



**FACTS**  
Flexible AC Transmission Systems

***Ingeteam***



# INGETEAM

## FACTS: FLEXIBLE AC TRANSMISSION SYSTEMS



**Ingeteam** is a leader company in the design and manufacture of **power converters** and **rotating electrical machines**: generators, motors, and submersible pumps.

With more than **20,000 generators** and **1,800 power converters** supplied around the world, in sectors as varied as energy, industrial, marine, or electric mobility.

Ingeteam offers our clients a team of the most technically **qualified personnel**, the most **advanced software designs** for the design of generators, and an **extensive experience** in advanced project management.

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# CHALLENGES OF THE ELECTRICAL GRID

The need for the integration of more renewable energy, the increase in electricity consumption, the difficulty of building large infrastructures such as lines, generation plants and substations... These factors present a challenge for the T&D power system, which is forced to operate increasingly closer to its **limits of stability**.

Consequently, some of the lines become overloaded, limiting the capacity for **integration of renewable energy sources** on the entire network.

**Flexible AC Transmission Systems (FACTS)** are the solutions that have been developed to improve both the **quality** and **efficiency** of the existing power grid, optimizing its operation.

## Why FACTS?

- To enhance controllability and increase the power transfer capability of a network.
- To increase the reliability of AC grids.
- To improve the power quality.
- To maximize the efficiency of the power transmission and distribution networks.
- To reduce power transmission and distribution costs.
- To defer costly investments in new grid infrastructure.







