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Toward Cost-effective and Resilient Microgrids

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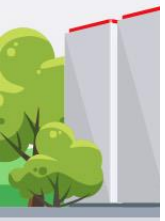
ENERGY STORAGE PROGRAM

U.S. DEPARTMENT OF ENERGY BATTELLE

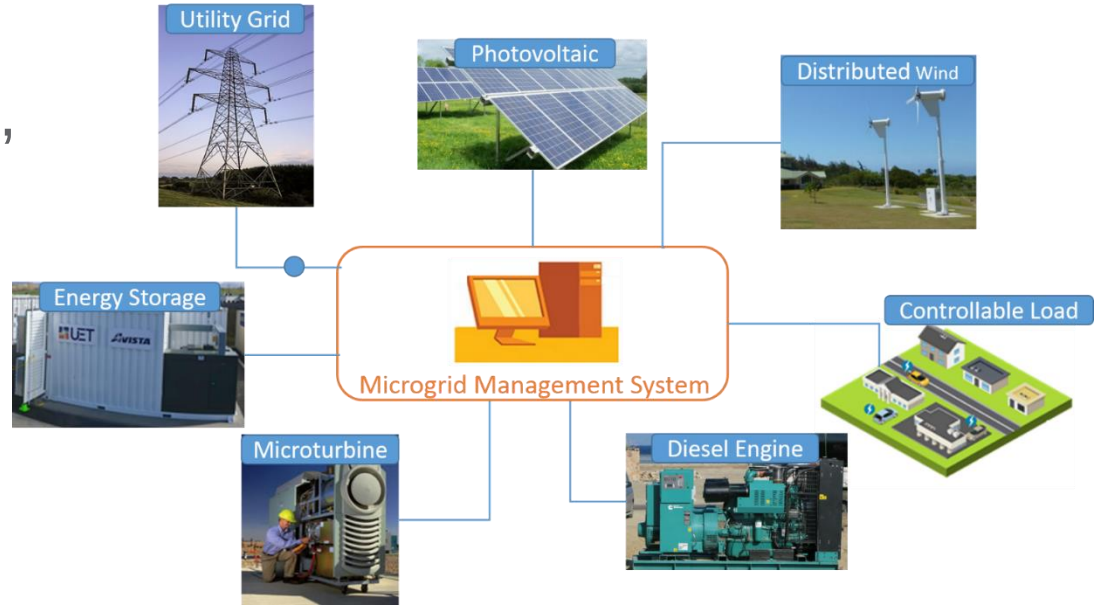
Outline

- Background
- Overview of Microgrid Assessment Projects
- Assessment Results
- Next Steps



Background

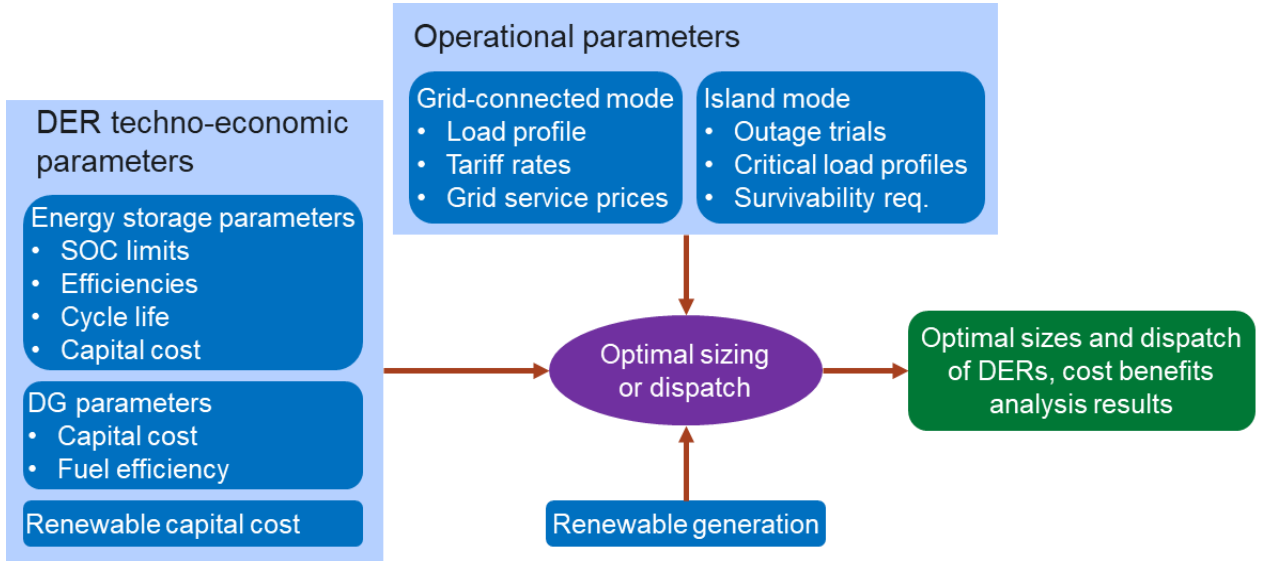
- Resilience has become a high priority for federal, state, and local governments, and is moving into industrial and commercial sectors.
- Recent developments and advances in distributed energy resources (DERs) make them more affordable, accessible, and prevalent in microgrids.
- The emerging DERs not only strengthen the resilience of critical facilities, but also provide economic benefits for bill management and grid services.



