



INDARCOM™

SYNCHRONOUS CONDENSERS

The Grid Reinforcer

Ingeteam

**ELECTRIFYING
A SUSTAINABLE FUTURE**

TODAY'S TRANSITION

Decarbonization and emission objectives are changing drastically the structure and operation of the energy sector, with an exponential increase of renewable energies, wind and solar. These changes are affecting the maintainability, conservation, and restoration of grid security.

New regulations are born with the objective of the integration of renewable energies in a safe way while maintaining and improving the quality and security of the electric supply.

Closing of main system power plants (thermal, nuclear), and atomization of the system, is pushing all generators to support the grid with new requirements locally.

Present

Centralized power generation →
 Fossil based generation →
 Closed market →
 Passive customers →
 Few consumer data →
 Bulk energy →
 High energy prices →

Near Future

Distributed model
 Renewables
 A liberalized electricity market
 Prosumers
 Big data (smart meters, comms)
 Grid services
 Low energy prices

INDARCOM SOLUTION

The Grid Reinforcer

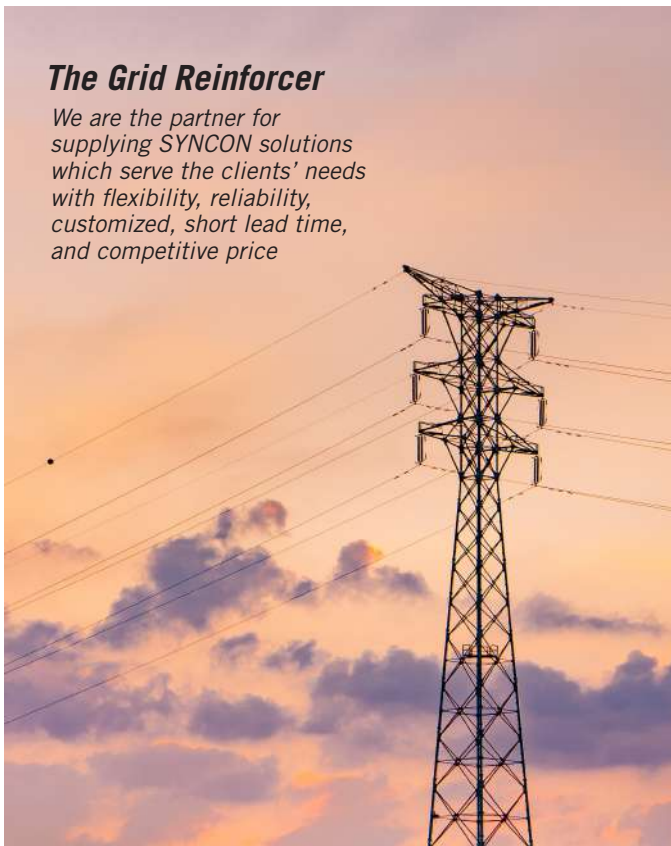
We are the partner for supplying SYNCON solutions which serve the clients' needs with flexibility, reliability, customized, short lead time, and competitive price

Ingeteam is able to provide solutions to support grid challenges. The solution can provide reactive power, short circuit power and required inertia adapting to customer needs.

INDARCOM Syncon main features (per Syncon)*

| | |
|---------------------|-----------------------------|
| Reactive Power | Up to 130 MVar |
| Short Circuit Power | More than 1200 MVA at 15kV |
| Inertia | Up to 900 MWs with flywheel |
| Excitation | Static or Brushless |
| Starting | Pony-Motor & VFD |
| Cooling | IC01/81W/616 |

**for specific requirements please contact Ingeteam*



TYPICAL APPLICATIONS & MAIN SEGMENTS

TSO/TNSP/DO

Transmission Substations
HVDC interconnectors

Benefits:

Provides short circuit strength
Dynamic reactive power support (voltage regulation)
Reduces local harmonic



RENEWABLES (WIND/SOLAR)

Renewable Power Plant Developers & Manufacturers

Benefits:

Increases short circuit ratio (SCR)
Dynamic voltage support
Provides inertia to improve RoCoF*
**Rate Change of Frequency*



RETROFIT OLD POWER STATION

Retrofit old Power Stations
Repowering of wind power plants
Renewable Power Plant

Benefits:

Modern controls and excitation – improved response time
Support dynamic voltage regulation and inertia as new systems



INDUSTRIES

Mining and high electric consumers

Benefits:

Reduced Dip impact
Stronger industry network
Improved power factor



ADVANTAGES AND KEY BENEFITS OF INDARCOM™

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.