**Electric machines  
manufacturing plant**  
Beasain (Gipuzkoa)



**Power converters  
manufacturing plant**  
Ortuella (Bizkaia)



**Power electronics  
laboratory**  
Zamudio (Bizkaia)

**Rotating electric  
machines laboratory**  
Beasain (Gipuzkoa)

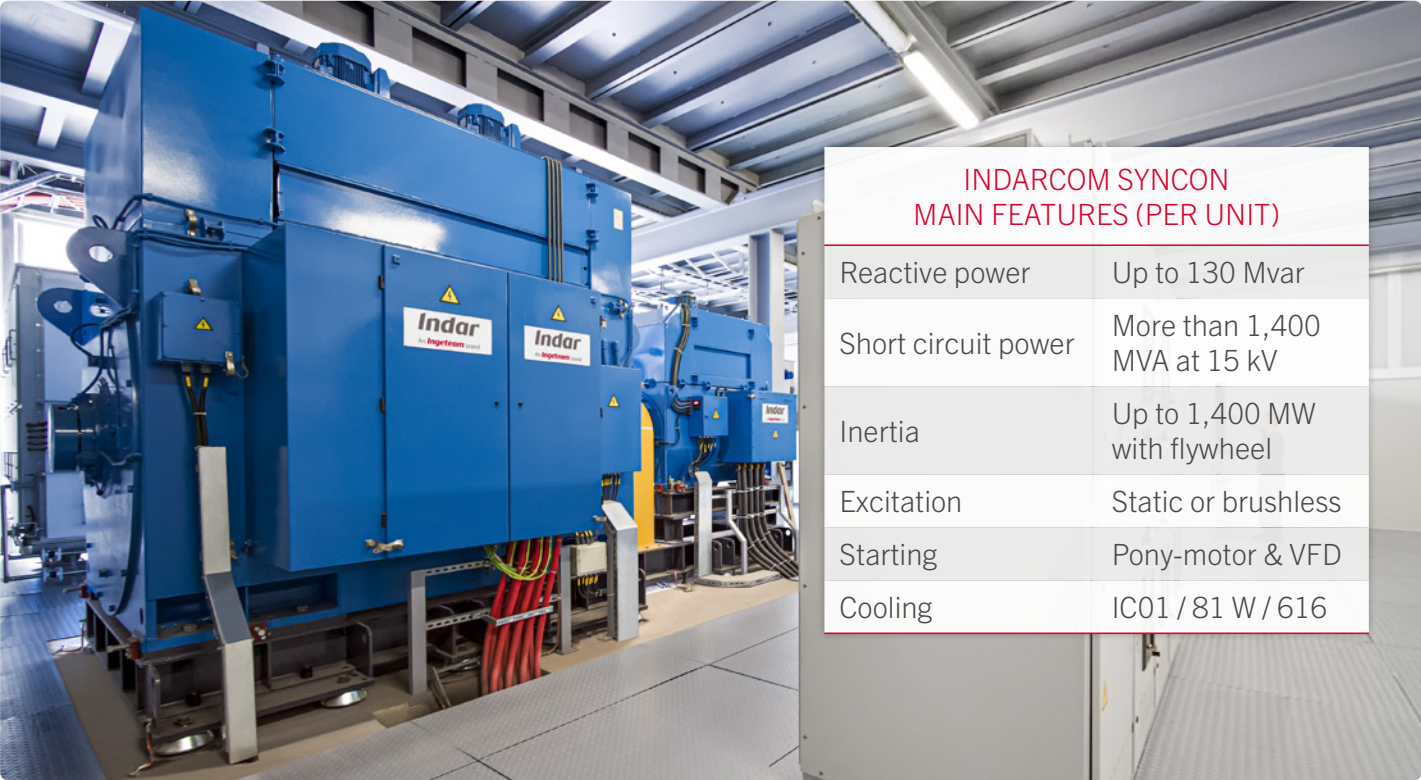




# INDARCOM SYNCON: SYNCHRONOUS CONDENSER

The **INDARCOM SYNCON (Synchronous Condenser)** solution features an electromagnetic design that meets the connection point requirements for **short circuit power, inertia, and reactive power**.

The equipment included in the full scope will comprise the synchronous condenser unit with the starter pony motor, the variable frequency drive, the **INDARGRID AVR** (Automatic Voltage Regulator), the cooling system, lubrication system, low voltage system, control & protection system as basic scope and the e-BoP extended scope that will include the medium voltage system and the auxiliary and step-up transformers.



INDARCOM SYNCON

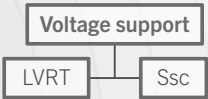
## Frequency support

It supports the rapid rate of change of system frequency (RoCoF)



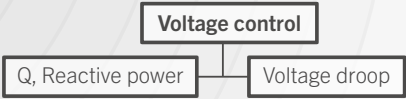
## System strength

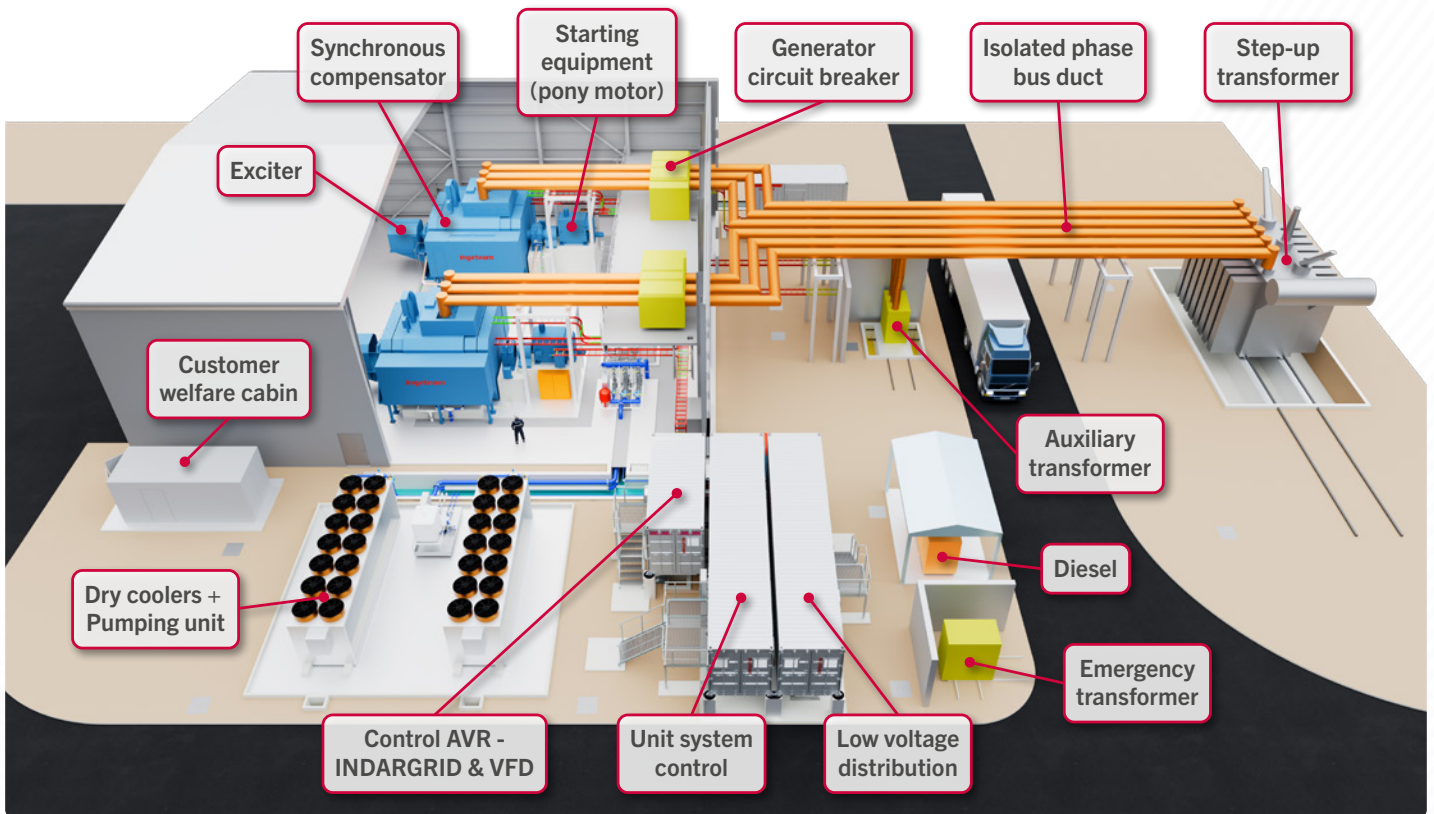
Associated with fault levels and short circuit ratios, it ensures safe protection systems required for fault ride-through and recovery from faults



