

# ANCILLARY SERVICES FOR PV LARGE-SCALE PLANTS A CASE OF SUCCESS IN LATIN AMERICA

S. Hurtado - GPTech Chief Technical Officer  
F. Guerrero, F. Benitez - GPTech System Integration Dpt.



## Advanced ancillary services solution for complete grid code accomplishment in a weak electrical network.

**10 MW PV Plant with GPTech's ancillary advanced services solution to meet all the grid code requirements, installed in the caribbean region**

Utilities and system operators are boosting the connection requirements of renewable facilities, forcing to enhance the management capabilities of the traditional PV inverters to tackle local instabilities at the interconnection point.

Some years ago, the maximum penetration limit of variable renewable energy to be supported by a country electrical grid was estimated about 20% to ensure the safety of the network with the required reliability and quality of power.

The smart combination of STATCOMs solutions, Storage and a customised Power Plant Control has made possible a stable performance under the hardest weather conditions in an island grid.

After the great success of several months of real operation, the renewable penetration limit can be definitively increased up to reach the 50%. Hence, renewable generation plants with an adequate selection of power electronics systems, ready to offer a power quality improvement, are becoming a new ally for the electrical grid stability, opening at the same time new market possibilities for the sector.

## ANCILLARY SERVICES FOR PV LARGE-SCALE PLANTS

# Ancillary services system description

Complex systems with an easy integration to meet the grid code requirements

The GPTech Solution makes the PV facility to comply with frequency response, voltage regulation, reactive power capability and ramp rate control.

This can be achieved by means of a Complete Ancillary System consisting of:

### **GPTech EnergyReserve® BESS**

BESS system with modular GPTech Battery Power Conditioning System.

### **GPTech GridCapabilities AVCS STATCOMs**

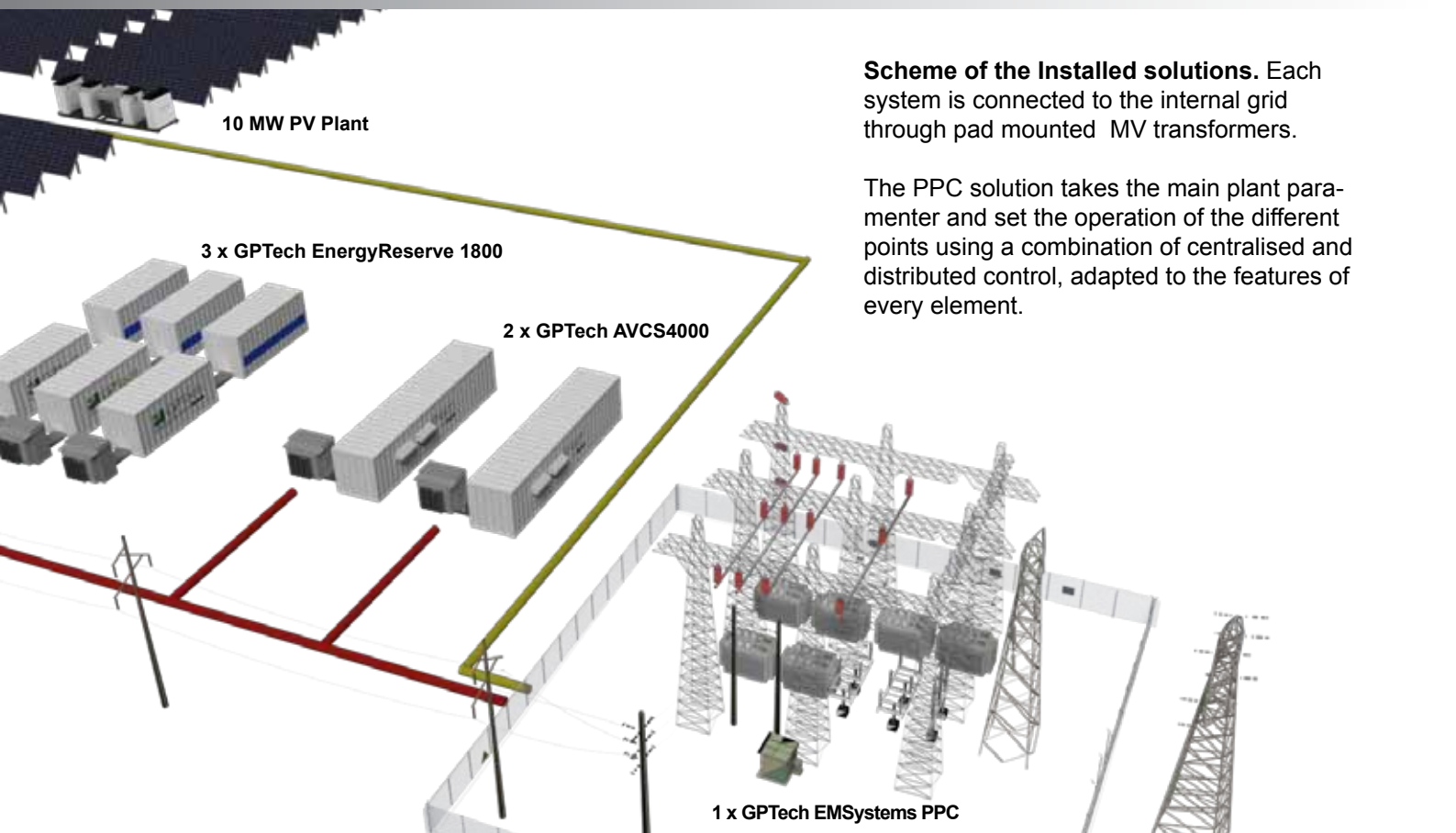
Integrated Solution using modular electronic converters for VAR support.

