Hydrogen: The Fuel of the 21st Century for the Pacific Islands

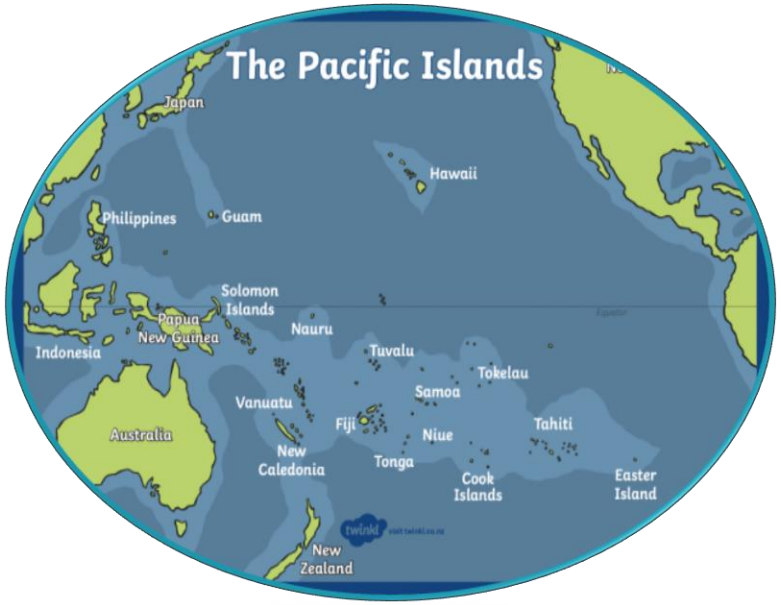
24/7 dispatchable and stable green energy supply

HYDROGEN POWER FIJI

HYDROGEN POWER NC

hdf-energy.com.au

CONTEXT



Reliance on fossil fuels

Most of the Pacific Islands are relying heavily on imported fossil fuels for their mobility and power generation, such as diesel, LPG and Heavy Fuel Oil. Oil imports massively outweigh goods exports in some countries, which is a hurdle to economic development.

Cost of electricity

Cost of electricity in the pacific is one of the highest in the world due to its market size, shipping cost, lack of resource / infrastructure and challenging environment.

Impact of climate change

Some pacific islands are directly experiencing the consequences of climate change such as sea-level rise and more severe / frequent cyclones. There is a strong willingness from population and governments to fight climate change, protect the environment and lead by example.

Support from international organisations

The current geopolitical context is highly favourable to the Pacific Islands. Some countries are extremely eager to help and support SIDS, especially for their energy transition.

Starting from scratch

Contrary to some developed countries, the pacific islands have not invested massively in gas and coal infrastructure. They have the opportunity to start from scratch and embrace new technologies.

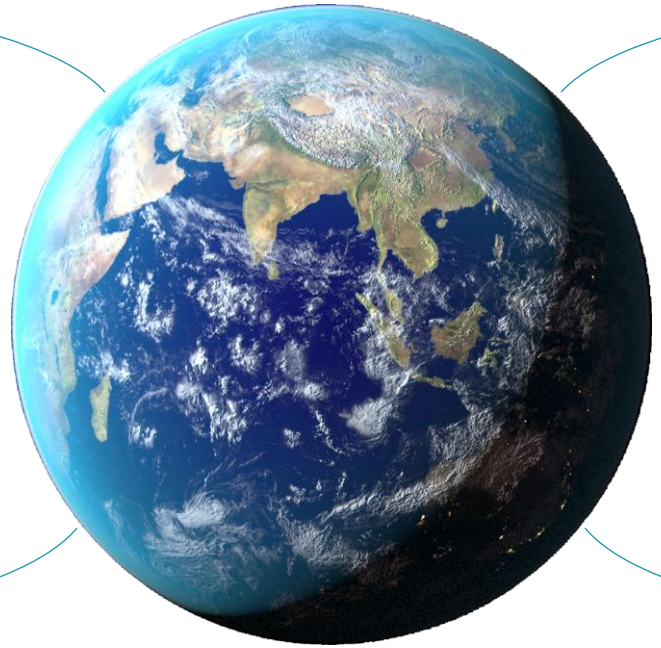
NEED FOR A RENEWABLE FUEL

FAST FACTS ABOUT H2

H2 can be produced from water electrolysis

Water = H_2O

$2H_2O + e^- \leftrightarrow 2H_2 + O_2$



Hydrogen is the most abundant element on Earth.

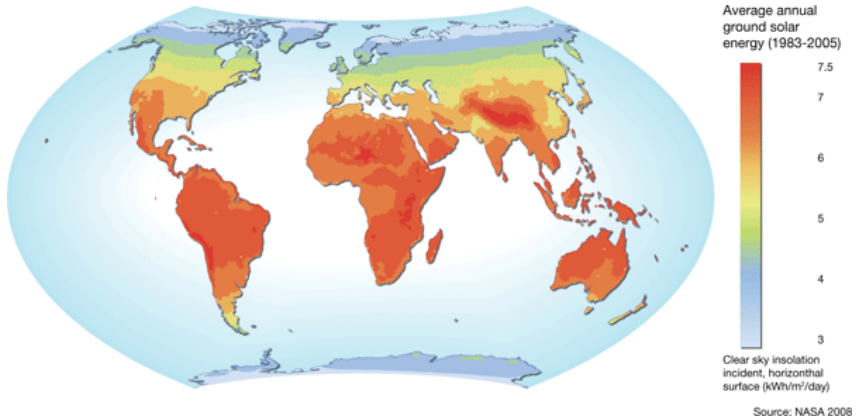
The combustion of hydrogen only emits water vapor

