The Strategic Role of BESS

Energy transition, variable renewable energy integration, and the core grid functions of BESS

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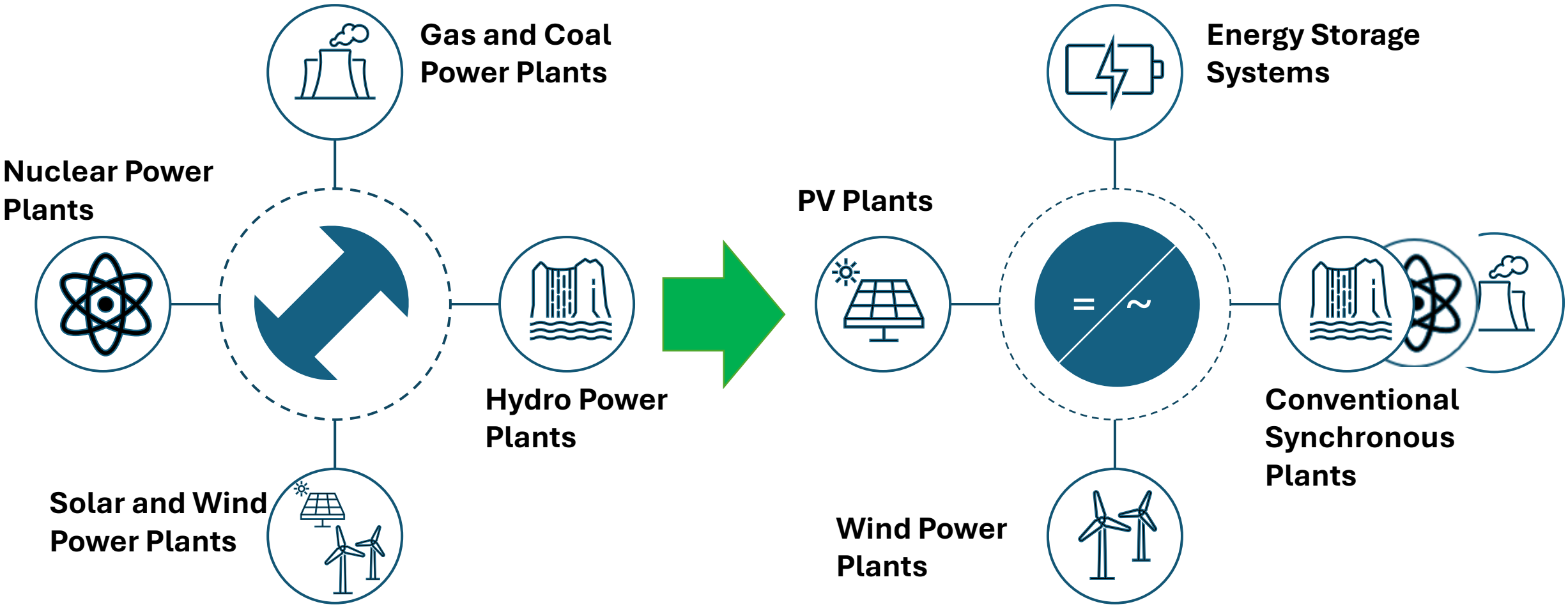
Evolution of Modern Power Systems



