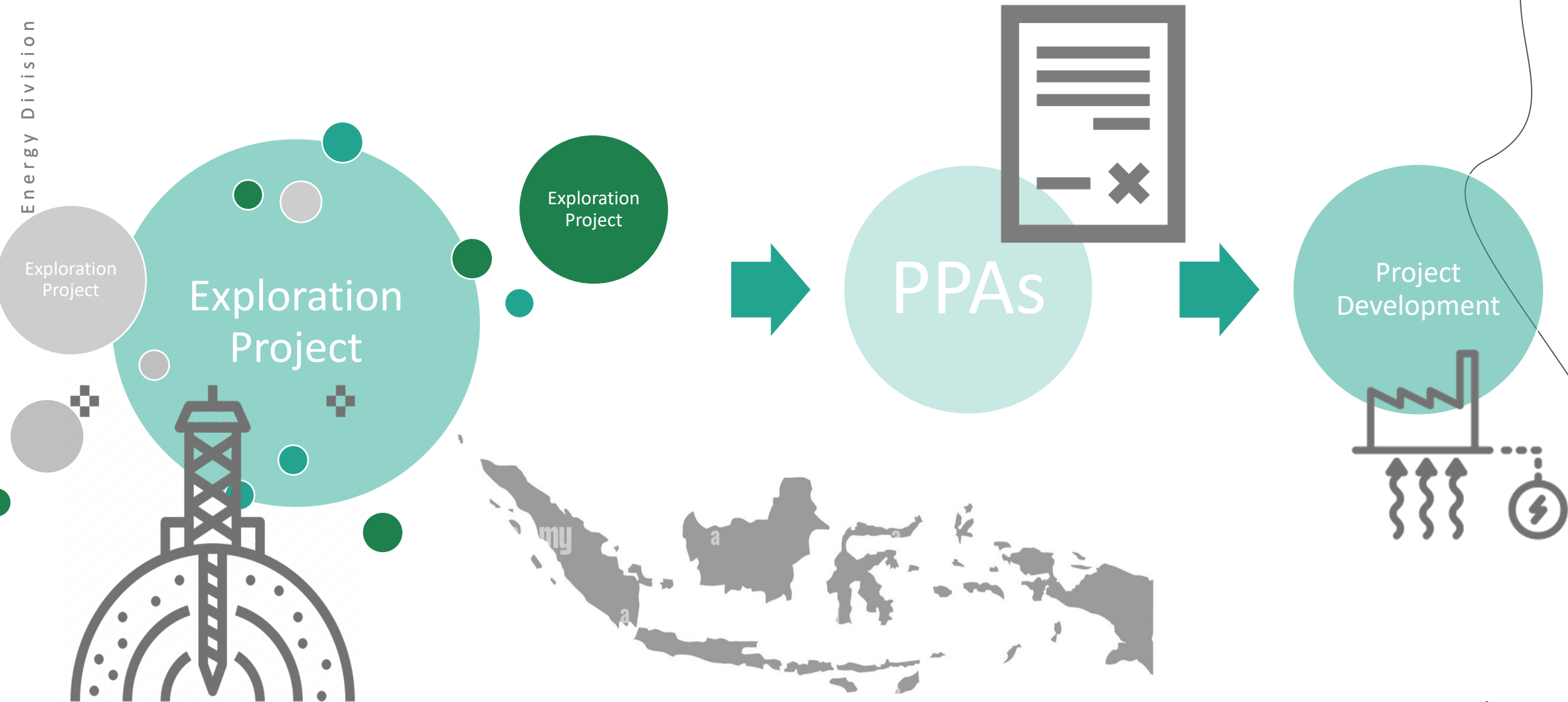
GDF Suez + Marubeni+ PT Supreme Energy

Marubeni (27.4%) + Tohoku Electric Power (10%)+
ENGIE S.A. (37.4%) + PT. Supreme Energy (25.2%)
98.4MW – 12/2021 – 30years