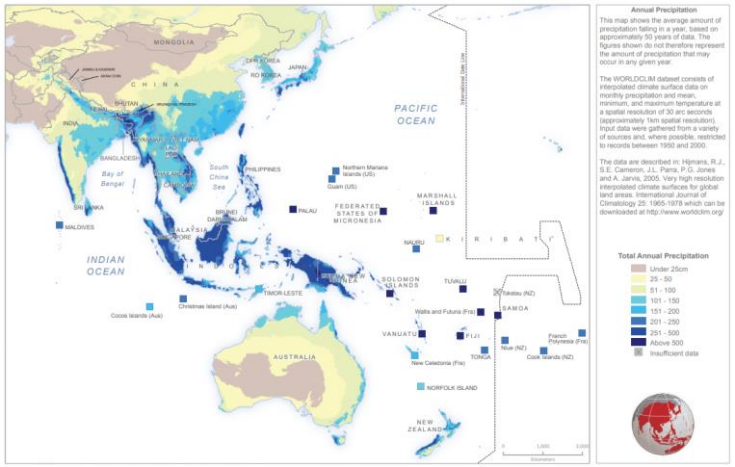
Production: 70 MtH2/yr

> 1000 x Fiji electricity consumption

INGREDIENTS TO MAKE GREEN H2

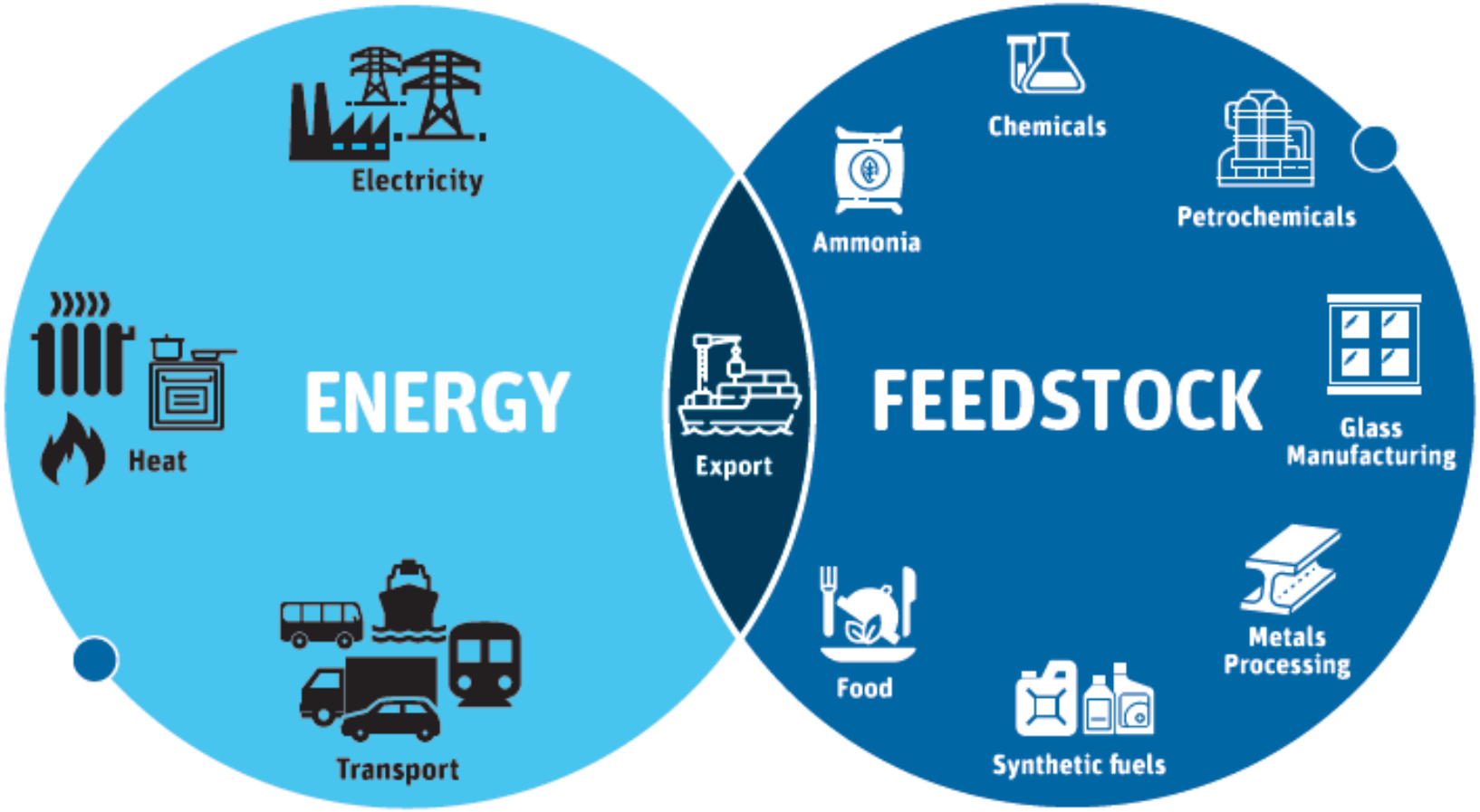
The pacific islands **are blessed with abundant sun**, water and land; all the ingredients we need to make green hydrogen. As opposed to fossil fuel, renewable energy resource are widespread worldwide.





APPLICATIONS

Hydrogen can be used to decarbonize several **hard to abate industries** such as heavy mobility, metal processing, steel manufacturing, feedstock and electricity production / energy export. For some of these applications, there is simply no alternative to green hydrogen.



HYDROGEN MOBILITY PROJECTS

Hydrogen will be used as a fuel source for heavy and long-distance mobility thanks to its power density

Mine mobility

People's mobility

Maritime mobility

Heavy mobility

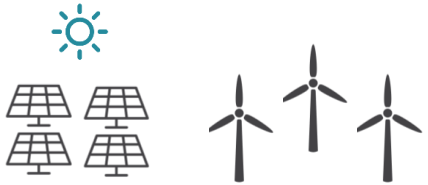
THE CHALLENGE OF RENEWABLE NETWORKS

Renewable energy technologies greatest challenge is **dispatchability**

Existing intermittent renewable power plants

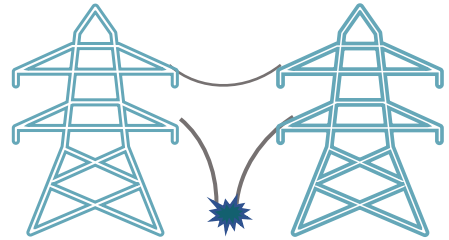
FROM VARIABLE CLEAN POWER…

1. Variable renewable sources…



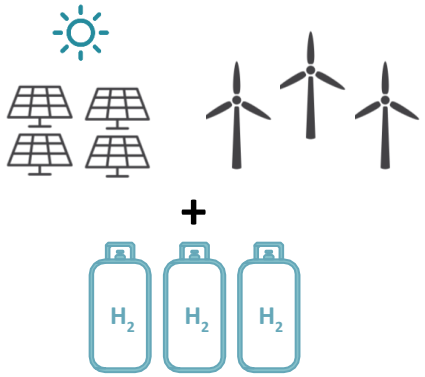
2. …cause mismatches between supply and demand…

