
HYDROGEN ENABLER OF THE ENERGY TRANSITION

November 2018



ENGIE
eps

A landscape photograph of a wind farm with several wind turbines under a blue sky with light clouds. The turbines are white with blue and red blades. In the background, there are blue mountains. The overall scene is bright and clear.

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Our Mission

—



The Group's mission is to **unlock the energy transition**, by mastering the intermittency of renewable energy sources. Being pioneer of **Hybrid Storage Solutions**, transforming **intermittent renewable** sources into a **stable power source**. And **enabling renewables to power society**: reliably, affordably and sustainably.



HYESS: one vertically-integrated technology platform



ADDRESSABLE MARKETS

Grid Support

Utility-Scale and behind the meter

Storage Systems

100%

45 GW
global 2016-2024
14 GW
EMEA
100
%



Independent Power Generation

and weak-grids stabilization

Microgrids

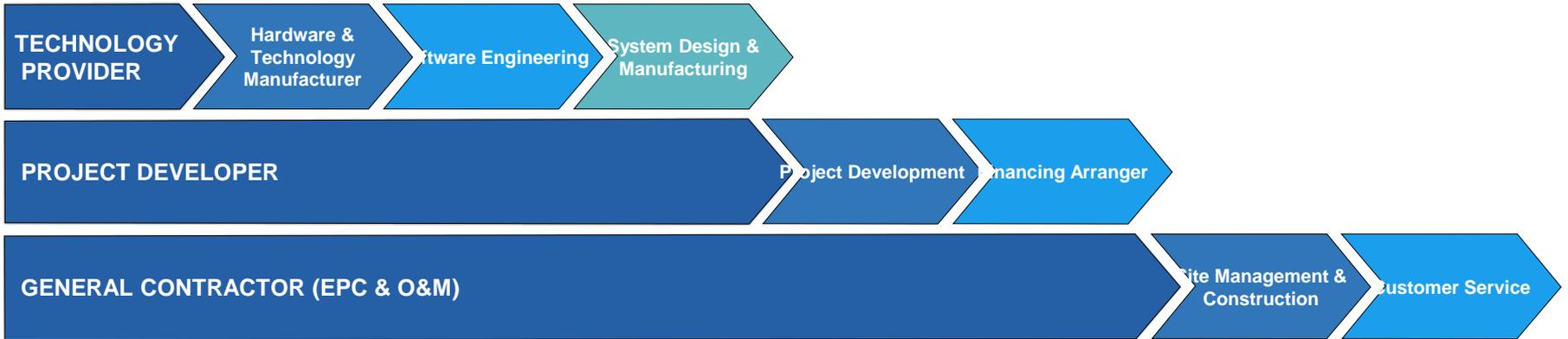
100%

600 GW
global to 2017
29 GW
Annually
100
%



BUSINESS MODEL

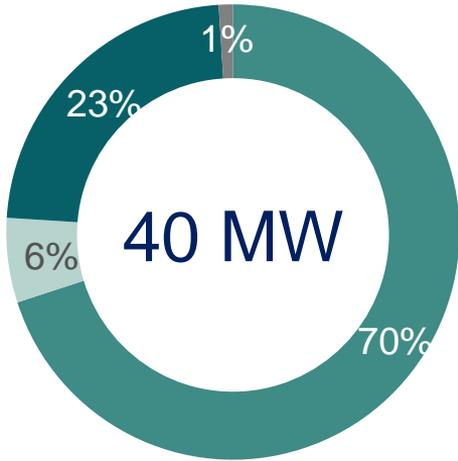
System Provider that develops its own pipeline of projects acting for the customer as a partner also for all the site activities: one single point of responsibility, minimizing project risk and complexity for the customer