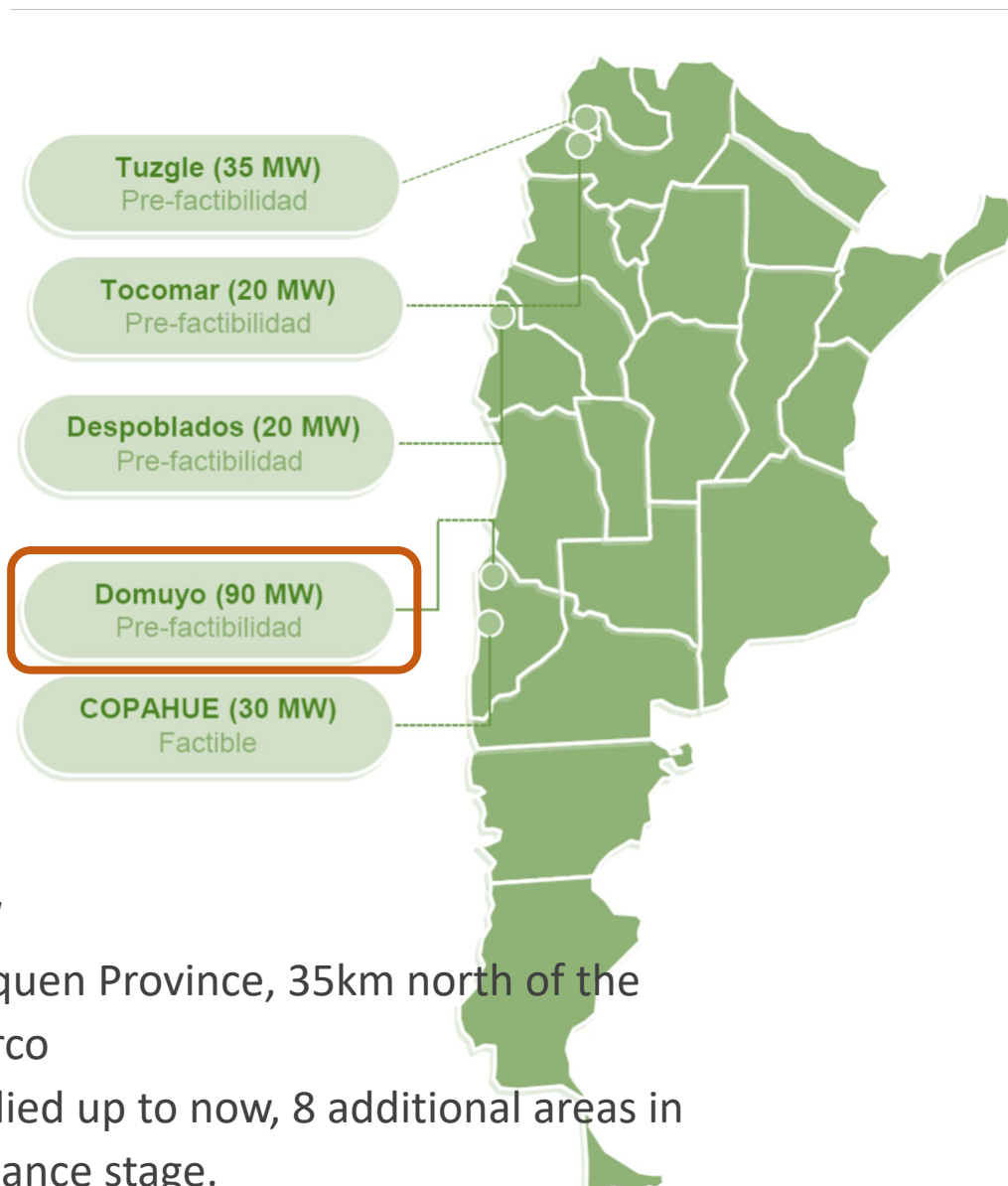


Alternative models

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Domuyo project



ADINQN
AGENCIA DE INVERSIONES DEL NEUQUÉN



GOBIERNO
DE LA PROVINCIA
DEL NEUQUÉN

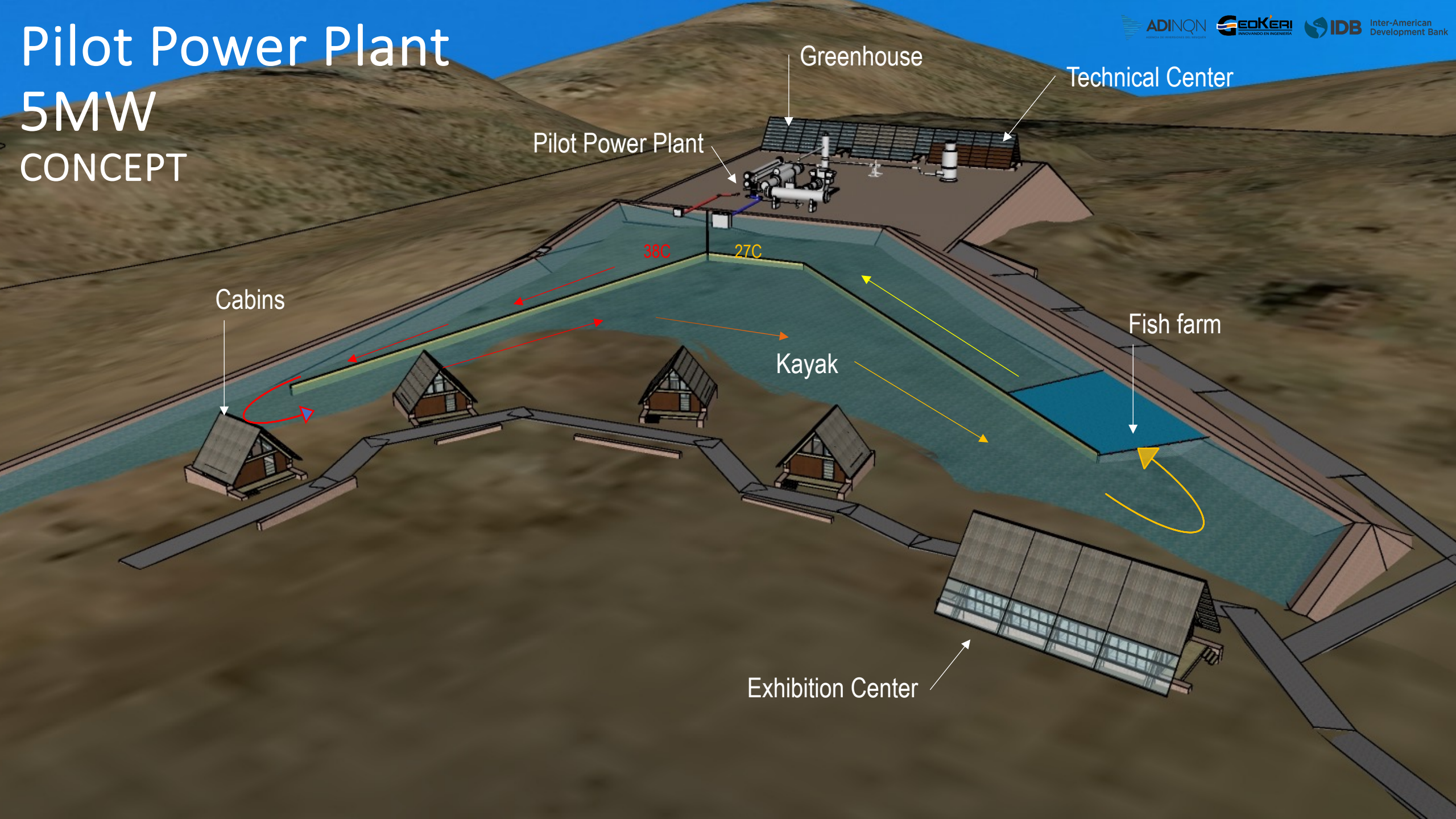


Phase 1: 3 exploratory wells + 5MW pilot plant + transmission line

Phase 2: Exploitation concession - private sector

- **Power: 90MW**
- Location: Neuquen Province, 35km north of the town of Varvarco
- 5 projects studied up to now, 8 additional areas in the reconnaissance stage.