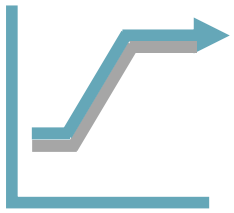
3. …which put a lot of pressure the power grid and electric system

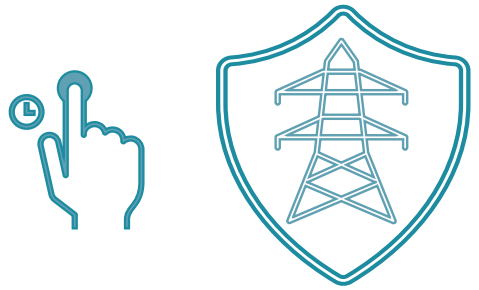


Our solution

…TO DISPATCHABLE CLEAN POWER



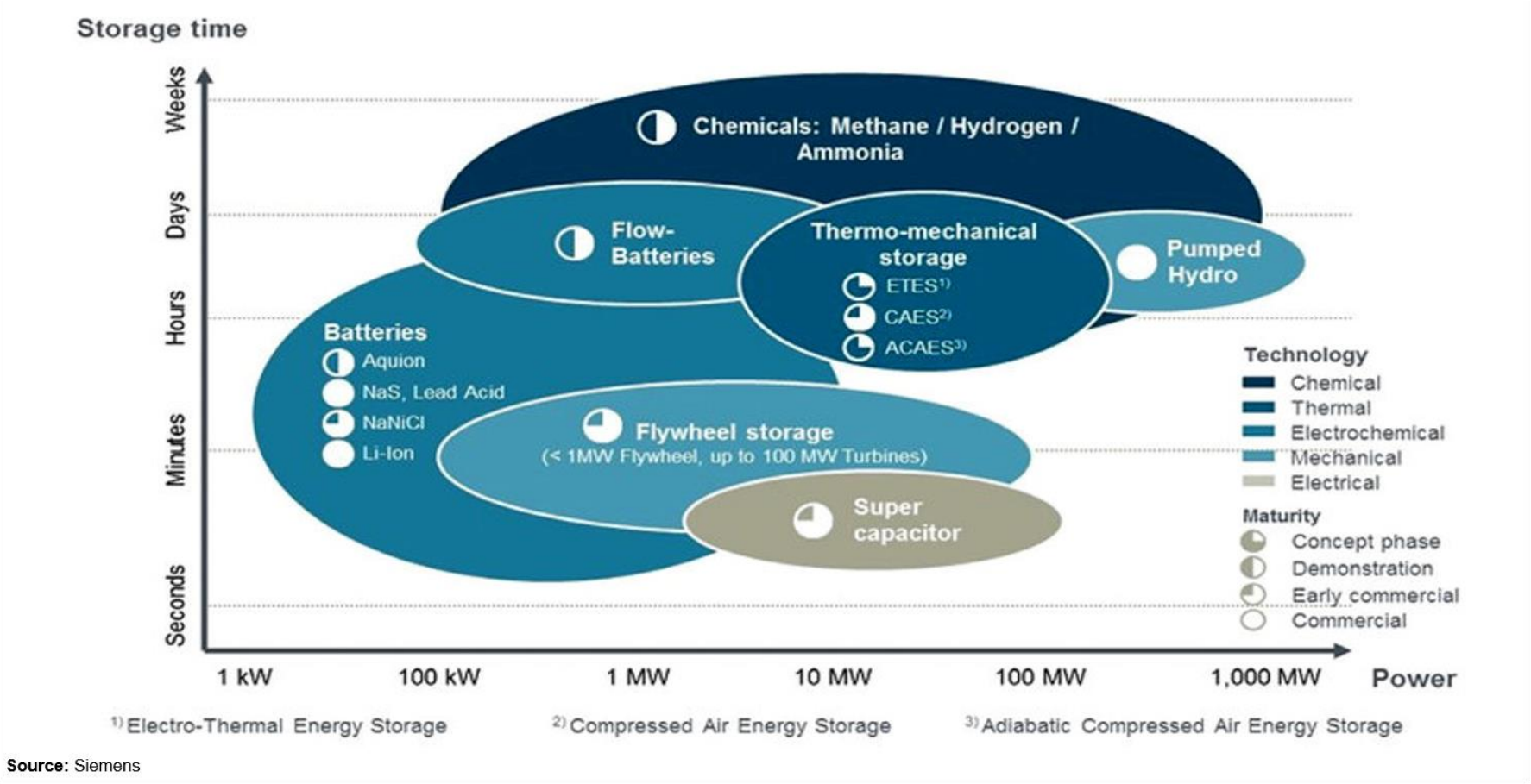




HYDROGEN TO STORE ELECTRICITY

Hydrogen is a very **cost-effective way to store electricity** for long period of times, from kW to MWe scale. This technology is extremely well-suited to the pacific islands due to its installed capacity, renewable energy resource and water availability.