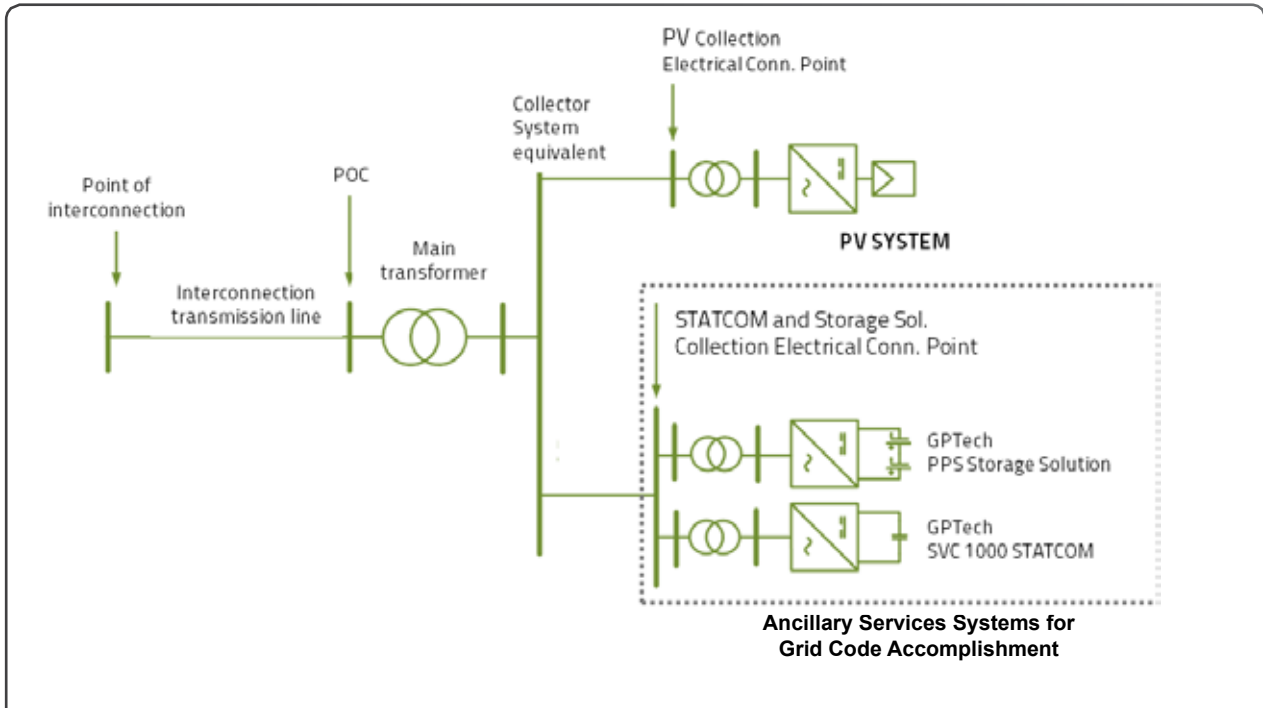
### **GPTech EMSystem PPC**

Power Plant Controller for centralised management of the Power Regulation.