1

Inertia

Requirements can be adjusted by machine design and/or flywheel addition improving grid stability.

2

Improves Voltage Regulation with continuously adjustable reactive power.

3

LVRT Low Voltage Ride Through Ingeteam Synchronous Condenser remain connected to the Grid in the case of Low Voltage events, supporting with current and system inertia.

4

Very Low Harmonics

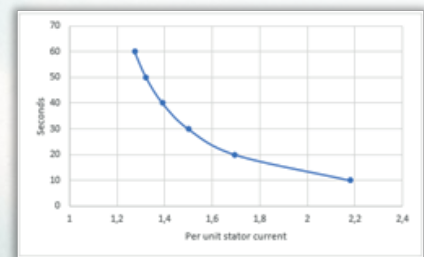
As a Synchronous machine, it is designed as Pure Sinus output, making it easy to integrate into existing grid environments

5

Short-Term Overload Capability

Compared with Power Electronics devices as STATCOMS, the Synchronous Condenser can support grid events with increased output during longer periods and higher ratings.

6



INGETEAM'S ADDED VALUE

Ingeteam has a long experience with more than 80 years of Indar electric rotative machine manufacturing. The solution is designed to provide the highest flexibility, reliability, and availability with low losses.

TAILORED DESIGN

The solution is developed to fulfill the customer's need and is adapted to the layout of the available space with minimal modification of the existing civil works.



RELIABLE AND ROBUST DESIGN

Ingeteam's synchronous condensers are based on generators that have been applied in over 100 applications. Resulting in low operational downtime and highest availability.



