Smart Grid: Considerations and Implications

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a passion for discovery

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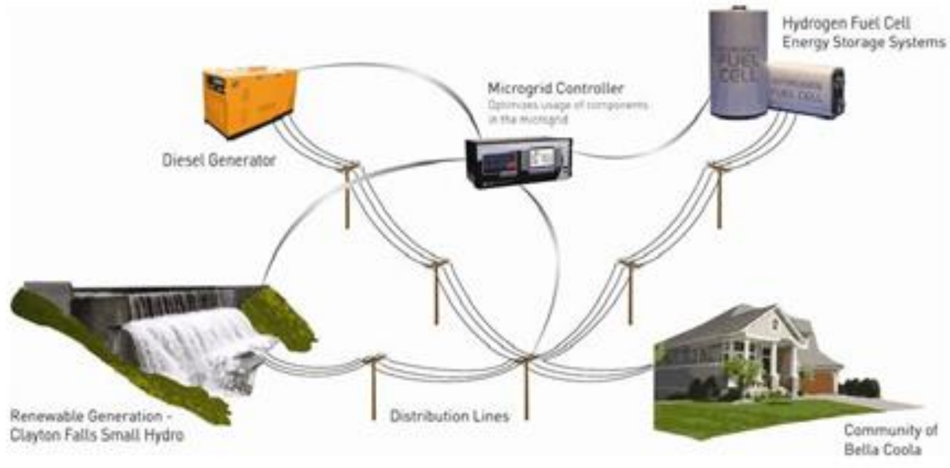
Introduction to Next Generation Microgrids

- The Next Generation Micro-Grid can be defined as a portion of the grid capable of being independently managed to achieve greater resilience in operations, optimized for reduced losses, leverage all sources of generation under the right circumstances to deliver an improved customer experience. There are a core set of configurations of differing intent:
  - Classic separable micro-grid
  - Defensive micro-grid
  - Demand response micro-grid
  - Controlled Separation Island
  - Recovery island
  - Island like feeder (or dependent muni/coop)
  - Real Islands

Key Considerations for Micro-grids



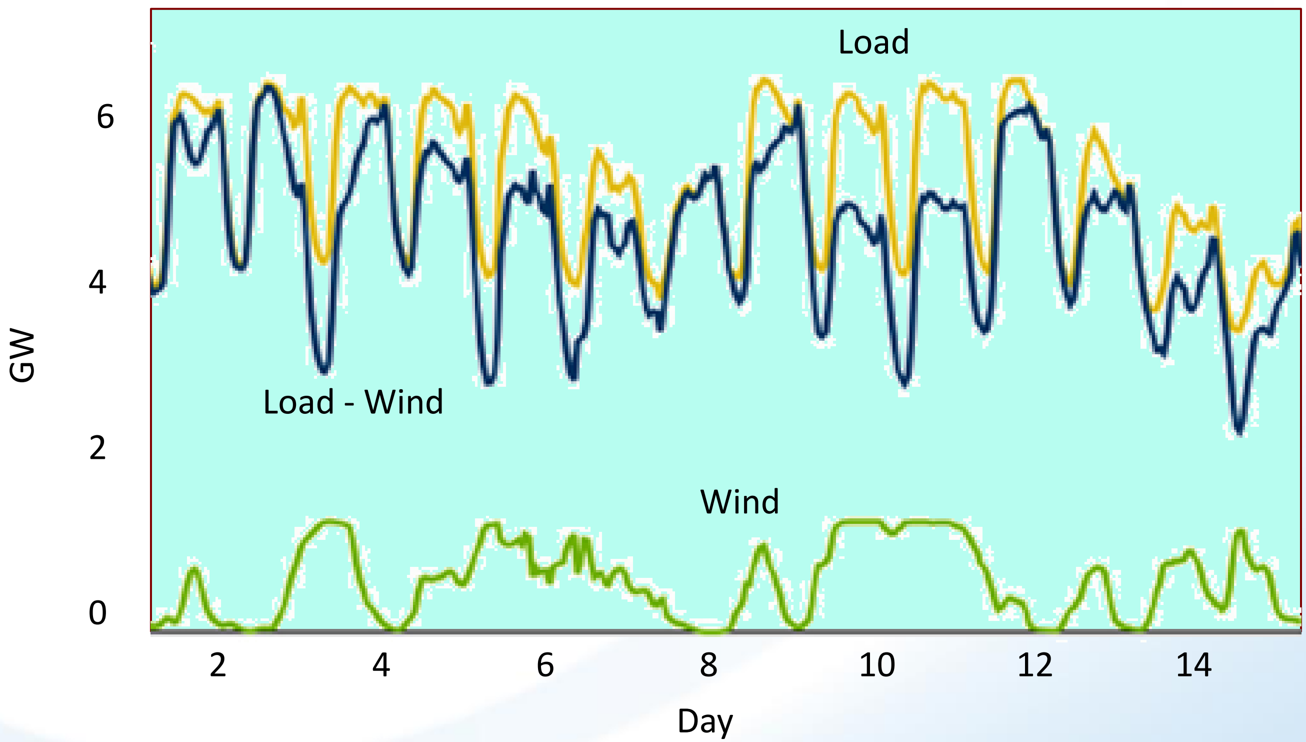
- Degree of Isolation
- Nature of the Local Power
- Operating Margin
- Load Capacity Factor
- Size of the Control Area
- “Permanence” of the Boundaries
- Regulatory Complexity “Seams”

