

# ***Ingeteam***

*READY FOR YOUR CHALLENGES*

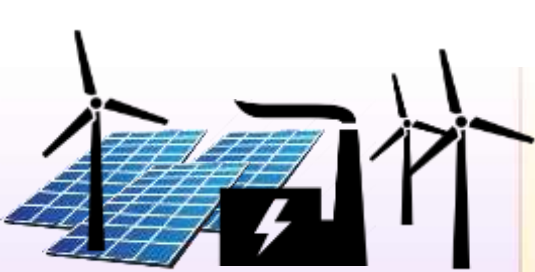
## **Grid, C&I stationary BESS**

[www.ingeteam.com](http://www.ingeteam.com)

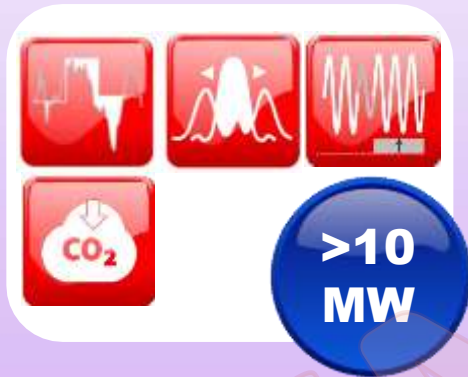
***luismanuel.saiz@Ingeteam.com***

# Almacenamiento + Electrónica de Potencia: Aplicaciones

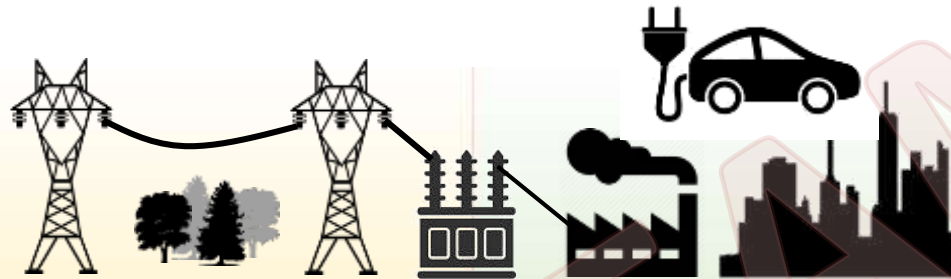
## APPLICATIONS



RENEWABLES / POWER PLANTS



- Renewable Stabilization
- Fossil Peaker Plant Replacement
  - ✓ On-peak/off-peak price arbitrage
  - ✓ Ramping Services



TRANSMISSION, SUBSTATION, DISTRIBUTION



- Ancillary Services
  - ✓ EFR
  - ✓ Demand & Supply balancing
- Investment Deferral
  - ✓ Defer T&D upgrades by strategic ESS



INDUSTRIAL, COMMERCIAL, RESIDENTIAL



- Smooth Peak Demand management
- Day/Night energy demand management
- Resilient power supply
- Green power supply for EV



REMOTE GRIDS & MICRO GRIDS



- Resilient power supply
- Microgrid stabilization services
- Cost and Emission reduction

# INGETEAM BESS : Integrated technologies

*Already Integrated Storage Technologies / Suppliers for Grid and I&C application  
(Residential not include)*



**SAMSUNG SDI**



*During 2020 with already awarded projects*

**Narada**

**CATL**



# INGETEAM BESS : Some of our customers



# INGETEAM BESS : Scope of Supply

Consultancy

Independant - reliable third companies

Power Conversion System

Local SCADA

EMS / Power Plant Controller



Housing

Power Transformer

Switchgears

INTEGRATION

Batteries – Super caps

Cap. Banks – Reactance Shunts

MAINTENANCE



CIVIL WORKS

ELECTROMECHANICAL WORKS

# INGETEAM BESS



## Solutions

Integrating batteries and U-cap from main suppliers

Global experience

Flexibility – Ad hoc solutions

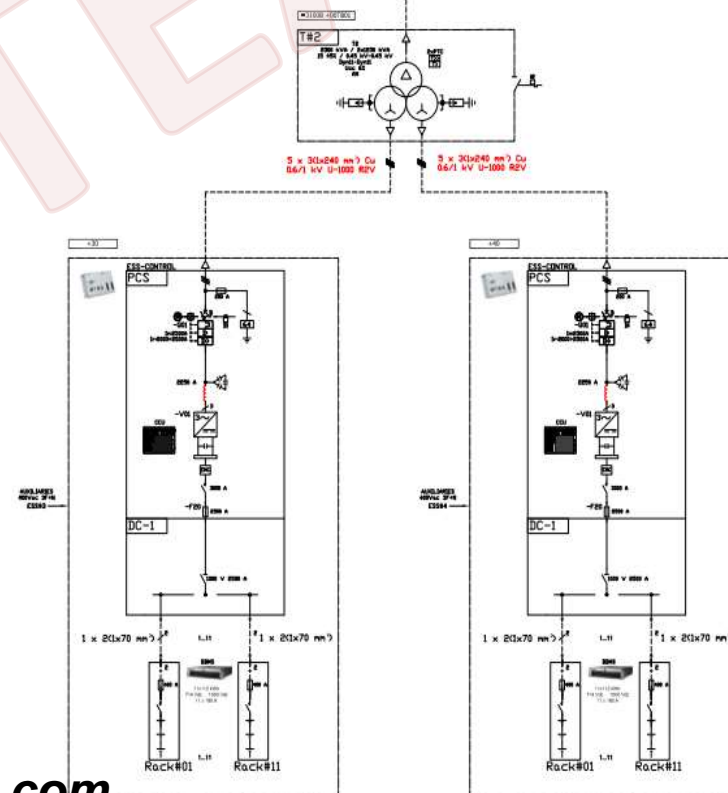
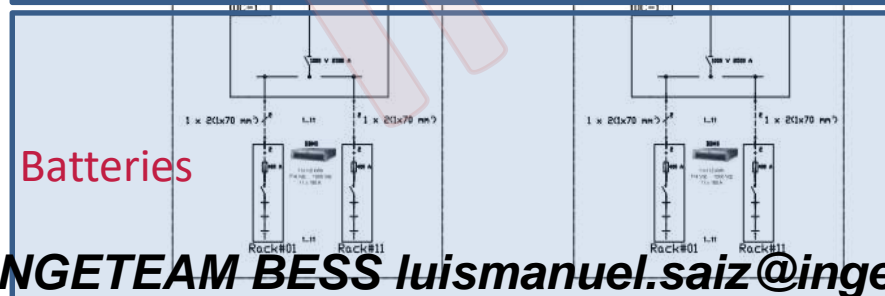
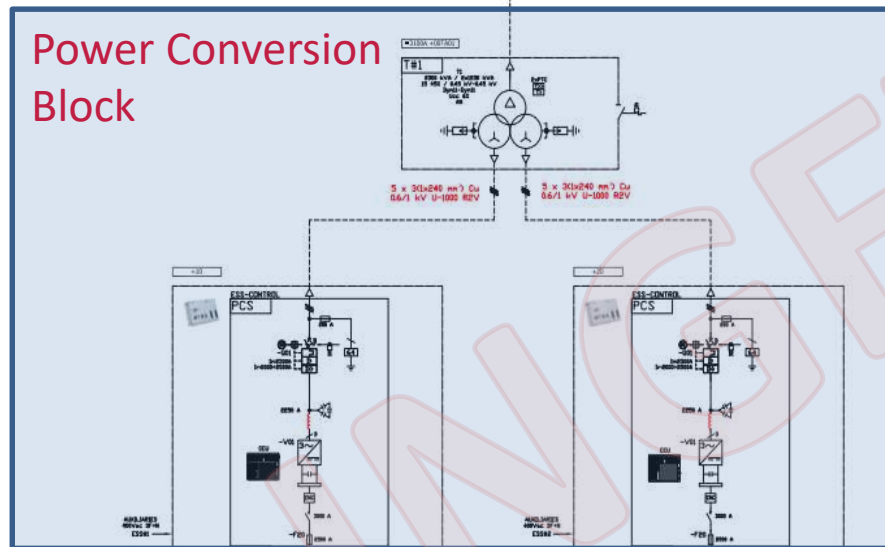
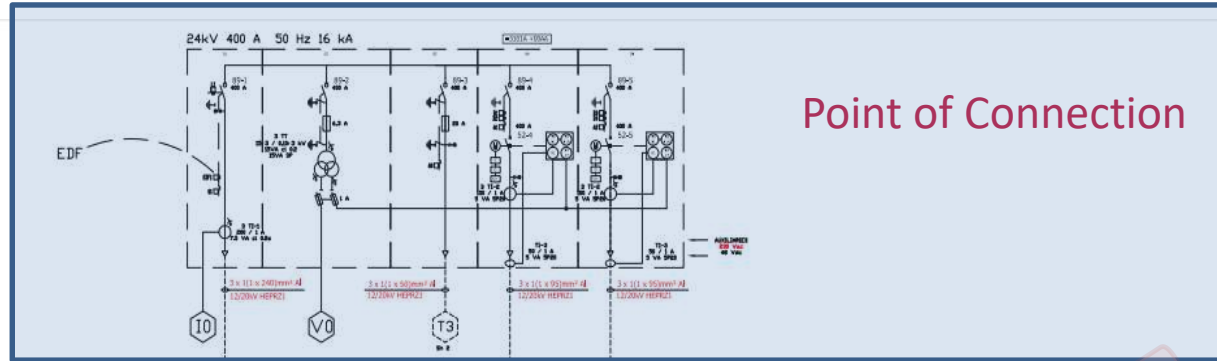
Warranty