The commercial project must operate for the next 20 years. Due to this, in addition to the technical solution it has been developed a sophisticated O&M plan, created according to the nature and specifications of the different components.

Storage-System O&M plan was expertise-analysed deeply to ensure the estimated performance of the plant. The result is an advanced service with optimal spare part management and programmed refurbishment task for the critical elements





SYSTEM	INSTALLED	CAPACITY
Storage	3 x Containerised ready-to-install Li-Ion Technology Intensium Max	3 x [1,1 MW Continuous - 1,8 MW peak during 1']
Battery Power Control System	3 x GPTech EnergyReserve® APCS1800 - DC/AC integrated BPCS with proofed WD conversion technology	3 x 1,7 MW
FACTS	2 x GPTech GridCapabilities AVCS4000 - 40ft Containers with SVC1000WD STATCOM units	1 x 4MVA (4 x SVC1000) 1 x 3MVA (3 x SVC1000)



**Connection Diagram and system final installation.** The flexibility to be directly connected to the AC Medium Voltage grid makes more easy to incorporate the solutions into an operational facility.

## ANCILLARY SERVICES FOR PV LARGE-SCALE PLANTS

# GridCapabilities AVCS STATCOMs

Integrated technology for supporting the grid through dynamic reactive power management.

GPTECH GridCapabilities AVCS STATCOM have been developed for supporting the electrical grid through an accurate dynamic reactive power management at the point of interconnection.



**STATCOM systems installed in the facility**, integrated in two fully-aconditioned 40ft maritime containers

Thus, these system are able to provide a set critical functionalities to achieve the best signal quality:

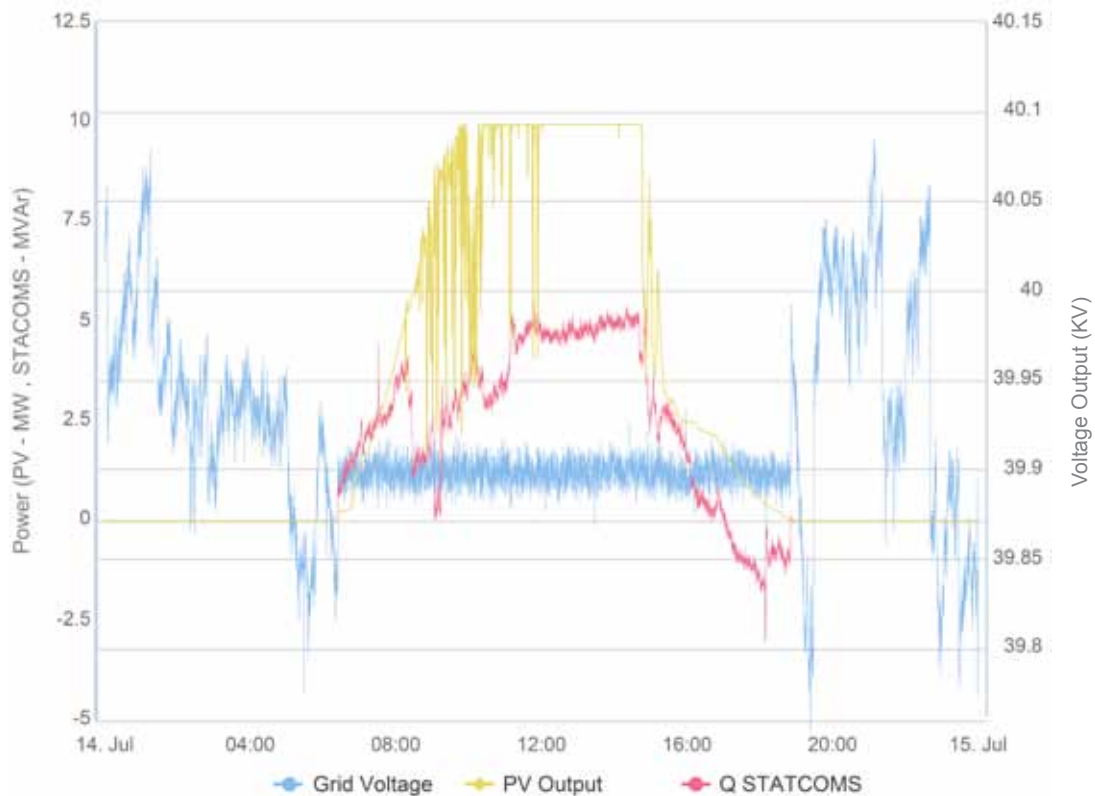
- Voltage control
- Power factor compensation
- Increase of power transfer
- Unbalances compensation
- Damping of power oscilations
- Voltage flicker correction

Voltage regulation and reactive power management at certain points of the grid, can be soundly achieved by means of these efficient and reliable electronics devices, even on days with high solar irradiance variability and operating in weak grids.