Renewables impact on island grids

- More distributed power
- Growing requirement for generation forecasting
- Increase in technological complexity
- Increasing value for storage and demand response
- Greater need for smarter grid tools – sensors, controls, models …

Matching supply and demand in time - renewables

Xcel Wind Farm, Minnesota
1.5 GW Wind in 10 GW Peak System

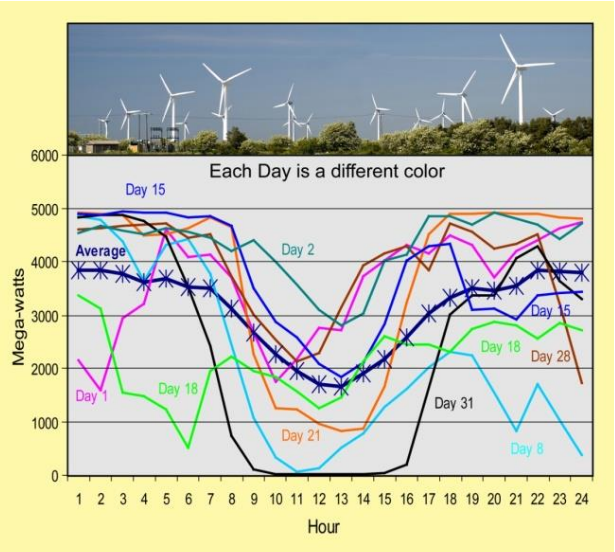


Key integration concepts

- Forecasting challenge: variability in load can be forecast and matched to supply;
  - renewables add variability (which is difficult to forecast) to the supply.

- Responses:
  - "Firming power" – through generation and storage
  - "Ramp rate requirements"
  - Improved forecasts – now, near and next

Large-scale energy storage is critical for renewable penetration **<u>and benefits grid stability and reliability</u>**

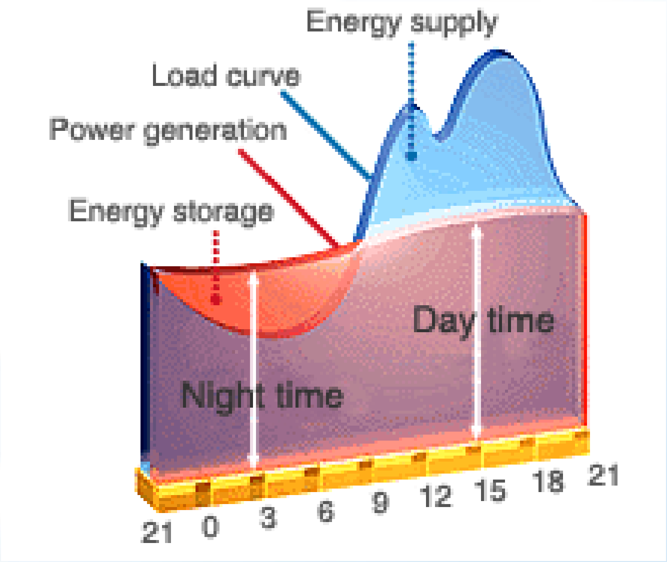


Drivers for Large Scale Energy Storage

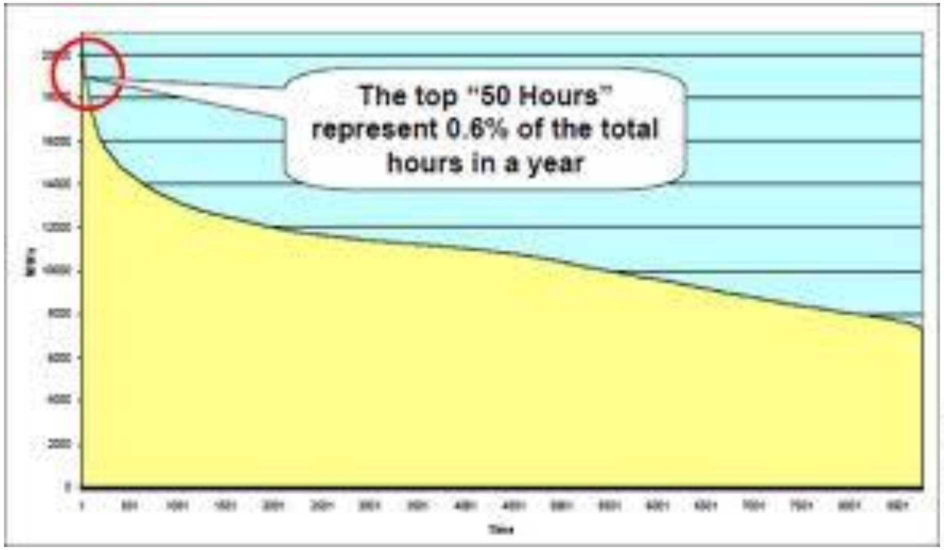
- Renewable Generation
- Grid Reliability Management
- Power quality
- Load leveling, shifting

Size of the challenge – How much storage is needed?

- Over 200GWh of balancing resource (e.g. storage) needed to meet DOE 20% Wind by 2030 goal (20% of wind output)
- 15,000 PHEV batteries required to shift 4 hours of wind from one 100MW project



Standard models may not hold



Load duration curve: for how long do you have meet what load?

In general: one seeks to use one's least expensive generation as much as possible … therefore most expensive resource is used to satisfy peak …
… However not always true …