

# C&I ESS Application of VSG Mode



Security Level:



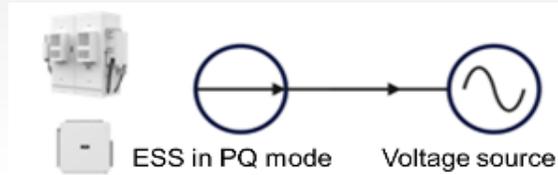
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# Differences between PQ and VSG Mode

## PQ Mode

The ESS works as a **current source** and responds to active/reactive power control commands. The ESS can **only run in parallel with voltage sources**.



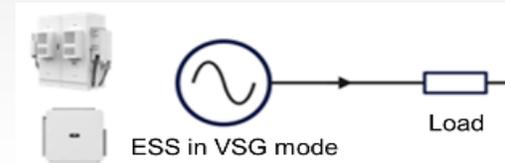
**1 min**

**Seamed on/off grid switchover time**

**VS**

## VSG (Virtual Synchronous Generator) Mode

The ESS works as a **voltage source** and can **independently supply power to loads** without other voltage sources. In this case, the ESS aims to **stabilize the frequency and voltage** of the power grid.



**<150ms**

**Seamless on/off grid switchover time**

### PQ Mode (Grid-Following)

### VSG Mode (Grid-Forming)

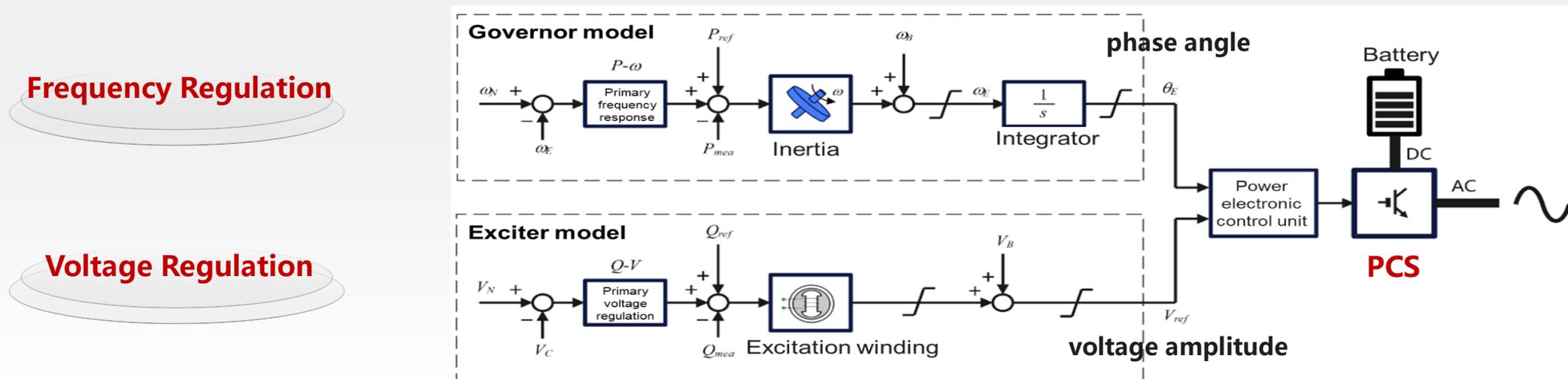
Output type	Current source	Voltage source
Independent power supply	No	Yes
Power Output Basis	scheduling commands	Loads
Derating Characteristics	The output power is limited during derating, and the ESS <b>doesn't shut down</b> .	If the output power exceeds the capacity after derating, the ESS <b>shuts down</b> for protection.
Surge load handling capacity requirements	Not considered	<b>supported surge loads</b> (such as transformers and motors)
Compliance with grid standards	compliant with the grid codes in the target markets	<b>No applicable standards</b> are available now
Application scenarios	<b>On-grid</b> , such as frequency regulation for grids, peak shaving and TOU	<b>Off-grid, on/off-grid switching</b>

# Working Mechanism of VSG Mode

## Mechanism and Function



## Main Control Loops



# Constraints and Impacts

## Constraints of application in VSG mode

### Reserve some SOC capacity:

- The grid-forming capability of an ESS depends on the charging and discharging capabilities.
- The end-of-charge SOC and end-of-discharge SOC are recommended to reserve some margin, to ensure the grid forming capability of ESS.

**10% - 90%**

Recommended operating SOC range in VSG mode

*The operating SOC range in PQ mode is 0% to 100%.*

## Impacts on the Grid in Seamless Switchover Scenarios

### Conflicts with the grid code standards:

- **Impact:** Seamless switchover conflicts with the requirements of the power grid code , such as fault ride-through\* and anti-islanding\*, **independent of operating mode.**
- **Reason:** In seamless switchover scenarios, when an exception occurs on the grid, the system quickly turns off the on/off-grid switch and changes to the off-grid status.

**Fault ride-through**

On-grid



**Anti-islanding**

On-grid



\* **Fault ride-through:** The inverters or PCSs stay connected and support the voltage recovery of the power grid.

\* **Anti-islanding:** If the power grid cannot be restored within a certain period, the inverters or PCSs should shut down for protection.

\* **Note:** Huawei's VSG mode seamless switchover is applied only in South Africa now. Other countries or regions need to obtain local authorization and apply for it.

# Thank you.

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