Pilot Power Plant 5MW CONCEPT



Greenhouse

Technical Center

Pilot Power Plant

Cabins

Fish farm

Kayak

Exhibition Center

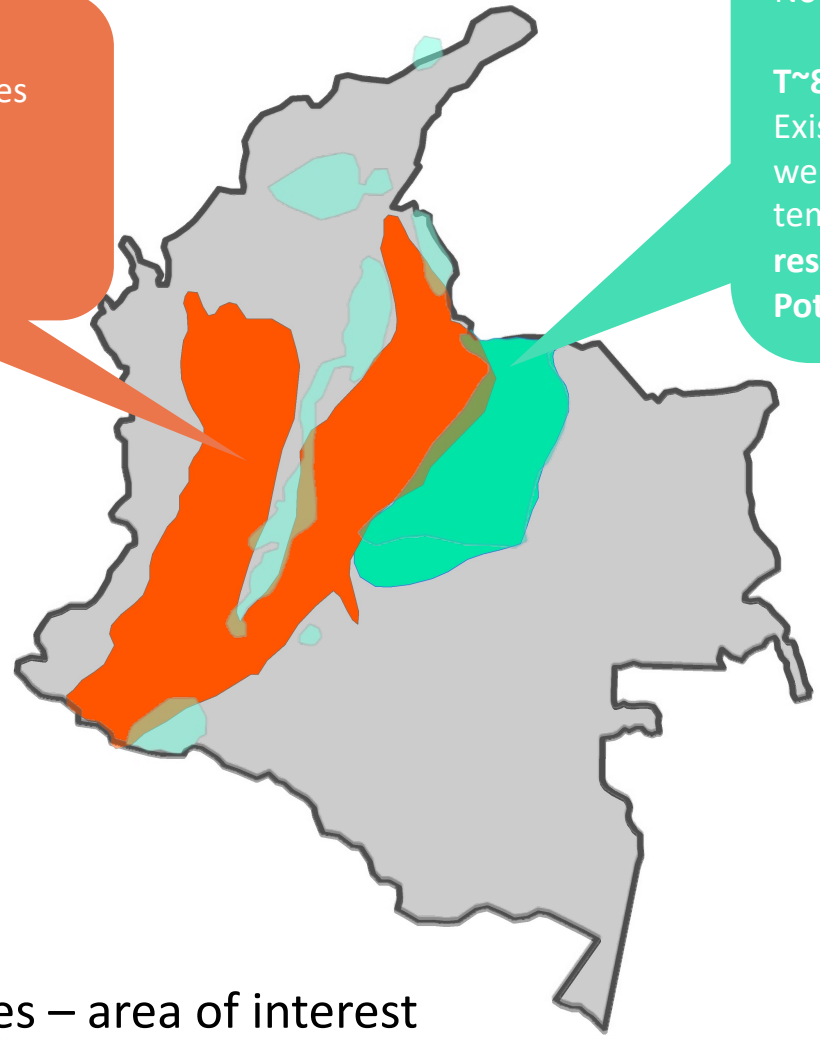
Colombia

Pwr2X + Non-conventional geothermal

High Enthalpy
Geothermal Resources
T>200°C
Untapped resources
(Surface exploration)
Potential: ~1200MW

Medium Enthalpy
Non- conventional Geothermal
Resources
T~85°C - 120°C
Existent non-productive O&G
wells with abundant high
temperature water (proven
resource)
Potential: ~1000MW