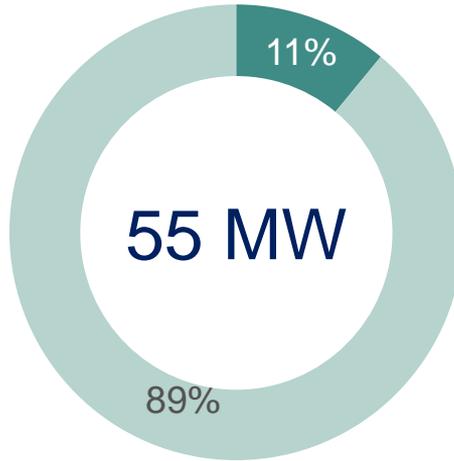
Source: EPS 2020 Technological Roadmap

Installed Base and systems under commissioning

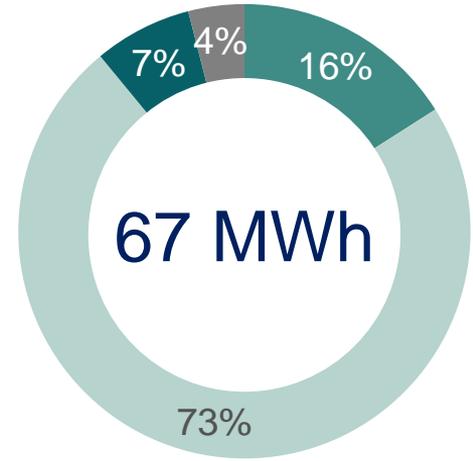
APAC Europe Africa Americas



Microgrids generation capacity



Grid-Support Solutions*



Energy Storage



* including utility scale and behind-the-meter solutions

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Technology Evolution



2005-2014



12 kW

SYSTEM SIZE

- H₂
- Pb

PRODUCT FEATURES

ElectroSelf™

- -

MICROGRID POWER SOURCE

2015



50 kW

- H₂
- Pb
- Li-ion titanate

ElectroSelf™

- Solar

2016



1 MW

- H₂
- Pb
- Li-ion ti
- Li-ion
- Na-Cl

HyESS®

- Solar
- Generators

2017



5.9 MW

- H₂
- all batteries

HyESS®

- Solar
- Generators
- Wind

2018



20+ MW

- H₂
- all batteries

HyESS®

- Solar
- Wind
- Generators
- Power Plants

One of the Largest worldwide

20MW, the Largest in EU*

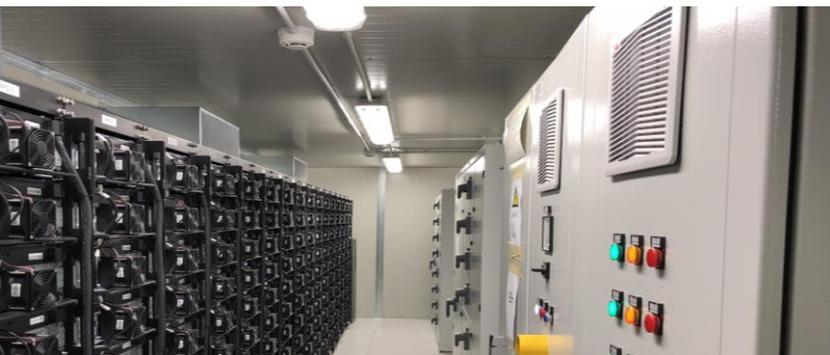


* According to Bloomberg New Energy Finance (Energy Storage Project Database, 28 October 2017) as of today just 18 li-ion energy storage systems have been commissioned in the world with a capacity higher than 20MW (all in the US, Korea and Japan).