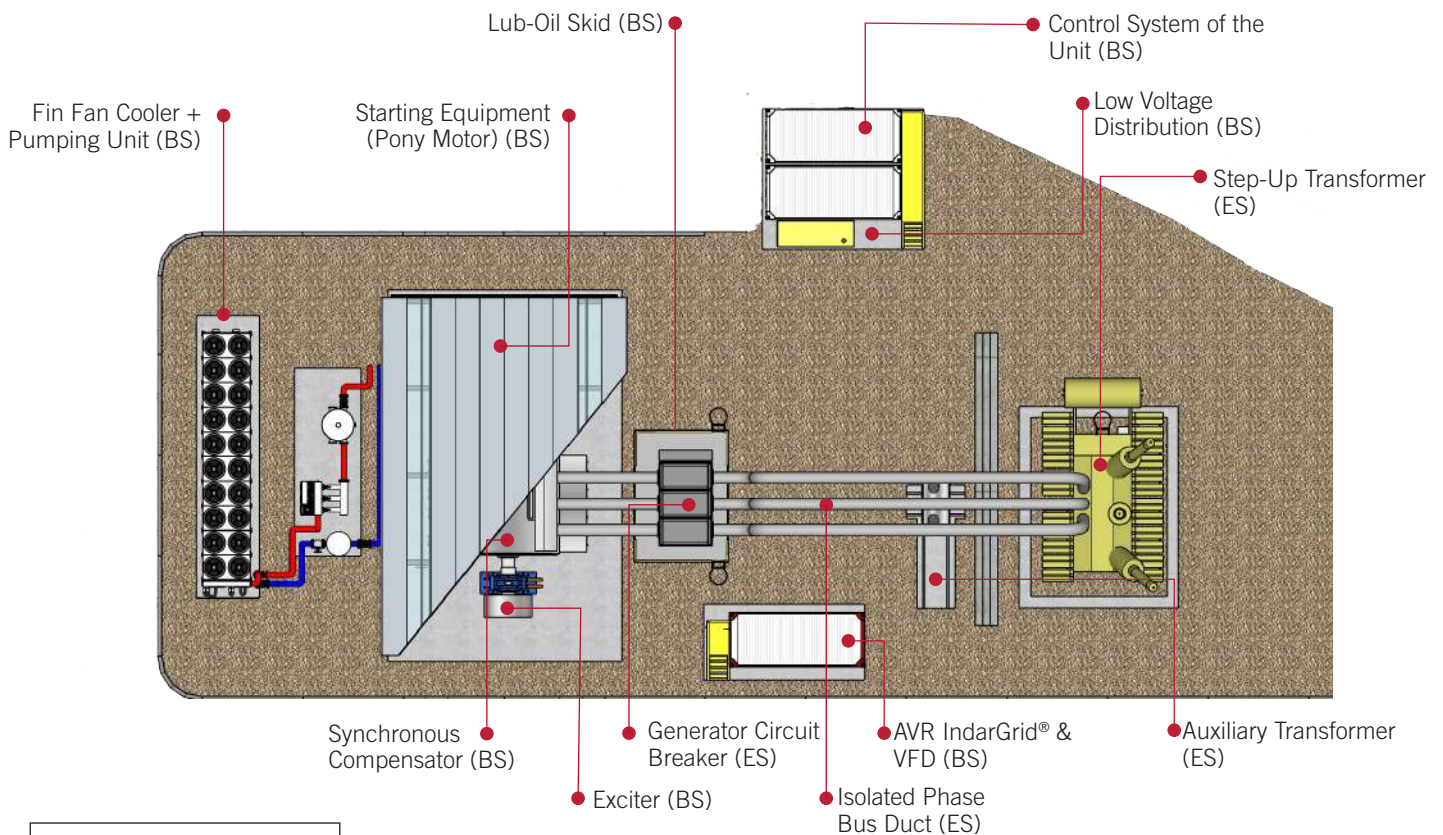
GRID CODE COMPLIANCE

Ingeteam has long experience in grid requirements fulfillment globally and it is backed by more than 20 years with 63 GW of Grid Code Compliance in hydro, wind and solar industry supported by Indargrid™ AVR.