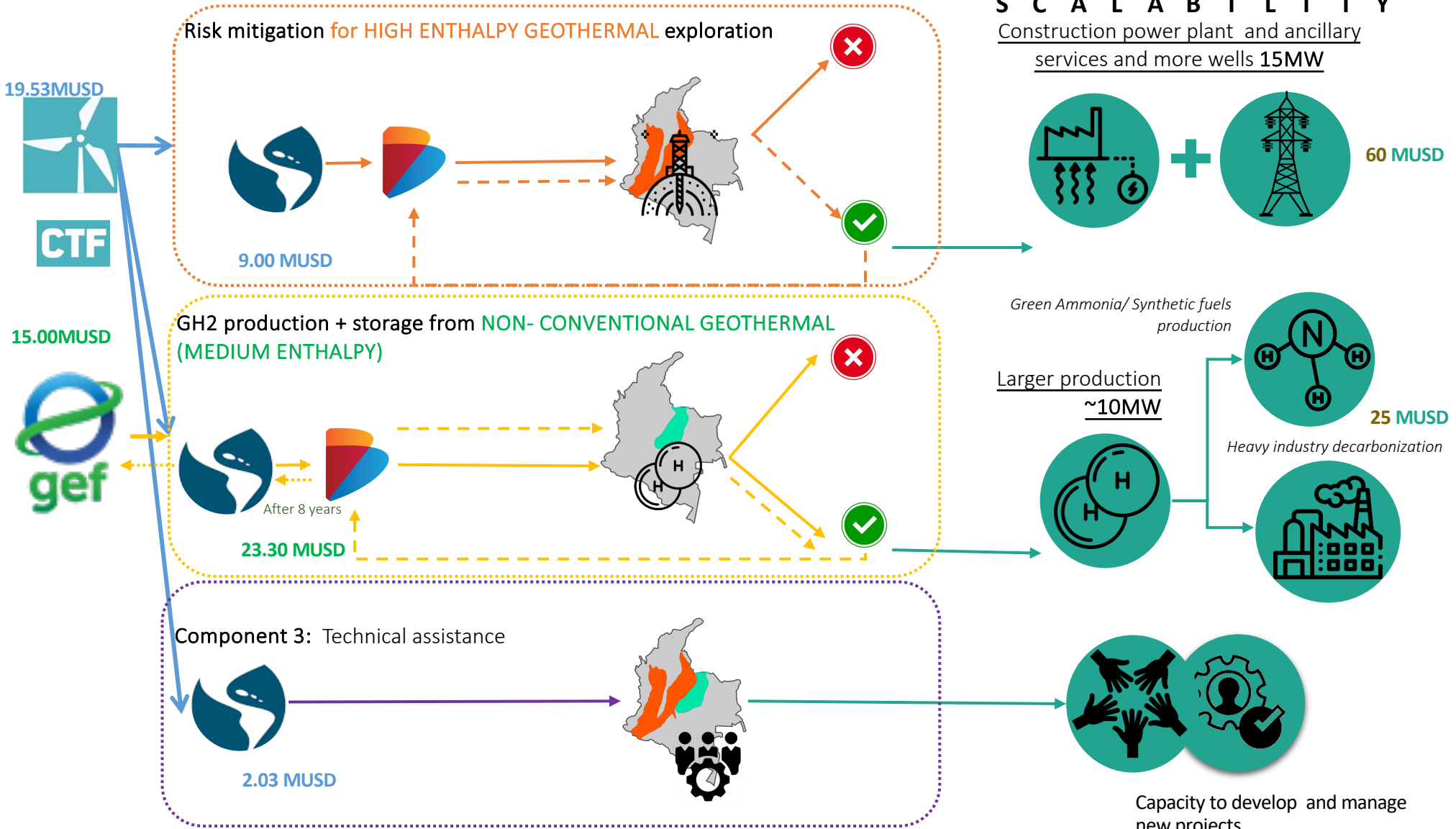

Colombia's coal
power capacity:
1658MW



● Llanos Orientales – area of interest

Colombia

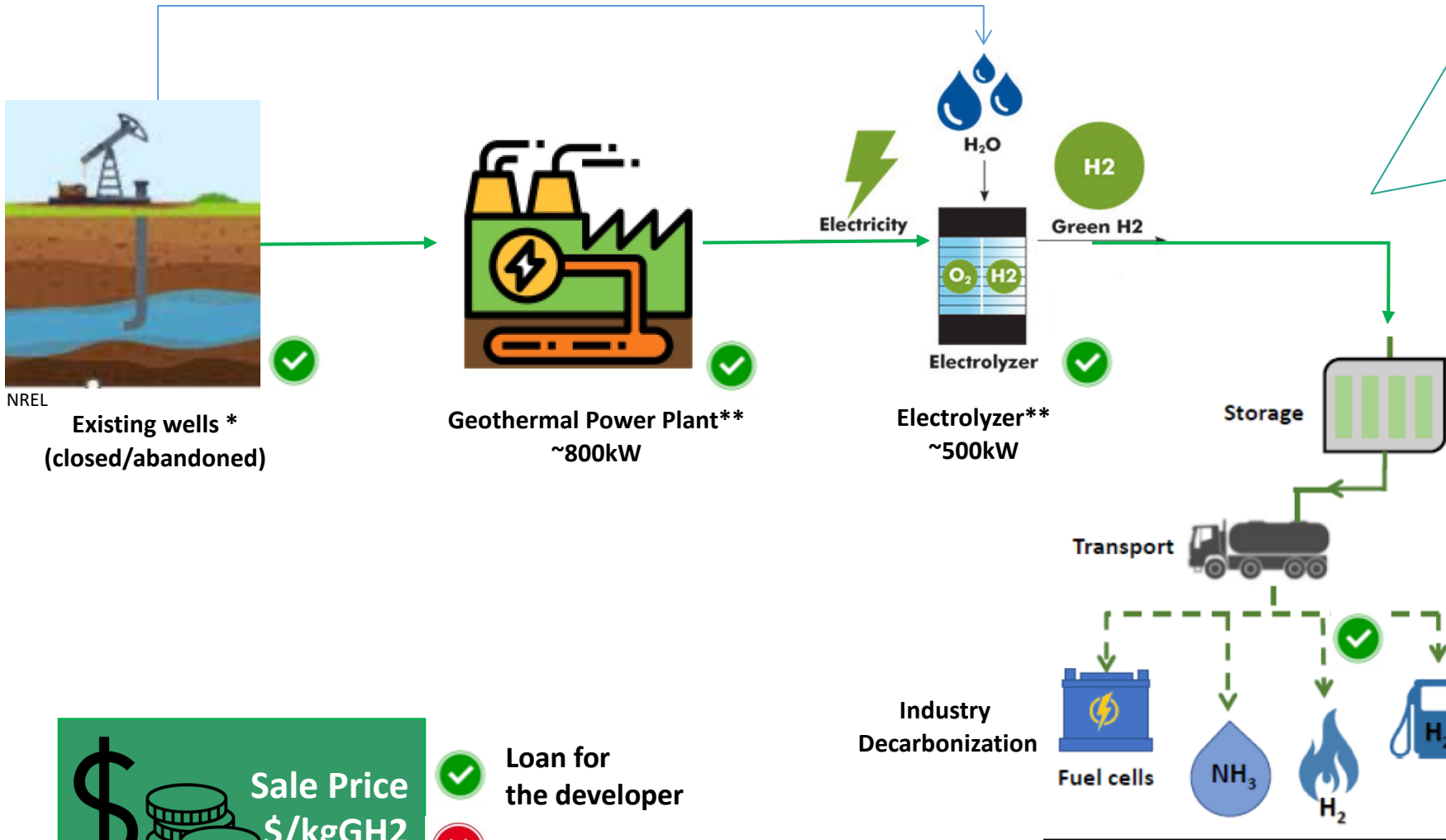
Pwr2X + Non-conventional geothermal



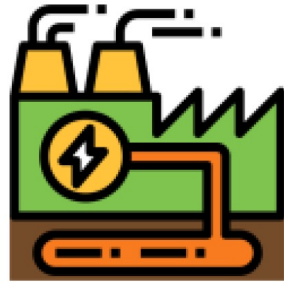
Colombia

Component 2: GH2 production + storage from **NON- CONVENTIONAL GEOTHERMAL (MEDIUM ENTHALPY)**

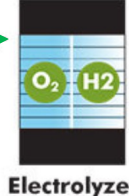
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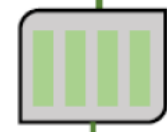
NREL
Existing wells *
(closed/abandoned)



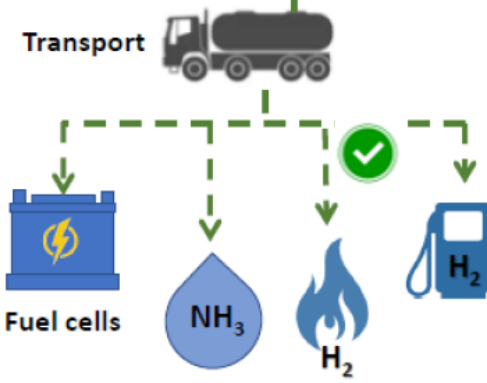
Geothermal Power Plant**
~800kW



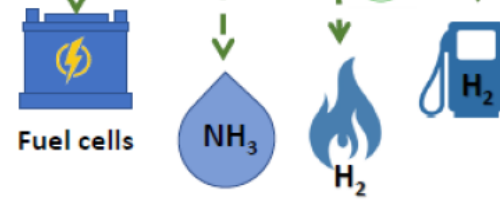
Electrolyzer**
~500kW



Storage



Industry
Decarbonization



- Non-utilization of oil residues
- The IDB Inspector will monitor the operations
- Statement in which the beneficiary commits to non-oil utilization

\$ Sale Price
\$/kgGH2

- Loan for the developer
- Grant

* Proven resource with no drillings involved