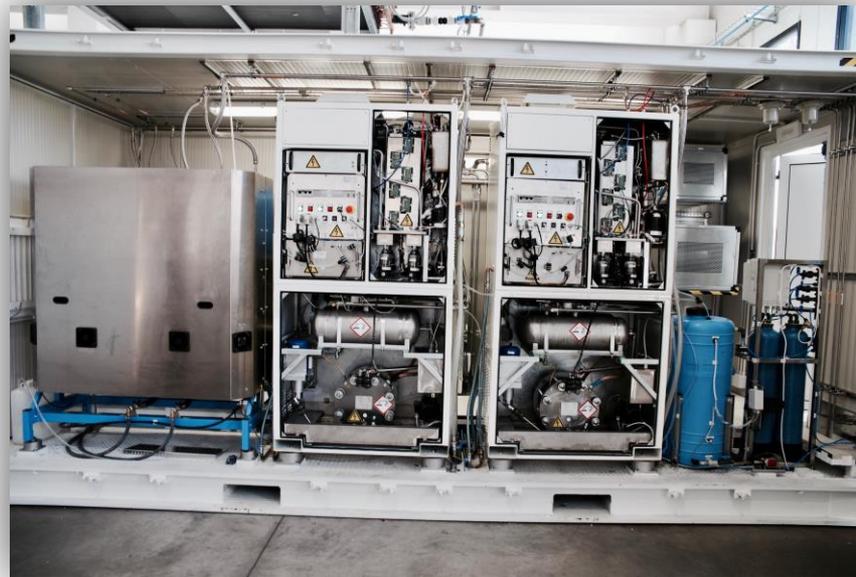
LITORAL - UTILITY-SCALE



SAT COMPLETED ON 24 SEPT 2018



H₂ Power to Power (P2P)



H2 P2P role in a solar/wind powered microgrid

Frequency and voltage stabilization (power application)

- 30-60mins of energy autonomy
- Fast response
- High-frequency, partial cycling

Li-Ion battery

Intra-day cycling of solar energy (energy application)

- Storage capacity (in MWh) of 1-3x PV capacity (in MWp), depending on load profile and cost of alternative sources
- One full daily cycle

Li-Ion vs other chemistries vs H2

Energy supply on still/cloudy days (capacity application)

- At least 24/48h of full load coverage

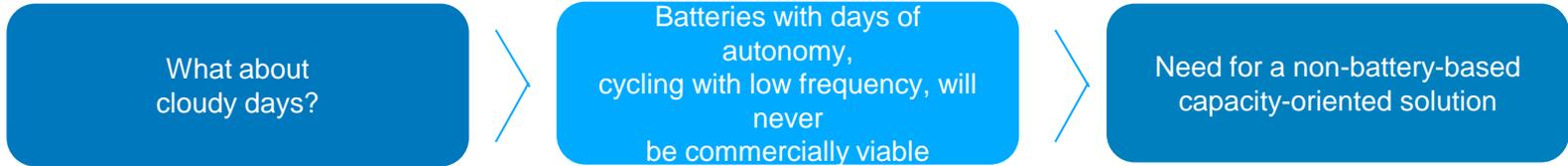
H2 vs diesel



H2 P2P vs diesel generation in microgrids

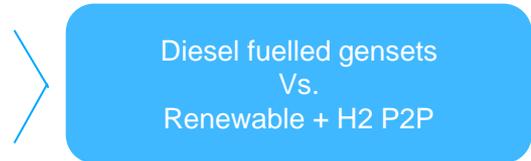
1 **Storage-enabled solar PV is set to dominate** new power generation capacity **build-up moving** forward, from temperate regions down to the equator

2 As distributed battery systems becomes more and more competitive for time-shifting solar power from day to night, on sunny days solar energy **will increasingly displace everything else** – the only limit being the footprint



3 In developed economies such role shall continue to be played by **natural gas in the next future**

4 In *non-methanized* regions, the game is on



Hybrid power plant in Chile

Group credentials

Stage: commissioned and in operation



For the first time, this Hybrid Power Plant combines renewables with the complete set of innovative technologies developed by the EPS Group to implement a micro-grid in Chile that brings electricity to more than 300 technicians constructing a power plant in the Atacama Desert, 4000 meters above sea level.

The entire system has been engineered in a containerised, plug & play solution that provides stable power on demand with the same level reliability of to the national electrical grid, using intermittent, renewable power sources coupled with storage.

Hybrid Power Plant:



PV: 125kWp



Hydrogen: 1MWh



Storage: 120kWh
(Li-ion titanate chemistry)



Master Controller
Pool Algorithms & Black Start Function



250kW Power Conversion System
Full Inertia DROOP Control Technology
Full DC BUS system.