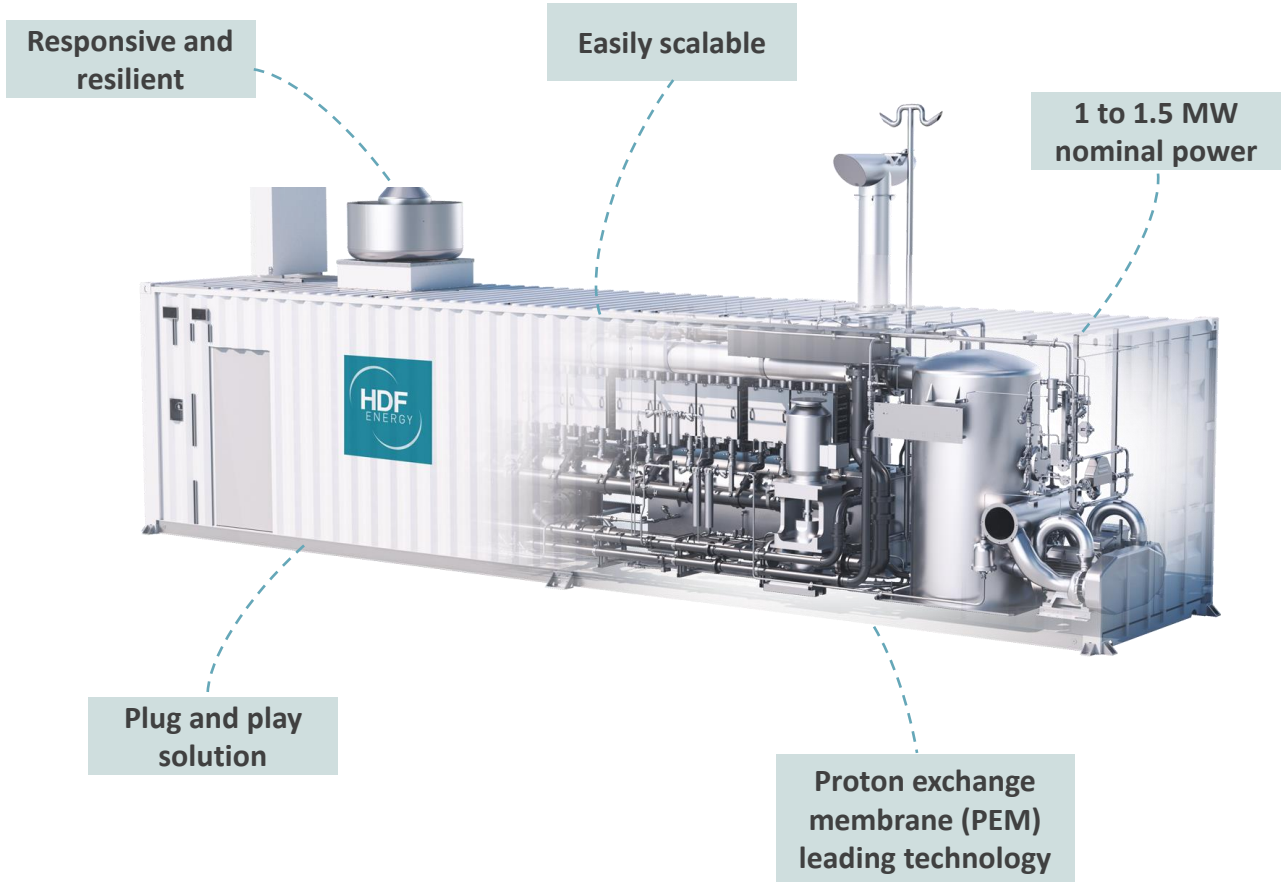
Comparison of electricity storage solutions by capacity and duration



Source: Siemens

HDF ENERGY TECHNOLOGY

The world largest and most efficient hydrogen fuel cell for electricity production



RELIABLE

CLEAN

SCALABLE

FLAGSHIP PROJECT: Caribbean

PROJECT CHALLENGES

- Massive production of hydrogen waste
- CO_2 High carbon emissions
- $$$ High electricity costs

CLEARgen, Martinique

OUR SOLUTION

CAPACITY
1.5 MW
Baseload

GENERATION
7 GWh/year

COST REDUCTION

CO2 OFFSET
5,000 Tons/year

Status : In Operation / Inauguration in Decembre 2019

Offtaker

15 years PPA with EDF

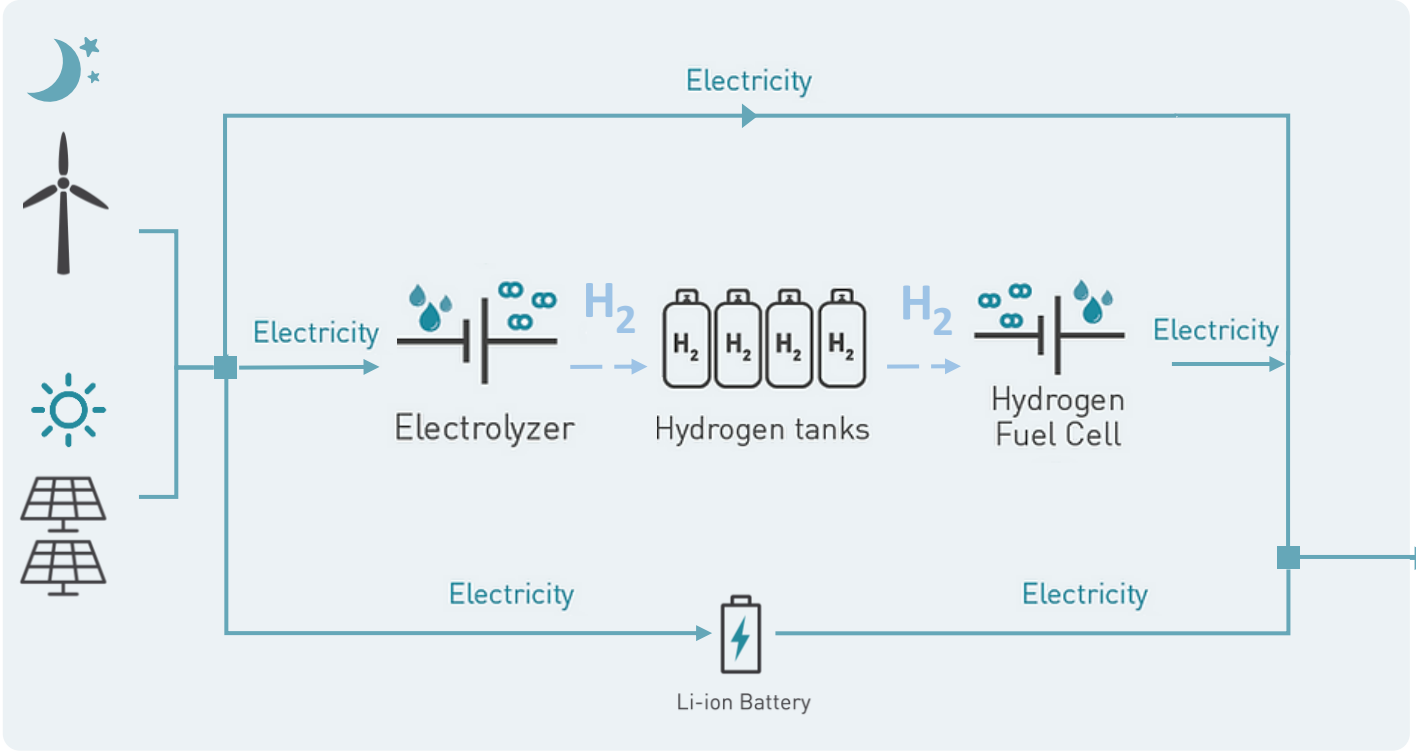
Project partners

FCH Fuel Cells and Hydrogen Joint Undertaking
cnrs
BALLARD
Jema Irizar Group
SARA