Outdoor certified

Safety & local regulation compliance

**INGETEAM BESS** [luismmanuel.saiz@ingeteam.com](mailto:luismmanuel.saiz@ingeteam.com)

# INGETEAM BESS : Single Line Diagram

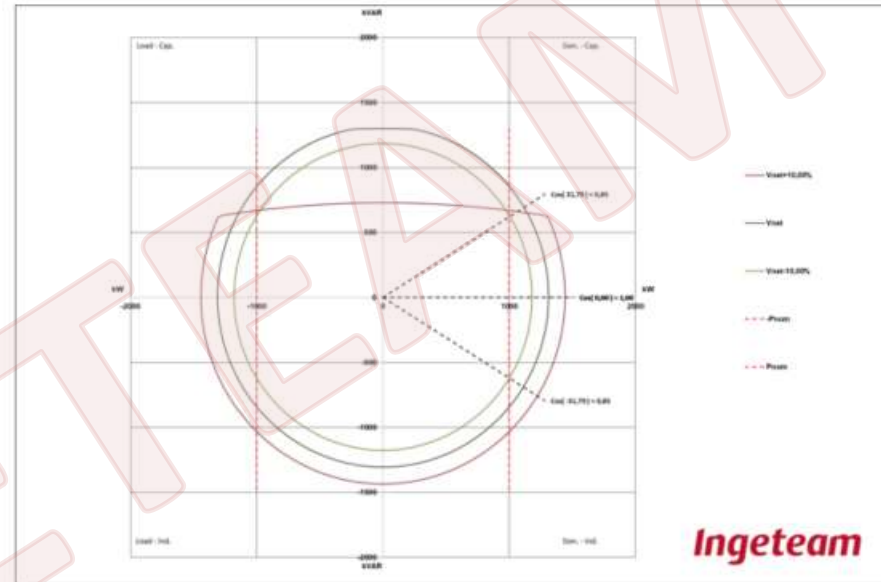
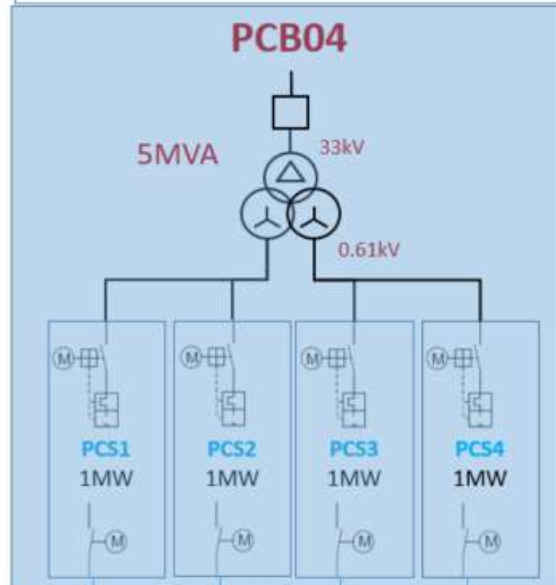


# INGETEAM BESS : Power Conversion Block

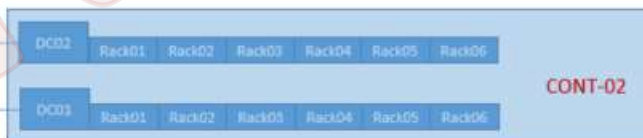
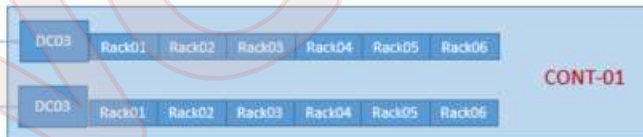
**Ingeteam**

**4MW- xxMWh installed BOL**

@ 50°C / P.F. 0.85 /  $\pm 10\%V_n$  /  $V_{batmin}$  1008V



40FT



40FT

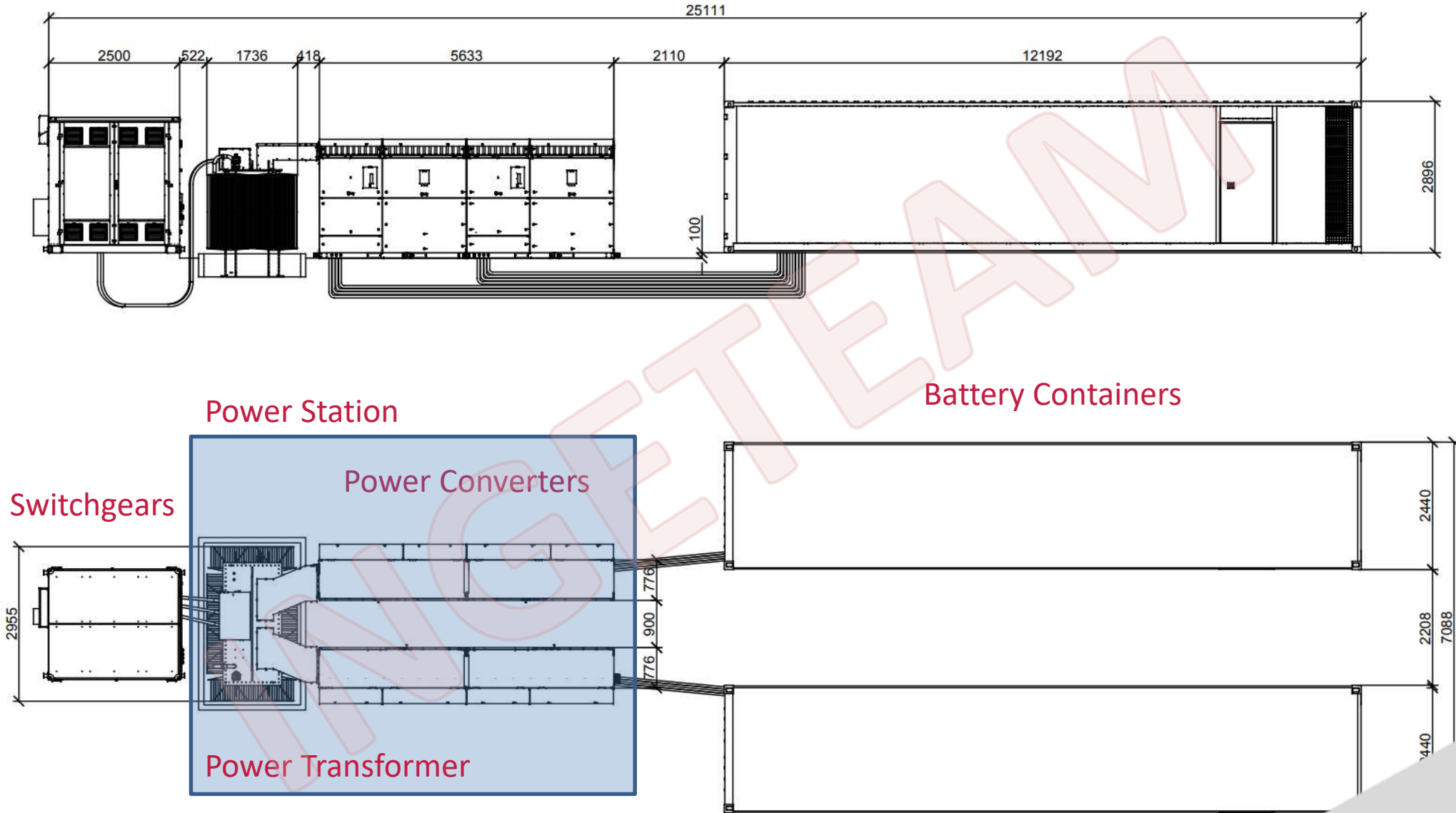
Racks Per Converter	Energy per PCS	Energy per Power Station	Power Per Power Station
6	1,38 MWh	5,52 MWh	5MW
7	1,61 MWh	6,44 MWh	5MW
8	1,84 MWh	7,36 MWh	5MW
9	2,07 MWh	8,28 MWh	5MW