## Voltage control

Stable operation during normal conditions through reactive power adjustment





INDARCOM SYNCON solution plant layout

## Benefits

- **High short circuit power**  
Reinforcing the grid and allowing further renewable integration. Approximate SCR at HV connection (including HV transformer impedances) is 4 times rated overexcited reactive power capacity.
- **Inertia**  
Requirements can be adjusted by machine design and/or flywheel addition improving grid stability.
- **Improves voltage regulation**  
Continuously adjustable reactive power.
- **LVRT (Low Voltage Ride-Through)**  
The Ingeteam synchronous condenser remains connected to the grid in the case of low voltage events, supporting current and system inertia.
- **Very low harmonics**  
As a synchronous machine, it is designed as pure sinus output, making it easy to integrate into existing grid environments.
- **Short-term overload capability**  
Compared with power electronics devices such as INGEGRID STATCOMs, the synchronous condenser can support grid events with increased output during longer periods and higher ratings.

# INGEGRID SOP:

## SOFT OPEN POINT SOLUTION

**INGEGRID SOP (Soft Open Point)** is a fast-acting system based on FACTS developed to link two different medium voltage circuits, with the same or different voltage levels, angle, or even frequency. It **manages bidirectional power flows** whilst permitting their voltage or power factor to be controlled separately, which **increases power capacity** without traditional reinforcement.



### INGEGRID SOP MAIN FEATURES

Rating: 150 kVA to 50 MVA (higher ratings to be discussed with manufacturer)

Containerized or building solutions, depending on the project needs

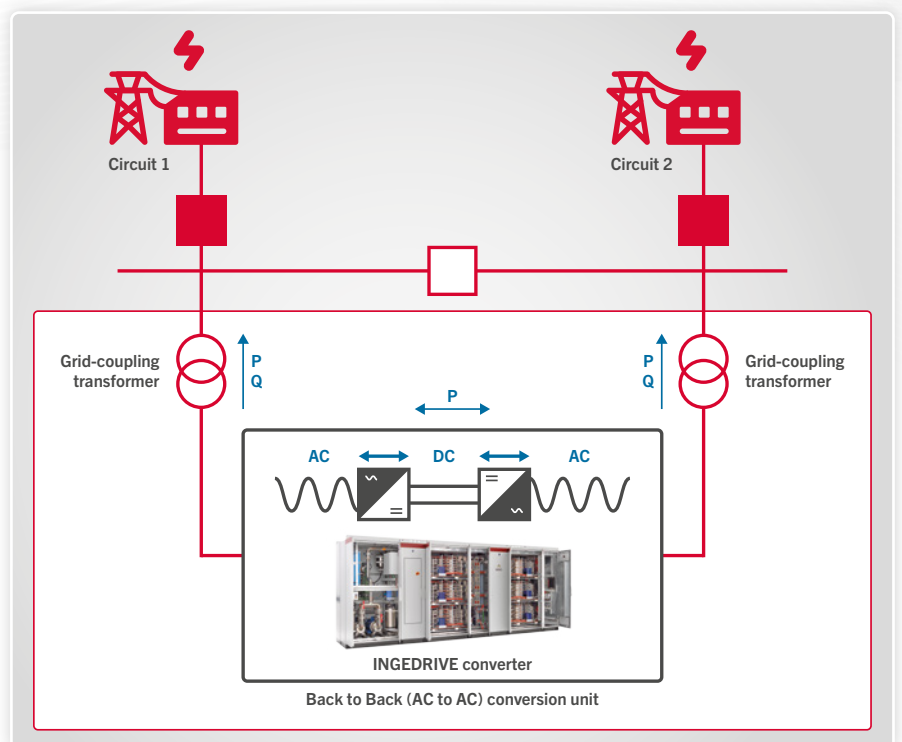
Suitable for lines up to 220 kV (higher line voltages to be discussed with manufacturer)