MASCORE

Microgrid Asset Sizing Considering Cost and Resilience (MASCORE): PNNL has developed methods and a tool to select, size, and evaluate energy storage and other DERs for a cost-effective and resilient microgrid.

- Modeling various DER technologies with different economic and technical characteristics
- Modeling and capturing diversified system conditions in both grid-connected and island modes
- Capturing the interdependency between optimal size and dispatch
- Simultaneously determining the optimal sizes of different DERs



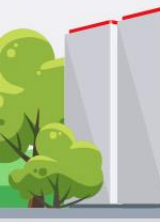
D. Wu, X. Ma, S. Huang, T. Fu, and P. Balducci, “Stochastic optimal sizing of distributed energy resources for a cost-effective and resilient microgrid,” *Energy*, vol. 198, May 2020, 117284

P. Balducci, K. Mongird, D. Wu, D. Wang, V. Fotedar, and R. Dahowski, “An evaluation of the economic and resilience benefits of a microgrid in Northampton, Massachusetts,” *Energies*, vol. 13, September 2020, 4802.

FY21 Microgrid Assessment Overview

PNNL has adapted and used MASCORE in four microgrid assessment projects:

- **NRECA**: four microgrid systems for improved rural resilience
- **Avista**: integration of battery storage, PV, and flexible building load used for multiple purposes to benefit both the customer and utility
- **OPALCO**: a hybrid battery storage paired with PV on an island for improved resilience, T&D deferral and bill reduction
- **PSE**: a storage-enabled microgrid supporting a high school as emergency shelter



Team Members

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- Dr. Di Wu – Principal Investigator
- Dr. Dexin Wang – Modeling & Optimization
- Dr. Avijit Das – Modeling & Optimization
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- Tao Fu – Load Modeling and Forecasting
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- Dr. Jason Hou – Load Modeling and Forecasting
- Dr. Sen Huang – Building Load Modeling
- Alasdair Crawford – Battery Energy Storage Modeling
- Dr. Vish Viswanathan – Battery Energy Storage Modeling
- Dr. Vince Sprenkle – Project Management
- Charlie Vartanian – Project Management
- Dr. Jan Alam – Project Management

