Renewable Energy Projects At Oil and Gas Scale

("Power to X", PtX)

The Asian Renewable Energy Hub

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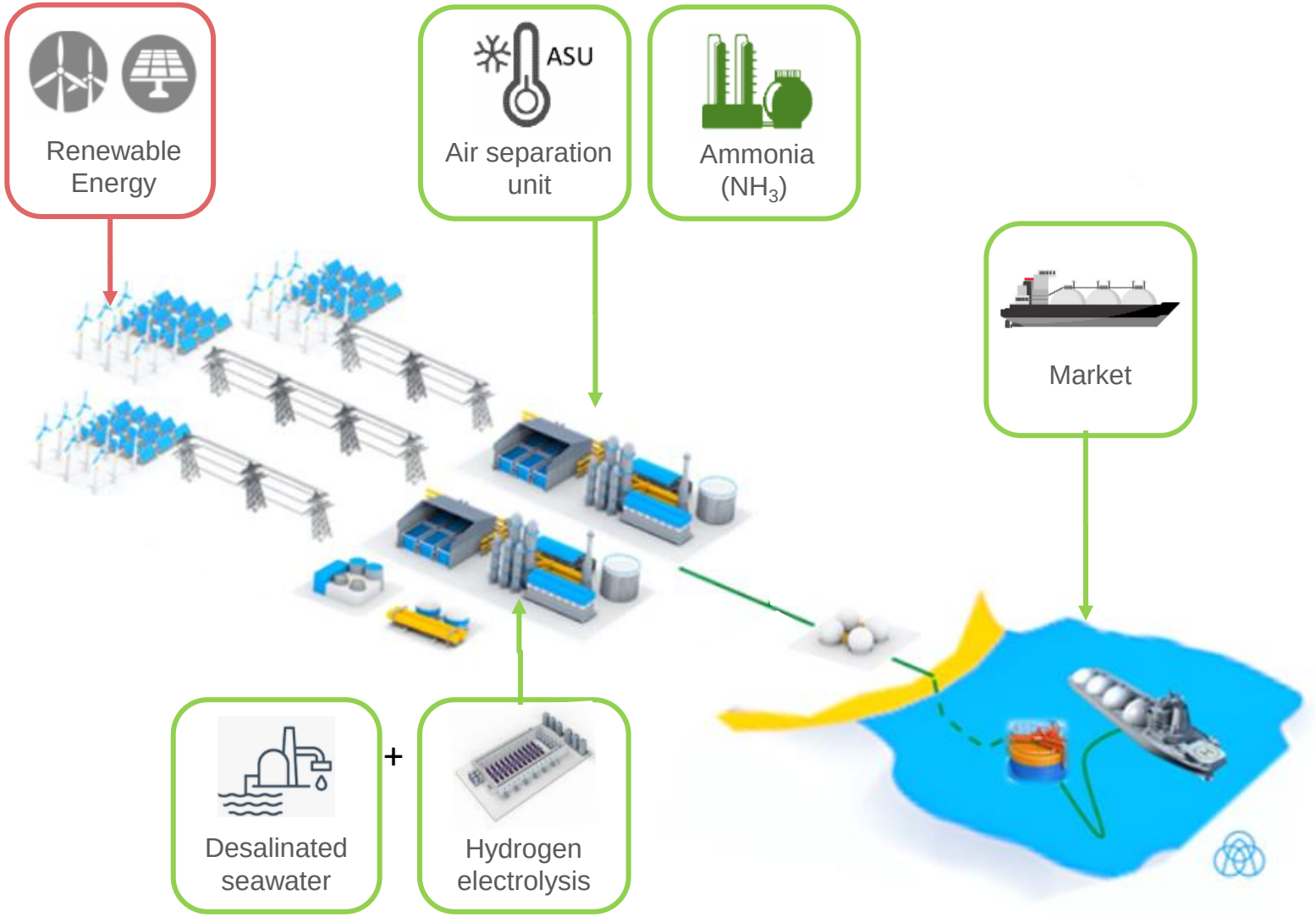
CWP