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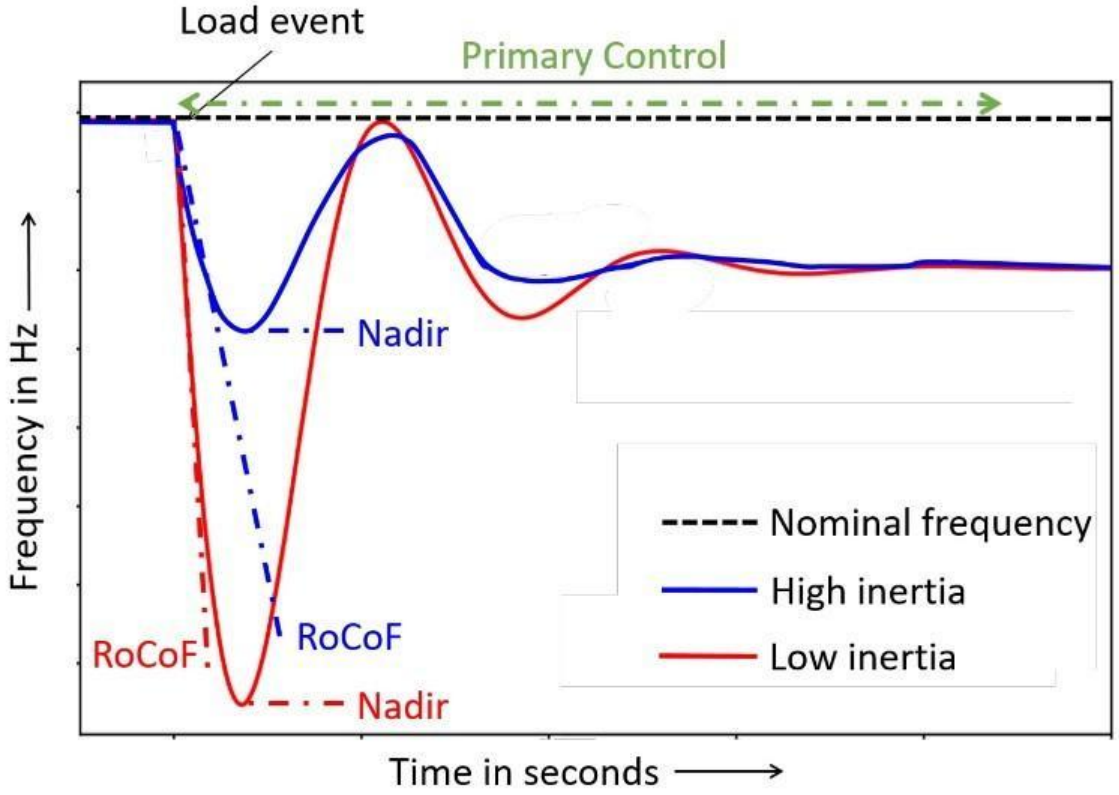
Why BESS Matters Now

- **System pressures accelerating:**
  - Rapid growth of solar & wind (VRE)
  - Declining system inertia and stability
  - Phase out of thermal generation
- **What the system now needs**
  - Fast, flexible response (seconds to minutes)
  - Firming of variable renewable energy
  - Replacement for peaking & reserve capacity
  - Local network and congestion support
- **Why BESS is central**
  - Fastest deployable flexibility solution
  - Highly modular and scalable
  - Capable of stacking multiple system services

Storage is no longer optional in modern power systems



Source: https://www.linkedin.com/pulse/specification-design-synchronous-condenser-system-renewable-/

