Siemens Gamesa Hybrid Technology

Applied to Greek Islands

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***Abstract*— Hybrid systems enable to reduce the dependency on fossil fuels, replacing Fossil power plants by renewable energy power plants, while maintaining grid stability even for very unstable grids.**

I. Introduction

Hybrid systems enable to reduce the dependency on fossil fuels, replacing Fossil power plants by renewable energy power plants, while maintaining grid stability even for very unstable grids.

SIEMENS GAMESA Renewable Energy (Siemens Gamesa or SGRE) has been working, through a combination of R&D and technology deployment efforts, on integrating renewables on weak grids and creating smart grids for the last 12 years.

These efforts have led to the creation of a robust integrated hybrid technology offering that is able to increment the penetration of renewable energy (both from Wind and Solar resources) reaching 100% renewable penetration if the island so requires.

This technology is ultimately demonstrated on a commercial scale Hybrid / Smart Grid Demonstrator located in Spain which incorporates Wind & Solar Renewable Resources, combined with different technologies of energy storage and diesel generation.

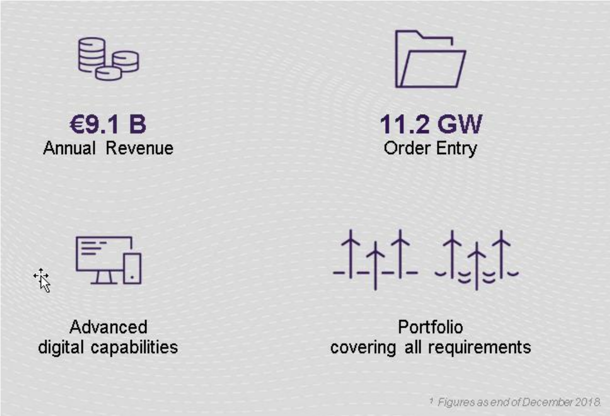
In this presentation, we will explain in detail what has been achieved in the hybrid/offgrid plant at La Plana (Spain) and what the plant configuration is. It will also be explained how this experience has been taken from an Offgrid scenario to a weak-grid scenario. This covers the different grid scenarios within the Greek islands.

This Hybrid Technology developed by Siemens Gamesa is now available to be applied in Greek islands to reduce the emissions footprint by replacing fossil fuel generation by Renewable Energy (RE).

II. About SIEMENS GAMESA

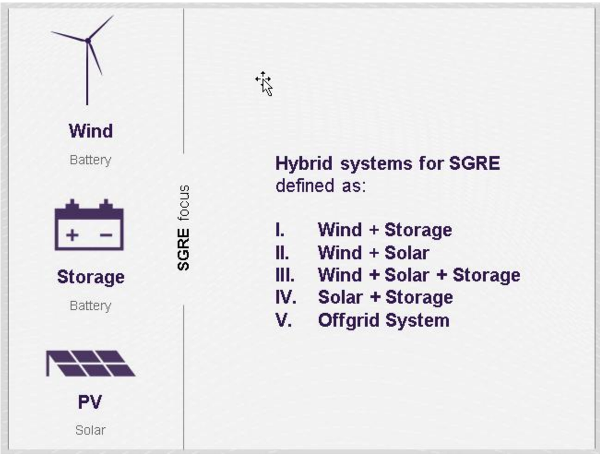
Siemens Gamesa Renewable Energy was created in April, 2017, with the merger of Gamesa Corporación Tecnológica and Siemens Wind Power under one roof: innovative spirit, dedication to technological excellence, and determination to provide real and lasting value to all stakeholders and customers.

Today, Siemens Gamesa Renewable Energy is a respected industry leader committed to providing innovative and effective solutions to the energy challenges of tomorrow.



III. Hybrid Solutions Definition for SGRE

Hybrid solutions for Siemens Gamesa RE are combinations of wind with either solar energy or storage or both. The product is available both for ON-Grid or OFF-Grid versions and it can be installed in all new power plants or on existing Siemens Gamesa Wind power plants.



In summary, this integrated Hybrid Technology is formed by a combination of the following:

a) SG HPC (Siemens Gamesa Hybrid Plant Controller). It is the brain of the system. It supervises grid requirements and acts upon those with the energy sources that may be available at the time. It also manages the plant in a way that optimizes the renewable energy penetration in the island and thus MINIMIZES the COE. It is a one-control-point system from which it manages (at a power converter level) all the technologies within the generation plant.

b) WIND Turbine Generators. Manufactured by Siemens Gamesa Renewable Energy, a leader within the Wind industry.

c) Solar PV Plant. Solar Energy Plant.

d) Energy Storage. Preferred storage technologies are Lithium (NMC-LFP), LdC or Redox Flow.

e) Diesel/Gas/HFO Power Plants. Only in pure Offgrid scenarios

IV. Hybrid Hystory by SGRE

2007. Galapagos, San Cristobal Project. First hybrid project with wind (2.4 MW) and diesel generators (1.95 MW total diesel plant). No Storage installed back in 2007. Maximizing wind power penetration through Hybrid Plant Controller and saving fuel. Daily renewable penetration up to >90%; monthly renewable penetration up to >60%.

