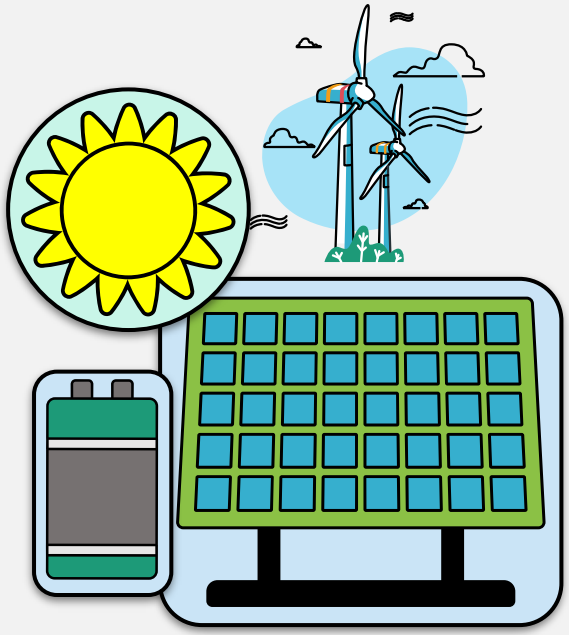
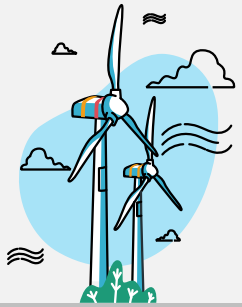


Utilization of Renewable Energy Resource for Ancillary Services Provision towards Grid Stability Enhancement

Akhillas Al Waaili

Contents



01 Introduction/Problem Statement

Climate Change

Power utilities are integrating RES for electrical energy to combat the power sector contribution to climate change.

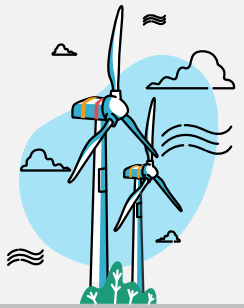
Power System Change

SGs are being replaced by Inverter-based RES

System Stability

- instability has become a threat to secure power grid operation with High RES.
- It is necessary for RESs to provide such ancillary services

	2023	2024	2025	2026	2027	2028	2029
Contracted Projects				MW			
Ibri II Solar IPP[a]	500	500	500	500	500	500	500
Total Contracted Capacity	500	500	500	500	500	500	500
Planned Projects							
Manah I Solar IPP [a]			500	500	500	500	500
Manah II Solar IPP [a]			500	500	500	500	500
Ibri III Solar IPP					500	500	500
JBB Wind IPP [b]					100	100	100
Duqm Wind IPP [b]					200	200	200
Ras Madrakah Wind IPP [b]					200	200	200
MIS Solar IPP 2027					500	500	500
Barka WTE IPP						140	140
Solar PV IPPs 2029							1000
Wind IPP 2029							200
Total Planned Capacity	-	-	1000	1000	2500	2640	3840

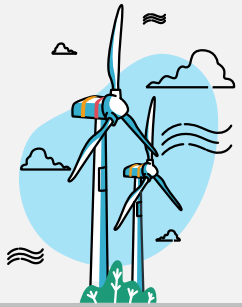


Objectives

Examine the various ancillary services provided by Renewable Energy Sources, to improve the stability and dynamics of the power systems.

Ancillary Service:

Services or **Products** (Not MW) that the power system needs to maintain the security, integrity, and reliability of the power network as well as the power quality.