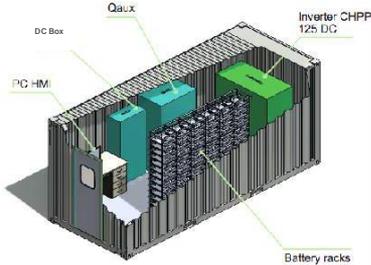


Peak Load PCS: 125kW
People: 300
Diesel reduction: 100%, backup only



Hybrid power plant in Chile

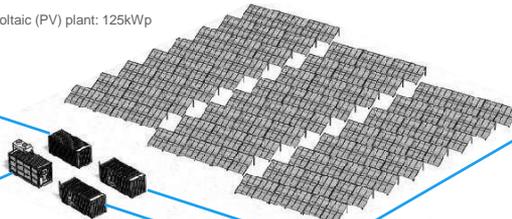
Balance of Plant (BoP Container)



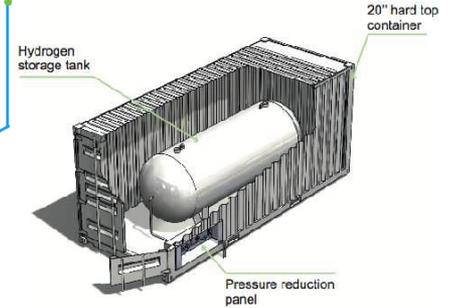
- 125 kVA Power Conversion System DROOP Virtual Inertia
- 132 kWh Li-ion Battery
- Microgrid Management System with POOL algorithms

First Hybrid Mini-Grid with hydrogen and li-ion storage technology. Cheap electricity to remote communities, operating in islanded mode 24/7. Complete replacement of the existing fossil fuel-based generator.

Photovoltaic (PV) plant: 125kWp

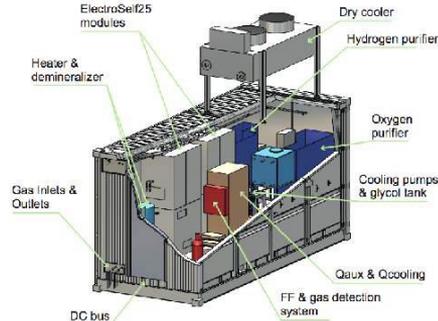


Oxygen Storage (O₂ Container)



- 6,000L pressurized Tank (Phom 30 Bar)

Power-to-Power (P2P Container)



- 2x25kW Electrolyzer, as Power-to-Gas (P2G) modules
- 2x25kW FuelCell, as Gas-to-Power (G2P) modules P2P
- Energy Management System

INNOVATION AT FULL SCALE

DIESEL FREE, PLUG & PLAY

Hydrogen as "green fuel", generating pure water as waste product. Plug and Play containerized solution, ready to scale-up power in case of demand increase.

OVERCOME DIESEL EFFICIENCY

Hybrid Storage configuration with a high-efficiency Li-ion battery to maximize the daily energy turnaround and P2P hydrogen system to provide long-duration capacity

CAPEX REDUCTION

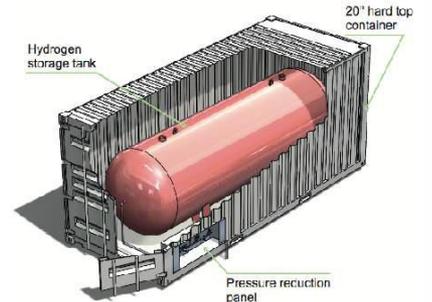
Higher Efficiency and CAPEX reduction: battery and H₂ Storage are charged directly by

SEAMLESS ISLANDED MODE

Seamless transition from grid connection to islanded mode. Meet the challenge for robust power supply, gaining control of the power needs on a "local" level.

DC Link with PV. Only one bidirectional Inverter for the entire system.