9 August 2021

GREEN AMMONIA PRODUCTION AND EXPORT SCHEMATIC

From wind and sun, to electrons, to molecules



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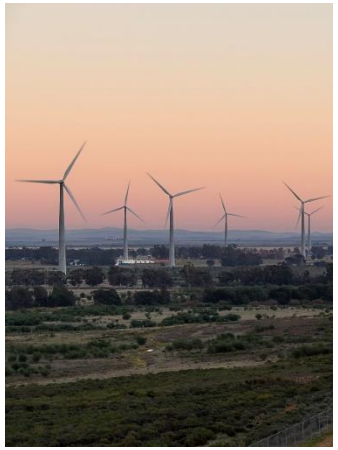
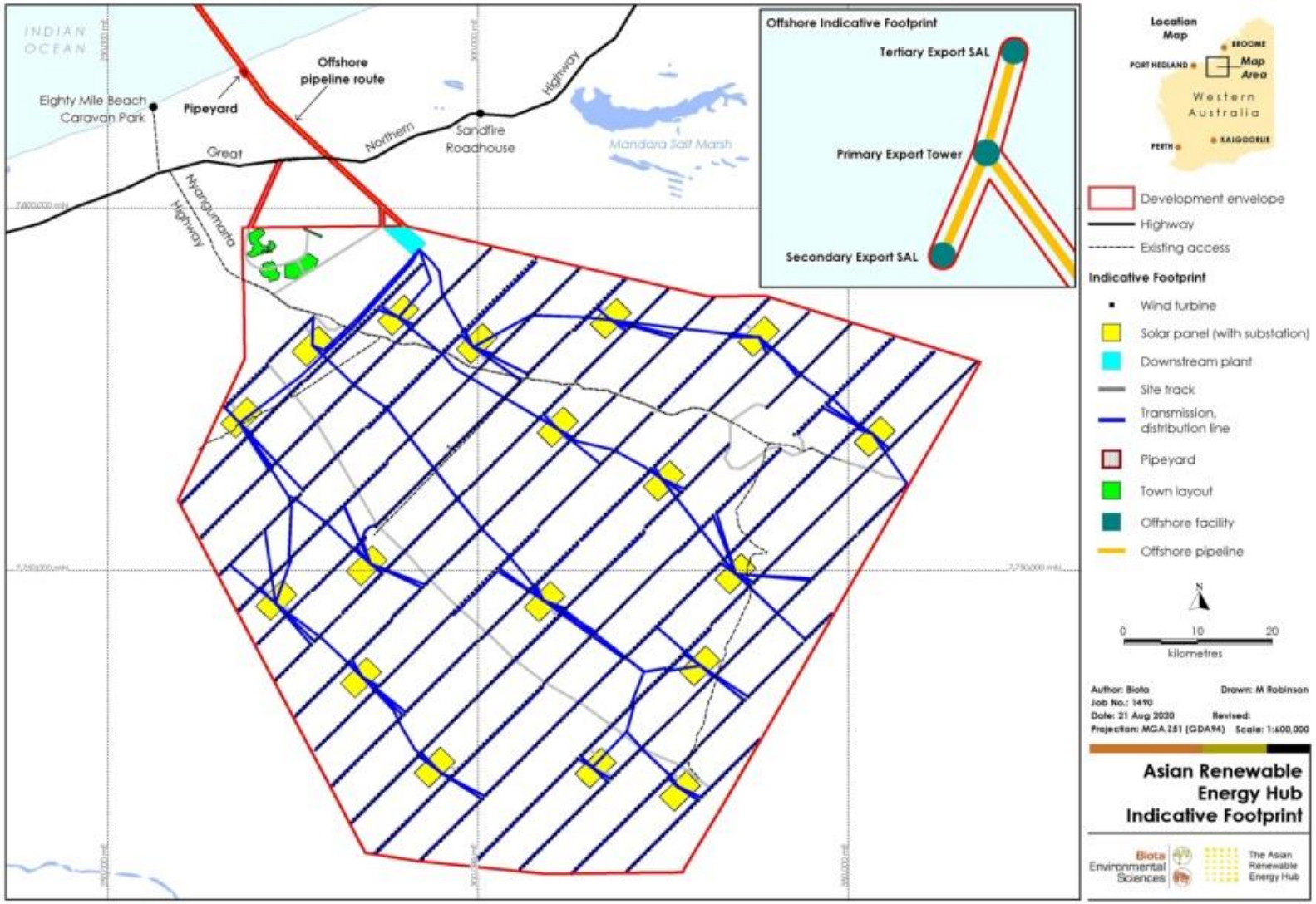
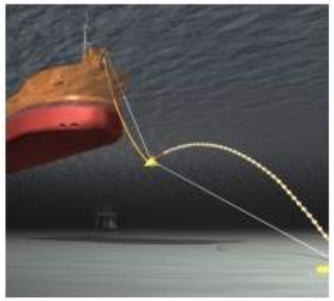
ASIAN RENEWABLE ENERGY HUB (AREH)