To be defined

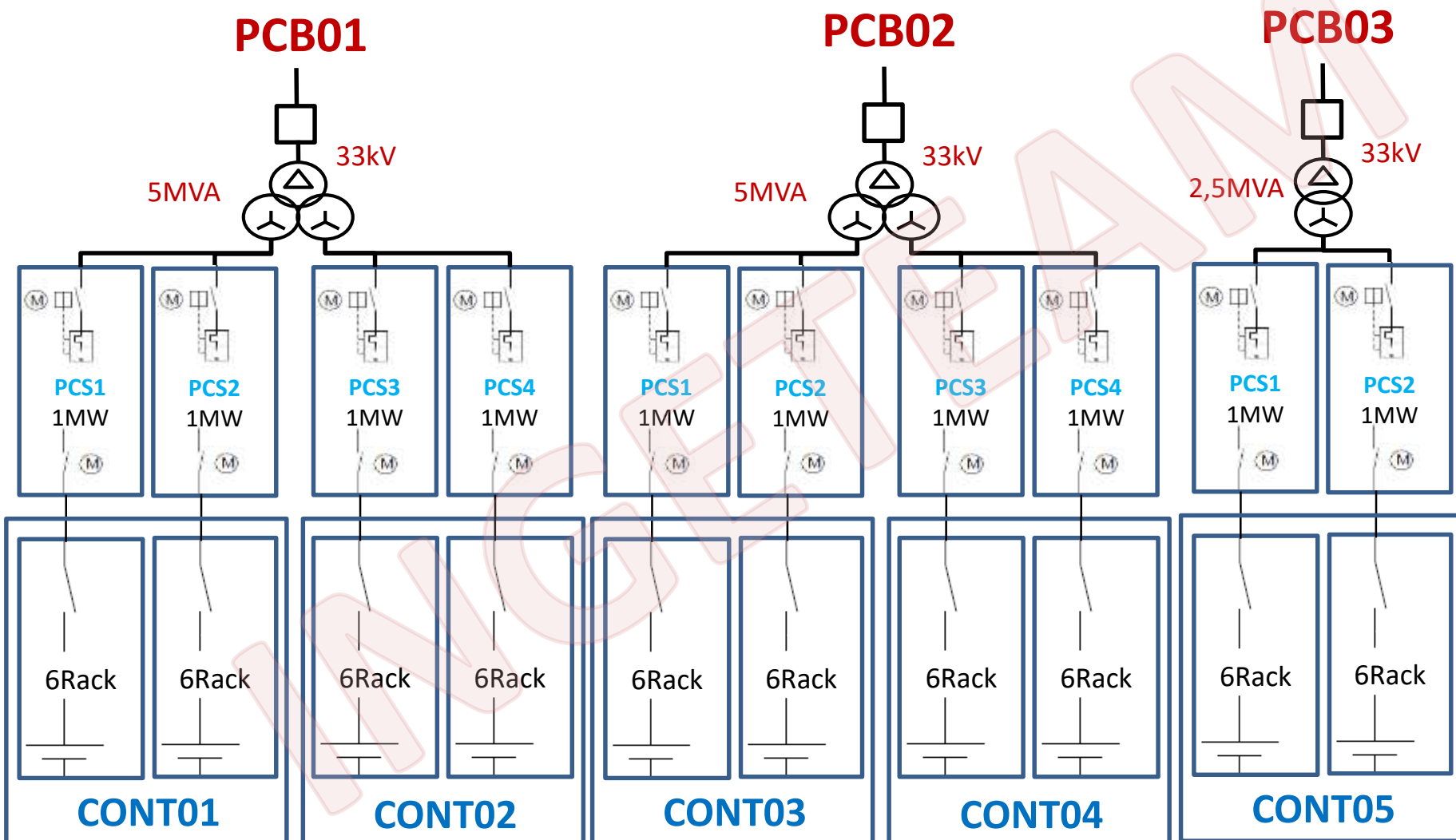
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# INGETEAM BESS : Power Conversion Block Layout



## INGETEAM BESS : Single Line Diagram



# INGETEAM BESS : Battery Selection

## 1. Sizing :

1. Cycling : Models and Simulations
2. Available Energy at End of Life (EOL)
3. Required warranty

## 2. Optimum C rate optimum vs oversizing

### 1. Price :

1. **You want** to buy certain **USABLE energy at EOL** but **you pay** for the **INSTALLED capacity BOL**.

1. For the same application and same usable energy EOL, different battery manufacturers will require different installed capacity BOL, so a better price per MWh installed BOL, not always is the best price.

### 2. EOL

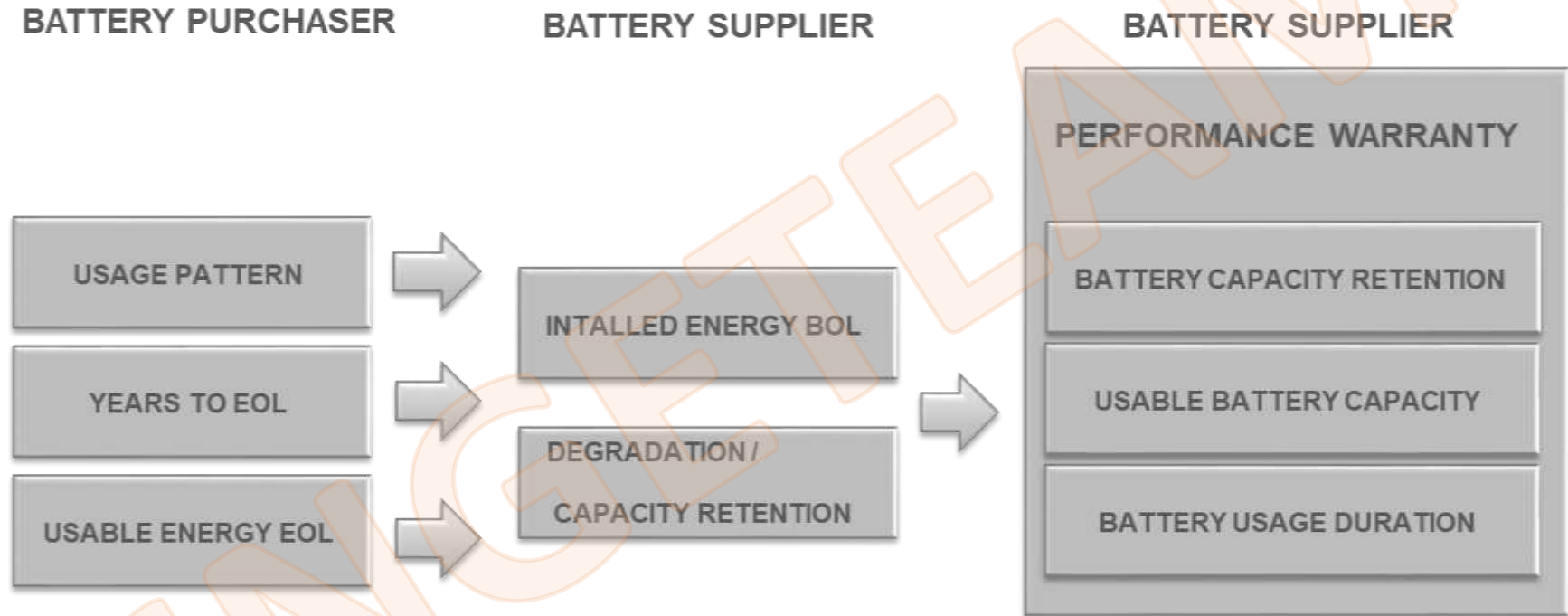
## 3. Efficiency / Maintenance / life time

1. Cycling & Calendar life
2. Partial or total replacement using the same or different kind of modules (estimation of future energy density/prices).