 ** None of these technologies present inherent risks themselves

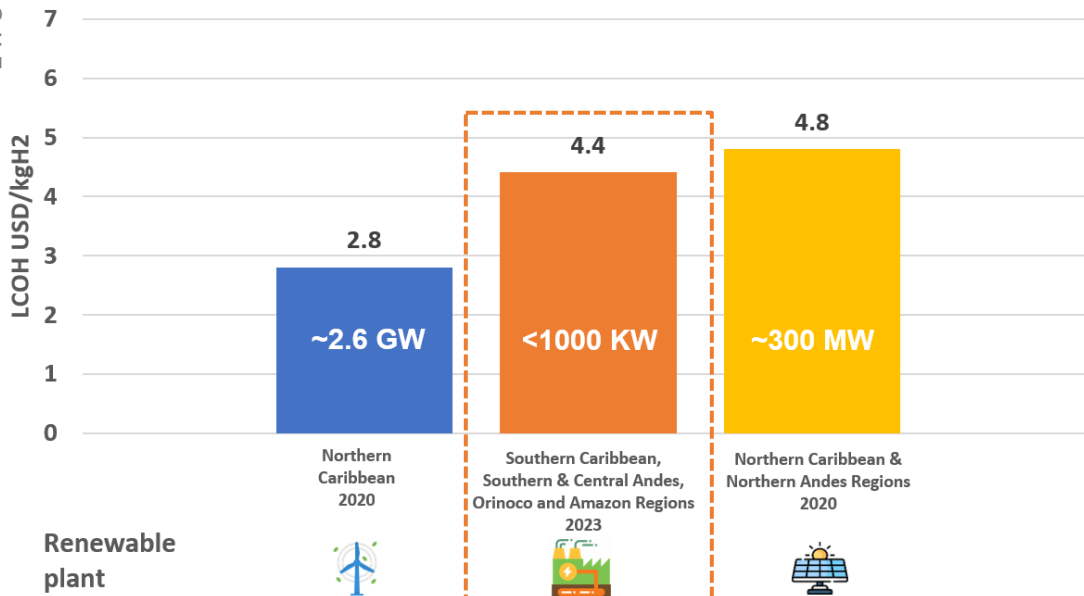
Innovation involves bringing everything together and creating the facility

Colombia

Component 1: Risk mitigation for HIGH ENTHALPY GEOTHERMAL exploration

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LCOH for different regions and technologies (2023)*



The price in 'Northern Caribbean' was calculated with a projected **wind** capacity of **2600MW**. The yellow column represents the **solar GH2** price with a projected capacity of approximately **300MW**. However, it is essential to acknowledge that these wind and solar projects are still in the planning phase and must undergo environmental and social assessments, including public consultations with indigenous communities. The price of GH2 produced by **non-conventional geothermal** sources, with artesian hot water wells, is achievable with a small-scale project of less than **1 MW**.