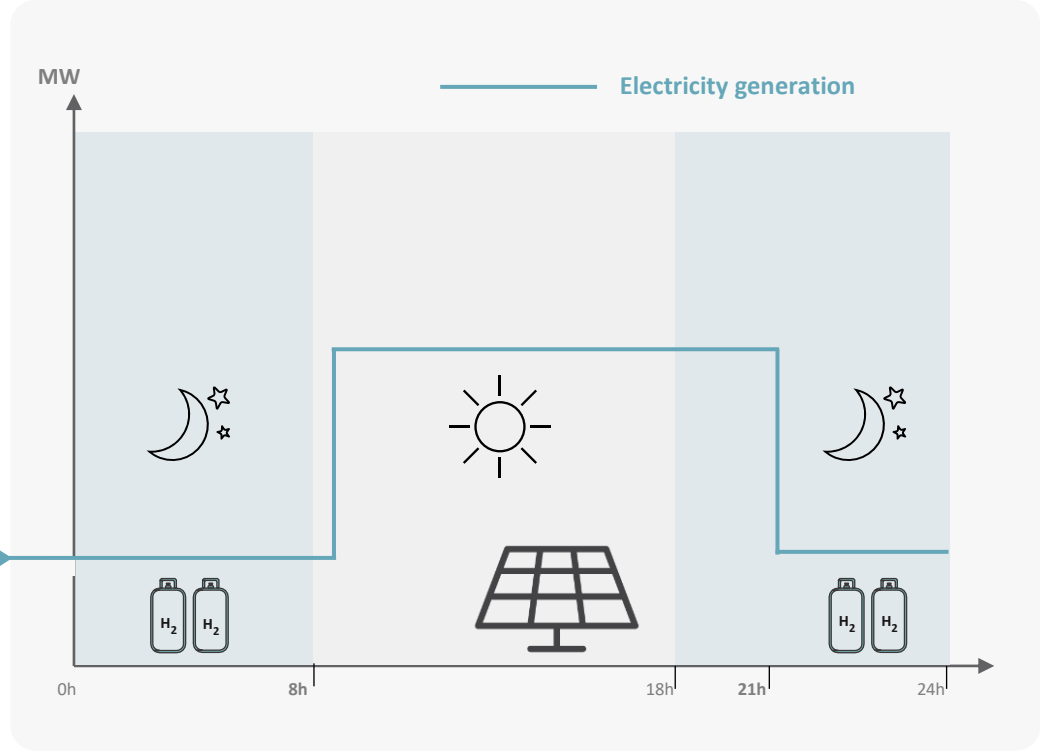
GREEN HYDROGEN ELECTRICITY

RENEWSTABLE®

Power-to-Power
Long term hydrogen storage



Fully dispatchable
green electrons

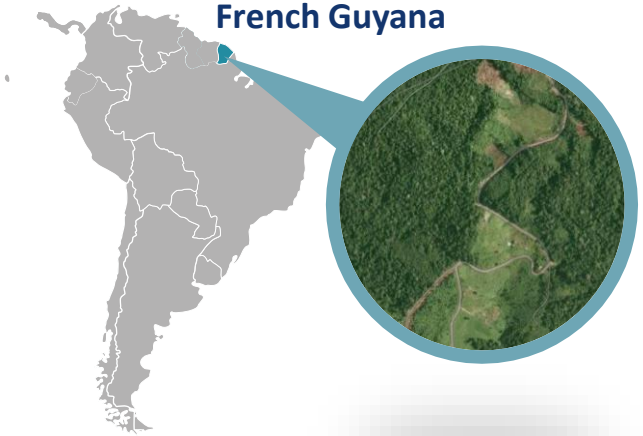


FLAGSHIP PROJECT: S.America

PROJECT CHALLENGES

- Aging diesel generators
- Unstable power grid
- CO_2 High carbon emissions
- $$$ High electricity costs