### Typical theoretic C-rates :

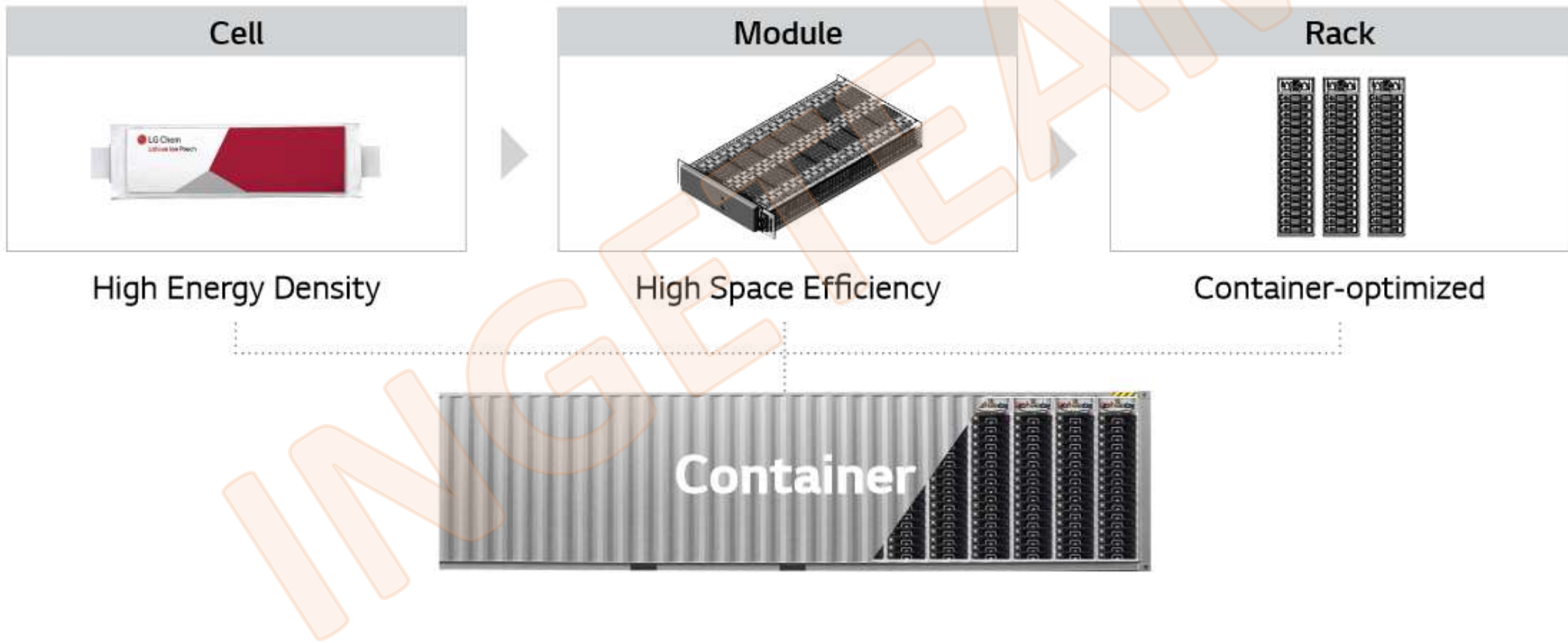
- |  |        |
|--|--------|
| 1. Frequency Regulation                      | : 2-4C |
| 2. Frequency Support                         | : >2C  |
| 3. Energy (Renewables Integration + Back Up) | : <1C  |

# INGETEAM BESS : Battery Selection



# BATTERIES : General Composition

With BPU and BMS!



# BATTERIES : Integration levels

## BATTERY INTEGRATION LEVELS

### CELL MANUFACTURERS:

SAFT, Leclanche, LG Chem, Narada, Panasonic, Samsung SDI, Kokam, CATL, ...

### MODULE SUPPLIERS:

LG Chem, Narada, Samsung SDI, ...

### STRING SUPPLIERS :

LG Chem, Narada, Samsung SDI, ...

### CONTAINER SUPPLIERS :

SAFT, KOKAM, LG Chem, Narada, Samsung SDI, ...

### CELL :

Purchases cells and assemble them (at least) into modules.

Tesla

### MODULE :

Purchases cells and assemble them (at least) into strings.

### STRING :

Purchases strings and assemble them into enclosures (containers, buildings).

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### CONTAINER :

Purchases enclosures (containers) and integrate them into systems (BESS).

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# INGETEAM BESS : Power Converter Selection

## Certificates Sizing

- 1.1 **Maximum Power of the plant.** It is not affected by the Energy.
- 1.2.1 **Peak current** to switch on inductive loads in case of grid forming capabilities
- 1.2 **Reactive Power** requirements (if any).
- 1.3 **Minimum Battery Voltage**
  - 1.2.1 Power Converter is current limited: So the lower the battery voltage is, the less power you can get from the same power converter
  - 1.2.2 Trend: Battery manufacturers are increasing their battery voltages
  - 1.2.3 Alternative: Additional DC-DC Conversion stage
- 1.4 **Maximum Battery Voltage.**
- 1.5 **Temperature and Altitude derating.**
- 1.6 **Grid Voltage Range**

## Price

# INGETEAM BESS Power Converters

Inverters up to 2.75 MVA - 1500 V DC

Outdoor IP56 / Indoor versions

Water/Air cooled models

AC/DC and DC/DC applications

IEC and UL versions

Based on PV inverters with **+16 GW** supplied worldwide



# INGETEAM BESS Power Conversion Systems

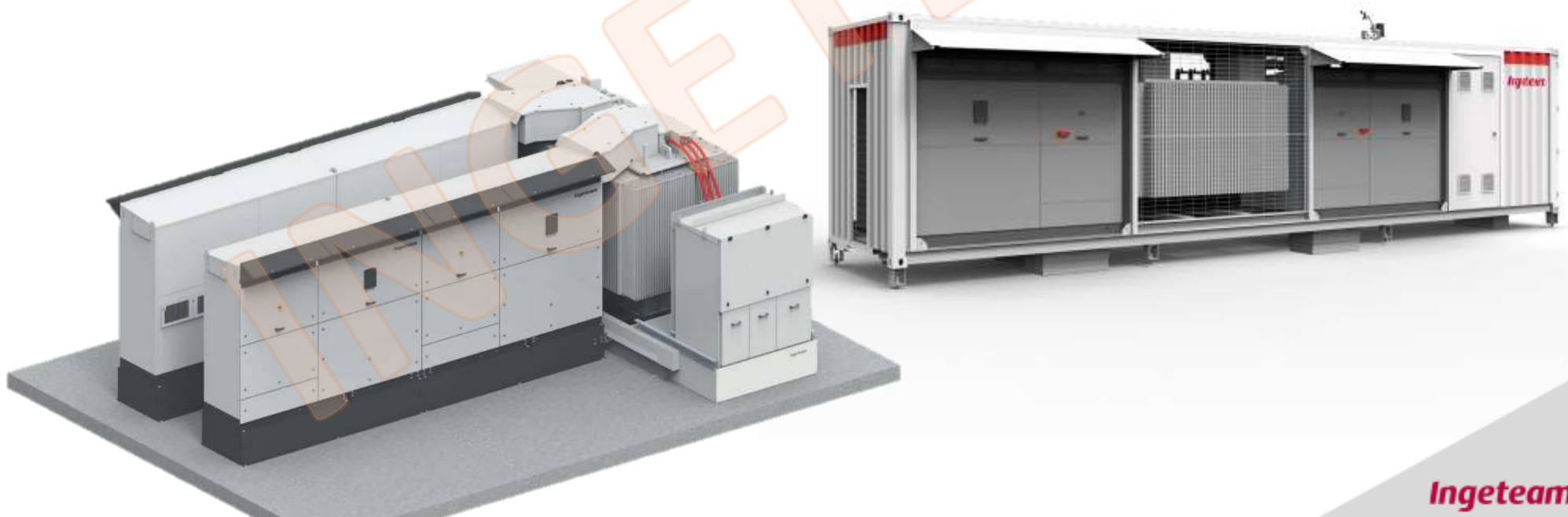
Turnkey solution up to **6MVA, 1.500 VDC and 33 kV**

