

# ENERGY STORAGE OVERVIEW

---

Legislative Energy Commission  
Nov. 9, 2017

Great River Energy, Minnesota Power,  
Otter Tail Power and Xcel Energy

# What is Energy Storage?

## Definition

Technology capable of storing previously generated electric energy and releasing energy later.

Can occur as potential, kinetic, chemical, or thermal energy.

Release of energy can be in forms that include electricity, gas, thermal energy and other energy carriers.

## Technologies

### EMERGING

**Solid state batteries:** Electrochemical storage, including advanced chemistry batteries and capacitors

**Flow batteries:** Energy is stored in electrolyte solution for longer life cycle and quick response

### EXISTING

**Flywheels:** Mechanical devices that harness rotational energy to deliver instantaneous electricity

**Compressed air energy storage:** Compressed air is used to create a potent energy reserve

**Thermal:** Heat and cold are captured to create energy on demand

**Pumped hydro power:** Large scale reservoirs of energy are created with water

## Asset Categories

Electric generation asset

Transmission asset

Distribution asset

DSM asset

## Uses

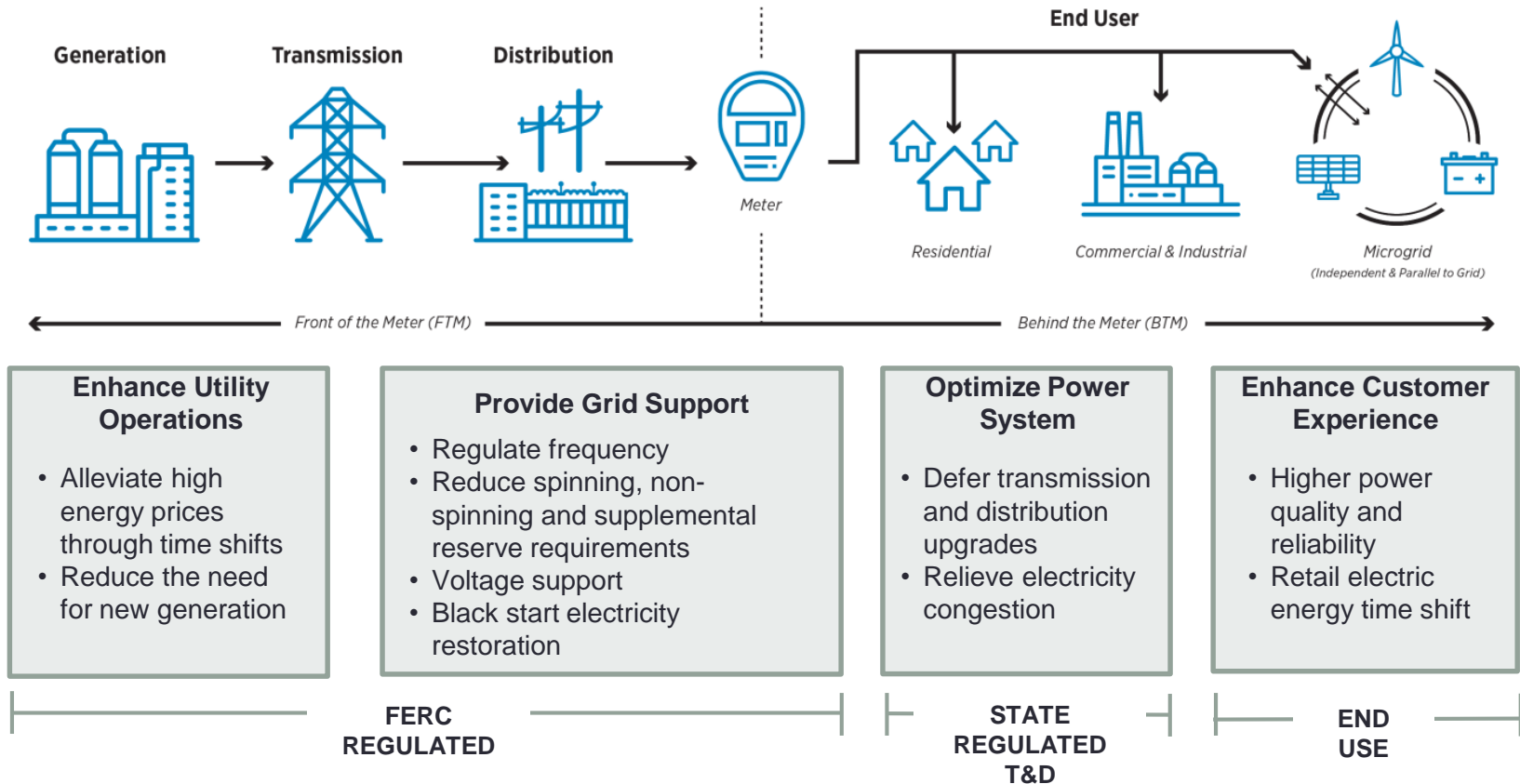
Capacity

Flexibility

Reliability/resiliency

Microgrids and community projects