**Inside the AVCS**, 4 SVC1000 are installed with customised aconditioning systems and all the protection and auxiliary components

## Voltage Regulation and Reactive Power Management



**Complete Voltage Regulation.** This real data capture of the voltage output shows the regulation of voltage stability using 1 x AVCS4000 and 1 x AVCS3000. As soon as the plant starts to operate, the AVCS regulates the voltage level with the reactive power. Its easy to see the reduction of the voltage variation to the limits required by the grid operator.

## GP Tech STATCOMs technology, 10 years of success

GP Tech accumulates a decade of experience in STATCOMs solutions for Utility-Scale facilities, reaching more than 1GW of installed equipment that work in Wind and PV Large-Scale facilities around the world.

STATCOMs solutions are installed in countries of different regions like Europe, South and North America or the Middle East, customised to help the power plants to meet different grid code requirements in the best conditions.

This solution offers an approach more reliable, flexible and finest to regulate voltage and reactive power capacities than traditional capacitor banks, helping to prevent retrofit costs while optimises the generation capacity.



2008: GP Tech STATCOMs installation for a 50 MW Wind Facility in Spain

## ANCILLARY SERVICES FOR PV LARGE-SCALE PLANTS

# GPtech EnergyReserve® Solution

State-of-Art Storage systems are the key for a new era of on-grid renewable energy development

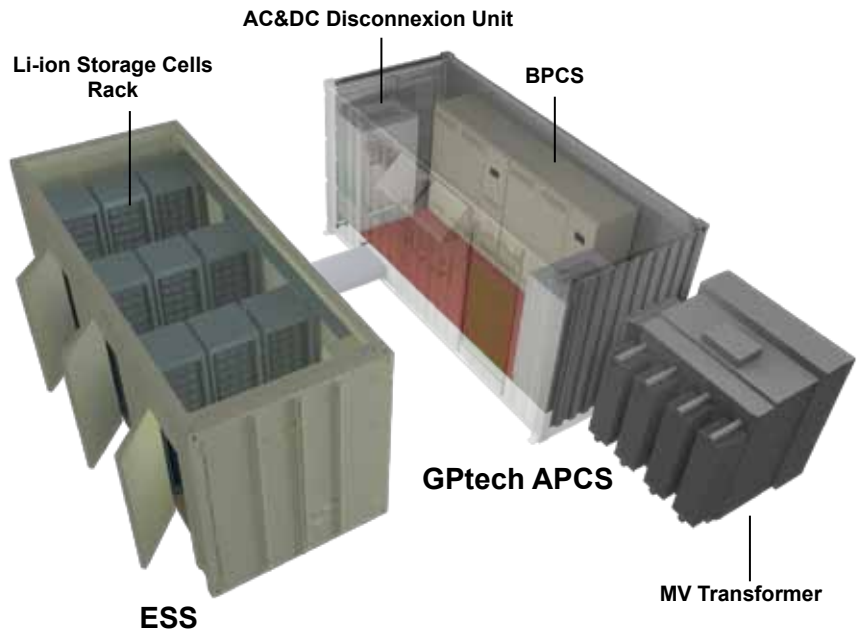
The System is composed of two main units: The Energy Storage System (ESS) and the Advanced Power Conditioning Station (APCS) which controls the bidirectional conversion of power to charge and discharge the stored energy.