Outdoor IP56 / Indoor versions

Water/Air cooled models

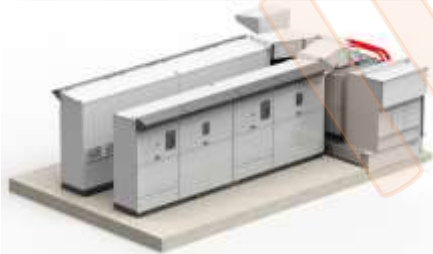
IEC and UL versions

It includes up to four outdoor (IP56) inverters, LV Board, Auxiliary Services, MV Switchgear and outdoor MV Transformer

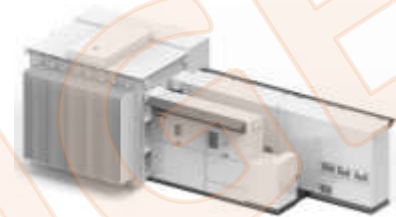


# INGETEAM BESS Power Conversion Systems

## INVERTER STATION



IEC



UL

## INTEGRATED SKID



## CON20 & CON40



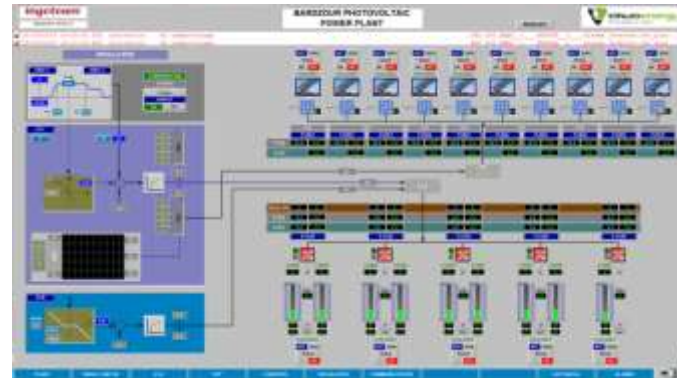
## SHELTER



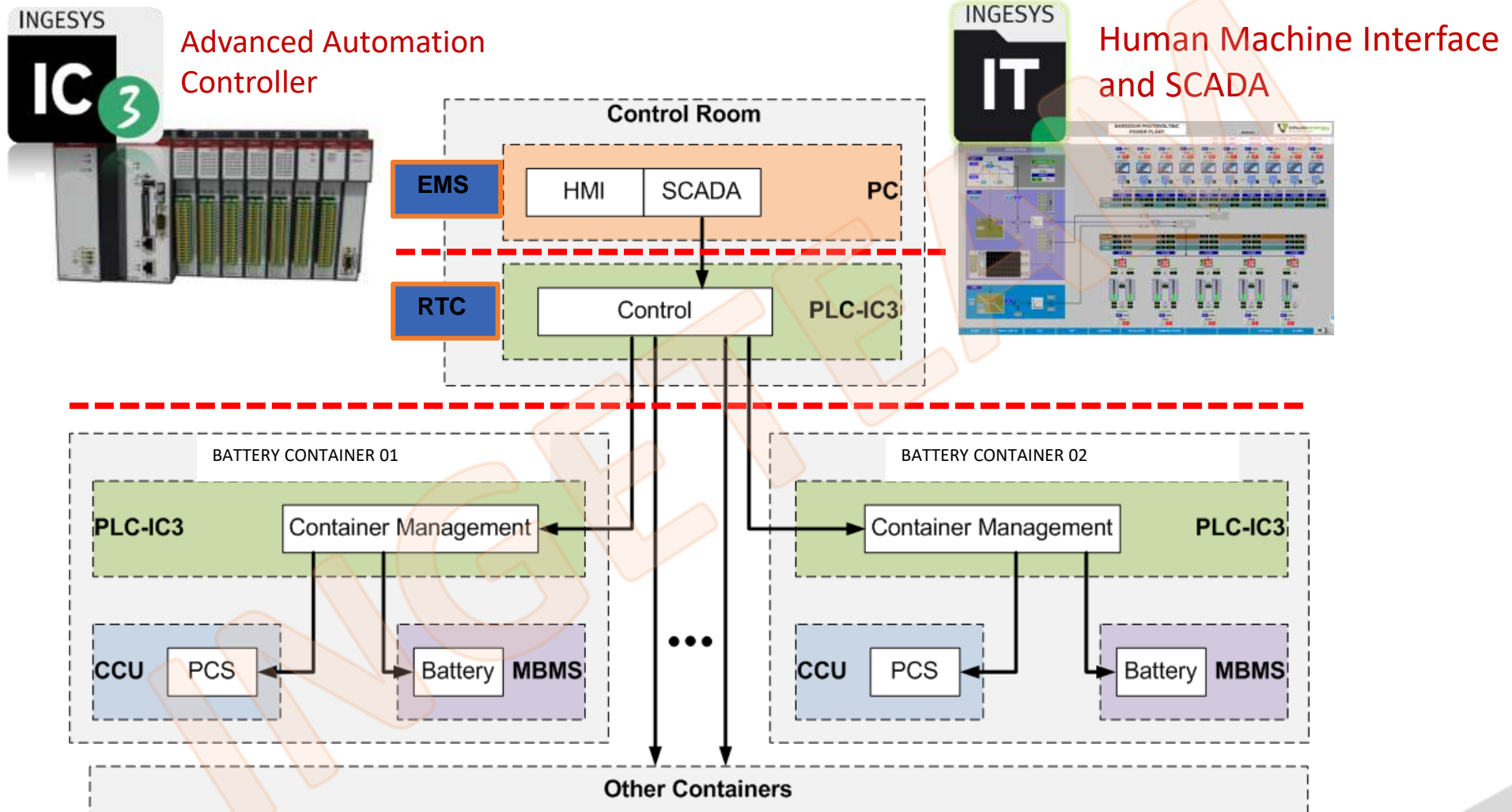
# INGETEAM BESS : Control

## Power Plant Controller – EMS - HMI

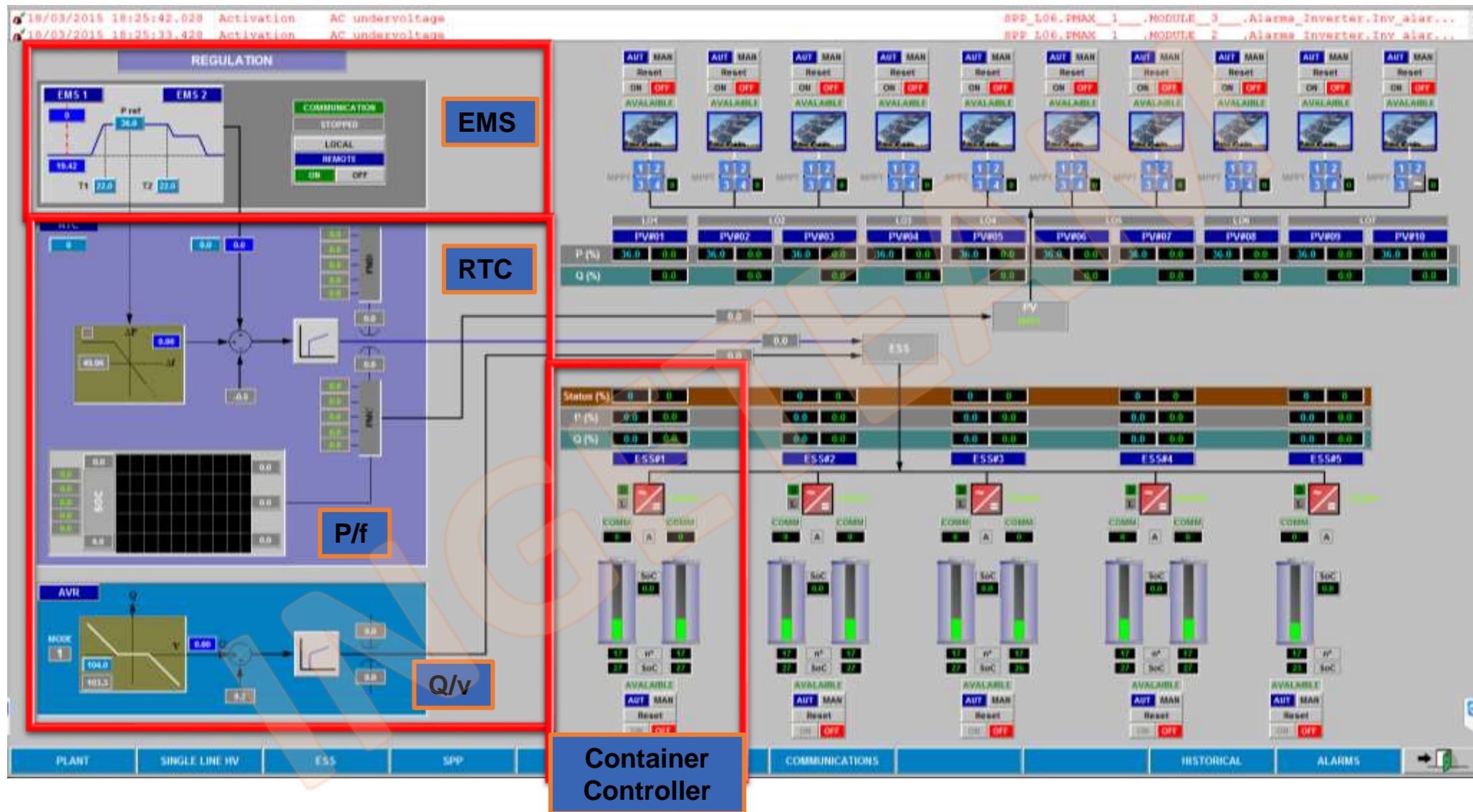
In-house technology  
Proprietary HW&SW platform  
Advanced automation controller  
SCADA + Human Machine Interface  
Flexibility- Ad hoc solutions  
Monitoring tools