Ancillary Services Classification

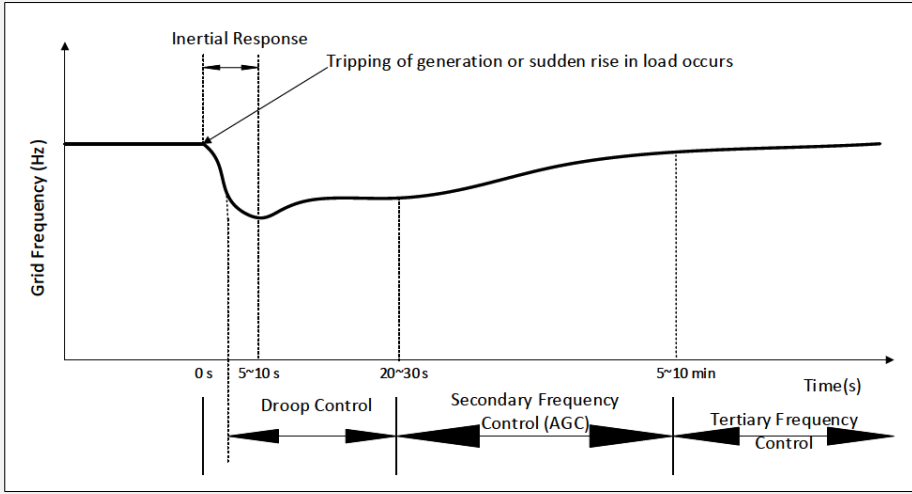
Ancillary Services Categories

- **Frequency Control**
  - Fast Frequency Response FFR (Inertia)
  - Frequency Containment Reserve FCR (Primary/ droop control)
  - Frequency Restoration Reserve FRR (Secondary)
  - Frequency Replacement Reserve (tertiary)
- **Voltage Control**
  - Normal Operation (steady-State) Voltage Control
  - Contingency Operation (dynamic) Voltage Control
- **System Restoration**
  - Black Start

Frequency Control Ancillary Services

Frequency Control Ancillary Services is further subdivided into four main categories:

1. **Inertial response**
2. **Frequency containment Reserve FCR (Primary/ droop control)**
3. **Frequency Restoration Reserve FRR (Secondary)**
4. **Frequency Replacement Reserve (Tertiary)**



5. Ramping Ancillary Service:

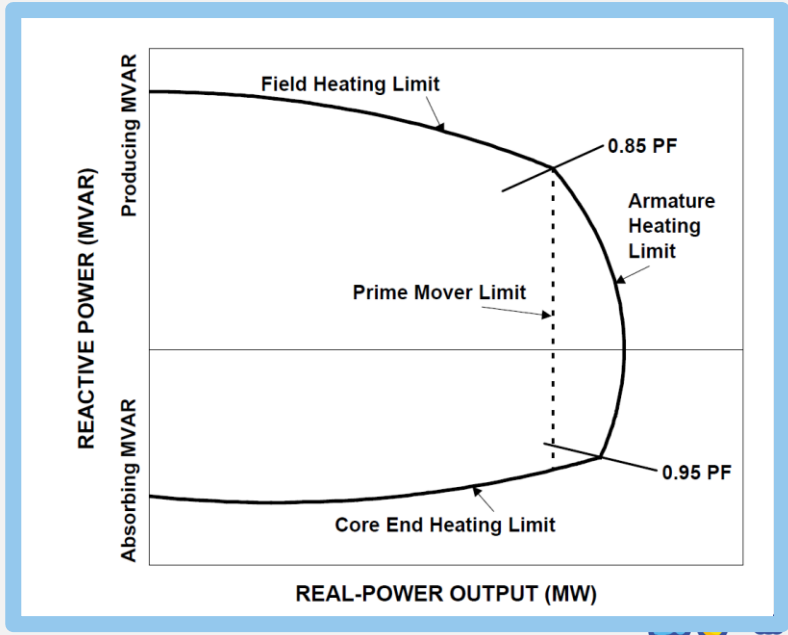
- **Ability to ramp output rapidly in response to sudden changes, such as may be caused by RES variations.**
- **75% of Renewables in Ireland**

Voltage Control Ancillary Services

The voltage control ancillary services are distinguished by the system situation:

1. **Normal Operation (steady-State):** This voltage control AS is used at the steady-state operation to maintain the system voltage within specified limits.

2. Contingency Operation (dynamic): In the contingency situation this AS is responsible for fast current injection to the system to support the voltage and avoiding voltage collapse during any system disturbances. Moreover, saving the network power quality.