NRECA America's Electric Cooperatives — Lauren Khair

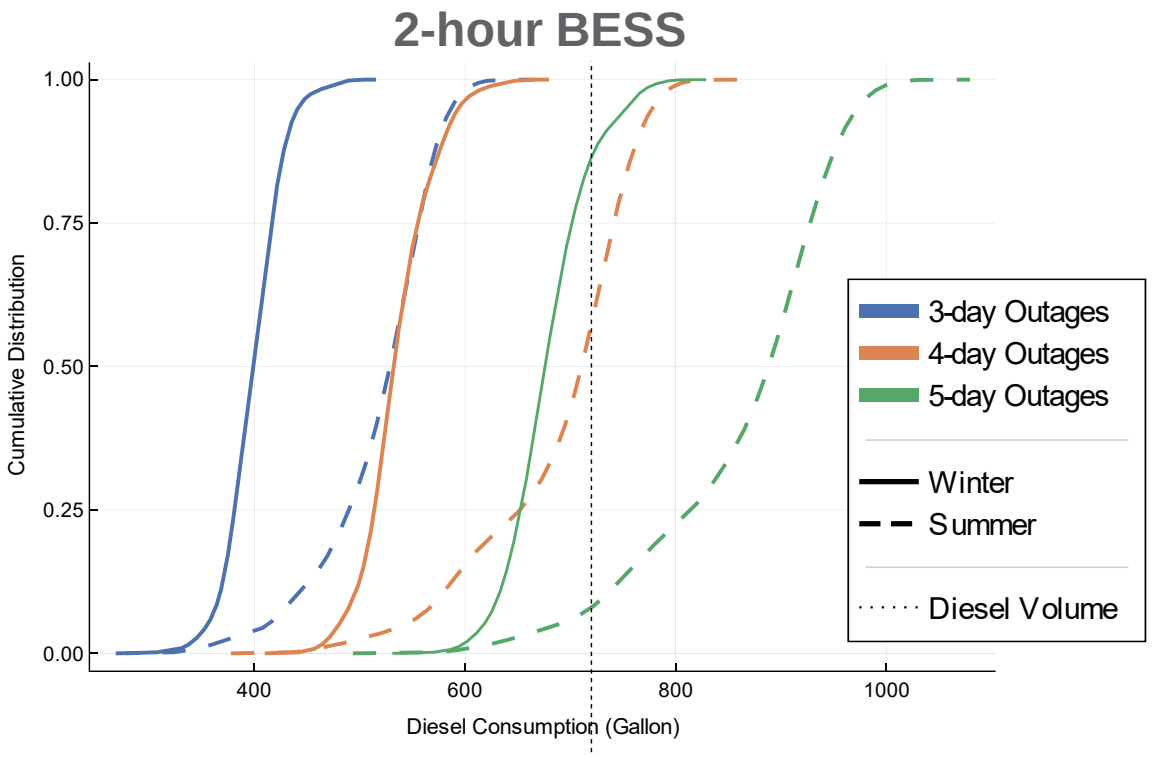
AVISTA — Mike Diedesch

Orcas Power & Light Co-op, Since 1937, Serving the San Juans — Russell Guerry

PSE Puget Sound Energy — Robert Zimmerman

NRECA Resilience Assessment Example

- Power adequacy
  - Peak load: **130 kW**
  - Existing generator: **400 kW**
  - **New BESS: 125 kW (1, 2 or 4 hours)**
- Energy adequacy
  - Fuel storage capacity: **720 gallons**
  - Full load (400 kW): **25 hours**
  - Minimum loading level (100 kW): **65 hours**
  - Average load in summer (80 kW):
    - ✓~**80 hours** (with an efficiency at 25% loading level)
    - ✓**~125 hours** (with an efficiency at 100% loading level)