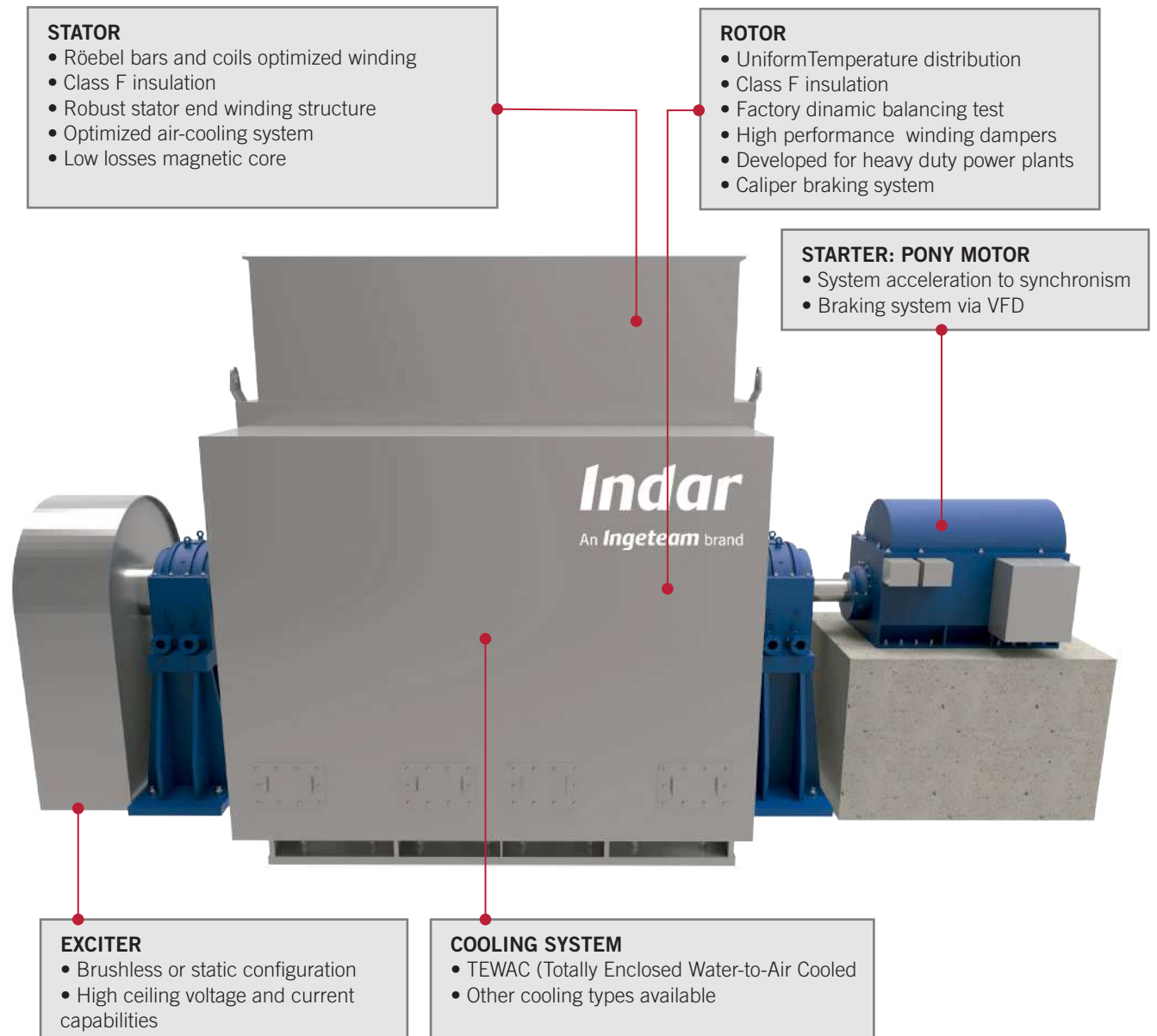
EXTENDED SCOPE WITH REDUCED FOOTPRINT

Optional modular package for the extended scope that includes containerized control units and easy operability.



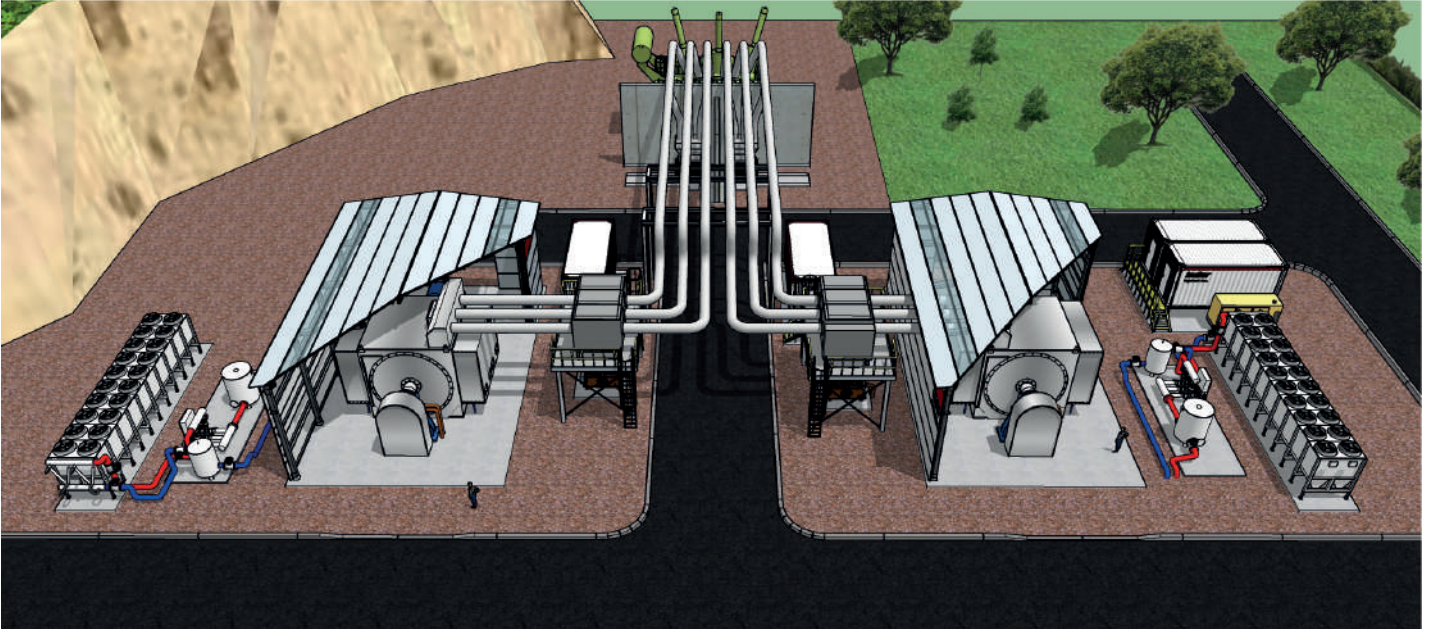
- Basic Scope (BS)
- Extended Scope (ES)