**Complete Storage Systems**, the two main elements (BESS and APCS) and the MV transformer

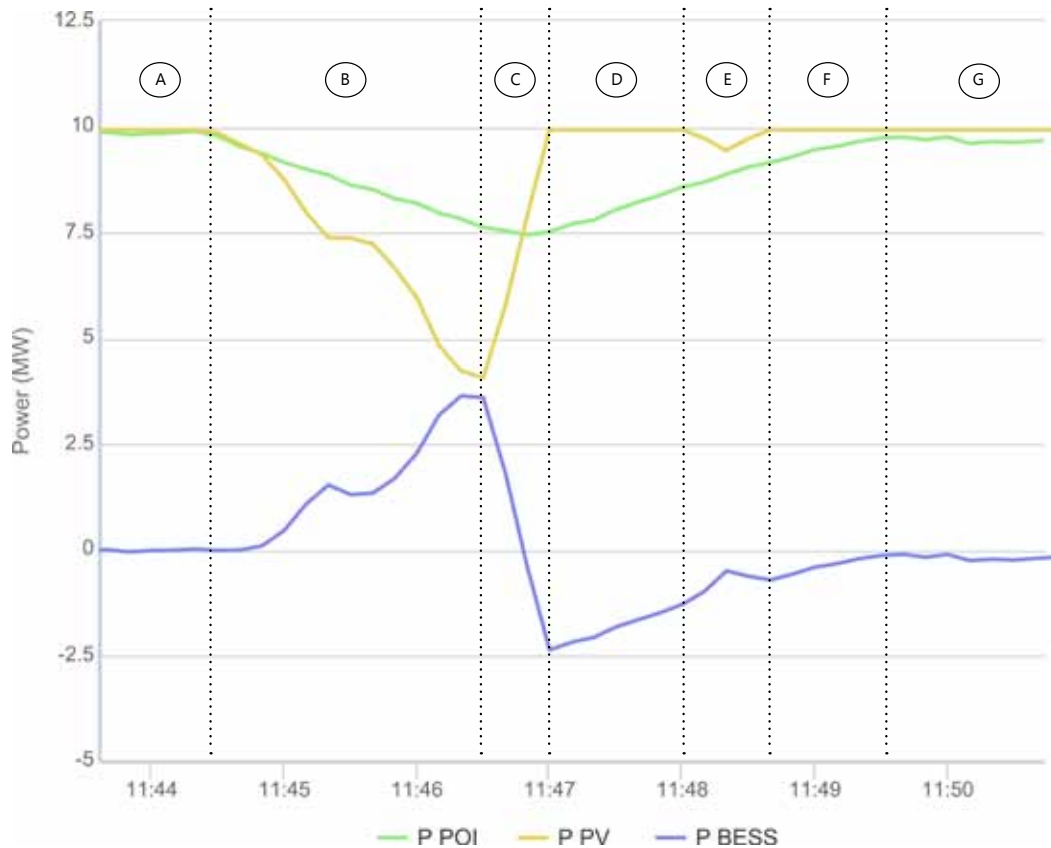
To solve the strict grid code requirements, a Lithium-Ion technology has been selected. In this way we obtain the faster response capability and higher energy density to ensure the accomplishment of technical requirements.

- Frequency Response/Regulation
- Ramp Rate Control
- Improvement of Power Quality
- Flexible Generation
- Power loss reduction








**EnergyReserve Elements**, The correct selection of the storage technology for the required functions, together with a customised control according to the electrical and ambient conditions are essential to optimise the final system.