# Potential Energy Storage Applications

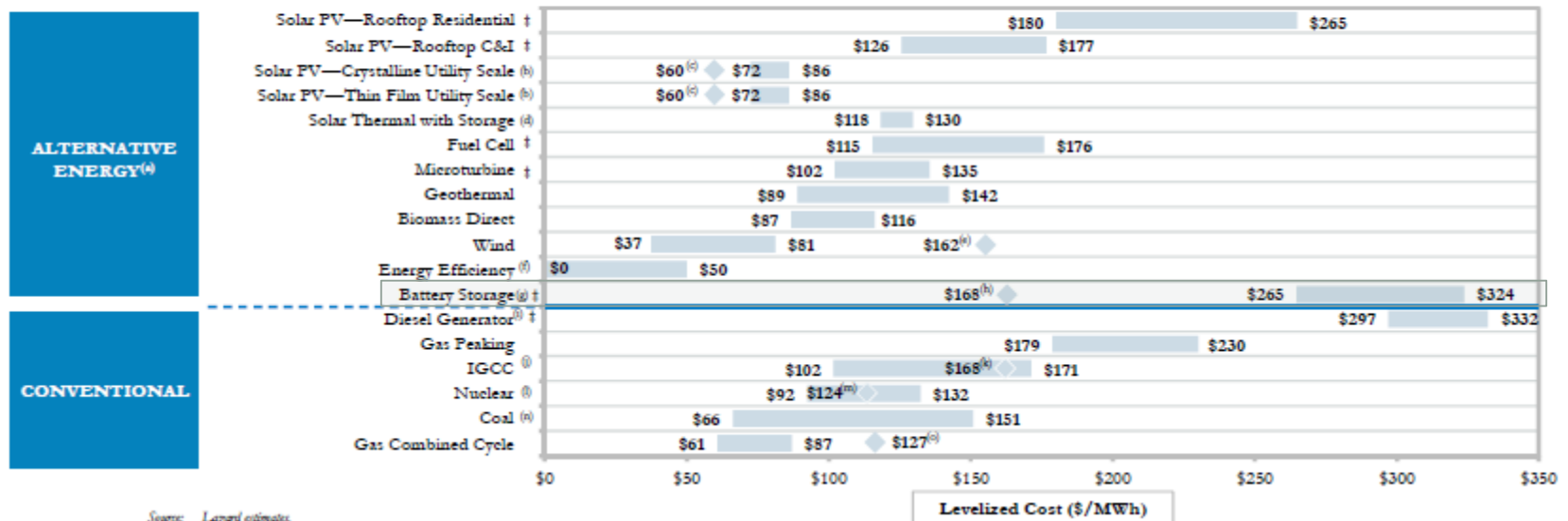


# Cost Comparison

LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 8.0

## Unsubsidized Levelized Cost of Energy Comparison

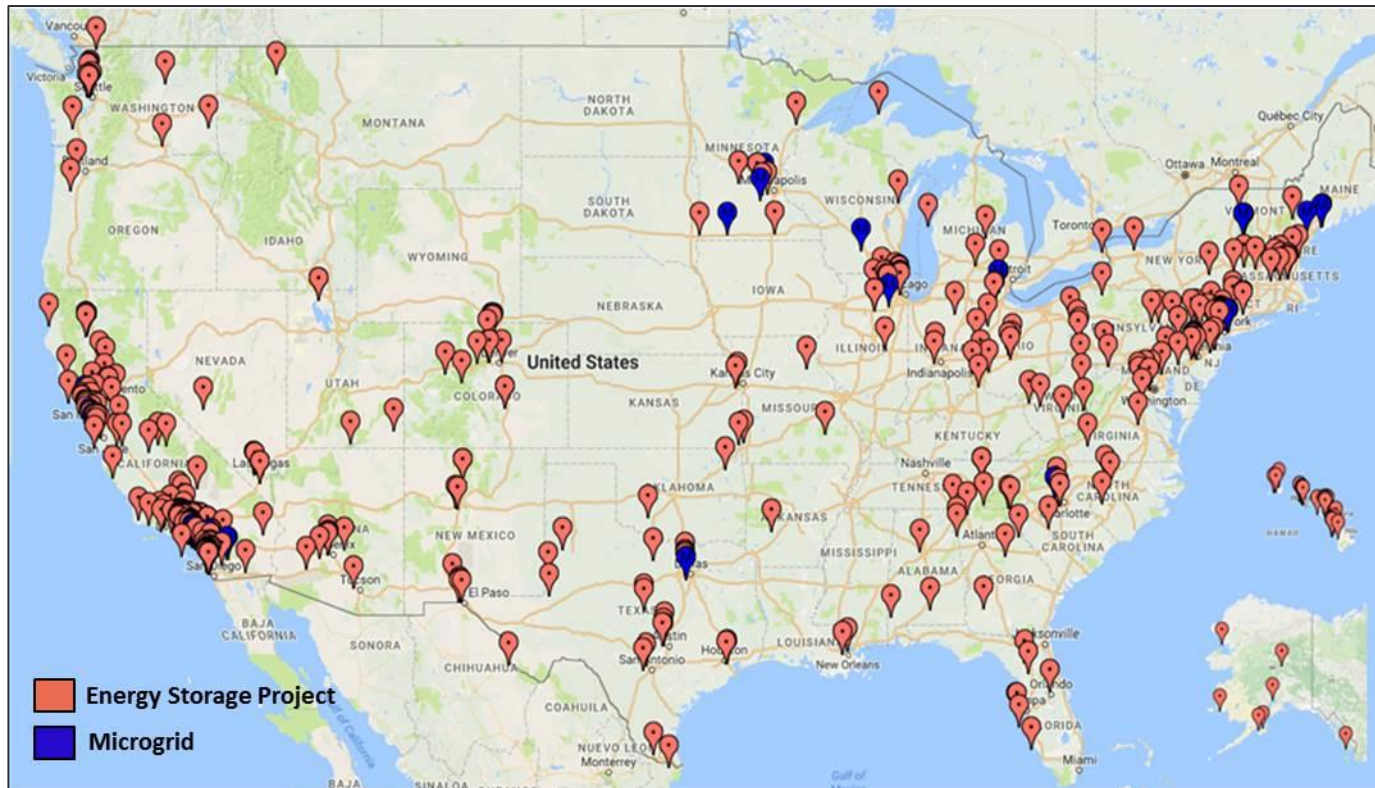
Certain Alternative Energy generation technologies are cost-competitive with conventional generation technologies under some scenarios; such observation does not take into account potential social and environmental externalities (e.g., social costs of distributed generation, environmental consequences of certain conventional generation technologies, etc.) or reliability-related considerations (e.g., transmission and back-up generation costs associated with certain Alternative Energy generation technologies)



LCOE of current stationary storage technologies is among the most expensive technologies (\$265-324/MWh)

The estimated implied levelized cost for “next generation” storage in 2017 is \$168/MWh

# Operational and Planned Energy Storage Projects



# Minnesota Utilities' Storage Projects

Pilots are underway to evaluate storage potential and technical performance.

All utilities are evaluating storage as part of their Integrated Resource Plans.

## Great River Energy

- Electric Thermal Storage
- Re-Volt Electric Vehicles
- Electric School Bus
- Grid-Interactive Water Heating
- Solar and Battery Storage
- Non-wire Alternatives

## Otter Tail Power

- Electric Thermal Storage
- Virtual Power Plant Storage Pilot
- Partnership With Virtual Storage Vendor

## Minnesota Power

- Hydroelectric Resources as Efficient Energy Storage
- SolarSense Customer Projects

## Xcel Energy

- Luverne Wind-to-Battery
- Belle Plaine Proposal
- Pena Station Microgrid
- Stapleton Neighborhood Demo
- Cabin Creek Generating Station
- Solar Technology Acceleration Center

# Key Takeaways

Energy storage is a promising technology.

Billions are being invested around the world to make it safe, reliable and reasonably priced.

It's not there yet. Energy storage is still very expensive and not ready to deliver safe, reliable and low cost energy to our customers.

Utilities are all learning, supporting and delving into this new technology. We're currently executing pilot programs to understand the technology and how it can be incorporated onto the grid and into the regional marketplace. At this time, that's the appropriate role for energy storage in the utility industry.

Any mandated implementation of storage today would require utilities and their customers to invest in inefficient technologies that will become out of date in a short time. More development is needed before we launch large-scale initiatives for energy storage.