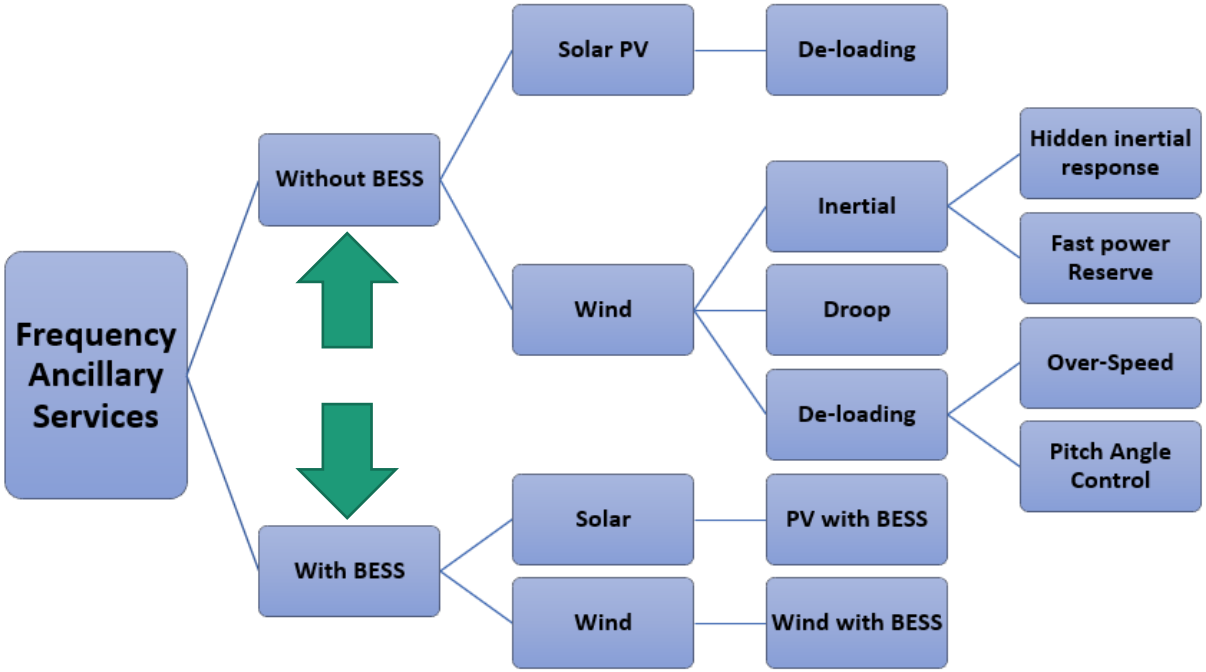


Restoration Ancillary Services

Black Start:

- Ancillary Service that is acquired in the event of a partial or total blackout with the goal of restoring the electric system (outage).
- Generating units that can start on local support alone, without the auxiliary supply from the grid power supply, are contracted to provide black start service.

Ancillary Services from Renewable Energy Sources



Ancillary Services from Renewable Energy Sources

With/Without ESS	RES type	Technique	Pros	Cons
Without ESS	Wind	Inertial	1. The inertia obtained from the rotating blade directly	1. Huge losses of aerodynamic due to constant power added to the controller.
		De-loading	1. Provision of primary frequency control	1. It cause losses of a percentage of power.
	Solar	De-loading	1. It is required an additional element. 2. Frequency regulation/ inertia proved.	1. It cause losses of a percentage of power. 2. Environment condition dependent.
With ESS	Wind	Inertial	1. High reliability for frequency support.	1. High investment cost (high battery/energy cost).
	Solar	De-loading	1. High reliability for frequency support. 2. High efficiency in maintaining the system stability.	1. High investment cost (high battery/energy cost). 2. Failure of battery power absorption, if it is fully charged.

International Implementation

	Ancillary Service from RES	Ref
Ireland	**Fast Frequency Response** provided by 211 MW of conventional 39 MW of **wind** 60 MW of demand side units	Fast frequency control ancillary services: An international review
National Grid	wind farms with a capacity above 50 MW, droop control and frequency support must be provided through different response strategies	A Critical Review of Current and Future Options for Wind Farm Participation in Ancillary Service Provision

Conclusion

1. Frequency Control Ancillary Services from RES is necessary to maintain system frequency.
2. Different Methods of FCAS are available: Need a detailed study for actual implementation, depends on:
    - System needs.
    - Electricity Market.
3. Implement the provision of FCAS for MIS system for 2028 year with more than 30% of RES

Thank You