Ramp Rate response for very fast irradiance fluctuations

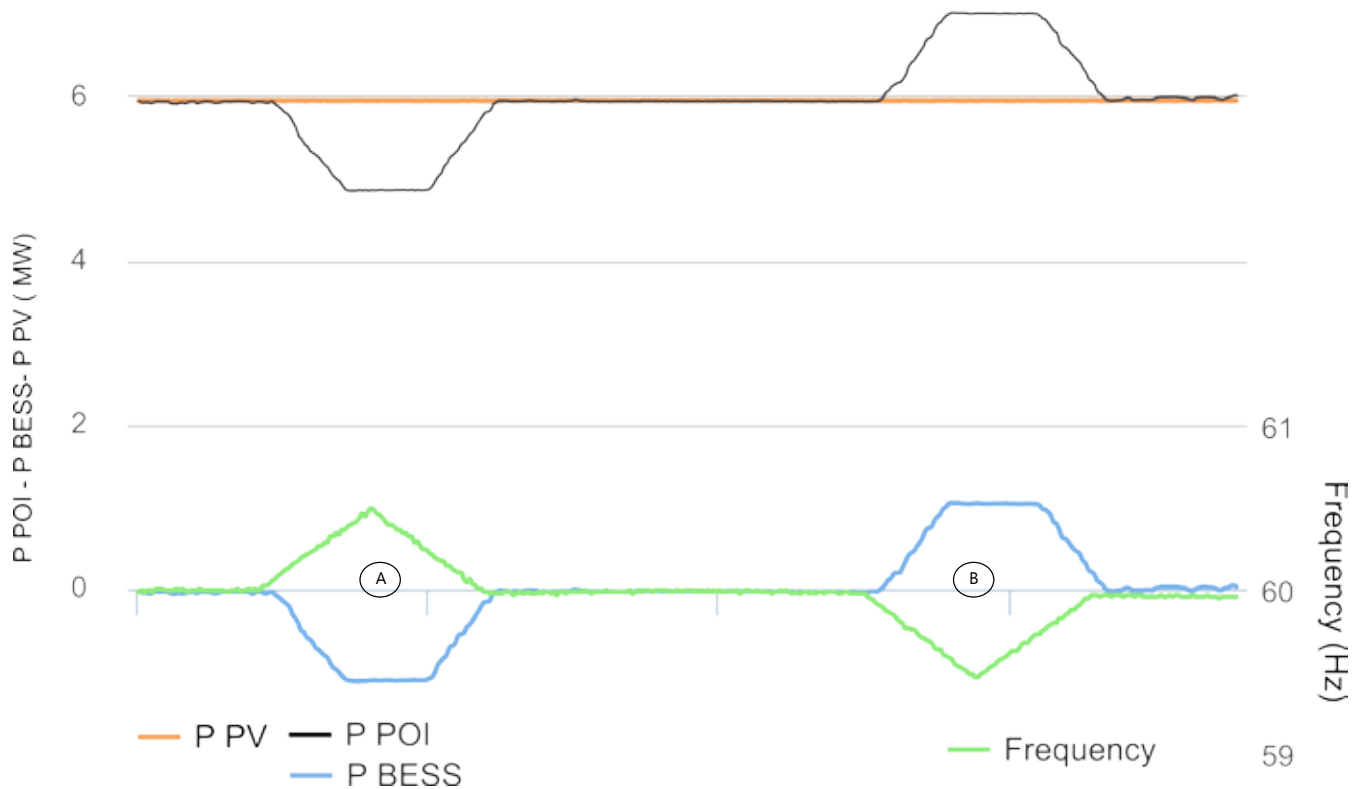


Ramp Rate Control. The real behavior of the PV Plant and BESS under a fast variation in irradiance can be observed in the graph. All the ancillary elements must be coordinated to provide a quick response under fast irradiance fluctuations to ensure the reliability of the plant as energy source for the grid.

	(A) The Facility operates under optimal weather conditions, transmitting the generated PV power to the grid through the Point of Interconnection (POI). The Battery storage system (BESS) is on standby.
	(B) With the fast change of irradiance, the PV decreased suddenly below 50%. The BESS starts to operate, working to levelize this reduction and maintain an output ramp-down according to the Grid Code specifications.
	(C) With a new increase in irradiance, the PV power source rises again. The BESS stop providing the extra energy needed for the ramp down.
	(D) To achieve a suitable ramp-up, the PV output power must be limited to accomplish with the grid requirements. However this excess of energy is used to recharge the BESS.
	(E) Even during the ramp-up, the system is ready to change its behavior and provide the power needed to keep the stability required by the network operator.
	(F) When irradiance conditions become steady again, the facility returns to generate in optimal production conditions
	(G)

## ANCILLARY SERVICES FOR PV LARGE-SCALE PLANTS

### Frequency Regulation with Storage Capabilities



**Frequency Response of 1Hz variation over 1 min.** With a +/- 1 Hz variation over one minute, the response of the different parts shows how the active power output is levelised to compensate the frequency variation.

- (A) During over-frequency events, it can be observed how the PV output does not vary, but the POI Power is limited to compensate the frequency change. The excess power is used for the battery system charging.
- (B) During the under-frequency event, the stored energy is used to increase the plant power output over the available PV source, achieving a complete frequency stabilisation