Hydrogen Storage (H₂ Container)



- 12,000L pressurized Tank (Phom 30 Bar) 1
- MWh storage gross capacity

Hybrid power plant in Chile

Balance of Plant (BoP Container)



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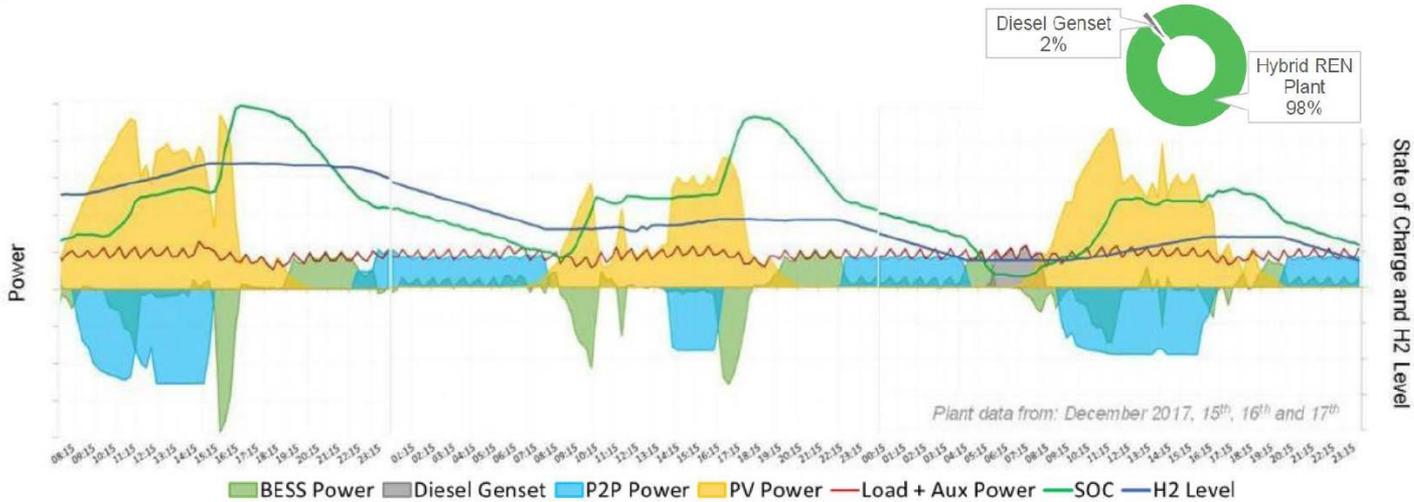
Hydrogen Storage (H₂ Container)



- 12,000L pressurized Tank (Phom 30 Bar) 1
- MWh storage gross capacity

Hybrid power plant in Chile: operational data

Results



With gas tank full the hybrid plant is able to cover up to 100% of the total daily camp load for 3 days

Courtesy of Enel Green Power

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EPS in Health Code



- 1 Online Anomalies Detection
- 2 Active Fault Management
- 3 Fault Identification
- 4 State of Health Evaluation: RUL
- 5 Real Time Performance Evaluation
- 6 Preventive Maintenance