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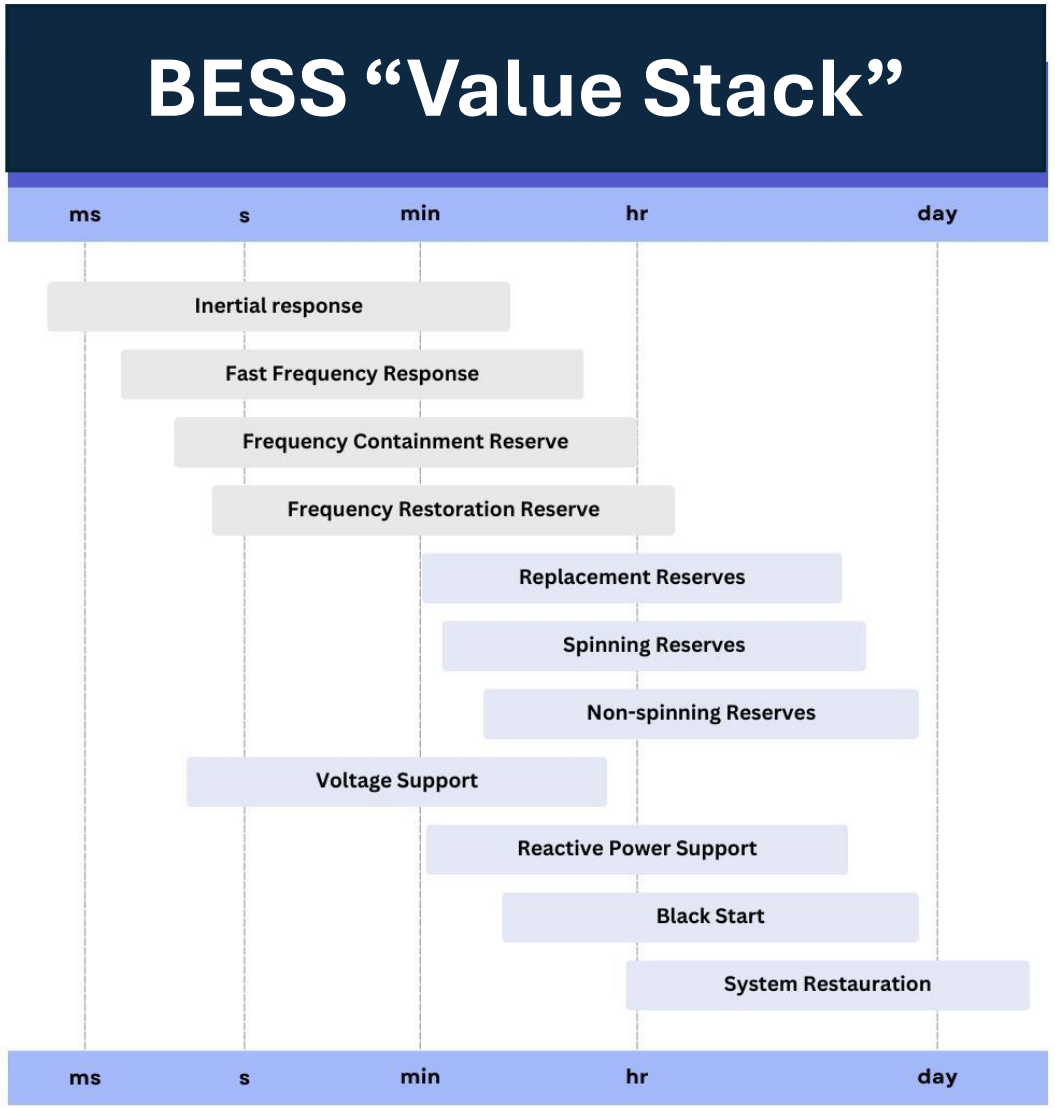
BESS Applications: BESS = Multi-Service System

Core applications across the system

- **Fast response (milliseconds)**
  - Frequency control / ancillary services (FFR & regulation)
  - Synthetic inertia
  - System stability support & contingency response
- **Short duration (minutes–hours)**
  - Operating reserves
  - Ramping and load following
- **Energy shifting (hours)**
  - Energy arbitrage (charge low / discharge high)
  - Solar and wind firming
- **Capacity role (peak / adequacy)**
  - Peaking plant replacement
  - Resource adequacy / reliability support

System-level roles

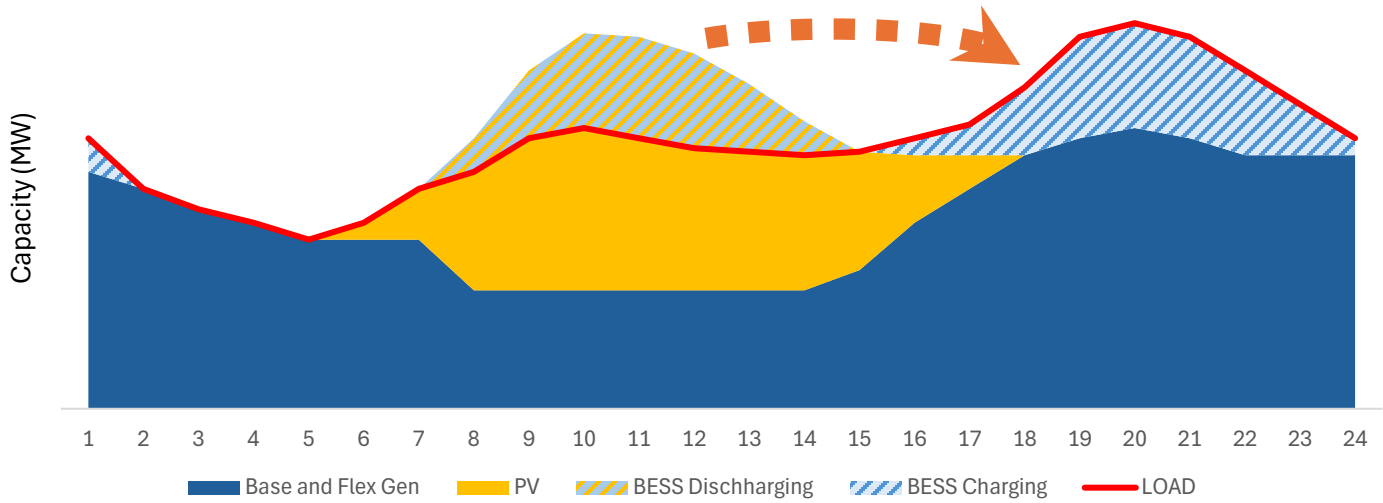
- Network congestion relief / deferral
- System strength (increasingly via grid-forming BESS)
- Black Start/System Restoration