Layout footprint dimensions: 25 * 40 m

SYNCON & MAIN COMPONENTS

There is minimal maintenance over the entire life of the plant, low OPEX

EXAMPLE OF A MODULAR PACKAGE OF 2 UNITS & MAIN EQUIPMENT



The extended scope of the INDARCOM solution will be a bespoke design that will cover the available plot considering optimized space with easy and secure access, operability. Regarding the project supervision and building, there will be a dedicated skilled team working and supporting the smooth running of the project until the handover of the plant.

The solution is built-in reduced footprint and has a fast lead time

The low voltage distribution system is designed on a container basis as well as the Control & Protection system and the VFD and AVR (Indargrid™)

- One container for each Syncon
- One container for the main LV
- One container for the Control system



EXCITATION SYSTEM

The excitation system (AVR) for these applications is an INDARGRID™ UF (Ultra-Fast) with PSS (Power System Stabilizer) and RM (Rotor Monitoring). This is an advanced Synchronous Generator Control System designed for improved operation of Grid Connected Synchronous Generators under new Grid Code requirements, supporting the integration of renewable energies.

INDARGRID™ is based on the proven technology of Ingeteam's INGECON WIND & SUN Technology with more than 63 GW of grid connected generators fulfilling worldwide Grid Codes, and a track experience of more than 200 Hydropower plants using INGECON H Technology.

It is valid for all brushless type synchronous generators, including the Synchronous Condenser application. The following are the main features:

This AVR includes very fast and accurate measures of grid parameters, like cycle-by-cycle Voltage, Frequency, Current and Power measurements, and cycle-by-cycle High-Resolution Frequency measures (1 mHz) that are necessary for compliance with requirements of the latest Grid Codes.

INDARGRID™ allows precise and fast control of reactive power (Q) and can improve the operation of prime mover active power control system, with the support of the fast-measured values of power and frequency in a wide range of grid-connected applications as Internal Combustion Engines based Gensets, Hydropower plants and Synchronous Condensers.

