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Smart Renewable Hubs for flexible generation

Presentation of R&I European Project: GRIDSOL project

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cobra

GRUPO COBRA is the main Developer, EPC and O&M Contractor of ACS Group´s Industrial Division.

It has an extensive experience in the development of services and maintenance activities to support the industry and engineering in the development of projects.

60 COUNTRIES

500 BRANCHES

30,000 PEOPLE

A WORLDWIDE REFERENCE

Global leader with more than 70 years experience in all fields related engineering, installation and industrial maintenance of infrastructures.

HIGH REPUTATION

Multi-disciplined engineering company with a strong reputation due to its employees high qualifications and an unwavering commitment to its customers.

INTERNATIONALLY CONSOLIDATED

Leading contractor with a global presence in 60 countries offering a wide range of services through more than 500 branches on five continents.

RENEWABLE POWER PLANTS

Project Development, Ownership, EPC and O&M of projects related to renewable energy. Cobra has extensive experience promoting and participating in concession assets, also offers comprehensive operation and maintenance services for power plants, through solid experienced manpower.

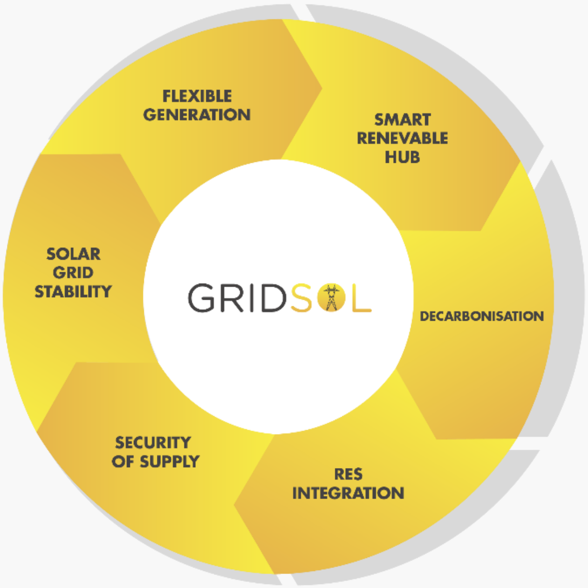
PROJECTS

- Photovoltaic Power Plants
- Wind Farms
- Concentrated Solar Power Plants
- Biomass o Biofuel Power Plants

+1.5 GW Ongoing

Context

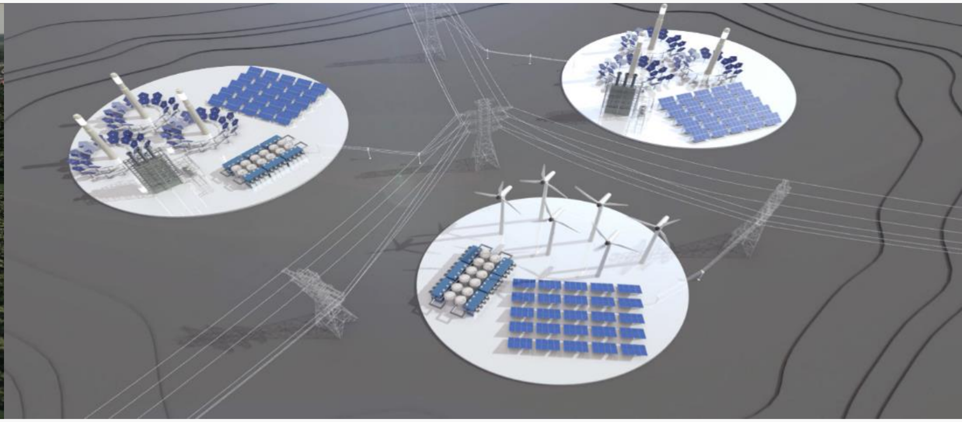
In a context of high Variable Renewable Energy (VRE) generation and ambitious decarbonisation targets, flexibility starts to play a key role to guarantee grid stability. In this regard, GRIDSOL project presents a new concept to increase renewable energy penetration in a grid-friendly manner: Smart Renewable Hubs (SRH).