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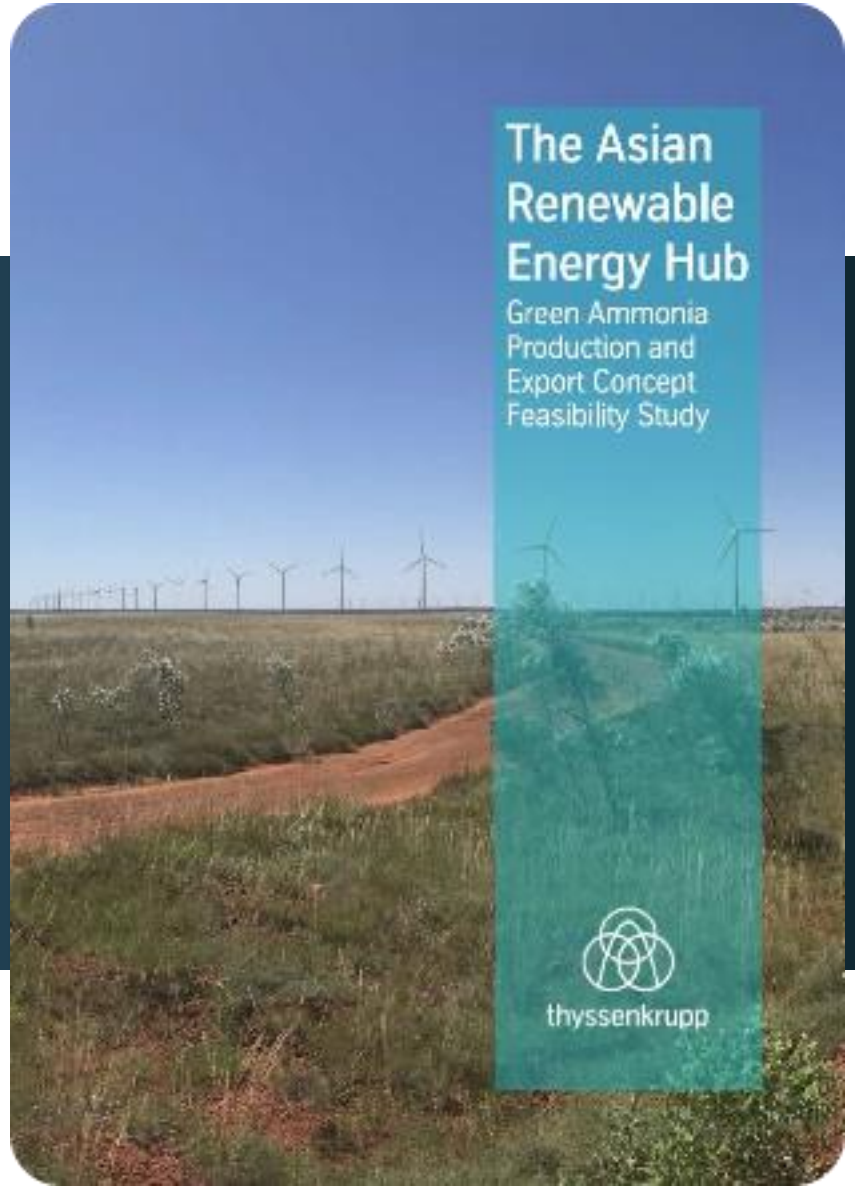
BY THE NUMBERS: ASIAN RENEWABLE ENERGY HUB

Feasibility Study conducted in 2019 by thyssenkrupp for full project scope.

