

# SYNCHRONOUS CONDENSERS



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Synchronous condensers, also called synchronous capacitors or synchronous compensators, are synchronous machines which can provide voltage regulation, reactive power, short circuit power, and inertia to the grid.

They play a key role due to the increased energy generation by renewable sources and shutting down of conventional power plants that lead to a worsening of electricity supply services, voltage quality and grid stability. A strategic deployment of synchronous condensers stabilizes the grid and helps to reduce the risk of blackouts. Simple and very reliable industrial solutions use turbogenerators as synchronous condensers, to maximize inertia contribution, or salient pole generators.

Thanks to its experience with more than 1,400 units installed worldwide, Ansaldo Energia can provide a wide portfolio of generators, equally suitable for both power generation and synchronous condensing applications. Today the grid owners are looking for the most reliable and simple solution to stabilize their grids: they can take advantage of the accumulated know-how gained on our machines in terms of proven design, state-of-the-art technology and robustness.

## Types of Generators / Synchronous Condensers



Up to 1200 MVA



**HYDROGEN - WATER COOLED TURBOGENERATORS**



Up to 740 MVA



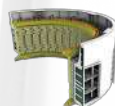
**HYDROGEN COOLED TURBOGENERATORS**



Up to 440 MVA



**AIR COOLED TURBOGENERATORS**



Up to 420 MVA



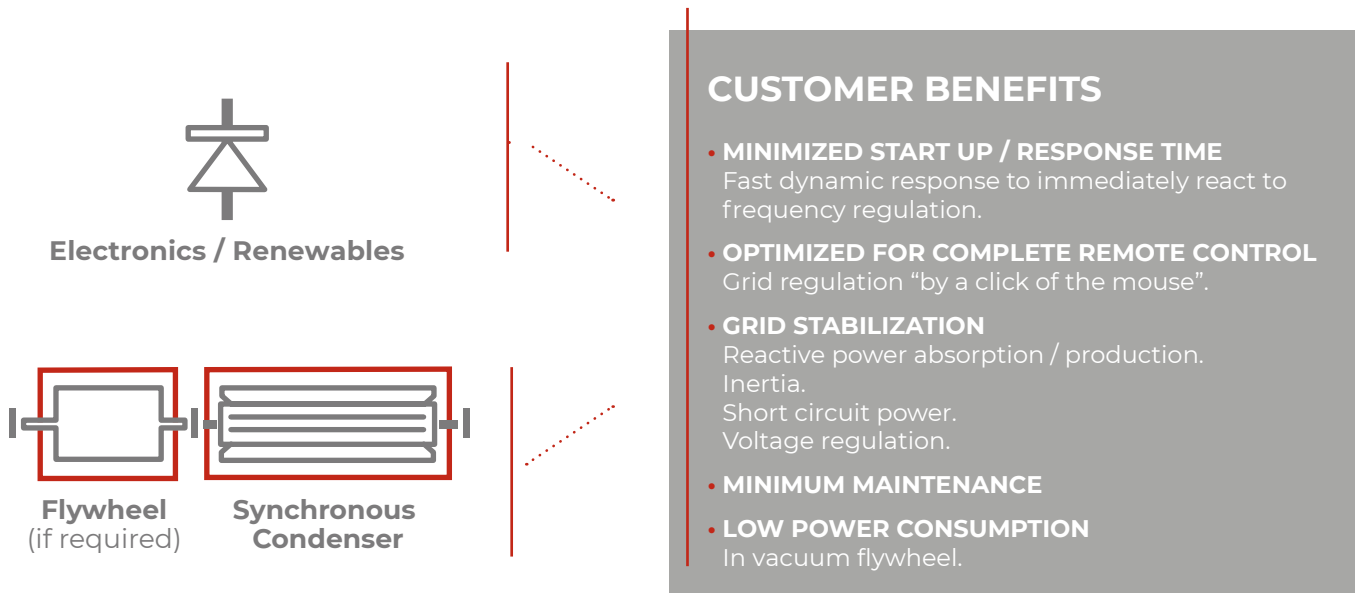
**HYDROGENERATORS**

## Stand alone package

Stand-alone packages are particularly useful for grid nodes where power electronics or renewable energy sources are connected.