Concept: Smart Renewable Hubs

GRIDSOL aims to provide secure, clean and efficient electricity by combining primary renewable energy sources and technology under an advanced control system. Video

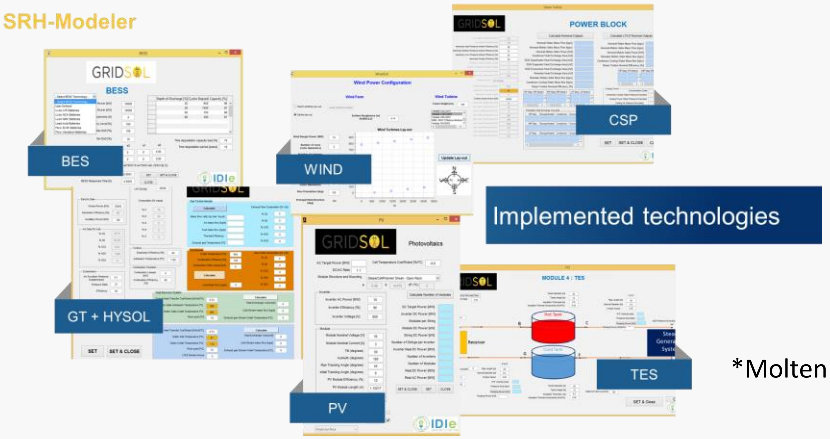
- The project presents a new concept to increase renewable energy penetration in a grid-friendly manner: "Smart Renewable Hub", which consists in a flexible hybrid power plant supplying clean electricity and contributing to grid stability.



Smart Renewable Hub Modeller (SRH-M)

The **Tool (SRH Modeler)** is capable of simulating, hourly or for other time steps, the production of renewable and non-renewable technologies, as well as TES and BES

Including a basic control system (analogous to DOME) and capability of optimizing the plant's configuration / energy mix

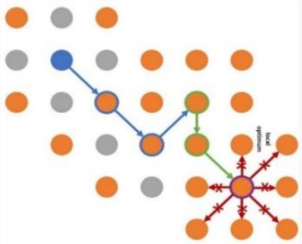


*Li-Ion & Flow

*Molten salts

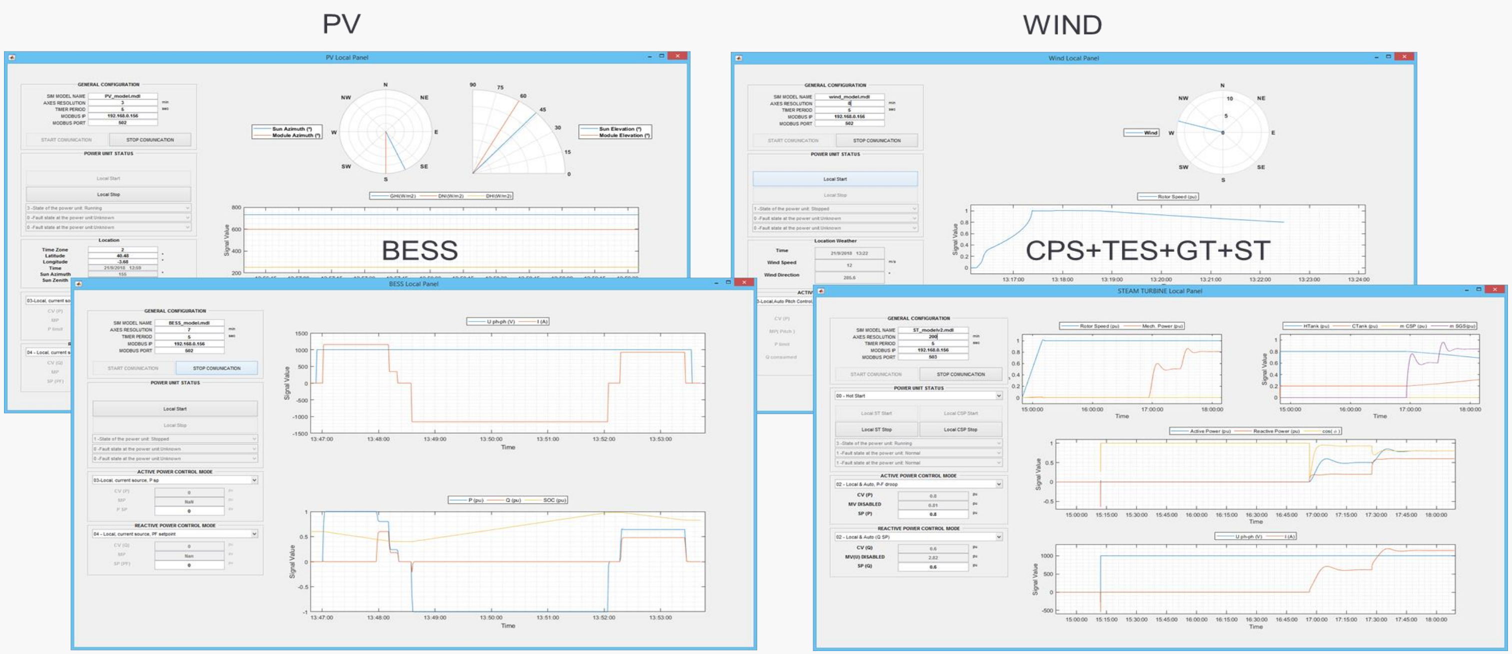
Step 1: a Monte Carlo method is used to screen the potential configurations within the boundary limits (land available, maximum installed power, etc.)