2014. ETES (Electro-Thermal Energy Storage): First thermal storage proof of concept commissioned in Hamburg. Next bigger demonstrator is being built in in the Hamburg harbor for inauguration in 2019.

2015. LA PLANA. Hybrid prototype test site commissioned. Spain. Siemens Gamesa Hybrid Plant Controller fine-tuned for both Ongrid & Offgrid projects.

2017. Kudgy. Wind (2 MW) & Solar PV (1.7 MW) Hybrid plant. India.

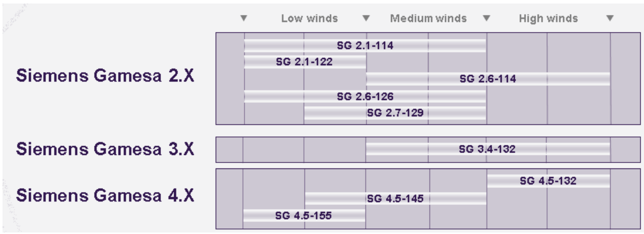
2018. Kavital. Wind (50 MW) & Solar PV (29 MW) Hybrid plant. India.

2019. Bulgana. Wind (196 MW) & Storage (20 MW / 34MWh). Under construction. Australia

V. Technology Overview

A. Wind

+90 GW Globally installed Wind Turbine Generators.



B. Solar PV

Hi-efficiency PV **modules**. Robust, simple single axis **trackers** with excellent capability to minimize shading loss from the structure, with possibility of self-powered engine configuration.

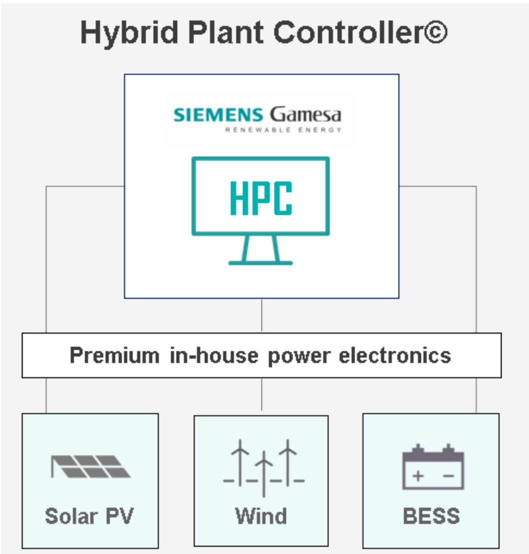
Solar PV Power Station: Plug&PlayISO container plug & play solution including: SGRE Solar Inverters + Transformer + MV Switchgear

C. Storage

E-PCS Power Station: Plug&PlayISO container plug & play solution including: SGRE PCSs + Transformer + MV Switchgear

DC BatteryModule. Li-Ion Battery integrated in a containerized module with DC protections, HVAC & fire detection and suppression system.

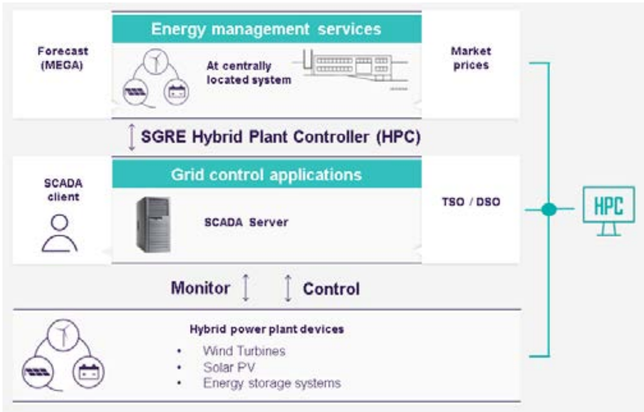
D. Siemens Gamesa Hybrid Plant Controller (HPC)



The HPC is the brain of the Hybrid plant it controls all the assets within a Hybrid Plant to ensure, grid connection compliance, revenue and asset longevity maximization.

In order to be able to successfully manage a complex Hybrid Plant, the HPC has different layers of control:

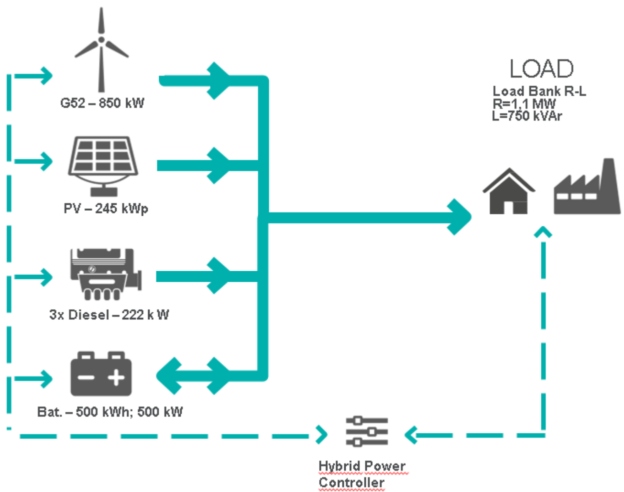
- Control at asset level. The HPC has some control functions performed by the WTG, the solar inverters and the storage PCSs. This is the only option to react quickly enough to ensure a strong grid stability.
- Hybrid Plant Control and Scada. Only one system controls and monitors at the Hybrid Plant level all the renewable and storage assets of the Hybrid Plant. It guarantees grid compliance.
- Energy Management Services are remotely located, and optimize hybrid plant revenue. It combines renewable production forecasting, together with market energy pricing forecasting and storage capacity management to deliver to the Hybrid Plant a Production Schedule. This production Schedule is sent to the Plant every 5-15 minutes and by following this schedule, the Hybrid Plant is able to optimize revenues.



VI. LA PLANA HYBRID SMARTGRID TESTING SITE

In 2015, Siemens Gamesa commissioned a unique, commercial scale, hybrid Ongrid & Offgrid testing site.

The plant is a mix of different technologies:



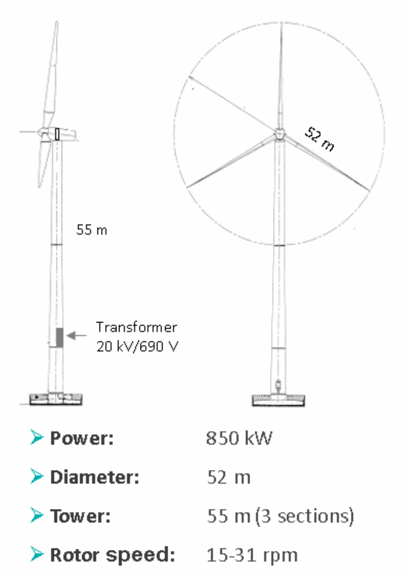
The HPC "Hybrid Power Controller" manages, in real time, the mix of the 4 energy sources: Wind, Solar PV, Storage (2 different technologies) and Diesel. Load is either provided by the grid or simulated using an Active and Reactive Power Load Bank by which a wide variety of load scenarios can be tested.

VII. LA PLANA. PLANT TECHNOLOGIES

In the below photograph, a picture of the Hybrid Plant is shown with the different components highlighted:

The description of the different technologies installed is as follows:

A. *Wind generation: G52 - 850 kW*



B. *Solar PV generation: 245 kWp*

C. *Diesel generation: 666 kW*

- Manufacturer: MTU
- Model: 6R1600DS300 (222 kW, 278 kVA)
- Number: 3
- Cylinders: 6
- Generator: HIMOINSA (HM 280B2) (Permanent magnets, brushless, self-excited)
- Controller: DEIF AGC
- Out voltage: 400 V
- Start time: 15 s
- Consumption (100% power): 59 l/h (0,267 l/kWh)

D. *Lithium Battery: 429 kW – 143 kWh*

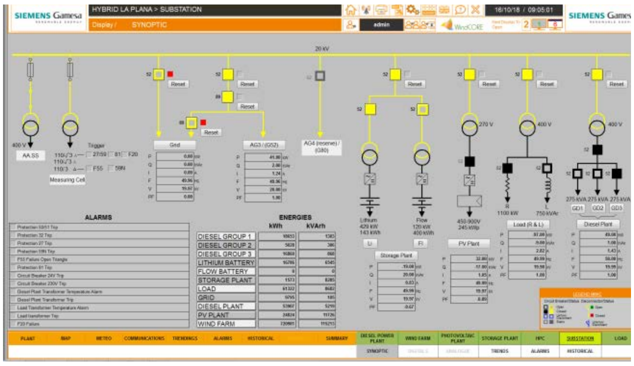
- Chemistry: LMO (Lithium Manganese Oxide)
- Cathode: Li Mn2O4; Anode: graphite
- Manufacturer: SAMSUNG
- Model: Mega 3.3A
- Battery with 3 racks in parallel (429 kW, 143 kWh)
- PCS: Gamesa Electric - GAE 1.25 MW (SGRE)
- Continuous discharge power: 143 kW (1 C)/rack
- Peak discharge power: 572 kW (4C, 5 min)/rack

E. *Flow Battery: 120 kW – 400 kWh*

- Chemistry: Vanadium
- Number of electrolysers: 120 (6 series, 20 parallel)

- PCS: Gamesa Electric - GAE 200 kW (SGRE)
- 2 Electrolyte storage tanks: 18.000 l

F. HPC – Hybrid Plant Controller



This site has enabled Siemens Gamesa to develop the Hybrid Plant Controller both for Ongrid and Offgrid projects in a real environment, which in turn allows us to provide robust and efficient Plug & Play solutions for Renewable energy needs in islands.