INGEGRID SOP building interior

The system is composed of a grid-coupling transformer connected to each node of the network. These are linked on the LV or MV side by a back-to-back **AC/DC power converter** system. In addition, energy storage can be installed on the DC bus.

The converter solution is optimized to meet the project needs. Therefore, our INGEGRID SOP solution is installed in factory-built, factory-tested **containers**, to **reduce commissioning and installation times**.

As an option, coils can be connected to **extinguish faults to ground**, resulting in an increase of the availability (e.g. SAIDI and SAIFI, etc.).

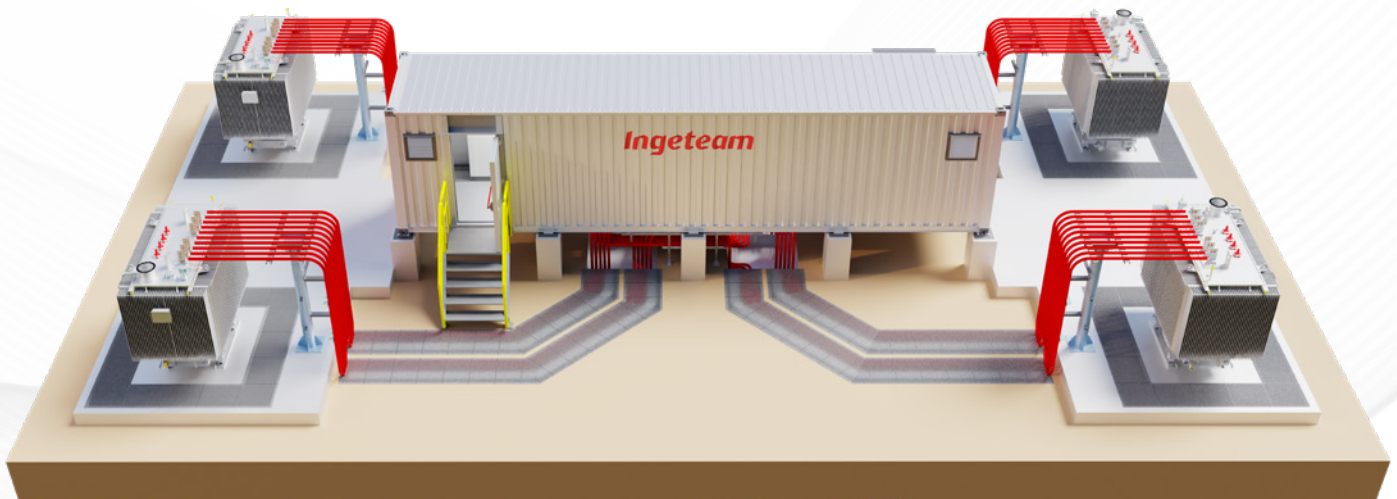


Soft Open Point scheme



## Functions

- **Active power flow control:** controlled power transfer between radial nodes.
- **Voltage control and stability:** independent voltage or Q control at each node.
- **Frequency control and stability:** P or frequency control at the chosen node.
- **Ready for Battery Energy Storage (BESS):** inertia, supply-demand balance.
- **Advanced grid forming capabilities:** islanding operation, black start and grid support, seamless transition to/from islanded operation.
- **Designed for fault extinction:** incorporating Petersen coils, or any other form of ground-fault neutralizers, supported with advanced islanded mode.
- **Power quality enhancement:** active filtering, flicker mitigation.