Step 2: "Base Case Evolution", a variant of an Iterated Local Search over a Steepest Ascent Hill-Climbing method, improved by the previous Monte Carlo to focus on the deepest attraction basins



Dynamic Output Manager of Energy (DOME)

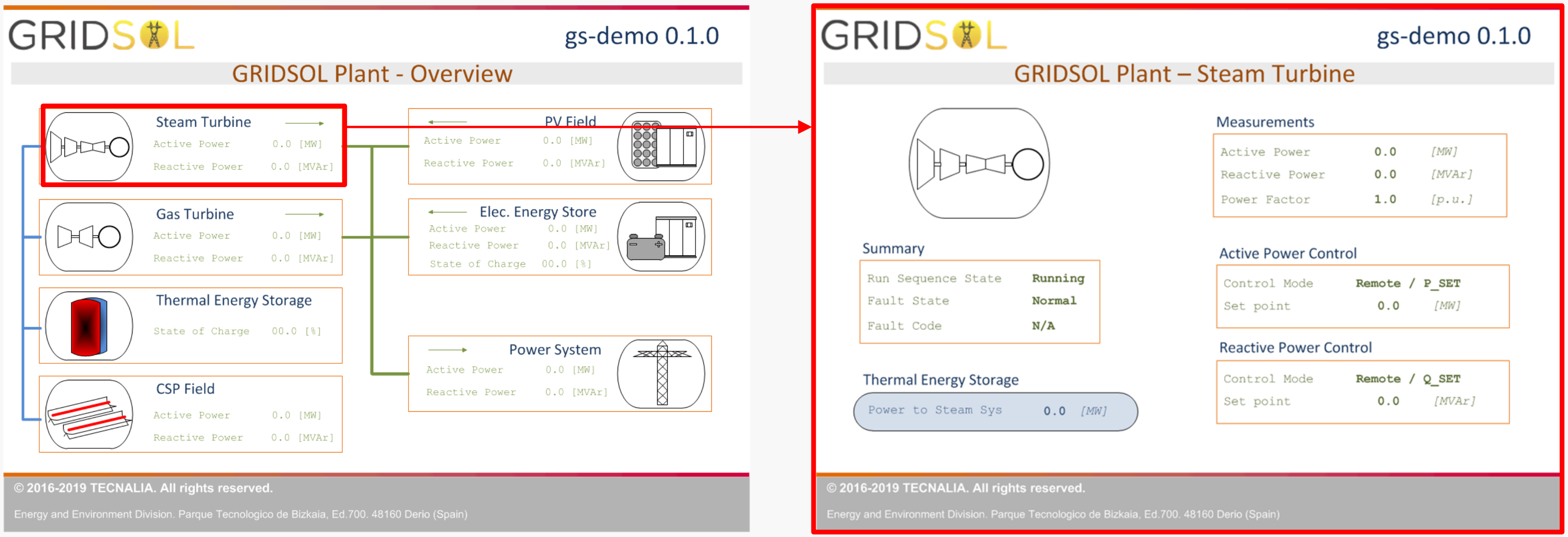
To make this hybridization possible, GRIDSOL develops a **Dynamic Output Manager of Energy (DOME)**. This advanced control system considers market and grid requirements, providing ancillary services and relieving pressure on the Electricity System Operator.