CEOG project, French Guyana



OUR SOLUTION

CAPACITY
10 MW/ 3 MW
Daytime / Nighttime

GENERATION
50,000
People

COST REDUCTION
LOWER
per year

CO2 REDUCTION
39,000 tons
per year

Status : Financial Close Q4-21, COD 2024

OFFTAKER
25 year PPA with EDF

EPC
SIEMENS energy

EQUITY PARTNERS
meridiam
SARA

FLAGSHIP PROJECT: CEOG

10 MW/ 3 MW **RENEWSTABLE** Power Plant

Hydrogen storage

Fuel cells

Batteries

P.V. Field

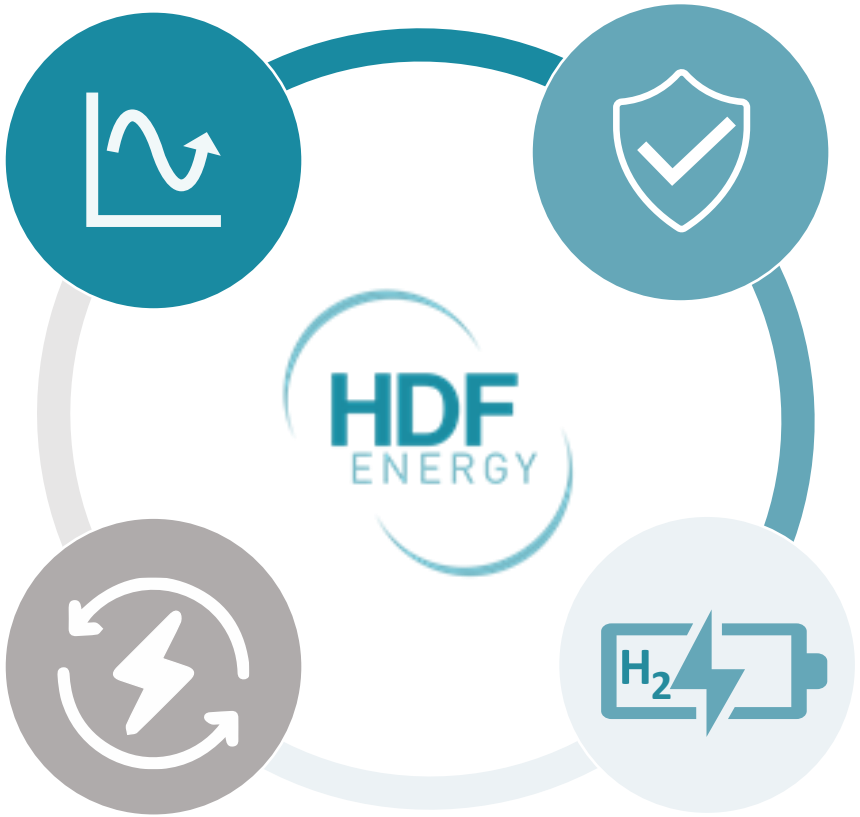
Electrolysers

RENEWSTABLE®

Renewstable® provides the following services (adaptable to multiple use-cases):

Power flexibility

- ✓ **On demand** energy
- ✓ Load following
- ✓ Morning and evening **peak response**
- ✓ Load management control



Ancillary services

- ✓ **Frequency** control
- ✓ **Voltage** control
- ✓ **Network** support control

System restoration

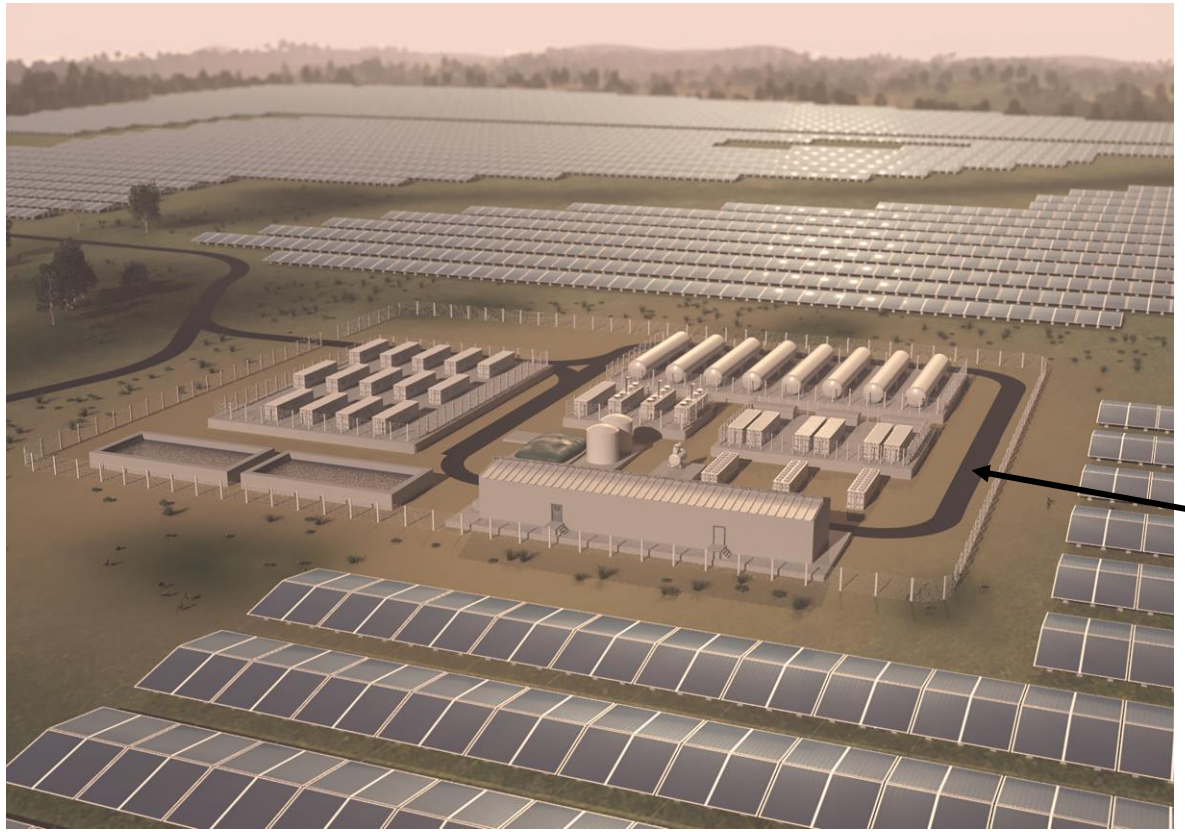
- ✓ Black start
- ✓ Island mode
- ✓ Operating reserves

Long term storage and Back-up capability

- ✓ **Capacity contract**
- ✓ Green **hydrogen** availability

VITI LEVU RENEWSTABLE

Fiji has the ambition to produce all its electricity from renewable energy by 2035. by combining hydrogen storage and hydro storage, Fiji will be able to achieve this ambitious goal.