INGEGRID SOP containerized solution

## Benefits

- Release unused grid capacity and delay/avoid construction of new lines.
- Intelligent and cost-effective grid reinforcement.
- Increase of hosting capacity.
- Improved reliability: reduce SAIFI and SAIDI.
- Improved grid stability: frequency and voltage.
- Firewall to fault propagation.
- No increase of touch and step voltage in existing assets.

## OPERATION MODES

P and Q control
Voltage regulation
Frequency regulation
Island mode
Fault mitigation and operation
Peak shaving mode and energy storage backed functions
Custom modes on demand

# INGEGRID SSSC: STATIC SYNCHRONOUS SERIES COMPENSATOR

**INGEGRID SSSC** is a FACTS device connected in series with a transmission line through a transformer, imposing a controlled impedance ( $\pm X$ ) at the power frequency, that **liberates unused capacity** in the network and **increase reliability**.



## INGEGRID SSSC MAIN FEATURES

Rating: 1.5 Mvar to 132 Mvar  
(higher ratings to be discussed with manufacturer)

Containerized or building solutions,  
depending on the project needs

Suitable for lines up to 400 kV (higher  
line voltages to be discussed with  
manufacturer)

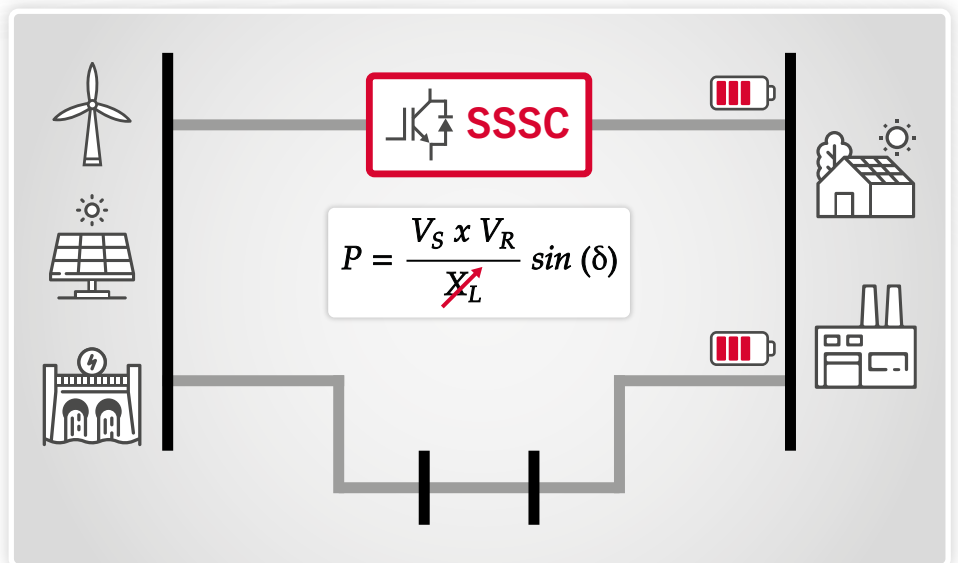
INGEGRID SSSC in Torres de Segre substation (220 kV) in Spain

## Features

- Maintenance at ground level, LV, easily replaceable critical components.
- Key blocks in factory tested containers, or building solutions.
- Simple coupling and paralleling arrangements.
- Scalable, modular-relocatable solution, with reduced footprint.

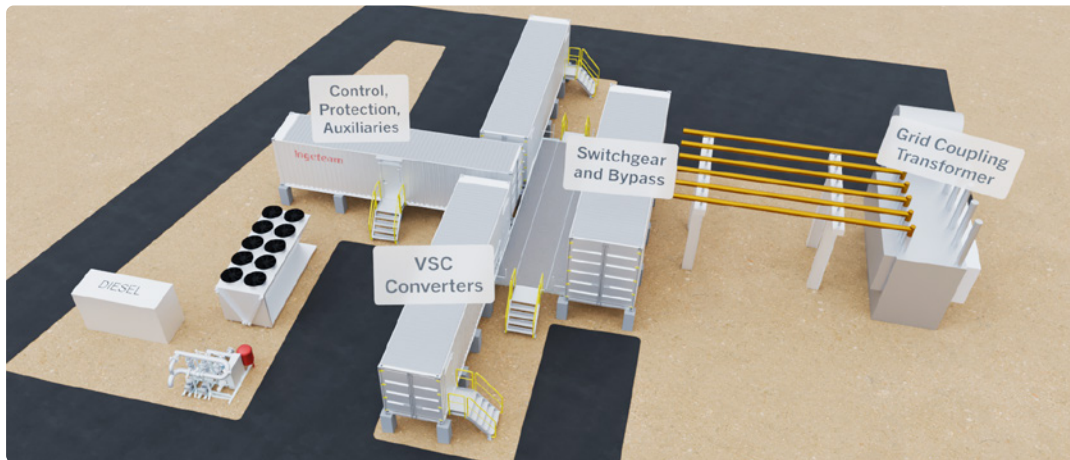
## Transformer-coupled SSSC systems advantages