Capabilities: Generation schedule, Real-time operation, support to market agent & plant operator...

Dynamic Output Manager of Energy (DOME)

User Interface: Web based UI for visualizing main plant parameters

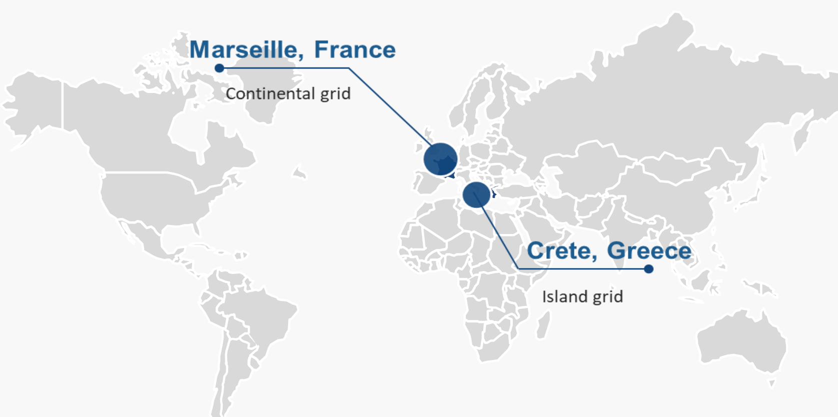


Case studies

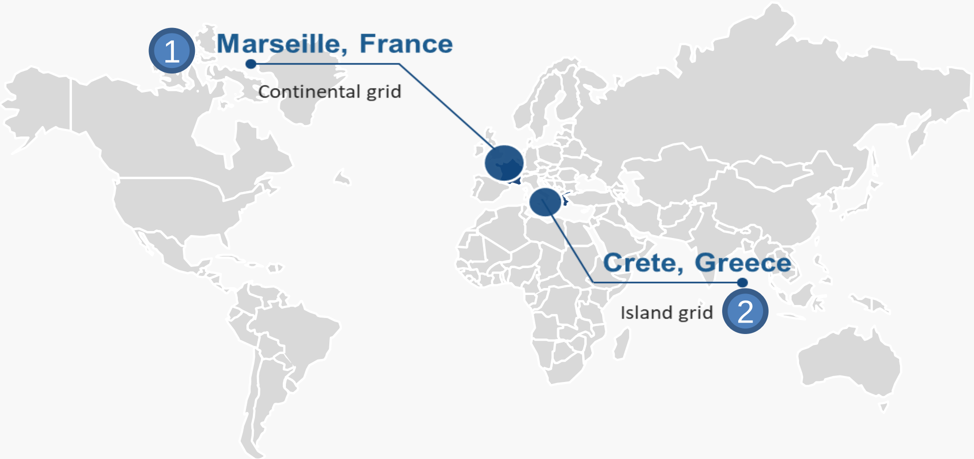
The aim of this study is to quantify the value of storage for flexible generation through hybrid solutions at an affordable cost. The choice and size of each technology at the SRH is optimized for the desired location, aiming at a renewable content of at least 80% on a yearly basis and a rate of return above 7.5 % for a 25 year life cycle.