Source: https://medium.com/%40brandonvar/grid-ancillary-services-18da30ed06c5

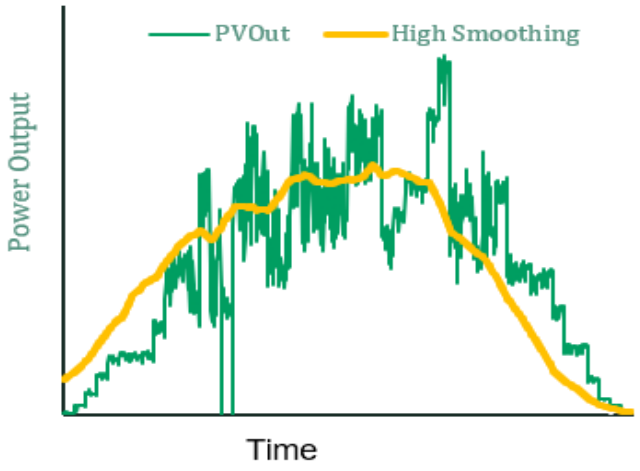
BESS Addresses & VRE Integration Challenges

"Solar Shifting" or Energy Shifting

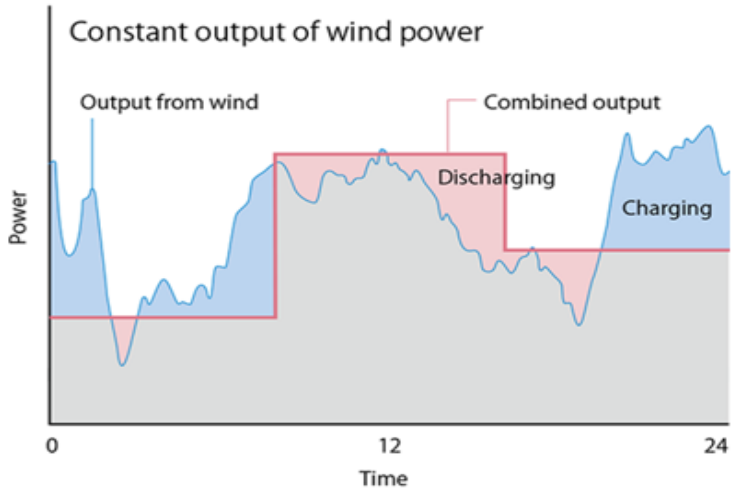


VRE Smoothing

A – PV ramp Smoothing



B Wind Capacity Smoothing



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BESS Addressing VRE Challenges

Category	Grid Challenge	BESS Response
Energy Balancing	Variability & Intermittency	Energy shifting / firming
	Flexibility Needs	Fast ramping & balancing
	Forecasting Uncertainty	VRE smoothing
	Reserve Requirements	Fast reserve replacement
Stability & System Strength	Low Inertia & High RoCoF	Synthetic inertia
	Frequency Stability	Fast frequency response
	Voltage Constraints	Volt-VAR support
	Reduced System Strength	Grid-forming operation
Network & System Operations	Congestion & Curtailment	Local energy buffering
	Black Start / Restoration	System restoration support

Strategic Question

BESS is becoming essential infrastructure for maintaining grid stability and flexibility in inverter-dominated power systems

The strategic challenge is to assess how much BESS is required, by when and where it is needed, and which value-stack applications it must perform

Thank You