- Continuous operation with a wide range of HV line currents (e.g. up to 6 kA).
- Inherent fault current reduction in the line.
- Optimized rating of power electronics for inductive (limiting) mode.
- De-couples power electronics and grid from transient disturbances and HF emissions.
- Reliable, well-known component to utilities.
- Converters at ground level.

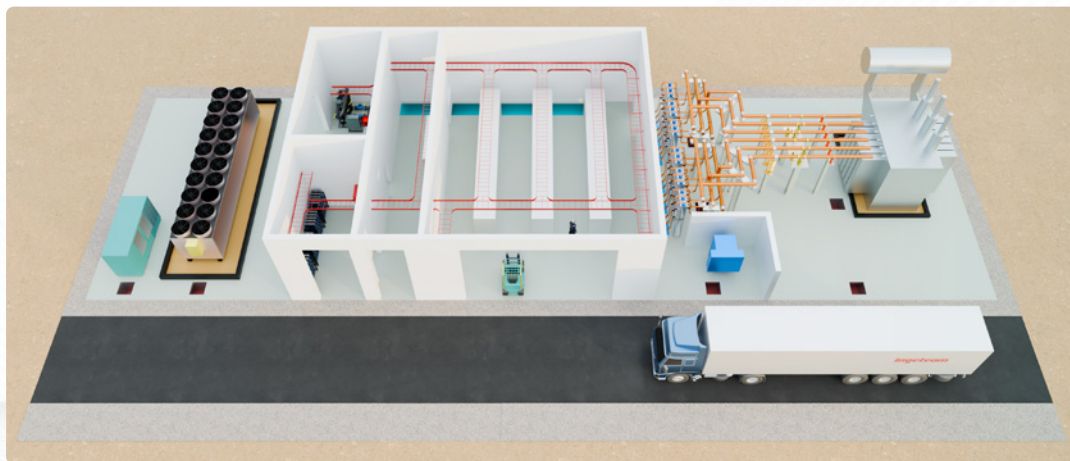


The SSSC liberates network capacity in meshed networks





INGEGRID SSSC containerized solution



INGEGRID SSSC building solution (also available for INGEGRID STATCOM and INGEGRID SOP)

## Benefits

- **Avoids line overload**
  - Redirects power flow to other less loaded parallel routes
  - Attracts power flow from congested lines
  - Dynamic power flow optimization (DLR)
- **Release of unused capacity**
  - Much more economical than routing new lines
  - Optimizes grid operation
  - Delays / avoids construction of new lines / HVDC corridors
- **Voltage stability**
  - Does not contribute to resonances
  - Mitigation of power oscillations
  - Grid-stabilization in contingency situations
- **Improved grid reliability**
  - Support during n-1 contingency situations

### OPERATION MODES

Power and current flow threshold control

Power flow control

Constant impedance / voltage / current control

PoD, SSR damping

# INGEGRID STATCOM: STATIC SYNCHRONOUS COMPENSATOR

An **INGEGRID STATCOM** is a fast-acting device based on power electronics VSC technology that it is connected in a shunt arrangement to an AC network, that is capable of sinking or sourcing reactive power, thus, allowing a **constant control of the grid** in the system to ensure its **stability**.