## Pioneers in Storage Systems...

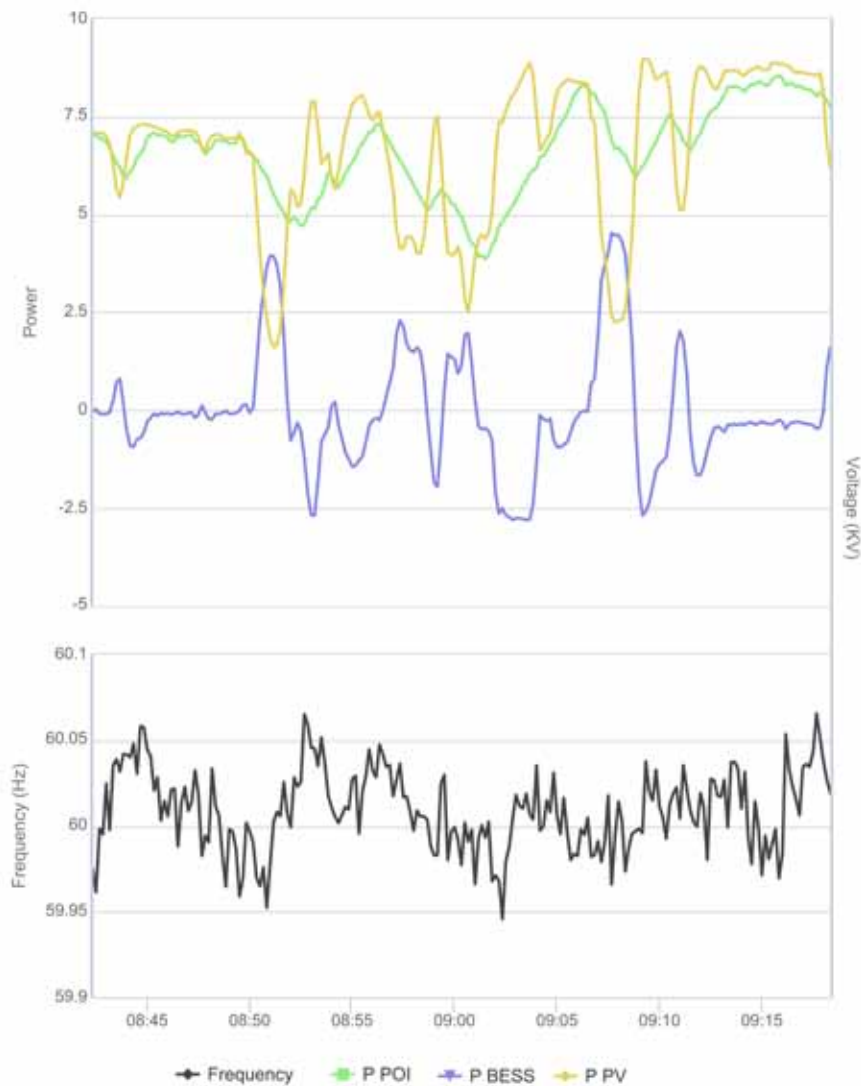
Since 2009, with the development of fly-wheel power converters for spinning reserve systems, the installation of one of the first hybrid PV-Batteries energy shifting systems in Europe, or providing the first storage conversion system for smartcity applications in Latam.

GPTECH works together with key players in the industry: utilities, manufacturer and key expert companies around the world to achieve new levels of performance and stability in complex environments.