EVOLUTION OF GREEN LCOH IN COLOMBIA

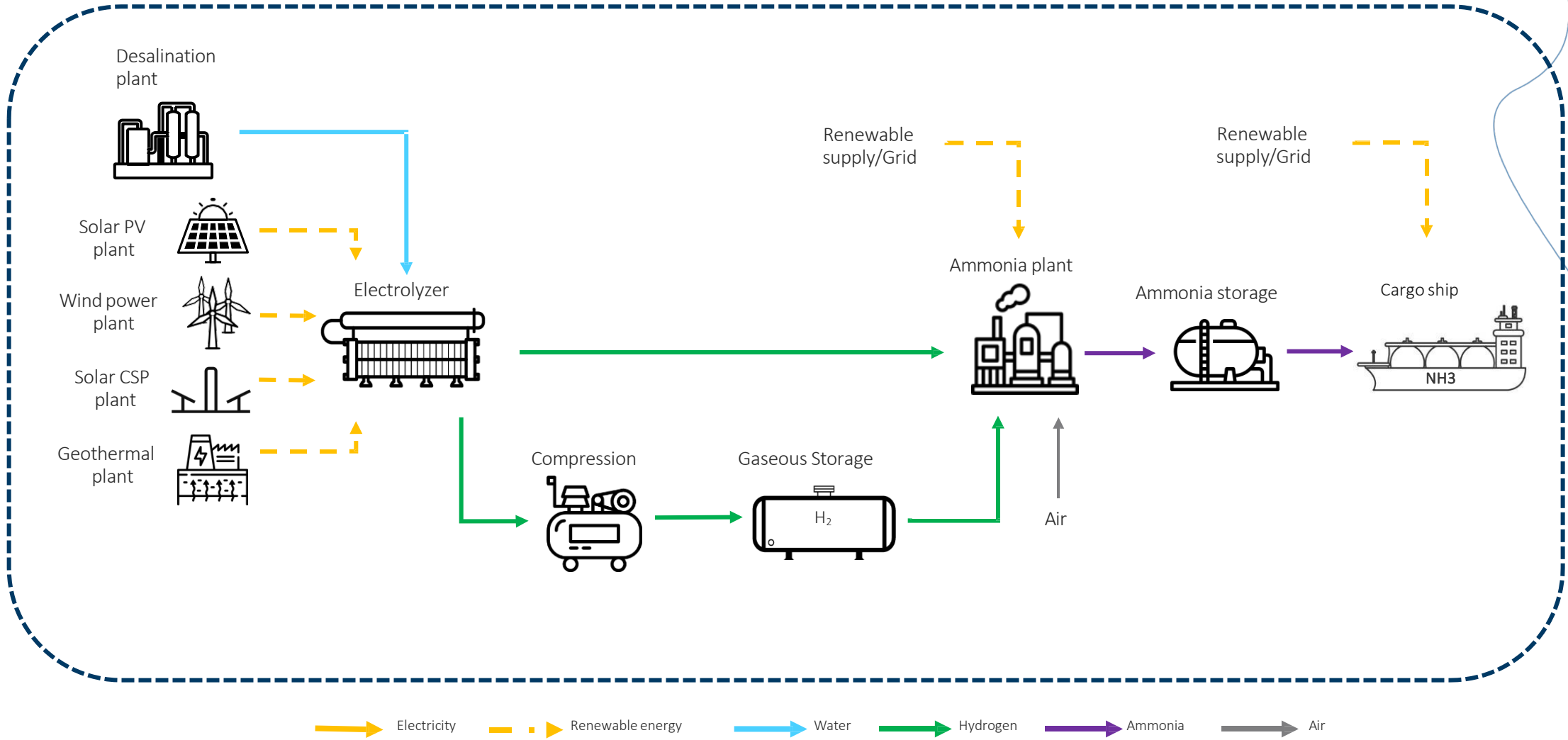


Projection LCOH for different regions and technologies*

* Based on the Colombia's Hydrogen roadmap 2020

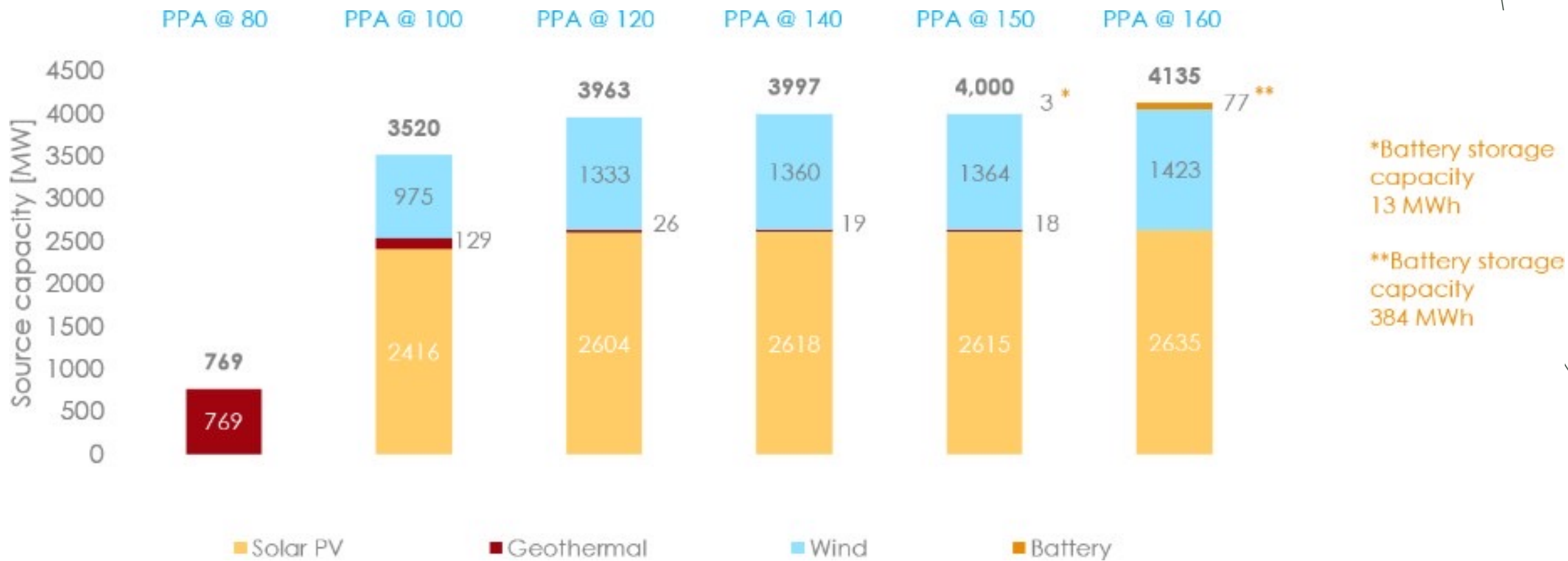
General overview of a Power-to-X project

Simplified outline of the Power-to-Ammonia value chain



Chile

Geothermal System in the Bio-Bio Region



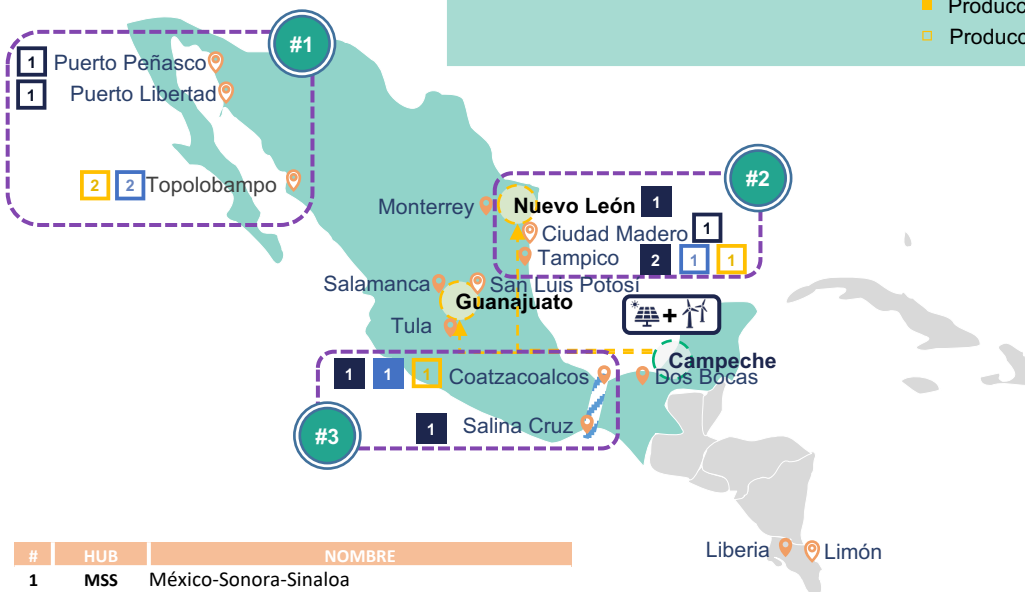
11 hubs with potential for export or local decarbonization



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Legend:

- Clúster oferta-demanda H2V
- Clúster demanda y/o comercio
- Clúster oferta electricidad renovable
- Hub regional
- Número de Hub
- Canal de Panamá
- Corredor interoceánico del Istmo de Tehuantepec
- Flujos de producción
- Producción Actual H2
- Producción Futura H2
- Producción Actual NH3
- Producción Futura NH3
- Producción Actual MeOH
- Producción Futura MeOH



#	HUB	NOMBRE
1	MSS	México-Sonora-Sinaloa
2	MTNL	México-Tampico-Nuevo León
3	ICS	Istmo de México-Coahuila-Coahuila de Zaragoza-Salina Cruz
4	CBP	Cartagena-Barranquilla-Panamá
5	CAS	Ceará-Alagoas-Sergipe
6	SPRJ	Sao Paulo-Río de Janeiro
7	CPBAM	Central Paraguay-Buenos Aires-Montevideo
8	CA	Chile-Antofagasta
9	CVB	Chile-Valparaíso-Biobío
10	CM	Chile-Magallanes