CAPACITY

30MW daytime / 7.5MW nighttime

YEARLY GENERATION

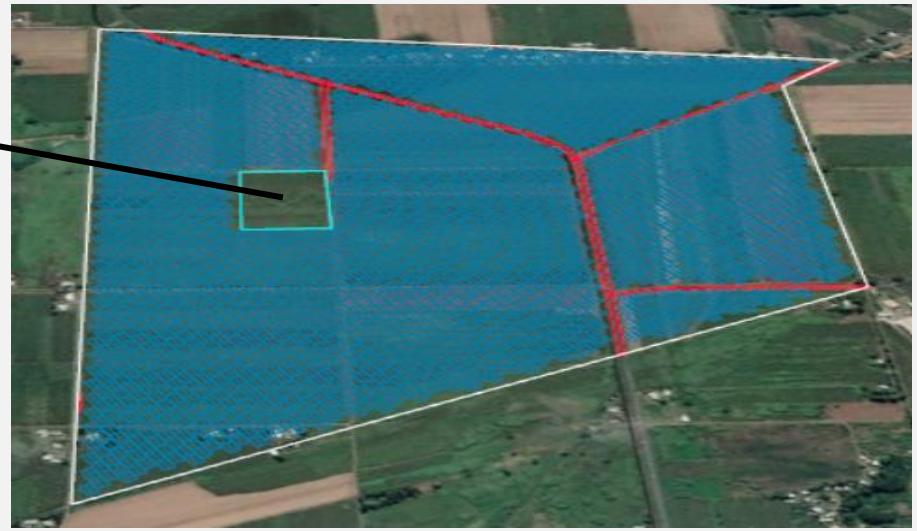
160GWh

HFO SUBSTITUTION ON THE GRID ALLOWED BY THE PROJECT

50%

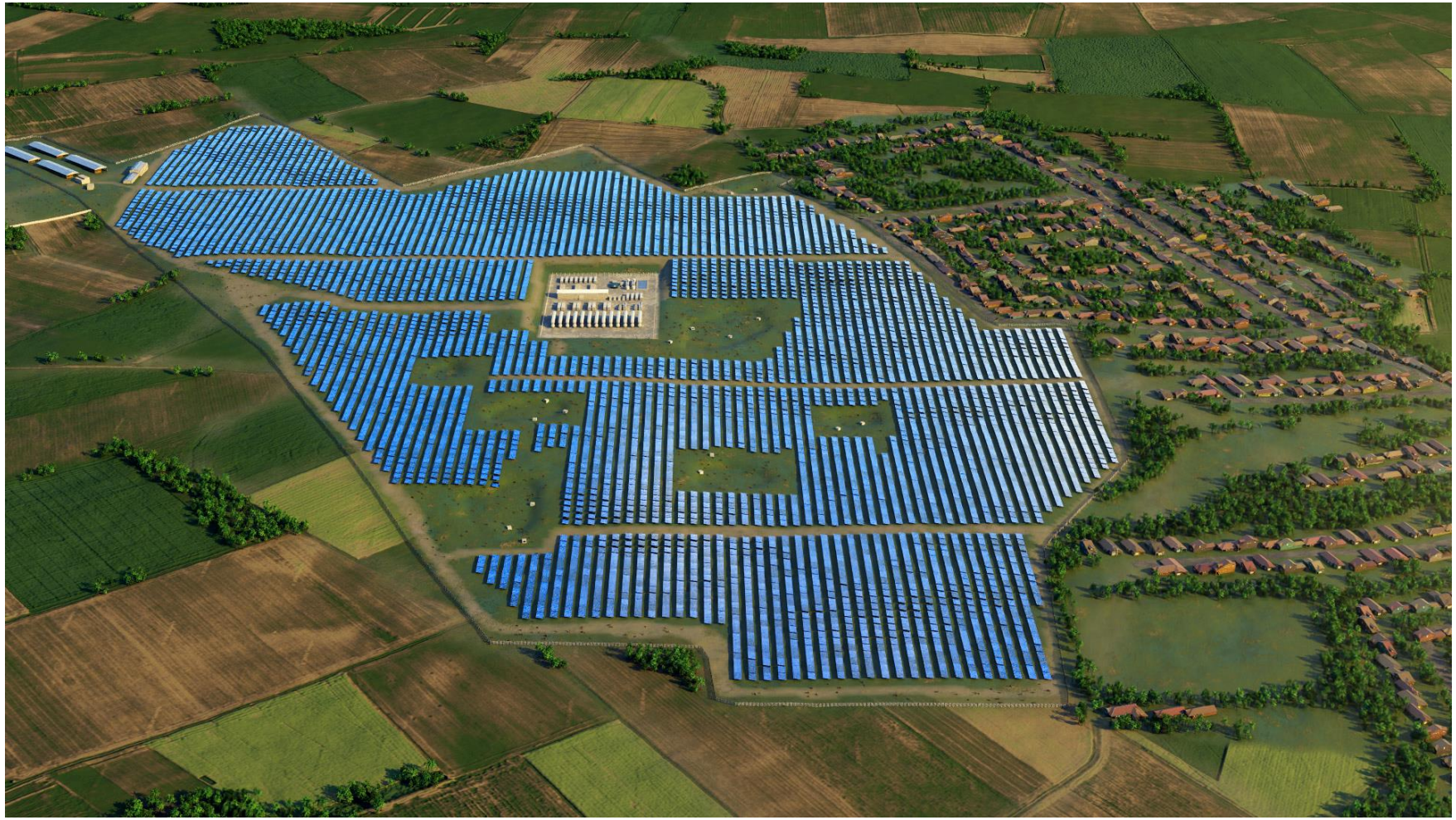
CO2 OFFSET

150,000 Tons/year



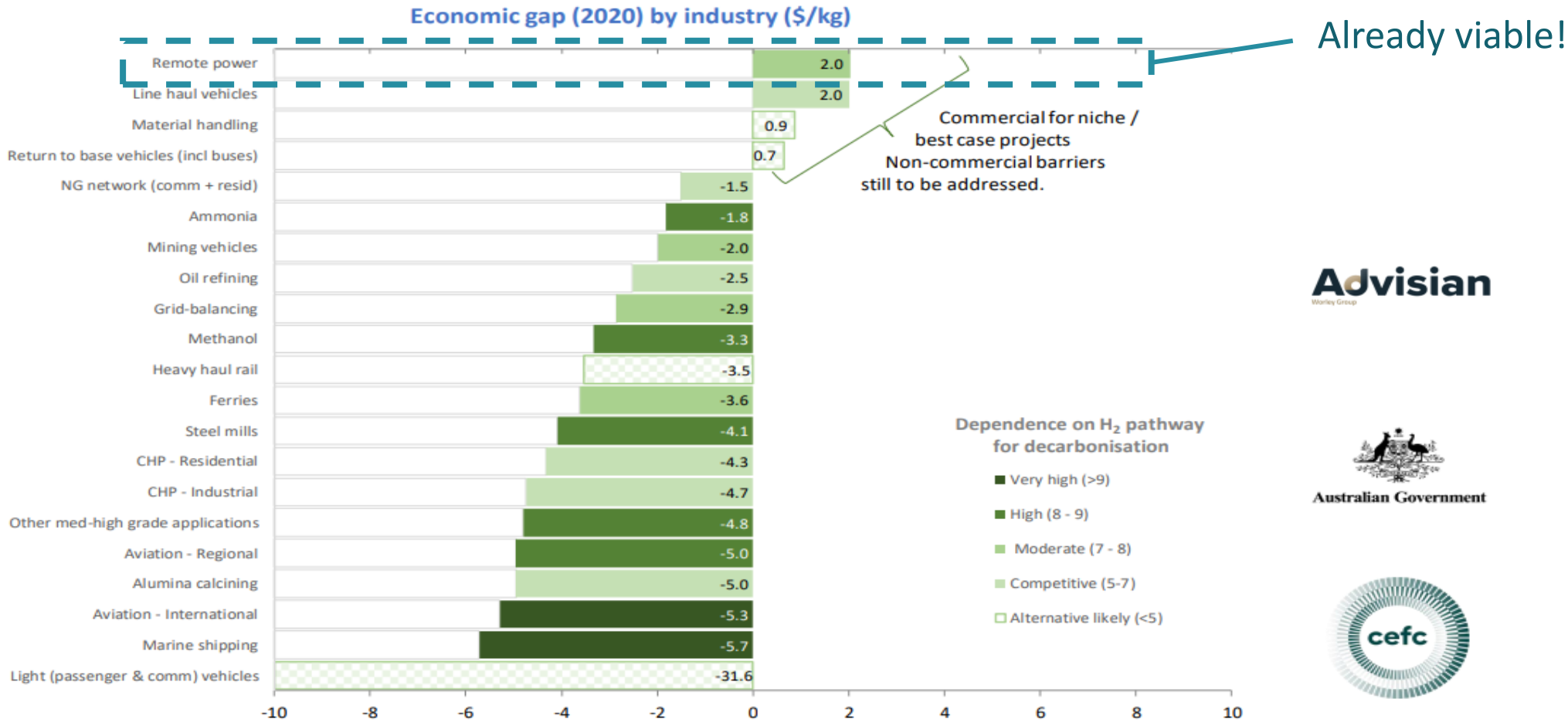
BARBADOS: DUAL USE OF LAND

Land in some islands is limited and renewable energy compete with other land uses. In Barbados, we solved that problem by combining our project with a large-scale black belly sheep farming facility (1830 sheep) on site. It will bring local lamb meat production, and local skin production set to take off the export markets.



ECONOMICS OF HYDROGEN

Hydrogen is **already viable** for **remote power generation**, especially when competing **against diesel generation**, which is often the case in the pacific islands. In addition, cost of hydrogen production / fuel cell is expected to decrease very quickly in the coming years due to economies of scale and billions of investment in hydrogen projects/technology.



Advisian

Australian Government

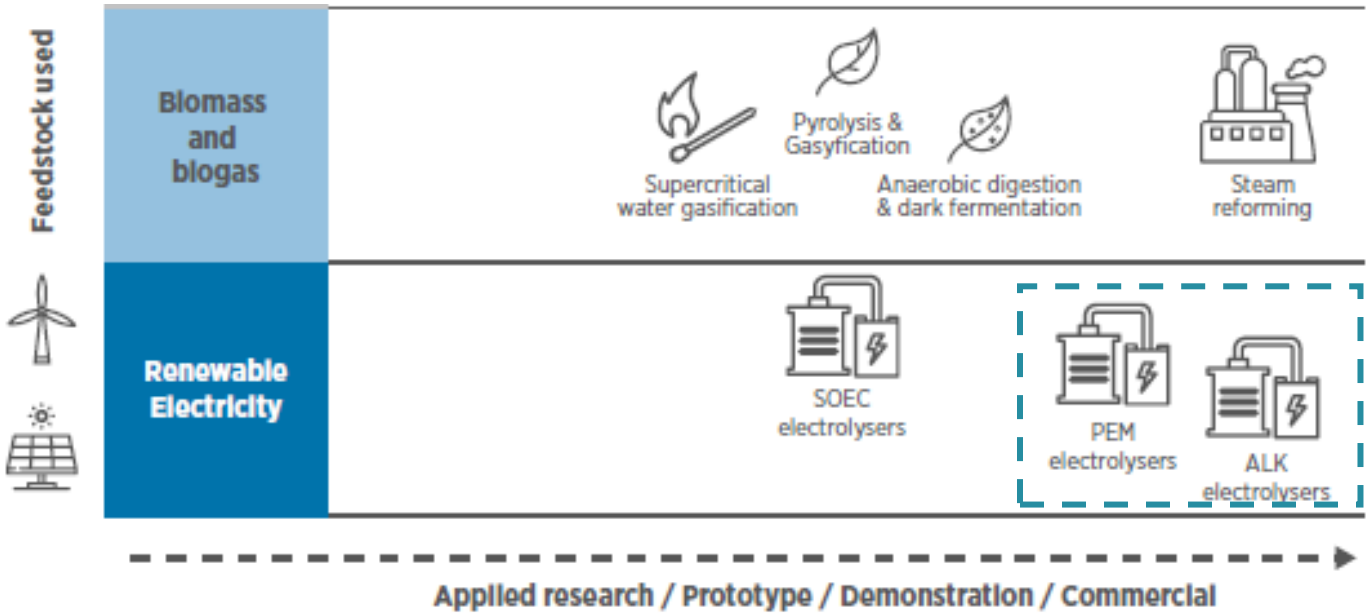
cefc

Technology Maturity

Hydrogen is produced at large scale worldwide, including through the electrolysis process. In the same way, hydrogen fuel cells have been deployed worldwide and production capacity is ramping-up quickly.

IRENA
International Renewable Energy Agency

Figure 6: Renewable hydrogen production pathways and current levels of maturity



Notes: ALK = alkaline; PEM = proton exchange membrane; SOEC = solid oxide electrolyser cell.
Source: Based on FCH JU (2015), Study on Hydrogen from Renewable Resources in the EU.

H2 production through **water electrolysis was invented in 1800** and has been perfected ever since

Hydrogen fuell cell have been used for decades. Our hydrogen fuel cells have now driven more than 50.000.000 km.

Production: 70 Mt H2/yr
Equivalent of > 1000 x Fiji's electricity consumption

Take away

Hydrogen is a very **cost-effective** way to **store and dispatch stable** renewable electricity to the grid.

HDF Energy has **successfully developed** and **financed** the largest **Power-To-Power** project in the world**.**

Hydrogen is **already viable** against diesel generation and is extremely-well suited to **decarbonize** the Pacific Islands.

The Pacific Islands should **be bold and embrace** hydrogen technology to build their **energy independence**.

There is a strong willingness from **investors and lenders** to **invest** in hydrogen and in the Pacific Islands.

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