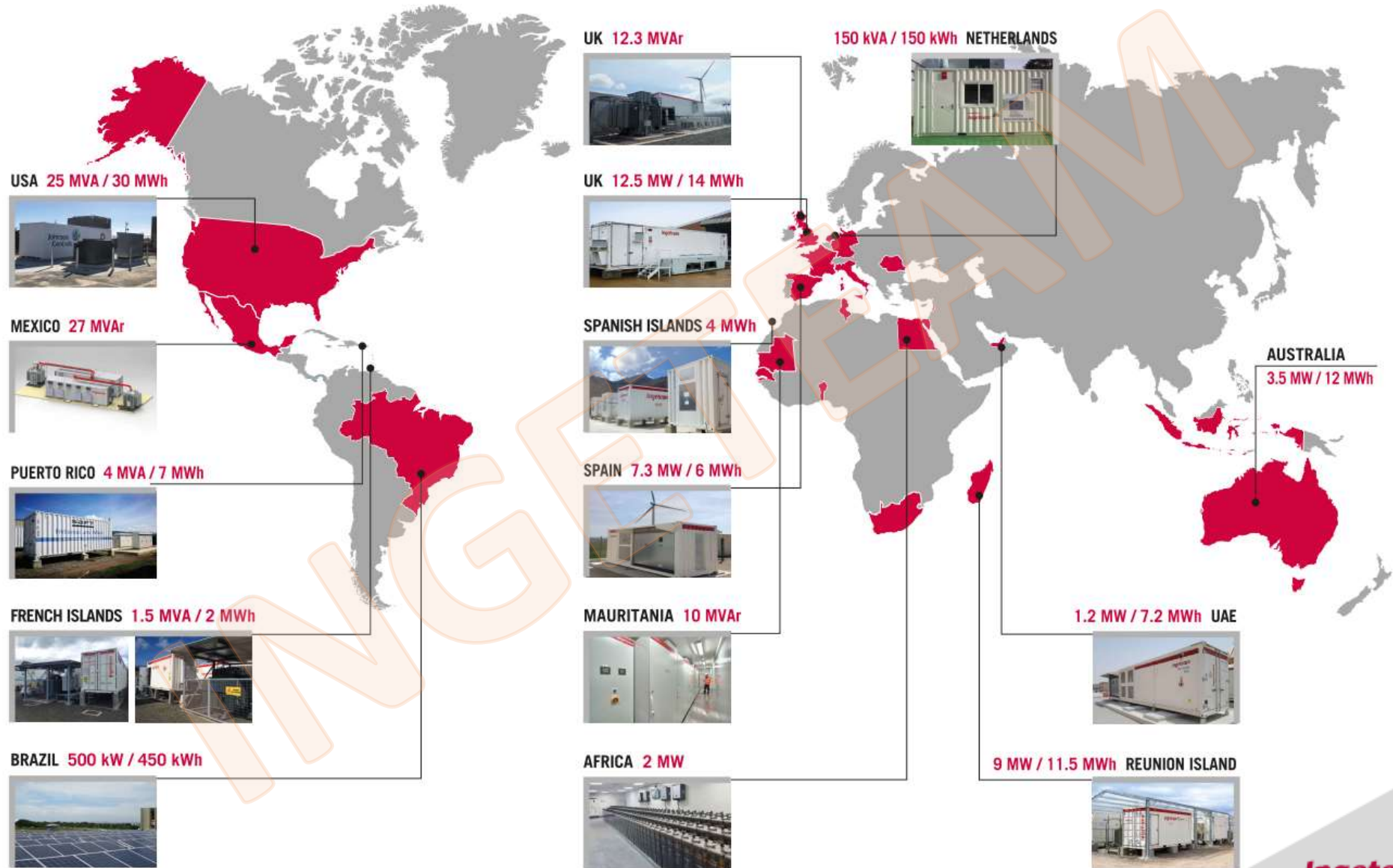
# INGETEAM BESS : EMS/RTC-Hardware/Software platform



# INGETEAM BESS : EMS/RTC-Hardware/Software platform



# INGETEAM BESS, more than 150 MWh installed worldwide



## INGETEAM BESS references :

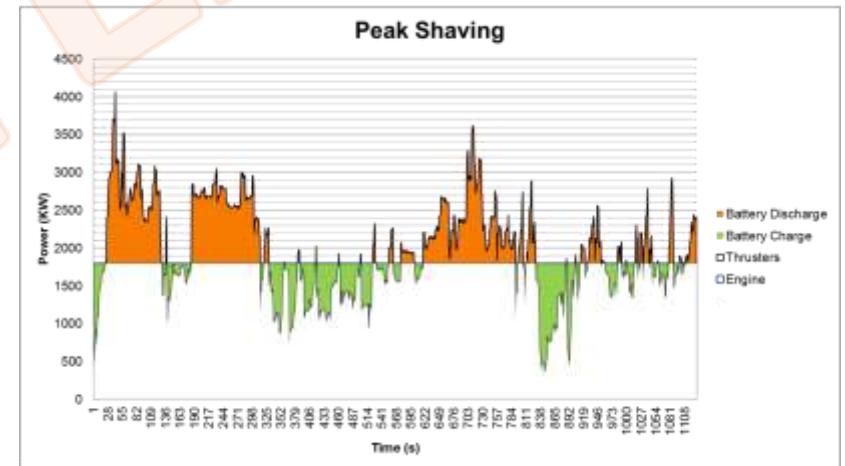
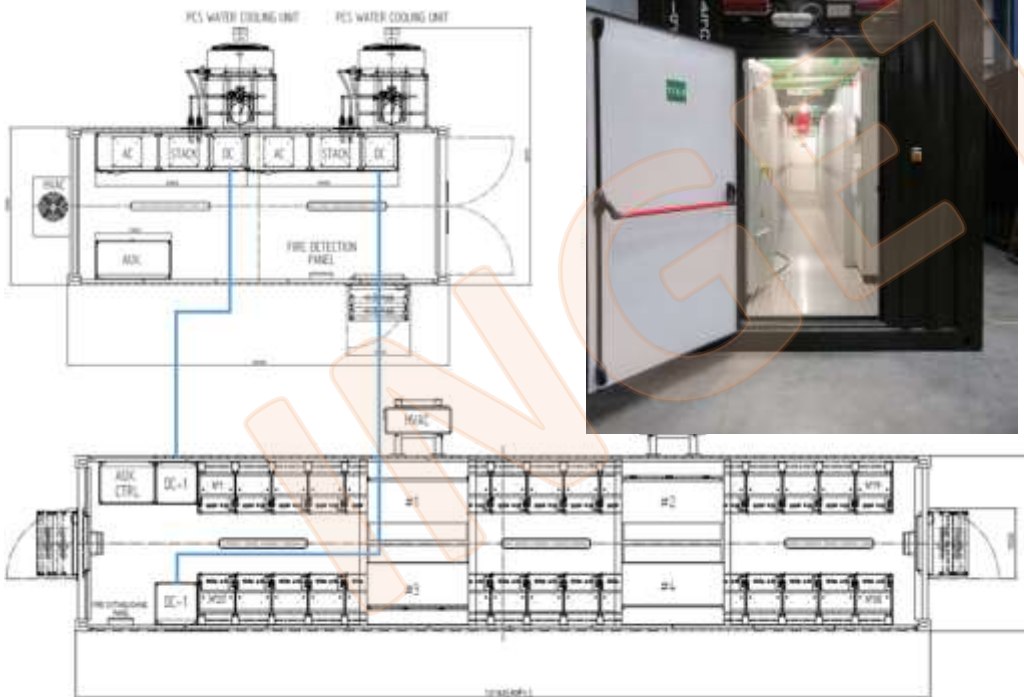
Year	Project Name	Country	Real Power (kW)	Energy (kWh)	Application
2020	CONFIDENTIAL	Ireland	3.000 kW	1.500 kWh	Frequency regulation
2019	Port Blair	India	16.000 kW	20.000 kWh	RES penetration
2019	CONFIDENTIAL	UK	9.000 kW	12.000 kWh	Peak Shaving & Stand-alone BESS in one mine
2019	Tauron	Poland	3.330 kW	3.500 kWh	GRID CONNECTED Frequency control, Grid support
2019	Savane des pères	France	2.760 kW	5.000 kWh	Energy shifting
2019	Millbrook BESS	UK	2.000 kW	2.400 kWh	GRID CONNECTED Peak Clipping
2019	Le Castelet	France	1.700 kW	560 kWh	Proof of concept of the synchronization service on a distribution and on a transmission system
2019	Stade de l'Est	France	1.170 kW	2.500 kWh	GRID CONNECTED
2019	Flexitranstore	Cyprus	1.000 kW	2.000 kWh	Active distribution node (ADN)
2019	Nouakchott airport	Mauritania	1.000 kW	3.000 kWh	Grid support - UPS
2018	5 Projects at : University of Hawaii Community Colleagues	USA	12.250 kW	12.500 kWh	GRID CONNECTED College Buildings Self Consumption
2018	Batrun	France	5.000 kW	4.550 kWh	Frequency Regulation
2018	WLU	Canada	2.340 kW	2.500 kWh	MICROGRID
2018	Gracious Living	Canada	2.340 kW	5.000 kWh	GRID CONNECTED
2018	Monarch	Canada	2.340 kW	5.600 kWh	MICROGRID
2018	ParkView	USA	1.250 kW	1.500 kWh	GRID CONNECTED