Forecasted investments in LAC: Electrolyzers and Renewables

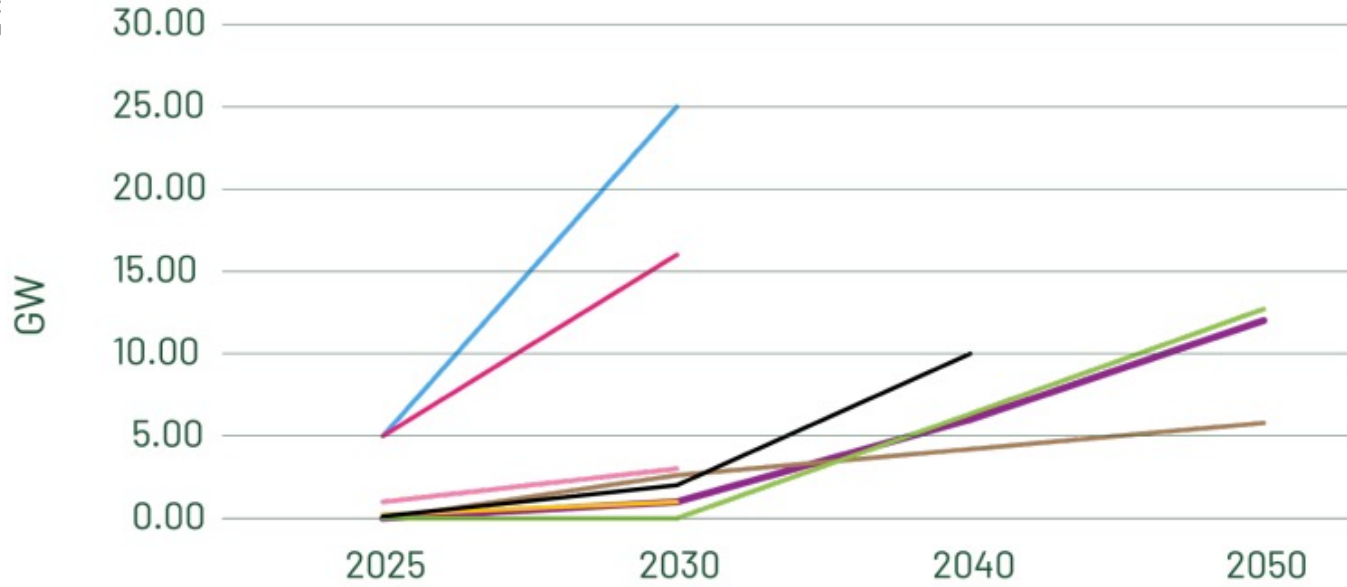


- Infrastructure
- Electrolyzers
- Renewables

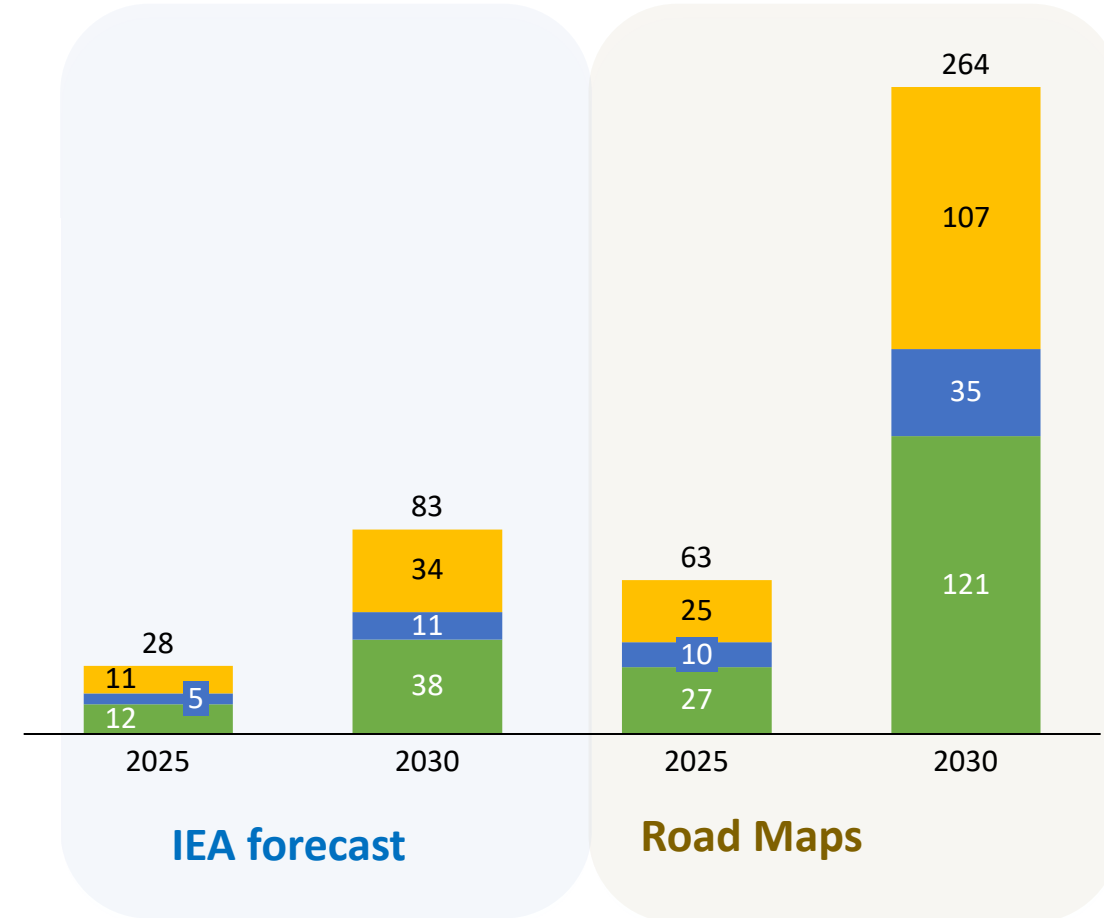
Bn USD

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Electrolyzers



- Colombia
- Chile
- Peru
- Costa Rica
- Panama
- Latin America - IEA
- Trinidad and Tobago
- Uruguay



*Forecasted electrolyzer and renewable investments for
2030:
USD 83Bn– 264Bn*

Gracias

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