## INGEGRID STATCOM MAIN FEATURES

Based on LV (1700 V IGBT technology) or Medium Voltage (MV IGBT technology) power electronics converters

30 kV to 220 kV at grid

1.5 to  $\pm 100$  Mvar (higher ratings to be discussed with manufacturer)

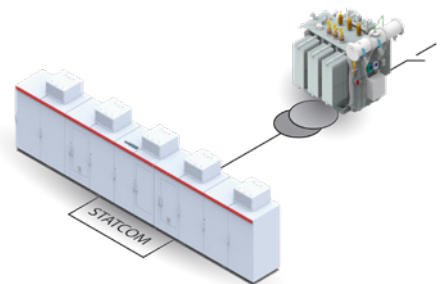
Liquid / air cooled

INGEGRID STATCOM in a wind farm in Santiago, Mexico

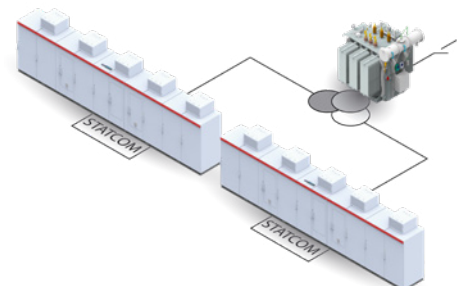
## Functions

- Dynamic and instantaneous reactive power compensation
- Dynamic power factor correction
- Support to power plants to meet grid code or connection requirements
- Dynamic voltage regulation
- Harmonic filtering
- Power Oscillation Damping (PoD)
- Mitigation of SubSynchronous Resonances (SSSR)
- Hybrid solution with SYNCON and BESS
- Grid voltage balancing
- Negative sequence compensation
- Black-start support

### Single secondary transformer configuration



### Double secondary transformer configuration



The full range of INGEGRID STATCOM is based on a modular design concept that supports up to 4 converters connected in parallel



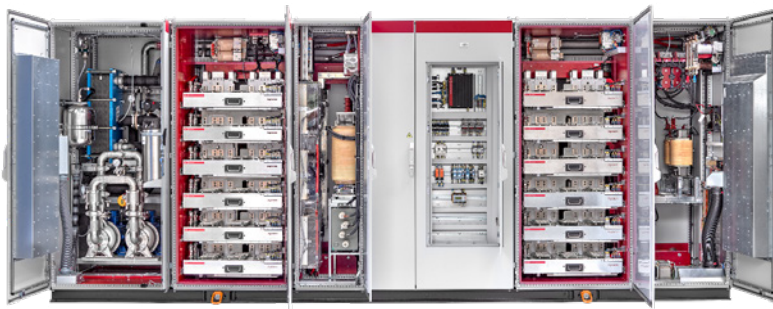
## Containerized solutions



**Low Voltage  
converter solutions**  
Power range:  
2.7 - 16 MVA  
Converter:  
Liquid cooling  
Container:  
Air cooling

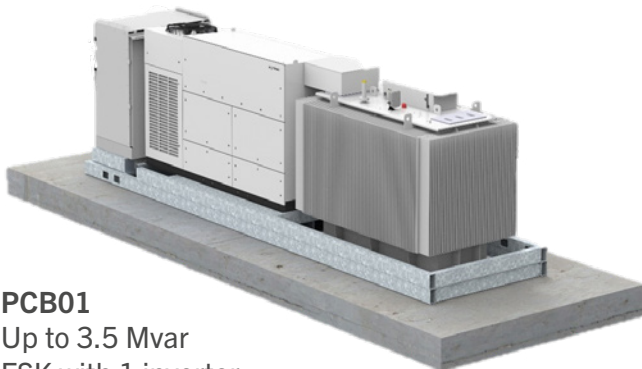


**3.3 kV Medium Voltage  
converter solutions**  
Power range:  
2.4 - 48 MVA  
Converter:  
Liquid & air cooling  
Container:  
Liquid & air cooling

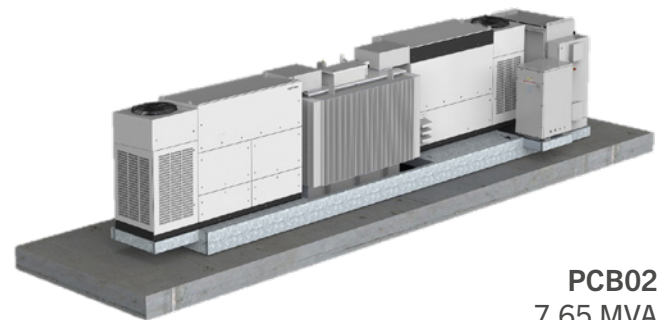


**6.6 kV Medium Voltage converter solutions**  
Power range:  
10 - 137 MVA  
Converter:  
Liquid cooling  
Container:  
Ambient air cooling included

## Full skid solutions



**PCB01**  
Up to 3.5 Mvar  
FSK with 1 inverter



**PCB02**  
7.65 MVA  
FSK with 2 inverters

## Benefits

- Supports compliance with new or demanding grid code requirements
- Voltage control
- Power factor control
- Balancing of the grid voltage
- Improves power quality
- Improves the grid stability
- Very fast dynamics

# CUSTOMIZED PROJECTS

All our systems can be designed as a containerized solution or in a building, depending on the needs of the client and the project.