1. Define the scenario including grid and market requirements for each location
2. Optimisation of Smart Renewable Hubs configuration
3. Profitability assessment

In this regard, two locations are evaluated, one in an interconnected electric system and another in an isolated electric system. The main services of energy storage considered are the avoidance of electricity curtailment, time shifting and ancillary service provision.



Case studies



Multi Criteria Decision Making

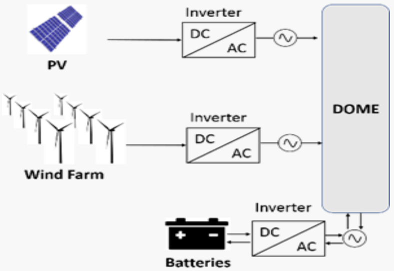
1. Interconnected electric system
   - Land availability
   - RE content (>80%)
   - Pool Price (€/MWh)
   - Grid codes & Market rules
   - Minimise LCoE
   - Maximise flexibility

2. Isolated electric system
   - Land availability
   - RE content (>80%)
   - Residual Load as demand curve
   - Grid codes & Market rules
   - Minimise LCoE
   - Firmness (>90%)

Case studies

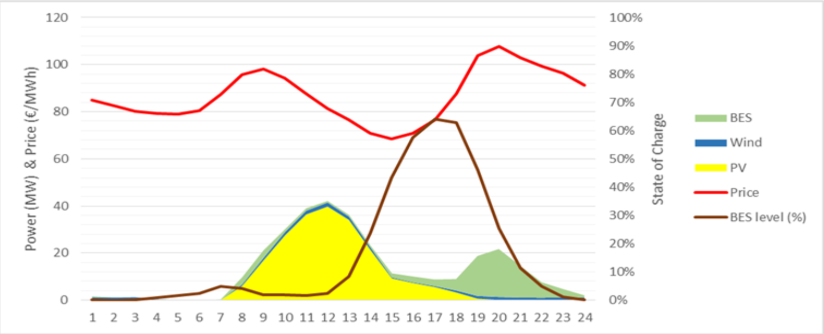
1. Interconnect system (Marseille, France)

The results show the suitability of a SRH composed by PV, Wind and BESS for an Interconnected System according to the grid and market requirements.



Location	Marseille (France)
Wind Power [MW]	10
PV Power [MW]	70
Batteries Power [MW]	64
Batteries Capacity [h]	1.5

The incomes of the SRH comes from the Electricity Market and therefore the control strategy is done to optimise the project profitability.



Location	Marseille, France
Land used [km^2]	2
RE content [%]	100
LCOE [€/MWh]	84.0
WASP [€/MWh]	89.6
AMP [€/MWh]	86.8
Gross margin	+5.6
Market value	+2.8

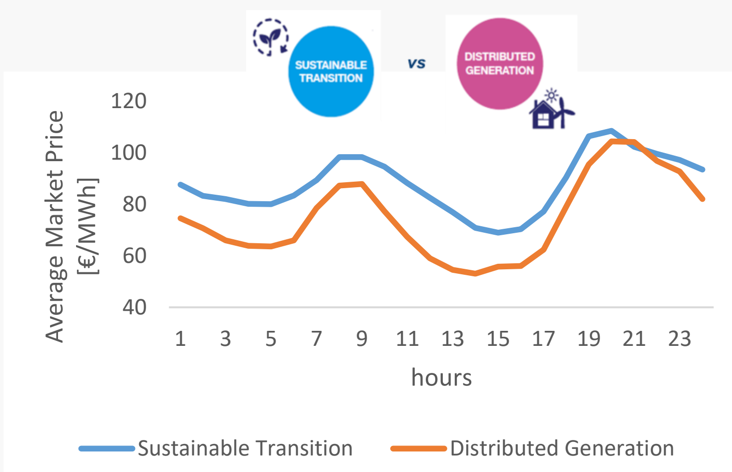
Case studies

1. Interconnect system (Marseille, France)

Further benefits are presented below:

ΔConsumer Surplus [M€]	ΔProducer Surplus [M€]	ΔCongestion Rent [M€]	ΔSEW [M€]	CO2 reduction [Mton/year]
46.6	- 55.8	18.4	9.2	0.1