# INGETEAM BESS. Case Studies

## Gas Gen-set + ESS (Peak Shaving)

Medium Energy (>1hour ) applications:

- ❖ Peak Shaving (Great Britain, 9MW/12MWh)
- ❖ Provide Power to the load reducing the power demand of the Gen-Sets:



# INGETEAM BESS. Case Studies

## Grid Support (Inertial Improvement + Frequency Regulation)

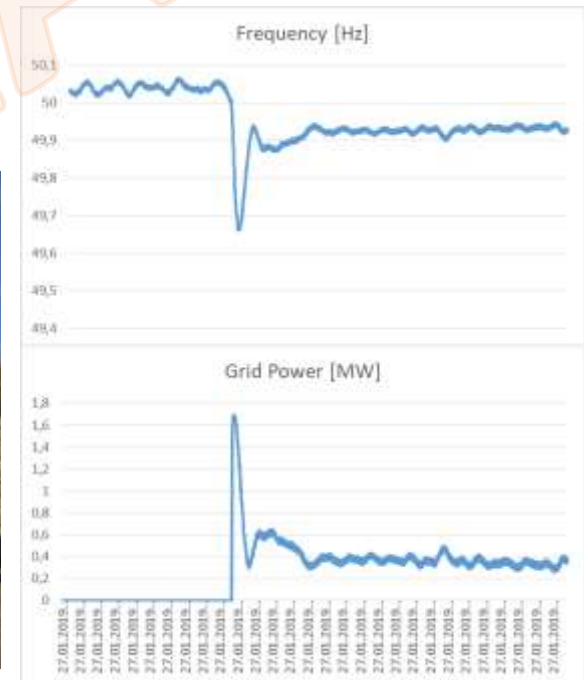
Low Energy ( $\leq 0,5$ hour ) applications:

❖ Primary frequency regulation (Reunion Island, 5MW/2,5MWh)

❖ Provide Power to the grid based on the grid frequency:

❖ Provide Power boost (5MW) with a  $df/dt > \text{threshold}$ .

$$P_{GRID} = k_{GAIN} \times (f_0 - f_{GRID})$$



## INGETEAM BESS references :

Year	Project Name	Country	Real Power (kW)	Energy (kWh)	Application
2018	Mohammed bin Rashid Al Maktoum Solar Park	UAE	1.250 kW	7.500 kWh	GRID CONNECTED Desalination Plant
2018	Beta 1	USA	1.250 kW	1.500 kWh	GRID CONNECTED Strategic Project - New Batteries
2018	Caravaca	Spain	1.250 kW	3.100 kWh	GRID CONNECTED ESS for Frequency Regulation
2018	ORS	Canada	1.170 kW	2.000 kWh	GRID CONNECTED
2018	Vectren Energy	USA	1.170 kW	4.000 kWh	GRID CONNECTED Frequency Control
2018	Klara CRE2	France	1.170 kW	1.800 kWh	GRID CONNECTED
2018	Itaipu	Brazil	20 kW	20 kWh	ESS for Stand-alone system
2018	Cook Island	Australia	1.000 kW	5.600 kWh	Maximize the benefits of grid-connected solar plants
2018	HIDot (hawai dpt of Transportation)	USA	830 kW	1.000 kWh	GRID CONNECTED
2018	Guadalix	Spain	175 kW	333 kWh	MICROGRID Battery storage system for grid connected and island operation.
2018	CT Repsol	Spain	100 kW	60 kWh	SMART GRID
2017	CONFIDENTIAL	UK	3.500 kW	2.000 kWh	Frequency Regulation Peak Clipping
2017	HYWINDESS	Spain	2.450 kW	1.100 kWh	GRID CONNECTED Wind and ESS Hybridation Control Strategies
2017	Mpower - West Dapto	Australia	1.500 kW	1.000 kWh	Grid connected and Grid forming Minimise supply disruptions in the event of main grid failure

**INGETEAM BESS references : 2018 Maktoum (Emirates) : 1,25MW – 7,5MWh (Sodium Sulphur)**

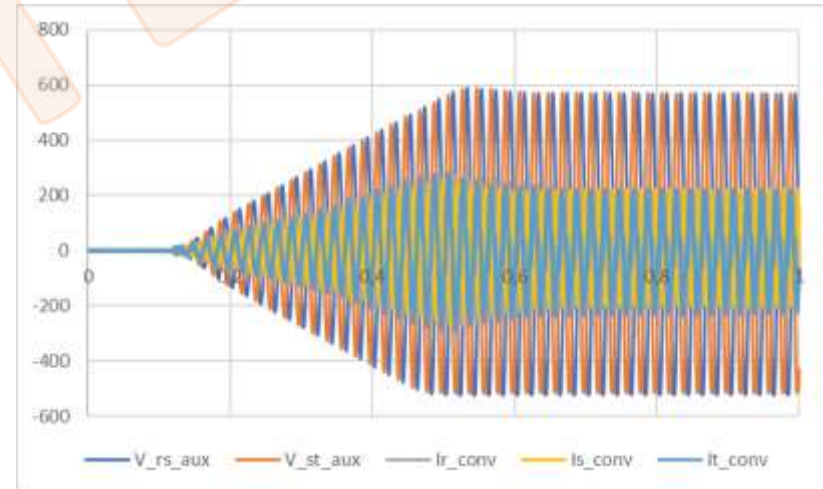


# INGETEAM BESS. Case Studies

## Grid Support (Frequency Regulation + Grid Forming)

High Energy (>2hour ) applications:

- ❖ Primary frequency regulation (Spain, 1,25MW/2MWh)
  - ❖ Provide Power to the grid based on operator commands.
  - ❖ Provide the option to the operator to generate an islanded grid in case of outage.