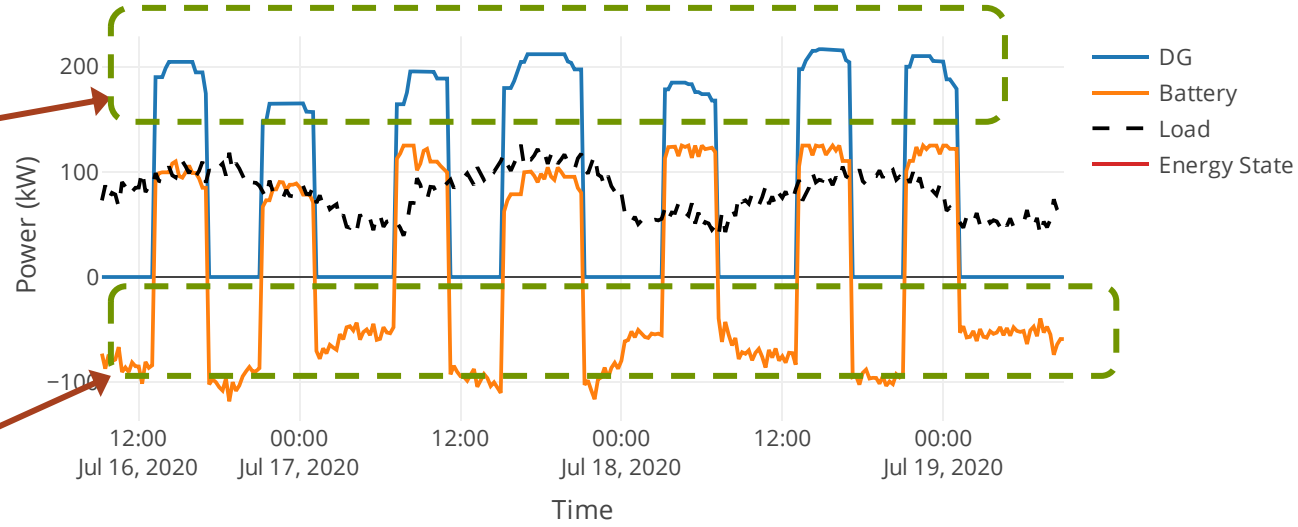


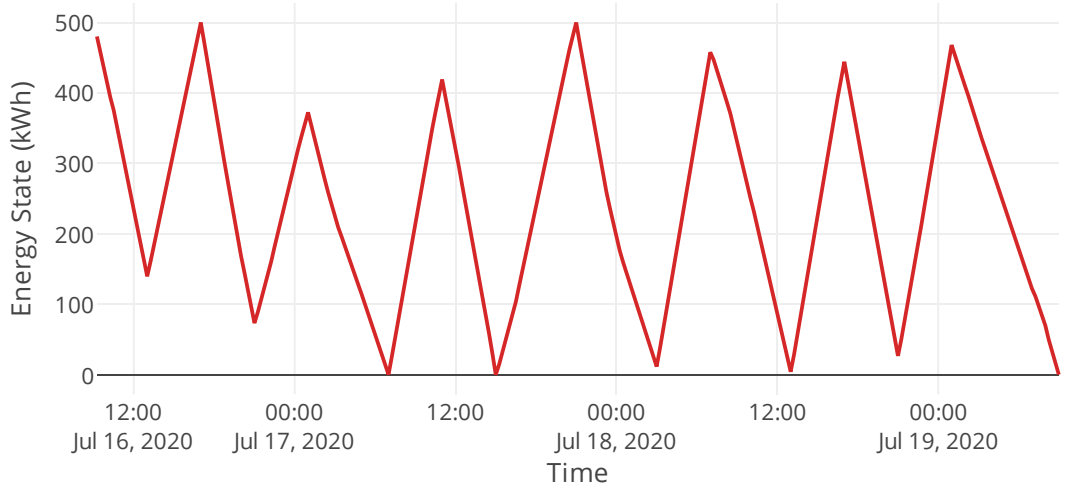
Improved efficiency and increased survivability against outages with a duration of 4-5 days

Optimal Coordination of DG and 4-Hour BESS

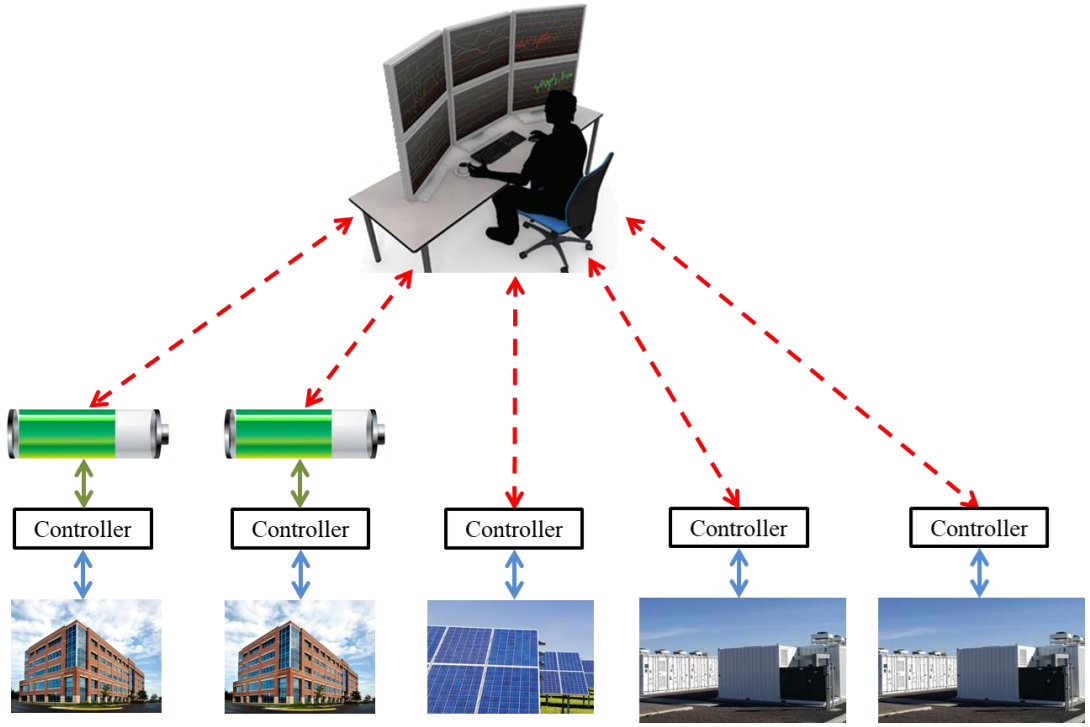
DG is on to charge battery while serving the load