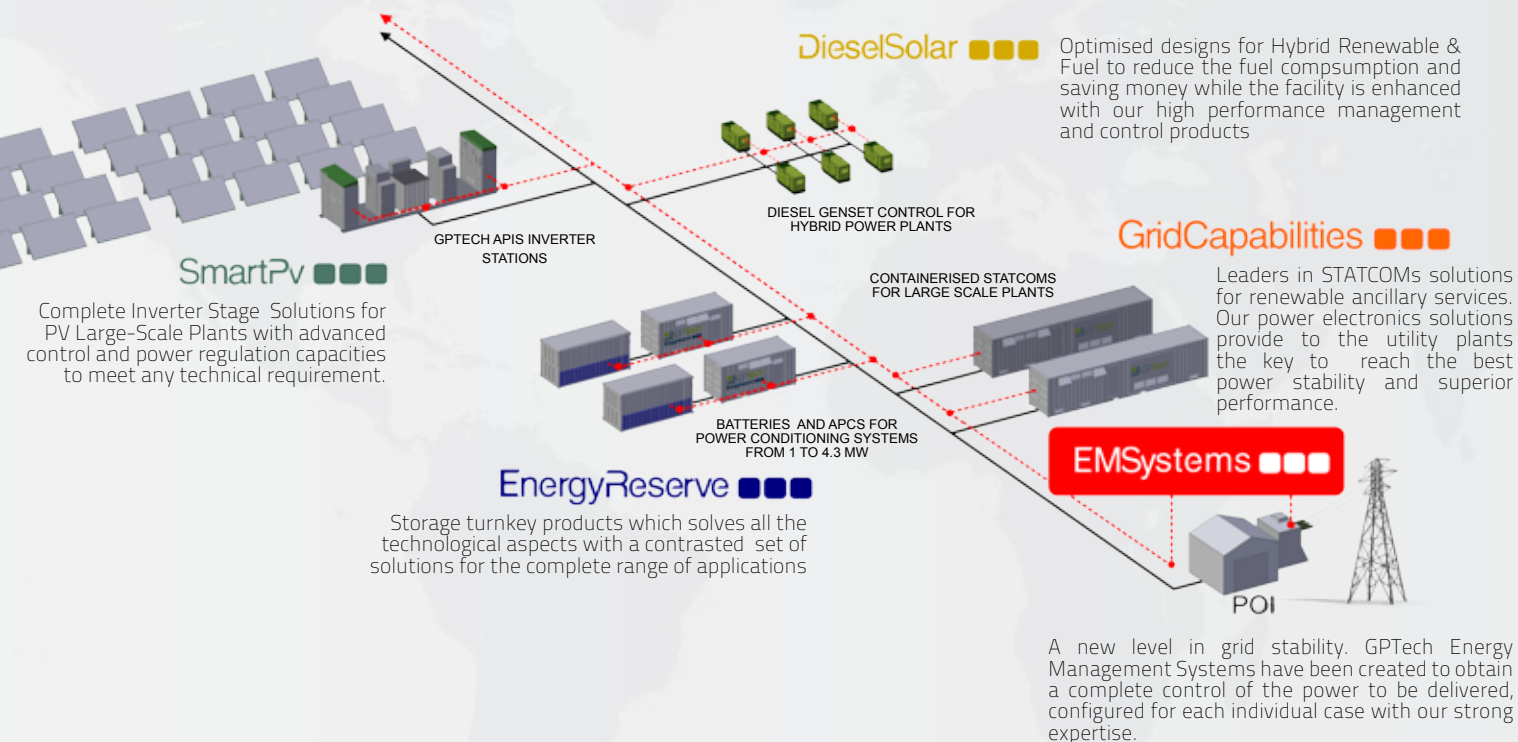
## Frequency Regulation and Ramp Rate



### Simultaneous real-time Frequency and Ramp Rate Compensation in the beginning of a cloudy morning.

The flexibility of the ancillary services system enables the facility to be fully adapted to the frequency variations while working to set the ramp rate conditions.

These features, combined with the power curtailment of the PV output and the advanced control and monitoring of the main elements by the EMS system PPC, convert this renewable facility into one of the most advanced related to its stability and robustness behavior built until now.



## Large-Scale Solutions

For over a decade, our experts develop innovative solutions to solve the new challenges emerging from the world growth of renewable energy sector.

GPTech develops technology and products for power conversion and management achieving total control of the generation chain to obtain the best performance in utility-scale projects.

For every new stage, we enrich our vision with the contribution of key industry players, so that our products and services provide a comprehensive response to the real needs of each project.



GPTech Headquarter

### BRAZIL

Edifício Candelária Corporate,  
Rua Candelária, 65, 16th Floor  
Centro, Rio de Janeiro, 20091-020  
tel. (+55) 21 2172-5351

### PUERTO RICO

Centro de Negocios SAN JUAN  
Metro Office Park (HQ)  
Metro Office Park Metro Parque 7 Street 1  
Suite 204 Guaynabo 00968  
San Juan de Puerto Rico

### USA

#### West

4370 La Jolla Village Drive,  
Northern Trust Building  
Suite 00, San Diego, California

#### East

1111 Lincoln Road 4th Floor  
(Regus)  
Miami Beach - Florida

### SOUTH AFRICA

Floor Lancaster Gate, Hyde Park Lane  
Cnr. William Nicol Dr. & Jan Smits Ave Hyde Park  
Sandton 2196 Johannesburg

### SPAIN

**Headquarter**  
C/ Camino de los Descubrimientos 17  
Isla de la Cartuja  
Seville

#### I+D Center

Avenida de Camas, 26-28  
PIBO 41110 Bollullos de la Mitacion  
Seville

### CHILE

Alonso de Cordova 5870 -  
Oficina 1810  
Las Condes  
Santiago