Based on the shaft inertia and electrical parameters required by the grid, this package is configured by combining standard turbo generators with minor adjustments (e.g., thrust bearing, phonic wheel, etc.), or using as alternative a fully tailored salient pole machine.

A flywheel can be supplied to provide the best match with the specific project requirements. With adding a flywheel, the increased inertia will contribute to the reduction of frequency transients. The standard fly wheel, rigidly coupled with 3000 rpm turbogenerators, runs in vacuum and has extensive operational records thanks to the units already in operation on the Italian HV grid.



## In vacuum flywheel

The flywheel is used to increase the rotating mass of the synchronous condenser for enhancing grid stability services: this is made by direct coupling an additional inertial mass to the synchronous condenser rotor.

Ansaldo Energia, starting from the specific constraints of required inertia, minimization of the power consumption, and availability, defined a standard vacuum flywheel, which has been installed on different projects in Italy.

The standard referenced flywheel increases the inertia of the synchronous condenser shaft by 1.35 GVAs: it adopts a referenced labyrinth plus brush seal technology, allowing for in vacuum operation, thus minimizing the windage losses.

By following the design and operational experience gained on the supplied units, Ansaldo Energia is able to propose a fully referenced solution that can be tailored to provide even higher inertia values.

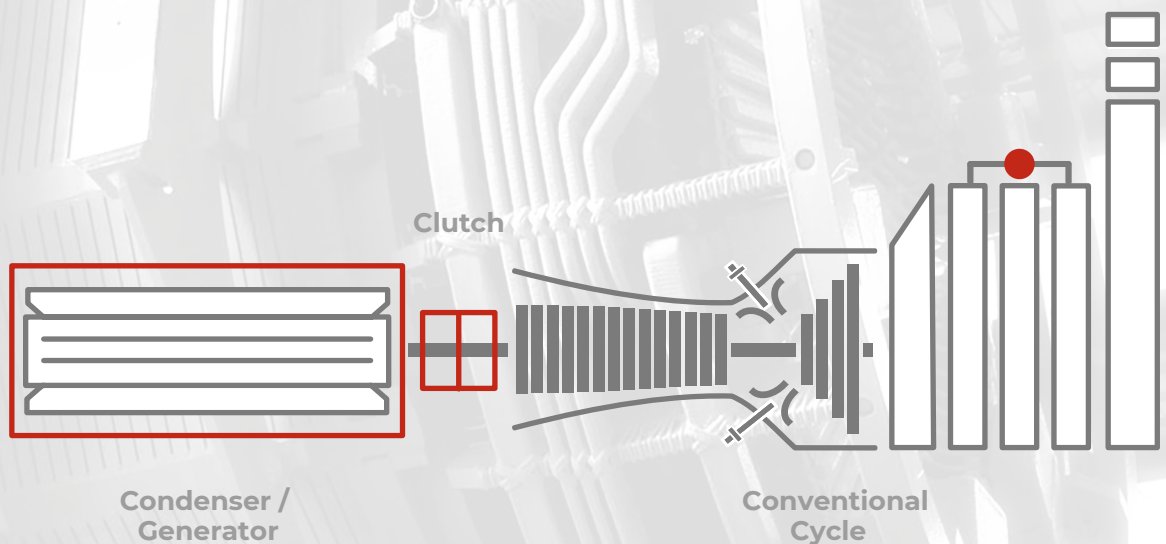
## Power Plants with synchronous condensing capacity

In conventional, combined or open-cycle plants, the driven generator is decoupled from the turbine by a clutch and operated as a condenser.

This solution is suitable for Customers needing to supply reactive power to the grid and no active power (turbine not in operation), as well as to reconnect the turbine in the event of active power demand, ensuring the maximum level of operating flexibility for the Customer.