16GW	wind generation
+ 10GW	solar generation
= 98 TWh	annual generation
into 14GW	electrolysers
>70% capacity factor	of the electrolysers
= 1.75 million	tpa of green hydrogen
= 9.9 million	tpa green ammonia (27,000 tpd)



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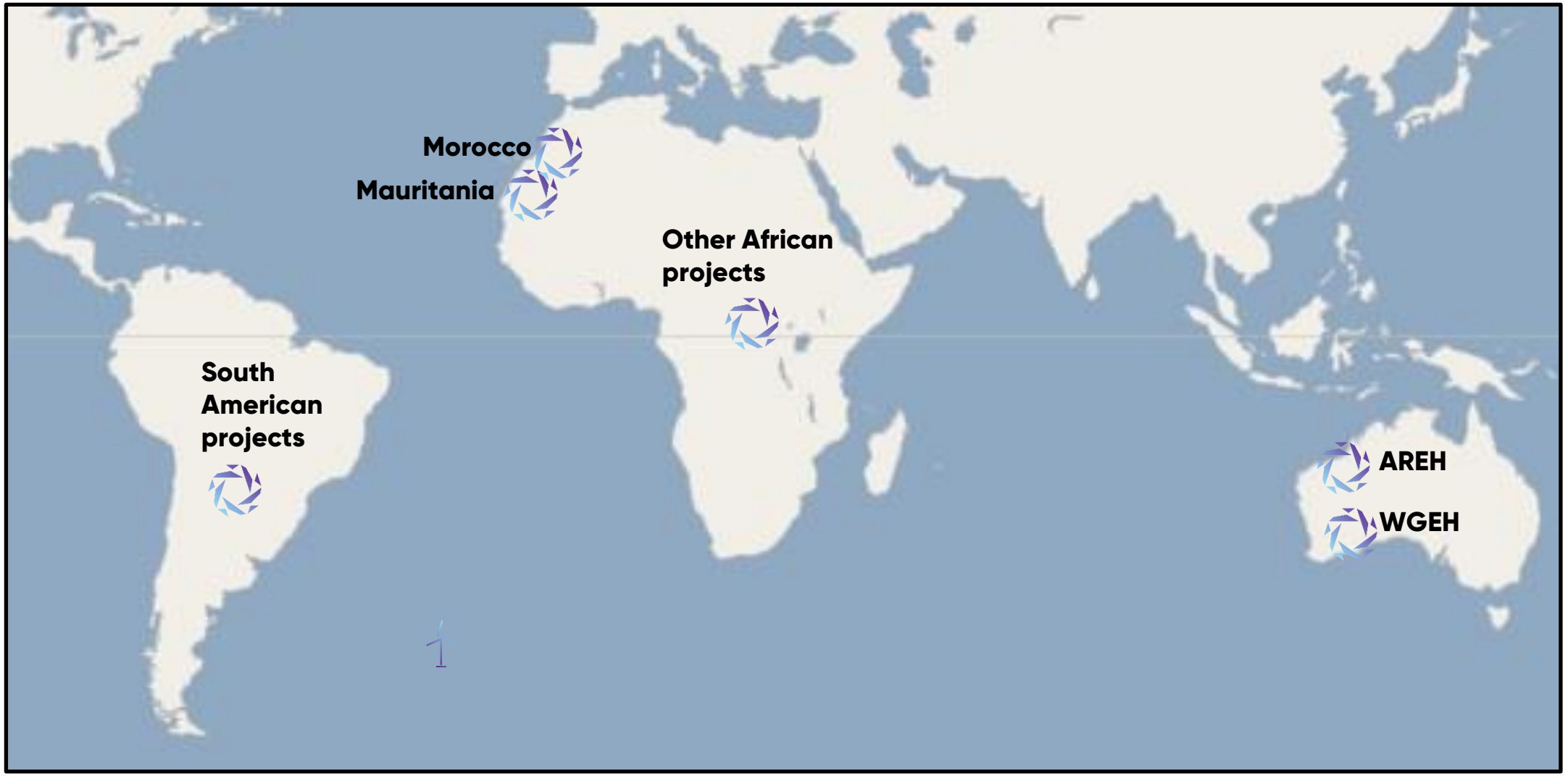
CWP GLOBAL'S 100GW+ PORTFOLIO OF PtX PROJECTS