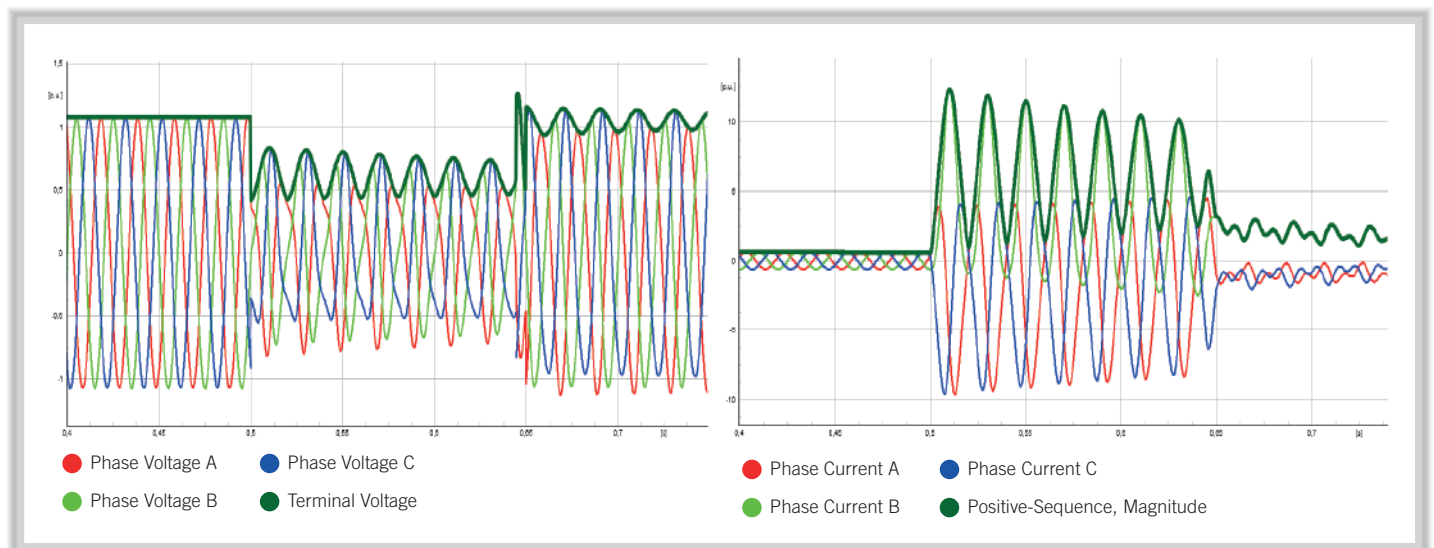
| | STATCOM | BESS+ STATCOM | SYNCON | INDARCOM |
|---|---------|---------------|--------|---------------|
| Voltage Fluctuations support | HIGH | HIGH | HIGH | HIGH |
| Variable Reactive power regulation | BIC | BIC | HIGH | HIGH |
| High Short Circuit Current | LOW | LOW | HIGH | BEST IN CLASS |
| Short Circuit Power Capacity | LOW | LOW | HIGH | BEST IN CLASS |
| Inertia | LOW | MEDIUM | HIGH | BEST IN CLASS |
| Fault Ride Through | HIGH | HIGH | HIGH | BEST IN CLASS |
| Overload capacity | LOW | LOW | HIGH | BEST IN CLASS |
| CAPEX | LOW | MEDIUM | LOW | LOW |
| OPEX | LOW | MEDIUM | LOW | LOW |

Main Features

- ✓ Thyristor based rectifier and crowbar
- ✓ Wide range of supply voltage
- ✓ Ultrafast and high precision measures
- ✓ Ethernet based communications with cloud storing
- ✓ Multiple rotor monitoring
- ✓ Multiprocessor control system
- ✓ IGBT exciter power stage
- ✓ Fast and accurate grid parameters