DG is off and the load is served by battery





Avista Shared Energy Economy

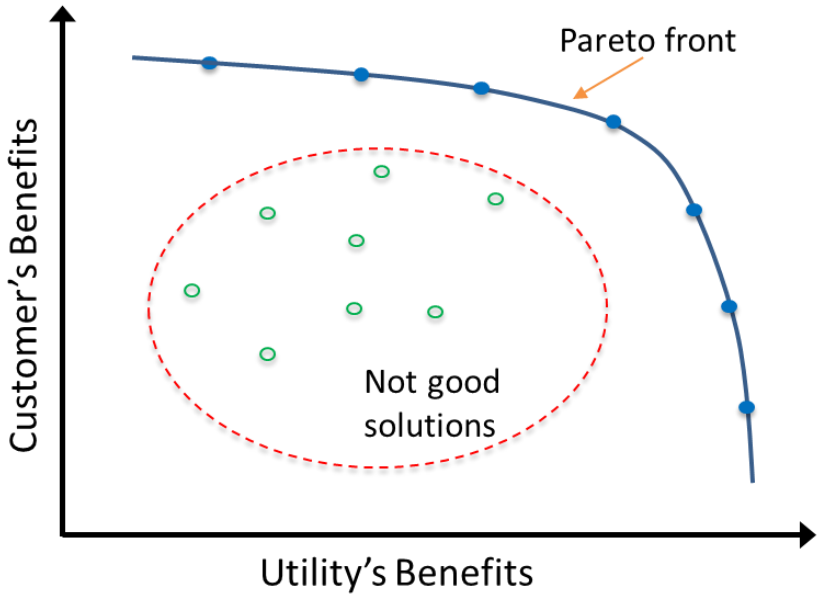


150,652 ft^2
1,100 kW

63,434 ft^2
300 kW

100 kW × 2

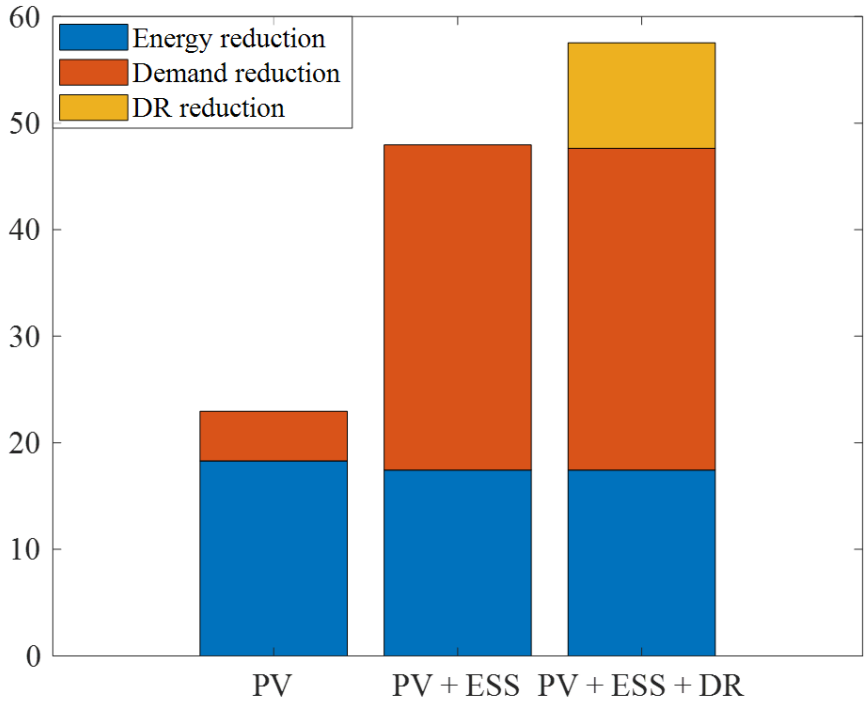
- 500 kW/1506 kWh
- 168 kW/334.8 kWh



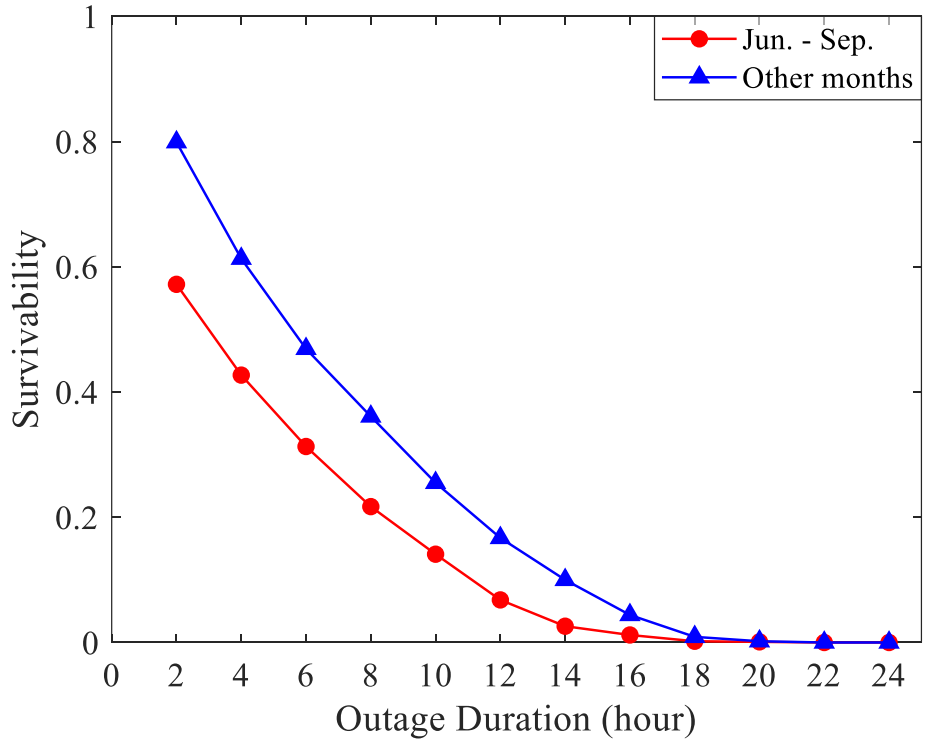
There does not exist a control strategy that can simultaneously maximize benefits for both parties

Avista Assessment Results

Customer Economic Benefits
($ thousand)

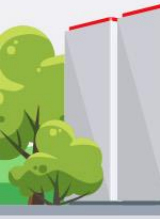


System Resilience



Looking Forward

- PNNL will continue to assist the microgrid design and assessment
  - NRECA: explore potential economic benefits
  - Avista: evaluate utility benefits and develop Pareto front analysis; collect field measurements and build the performance model into the economic and resilience analysis
  - OPALCO: quantify T&D upgrade deferral and resilience benefits and assist the decision-making in system design
  - PSE: define data requirement and perform techno-economic assessment
- PNNL will seek to publish the findings of the microgrid assessment
- PNNL will enhance the microgrid sizing and assessment framework by integrating environmental benefits and energy equity



Acknowledgments

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Mission – to ensure a resilient, reliable, and flexible electricity system through research, partnerships, facilitation, modeling and analytics, and emergency preparedness.

https://www.energy.gov/oe/activities/technology-development/energy-storage

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Thank You

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