Renewable energy at oil and gas scale



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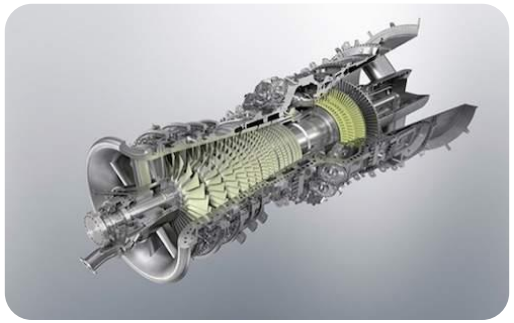
KEY MARKETS

Multiple scalable markets, as NH_3 and/or H_2

Power generation



Shipping

Fuel cell vehicles

Green steel & other industry

Consumption as hydrogen after ammonia cracking

Consumption as ammonia

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BENEFITS OF GREEN NH_3 / H_2 PROJECTS

Deliver green hydrogen / ammonia & where when the markets need it

- Projects on different continents to service different regional markets.
- Projects are developed in phases & are highly modular, to grow supply as demand scales.

Highly competitive hydrogen and ammonia supply

- Excellent renewable resources: wind and solar.
- Windy at night, sunny during the day. High electrolyser utilisation factor.
- Large economies of scale. Costs decrease in successive project phases.

Long term fixed priced product

- Fossil fuel hydrogen pricing will be indexed to other commodities such as HH, JKM or Brent. Green supply will not – there's no fuel cost.
- Green hydrogen does not have commodity price exposure, enabling long term and stable price certainty.
- Stable fixed pricing provides confidence to the private sector and to governments for the development of new industries and markets.

Zero carbon and climate change regulatory risk

- The green H_2 and NH_3 produced from green projects will have no carbon production footprint and thus will not be exposed to any future carbon pricing or related regulation that imposes additional costs on fuels with a carbon footprint.

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CHALLENGES OF GREEN NH_3 / H_2 PROJECTS – GLOBAL

- There is not even one big scale PtX plant in operation yet globally.
- The markets & many of the enabling technologies are not yet ready (ammonia ship engines, ammonia gas turbines etc).
- We are all looking into the future and relying on assumptions and cost curve projects (wind, solar, electrolysers, hydrogen storage etc). These have a big impact on future production price of green hydrogen and ammonia & their competitiveness against fossil fuel alternatives.
- Scale and efficiency are the main drivers for PtX projects to be able to compete with fossil fuel generation.
- Development of PtX projects is much more complex than development of regular wind and solar projects. More technologies to integrate together, global markets to operate in & much greater scale.
- Supply chains for the production of wind turbines and electrolysers in particular need to scale significantly.
- There are no carbon emissions at point of hydrogen or ammonia consumption – only at point of production. Some markets are therefore tempted to start with fossil hydrogen instead of renewable hydrogen.
- Need for certification to compare carbon emissions from different production methods & locations.

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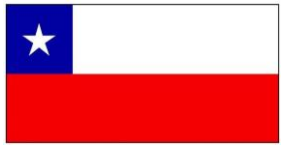
CHALLENGES OF GREEN NH_3 / H_2 PROJECTS – CHILE



- Chile has natural advantages and two potential hydrogen valleys: North (Atacama, solar, will probably feed local markets) and South (Magallanes, wind, exclusively export orientated).
- Government should encourage large scale projects and try to avoid small scale competition between developers that will only slow down and congest the process & reduce global competitiveness.
- Feasibility periods for new projects are the riskiest times, where developers usually carry all the risks & costs of establishing complex PtX projects. All parties involved should aware and be supportive of this.
- Non-fiscal landowners understandably want to maximise their land value & early payments, but this can slow down the negotiation process.
- Regulation, permitting and legal frameworks will need to move as fast as the industry grows to allow the big scale projects to be constructed.
- Existing infrastructure will also have to adapt to the new industry to be used by these projects to be exported to foreign markets and to decarbonize the regional economy.
- The Hydrogen Roadmap & all of its objectives need to be of national interest, whatever political party is in power.
- Need incentives, tax breaks and other mechanisms to accelerate development of the hydrogen industry.
- Political and economic risks are carefully considered by customers, financiers and developers. Chile's upcoming constitutional changes and presidential elections will impact investment decisions.

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