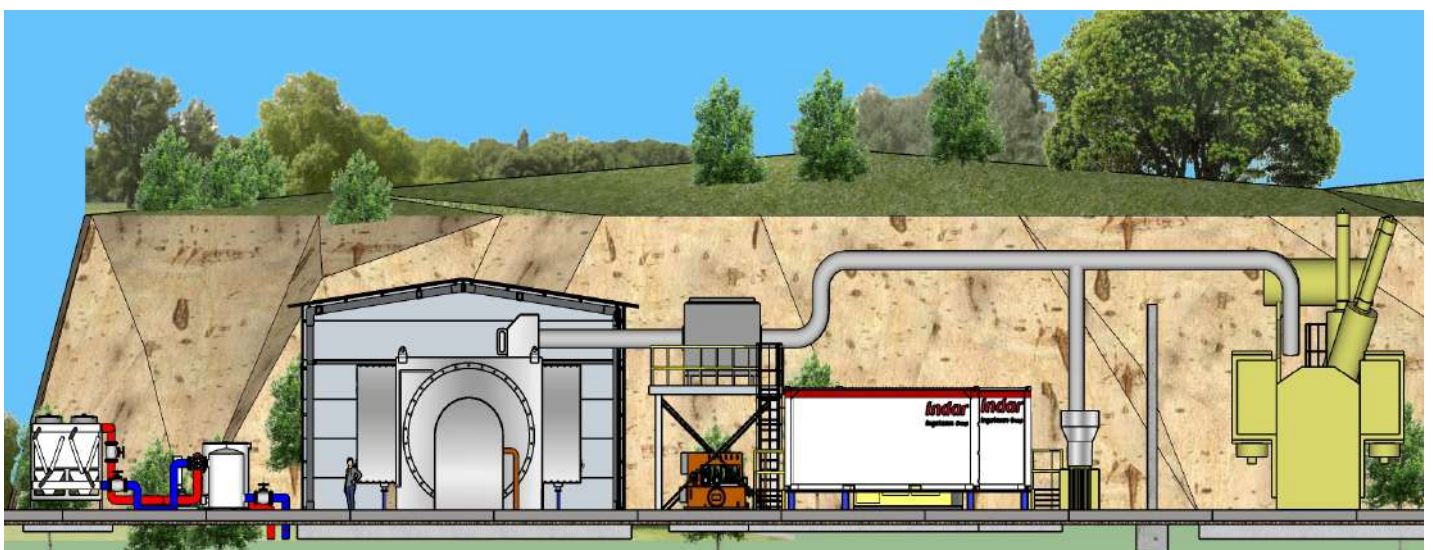
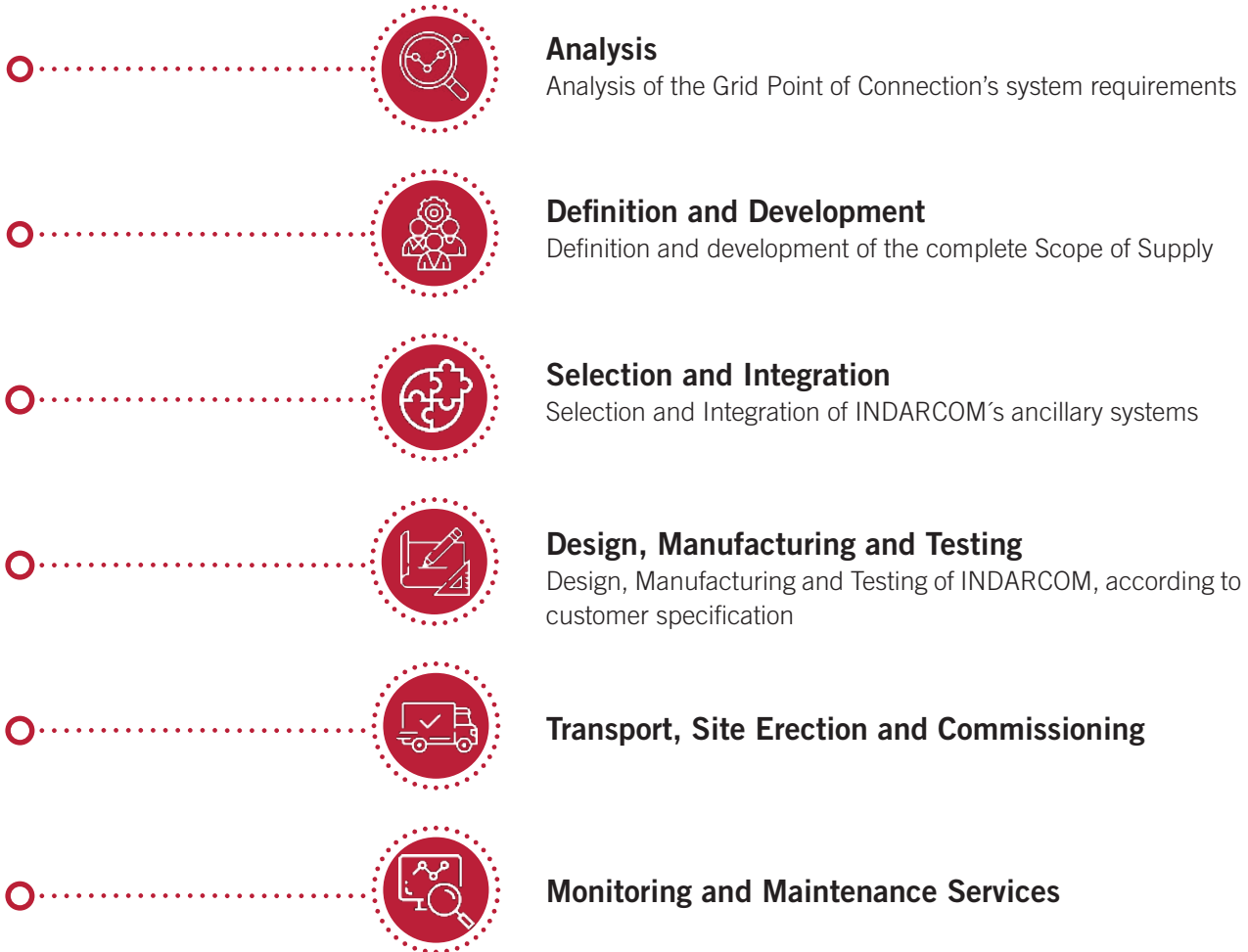