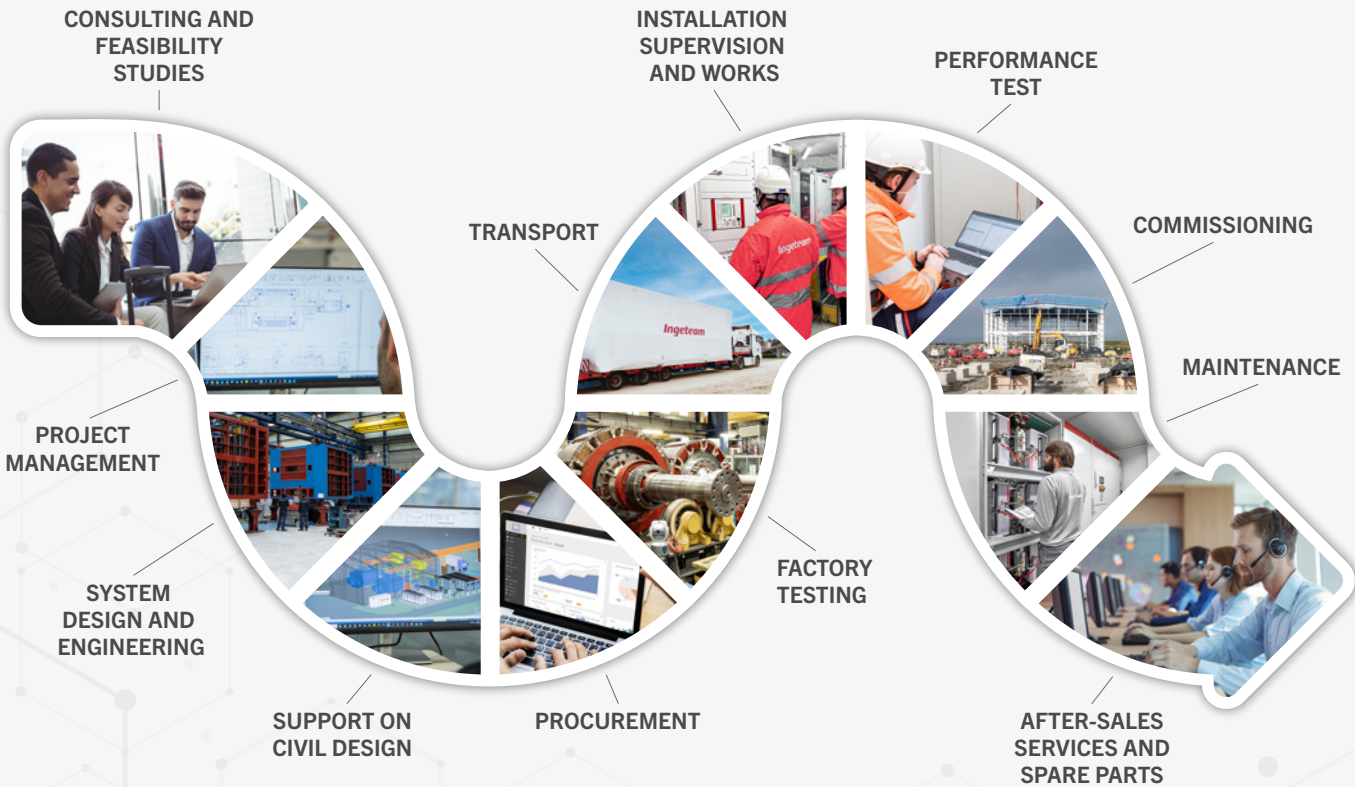
Containerized solution



Building solution

## Added value

Ingeteam has a long experience, with more than 80 years of electric machine manufacturing. Solutions are designed to provide the highest flexibility, reliability, and availability, with low losses.









***Ingeteam***

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