Two operating modes are therefore possible:

- Power Mode (turbine engaged)
- Synchronous Condenser Mode (turbine disengaged)



### CUSTOMER BENEFITS

- **OPERATING FLEXIBILITY**

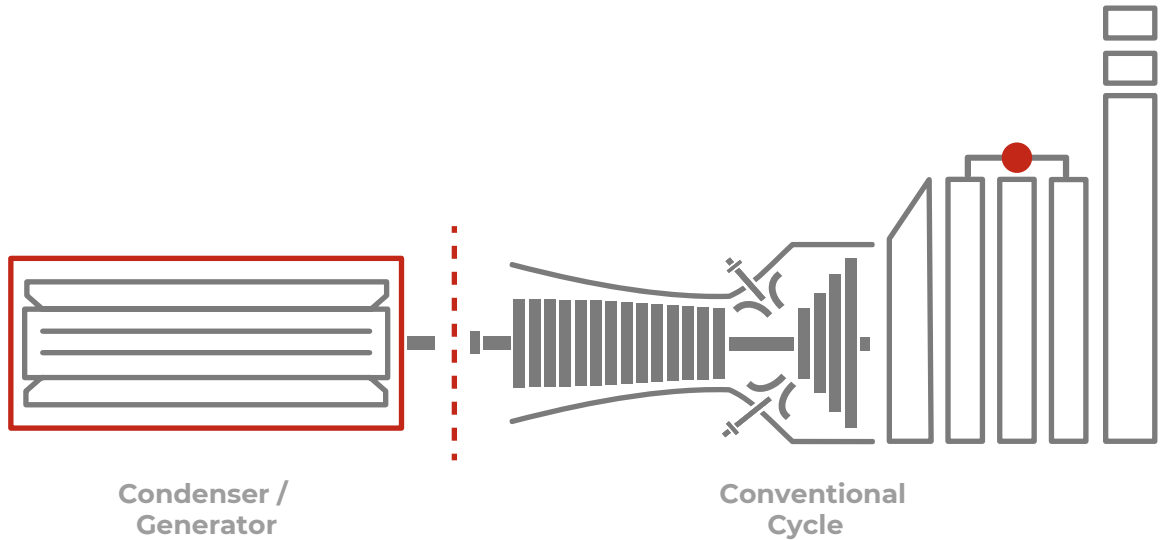
Maximum capability to catch market opportunities in terms of active power production or providing grid services only and most favorable participation to ancillary service markets (where allowed by the National Grid Codes).

Depending on the clutch and the supplied turbine, switching from Power Mode to Synchronous Condenser Mode is possible by disengaging the clutch when the turbine is already supplying power to the grid.

In this case, the turbine is shut down while the generator remains connected to the grid, working as a synchronous condenser.

# Retrofit solutions for existing power plants

Ansaldo Energia provides full support to convert existing or obsolescent power plants to synchronous condensing facilities, adding new value to present assets. We can tailor the most suitable option according to Customer needs, ranging from the easiest solution, i.e. mechanically decoupling the turbine and using the generator as a stand-alone package, to more specific ones such as converting the turbine shaft into a flywheel or other, more impacting, solutions.



## CUSTOMER BENEFITS

- **MAXIMIZE YOUR INVESTMENT RETURN FROM EXISTING PLANTS**  
Our tailored solutions to keep alive your plant.

## Summary

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dolor sit

<b>RATING</b>	Up to 850 MVA
<b>RATED VOLTAGE</b>	Max. 27 kV
<b>INERTIA</b>	As required by grid
<b>EXCITATION</b>	Static
<b>STARTING</b>	SFC or as required

## Worldwide references

Ansaldo Energia provides generators equally suitable for both power generation and synchronous condensing applications, based on proven design and expertise dating back to 1920.

Grid owners looking for the most reliable and simple solution to stabilize their grids can take advantage of the high level of reliability and availability combined with the minimal maintenance downtime of the Ansaldo Energia portfolio.

Fast-track delivery, installation and commissioning capabilities add a key value to Customer profitability.

## Case Histories



### TERNA Project: CODRONGIANOS

**Power:** 2 x 250 MVar

**Speed:** 3000 rpm

**Voltage:** 19 kV

**Delivery Time:** 20 months from NTP to PAC (4 month in advance from contractual scheduled data)

**Operation year** (units connected to grid): 2014



## **TERNA Project: MATERA, FOGGIA, GARIGLIANO, SUVERETO, CANDIA, VILLANOVA**

**Power:** 8 x 250 MVA with flywheel

**Inertia:** more than 1.75 GVAs on each shaftline

**Speed:** 3000 rpm

**Voltage:** 19 kV

**Operation year** (units connected to grid): 2020



## **BRINDISI NORTH Project: Conversion of non-OEM generators**

**Power:** 2 x 370 MVA (2 x 260MVA)

**Speed:** 3000 rpm

**Voltage:** 20 kV

**Retrofit year:** 2020



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