On the other hand a sensitivity analysis shows how a different market price scenario is impacting the project profitability:



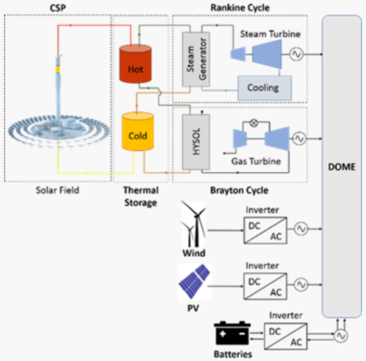
– 10-30% Gross margin

*Based on TYNDP 2018 scenarios

Case studies

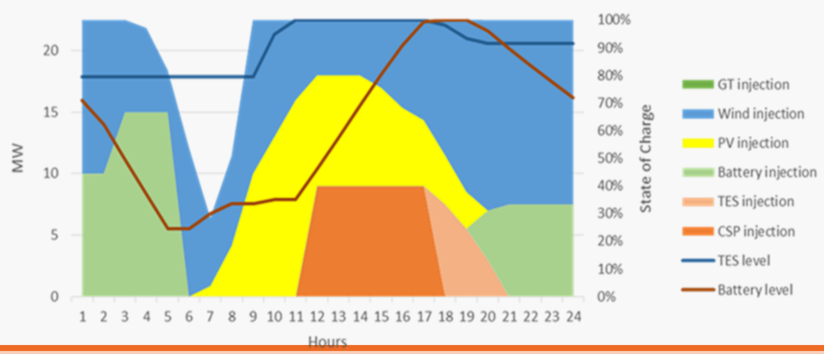
1. Non-interconnected system, Crete (Greece)

The results show a SRH composed by CSP, TES, PV, Wind, BESS and HYSOL due to the greater need of flexibility to displace fossil fuel plants.



Location	Crete (Greece)
Wind Power [MW]	10
PV Power [MW]	34
Batteries Power [MW]	11
Batteries Capacity [h]	12
GT Power [MW]	9
ST Power [MW]	12
TES Capacity [h]	17
Solar Multiple	2.2

The incomes of the SRH comes via PPAs and therefore the control strategy is based on the system operator conditions.



Location	Crete, Greece
Land used [km2]	2
RE content [%]	81.8
Peak demand [MW]	56
LCOE [€/MWh]	173.4
Firmness [%]	90.3
AGC [€/MWh]	≈200
PPA [€/MWh]	≈180
Gross margin	+6.6
Market value	+16.6

Case studies

2. Non-interconnect system, Crete (Greece)

Further benefits are presented below:

	Crete's Power System	Crete's Power System with SRH
Thermal production (GWh)	2,233.1	2,141.6
RES Penetration (%)	23.43%	26.61%
CO2 emissions (tn)	1,638,846	1,550,984
CO2 cost (€)	8,194,230	7,754,571
Fuel Cost (€)	262,151,124	249,725,333
Wind production curtailed (%)	5.65	5.20
RES cost (Wind, PV, SRH)	126,500,470	113,534,287
Annual Energy system cost (€)	390,578,942	390,405,120

With **the addition** of **SRH:**

Thermal production ↓ 4.1%

RES penetration ↑ 3.17%

CO_2 emissions / cost ↓ 5.4%

Fuel Cost ↓ 4.7%

Annual Energy system cost ↓ 0.44%

Conclusions

- Smart Renewable Hubs (SRH) select and combine the most suitable technologies to deliver an optimal configuration at each location.
- A SRH composed by PV and Wind with BESS provide cost-effective solutions to increase RES penetration.
- In isolated grids, the greater requirements of firmness implies the need of CSP, TES and GT to provide back-up.

Further research

- The necessity of flexibility (energy storage) to integrate RES will increase in coming years as a result of a progressive shut-down of conventional power plants. Then, a more reasonable electricity price signal incentivising flexibility and a greater CO_2 price are needed to achieve EU decarbonisation goals.
- BESS market uptake requires further research to achieve competitiveness.

Thank you for your attention

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