• Initial study & future opportunities
• Energy storage: a pathway to 10% solar?
• Energy storage & resource planning
Energy Storage Study

• Investigated potential costs and benefits of installing energy storage devices:
  • utility-managed
  • grid-connected
  • residential and commercial buildings
  • in Minnesota
Where could storage add value?

- Energy assurance
- Affordability
- Economic efficiency and reliability
MN SOLAR PATHWAYS

Storage: Pathway to 10% solar?
Scenario-based technical analysis

Evaluate technical and economic potential for technologies to complement solar in future high penetration scenarios
Wind Energy Storage

Demand-Side Management

Energy Curtailment

Geographic Dispersion

Portfolio of Technologies Considered

Minimum

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Energy Storage Technologies

Electro-chemical
(Batteries)

Mechanical
(Flywheel)

Bulk Mechanical
(Compressed Air)

Thermal
(Ice/HOT Water)

Bulk Gravitational
(Pumped Hydro)

Transportation
(Electric Vehicles)

Images: Strategen
Energy storage is broad category including diverse technologies and benefits to the electric grid.
DOE Energy Storage Database

Existing:

(1) Sodium-Sulfur Battery: 1,000 MW
(12) Other Batteries: 0.465 MW
Total: 1.465 MW

Proposed:

Connexus
Solar + Storage: 20.0 MW

Xcel Wind-to-Battery Project
Luverne, MN 2008
1,000 kW Sodium Sulfur
Duration: 7 hour at 1MW
Energy Storage in Resource Planning & Acquisition

- Types of storage that are already used in resource planning
  - Thermal storage ➔ load shaping
  - Wind + hydro curtailment ➔ hydro storage
Energy Storage and Resource Planning

• Provides peaking services
• Creates increase in demand during demand during off-peak
• Creates increase in supply during on-peak
• Might bid against traditional peaking units
• Benefits include flexibility & no environmental costs
• Need to consider what (marginal) resource is displaced
Summary

• There are future opportunities for study
• Energy storage is one pathway being explored to help meet a 10% solar future
• Energy storage has a place in resource planning
Thank You!

Bill Grant
Bill.Grant@state.mn.us
651-539-1801