# INGETEAM BESS. Case Studies

## Frequency Regulation (ESS)

Low Energy ( $\leq 0,5$ hour ) applications:

- ❖ Primary frequency regulation (**Great Britain, 3,5MW/1,75MWh**)
  - ❖ Provide Power to the grid based on the grid frequency:

$$P_{GRID} = k_{GAIN} \times (f_0 - f_{GRID})$$



## INGETEAM BESS references :

Year	Project Name	Country	Real Power (kW)	Energy (kWh)	Application
2017	ACUA	USA	1.100 kW	1.500 kWh	Peak Shaving Energy Saving in waste water treatment plant GRID CONNECTED
2017	TEP BESS	USA	500 kW	1.000 kWh	GRID CONNECTED
2017	IHI BESS	USA	250 kW	250 kWh	GRID CONNECTED
2017	Caribe	France	60 kW	100 kWh	Residential Selfconsumption
2016	Coto Laurel	USA	5.100 kW	5.000 kWh	GRID CONNECTED PV Penetration Ramp Rate - Frequency Control Grid Code Compliance
2016	Hammer Electric SAE	Egypt	125 kW	276 kWh	Street lighting Egypt (LED)
2015	80 Private Sites	South Africa	28.800 kW	4.000 kWh	Stand alone system
2015	TESO FERRY	The Netherlands	3.000 kW	1.600 kWh	ENERGY STORAGE\R Hybrid Ferry Electrical Propulsion including batteries increasing efficiency
2015	Diamant	France	1.500 kW	2.000 kWh	GRID CONNECTED STATCOM + Energy Storage PV Penetration Ramp Rate - Frequency Control Grid Code Compliance
2015	PRANG	USA	1.200 kW	3.000 kWh	GRID CONNECTED PV Penetration Ramp Rate - Frequency Control Grid Code Compliance
2015	Vega Baja	USA	400 kW	500 kWh	GRID CONNECTED PV Penetration Ramp Rate - Frequency Control Grid Code Compliance

## INGETEAM BESS references : 2014 Diamant : 1,5MW-2MWh – 20 years



## INGETEAM BESS references :

Year	Project Name	Country	Real Power (kW)	Energy (kWh)	Application
2015	Guayama	USA	400 kW	3.000 kWh	GRID CONNECTED
2015	Brazilian Army	Brazil	125 kW	276 kWh	Stand alone system
2015	Power Chafarinas	Spain	100 kW	2 kWh	Stand alone system
2015	European Commision Joint research centre	The Netherlands	75 kW	150 kWh	GRID CONNECTED
2015	67 Private Sites	France	3 kW	7 kWh	Residential Selfconsumption
2015	R&D Laboratory Iberdrola	Spain	12 kW	24 kWh	GRID CONNECTED
2015	Private Site	Senegal	30 kW	300 kWh	Stand alone system
2015	Synergie Solaire	Benin	3 kW	25 kWh	Stand alone system
2015	Residential Selfconsumption	Spain	3 kW	1 kWh	Residential Selfconsumption
2015	DECCI	Cezck Republic	15 kW	228 kWh	Portable Microred generator
2014	Bardzour	France	4.000 kW	9.000 kWh	GRID CONNECTED PV Penetration Ramp Rate - Frequency Control Grid Code Compliance
2014	BESS Abeinsa	Spain	1.500 kW	250 kWh	GRID CONNECTED
2014	PVCROPS Project (III)	Spain	100 kW	38 kWh	GRID CONNECTED Validation of a selfconsumtion PV application with energy storage for residential application
2014	PVCROPS Project (I)	Portugal	50 kW	30 kWh	GRID CONNECTED Validation of a selfconsumtion PV application with energy storage for residential application

## INGETEAM BESS references : 2014 Institute for Energy and Transport JRC-IET -

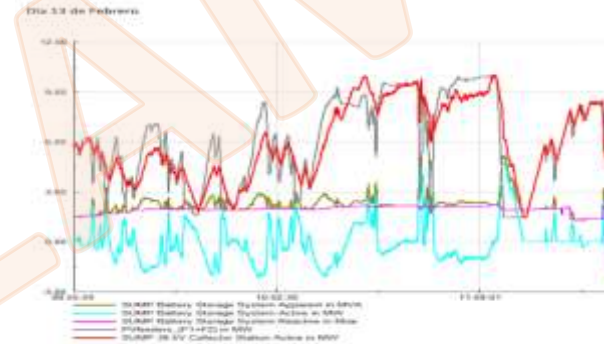


# INGETEAM BESS. Case Studies

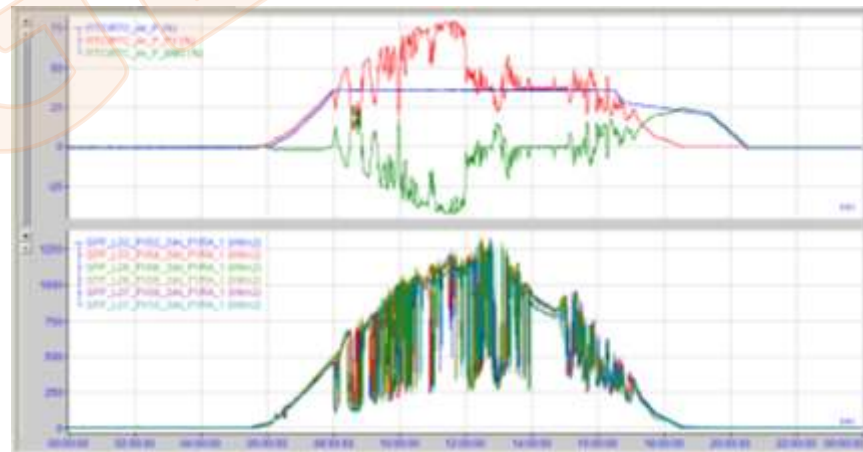
## Renewable Integration (PV + ESS)

**High Energy (6hour>E>1hour )** applications:

- ❖ At beginning focused on ramp rating of Grid Exchange Power (**Puerto Rico, 14Mwp, 4,5MW/1,5MWh**)



- ❖ Currently focused in create a stable and predictable power generation:  
(**Reunion Island, 9MWp, 4,5MW/5MWh**)



**INGETEAM BESS references :** 2014 BESS ABENGOA (Spain) : 1,5MW – 350kWh (Li-Ion)

*Ingeteam Power Converters Integrated by Abengoa*



**INGETEAM BESS** [luismanuel.saiz@ingeteam.com](mailto:luismanuel.saiz@ingeteam.com)

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## INGETEAM BESS references :

Year	Project Name	Country	Real Power (kW)	Energy (kWh)	Application
2014	Romania	Romania	5 kW	7 kWh	New Development
2014	PVCROPS Project (II)	Spain	5 kW	10 kWh	Validation of a self-consumption PV system with energy storage for residential application
2013	STORE Project 2: Guinchos Power Station	Spain	4.000 kW	7 kWh	GRID CONNECTED STATCOM + Energy Storage Frequency Regulation within a Diesel Generation Power Plant
2013	STORE: Aldea de San Nicolás	Spain	1.500 kW	3.000 kWh	GRID CONNECTED STATCOM + Energy Shifting Sucesfully working for Load Shifting, voltage regulation, Frequency Regulation in Distribution
2013	ILIS Project (II)	Spain	1.000 kW	560 kWh	GRID CONNECTED
2013	STORE Project 1	Spain	100 kW	70 kWh	GRID CONNECTED
2013	Regal Top Project	Italy	50 kW	40 kWh	Experimental project
2013	ILIS Project (I)	Spain	100 kW	38 kWh	GRID CONNECTED
2012	Private Site	Spain	15 kW	55 kWh	Stand alone system
2012	Private Site	Spain	10 kW	100 kWh	Selfconsumption + EV Charger
2011	UPNA	Spain	30 kW	75 kWh	MICROGRID grid-connected
2011	Atenea	Spain	50 kW	100 kWh	MICROGRID grid-connected
2010	Chafarinas	Spain	90 kW	1.450 kWh	Stand alone system
2010	Smart-City Málaga	Spain	100 kW	105 kWh	MICROGRID grid-connected
2008	4 installations of 30kW-300kWh	Australia	120 kW	1.200 kWh	Stand alone system
2006	Nembrala	Indonesia	30 kW	300 kWh	Stand alone system
2006	Private Site	Tunisia	10 kW	150 kWh	Stand alone system

**INGETEA BESS references :** 2013 Aldea de San Nicolás (Spain) : 1MW – 3MWh (Li-ION)



**INGETEAM BESS references :** 2013 Guinchos (Spain) : 4MW – 6 seconds (Ultracaps)



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***luismanuel.saiz@ingetteam.com***