EPS in Health Code



ElectroSelf



DcDc Converter



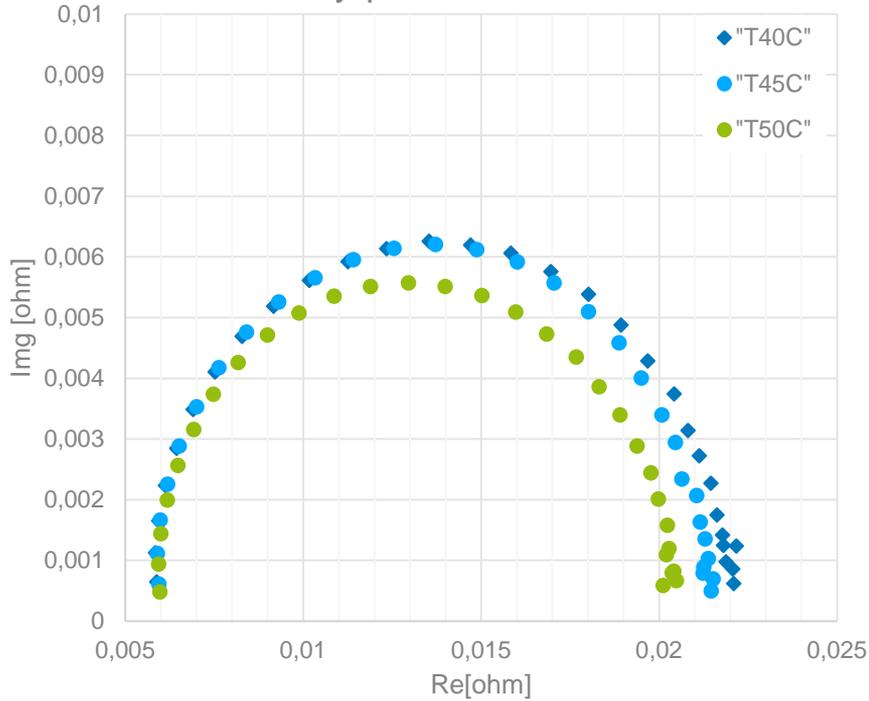
EIS Board



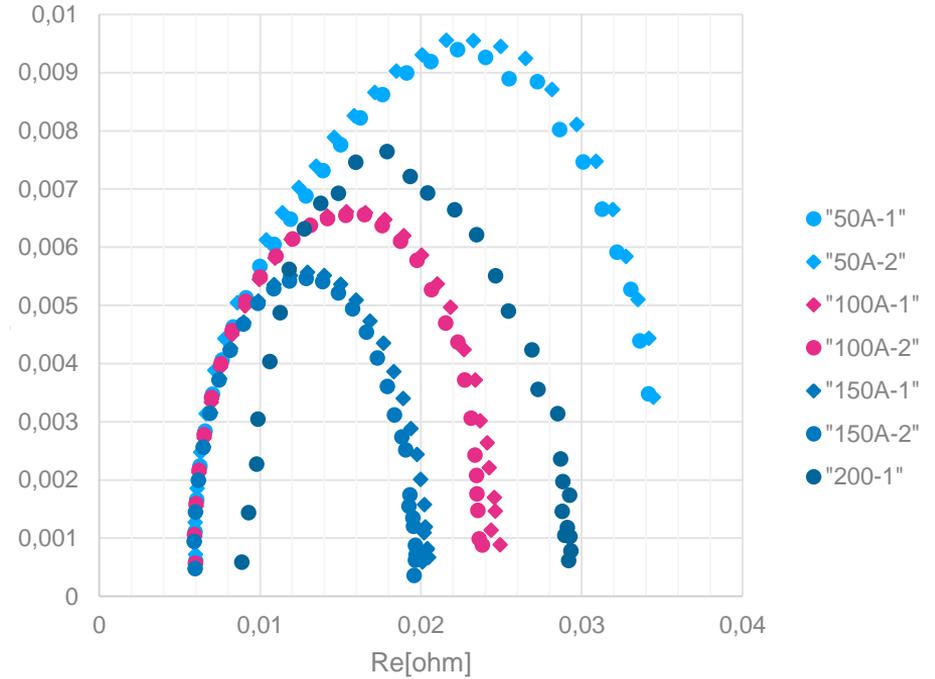
FC Stack

EPS in Health Code

Nyquist @150A



Nyquist @50°C



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REIDS Project – Semakau Island

Group credentials
Stage: Under Construction



State of the art improvements:

Lifetime and reliability through electrolyte recovered and reused; and 99.9995% Hydrogen gas generated able to be used in a nearby **Fuel Cell Electric Vehicle Refilling station**.

