Energy Storage for Integrating Wind

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Energy Storage is a Multifunctional Tool

- Voltage support
- Frequency regulation
- Spinning reserve
- Renewable integration
- Peak shifting
- T&D deferral
- Power quality and reliability
Renewable Ramp Management

Absorb sudden changes in wind farm output

Wind Project Output

Wind Project Ramp Rate

Storage System Sizing

Wind Farm Ramp Rate

Net Ramp Rate With Storage

Ramp Limit ±X MW/min

Net Ramp Rate With Storage
Renewable Ramp Management: Denmark
Multiple Uses: Tehachapi Storage Project

- **Customer**: Southern California Edison

- **Location**: Tehachapi Windfarm
  - California’s largest wind resource
  - Wind development potential driving grid infrastructure upgrades and expansion
  - 2nd largest wind park in the world
    - 660MW installed / ~5,000 turbines

- **System**
  - 8MW – 4 hour (32MW-hour) GBS system
    - World’s largest Li-ion battery system when complete
  - Dynamic 4-Quadrant PCS/Grid Interface
  - A123 Prismatic Cells
  - Installation / Operation 2012
  - 13 Targeted Operational Uses – Individually and Stacked
Multiple Uses: Tehachapi Storage Project

• Transmission-Related Uses
  + Voltage Support & Grid Stabilization
  + Demonstrate a decreased in transmission losses
  + Demonstrate how the system can defer transmission investment
  + Optimize Size and Cost of Renewable Energy-Related transmission

• System-Related Uses
  + Provide System Capacity and Resource Adequacy
  + Black Start
  + Wind Firming

• ISO Market-Related Uses
  + Frequency Regulation
  + Spinning and Non-Spinning Reserves
  + Ramp Management
  + Energy Price Arbitrage
Diverse System Needs...

Storage System Sizing

- Frequency Regulation
- Wind Ramp Management
- Wind Firming
- Spinning Reserve
- Capacity

Power Output (MW)

Energy Capacity (MWh)
...Need a Flexible Product Architecture...

More Power:
Choose Inverter Size

More Energy:
Select Number of Racks

Scalability:
Add Containers
...and A123 Provides Solutions Worldwide

Over 40MW in service today