EXAMPLE OF SIMULATION BASED ON IN HOUSE DEVELOPED MODELS



Ingeteam provides computer original PSSE/ DigSilent / PSCAD, EMT/ RMS models of the syncon and AVR to run simulations on final grid code requirements.

The solution configuration process can be defined as follows:

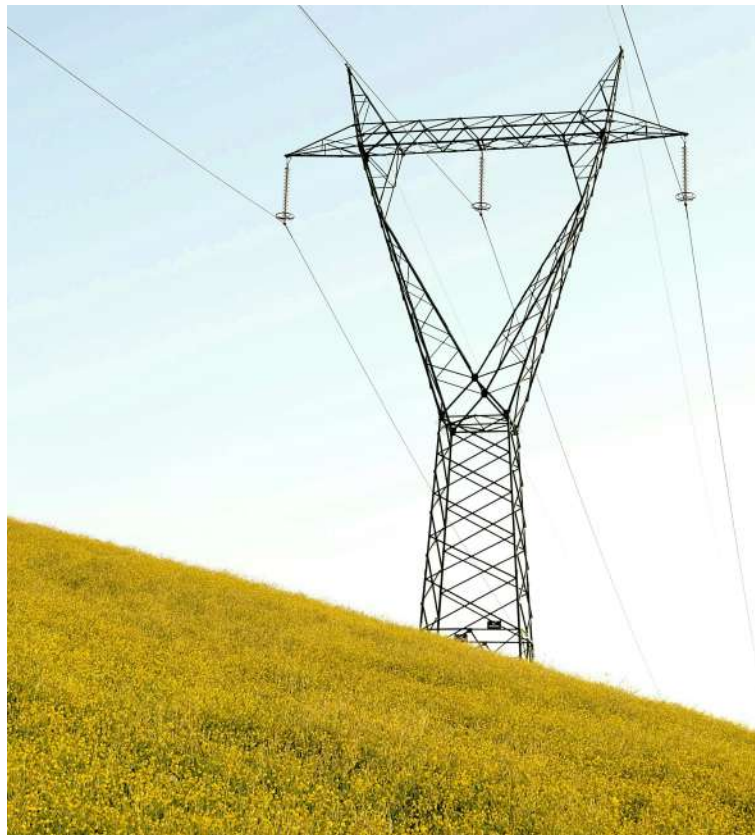


GRID CODE COMPLIANCE

- Most competitive solution to reduce RoCoF
- LVRT (Low Voltage Ride Through) compliant

GRID SUPPORT

- Local voltage and frequency support during contingencies and faults
- Provides short term overload capability



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