P2G 50kW
Power-To-Gas

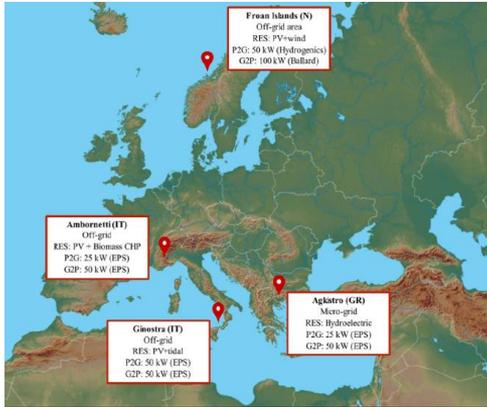
G2P 50kW
Gas-To-Power

H₂
2MWh Hydrogen
and Oxygen storage

 70 kVA
bi-directional PCS



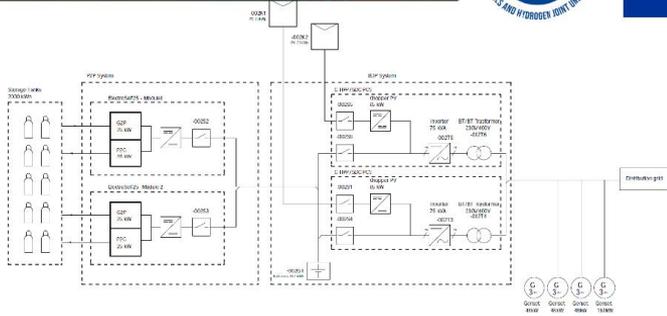
REMOTE Project



In the REMOTE project

EPS will develop 3 microgrids, all based on the integration of RES, batteries and hydrogen-based energy storage solutions

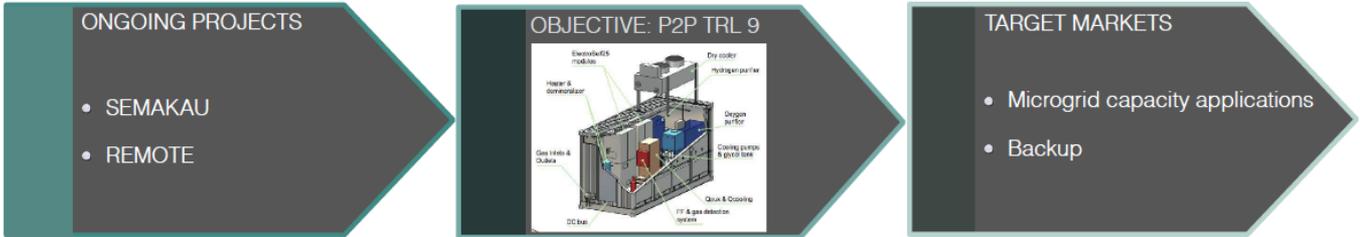
- Ginostra Smart Island, 2MWh (Italy)
- Off-Grid Microgrid in Serres, 1MWh (Greece)
- Off-Grid Microgrid in Ambornetti, 0.5MWh (Italy)



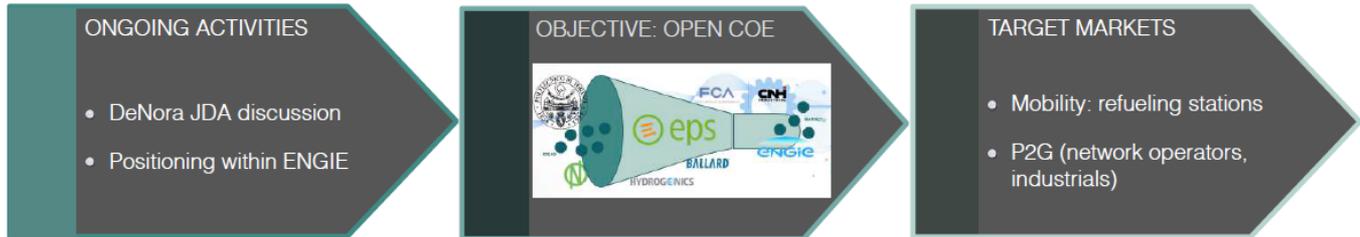
From kW to MWs



Closed Innovation on KW scale



Open Innovation on MW Scale



Thank you for your attention!

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