Cooperative Research Network

DOE Electricity Distribution System Workshop

Forward Looking Panel

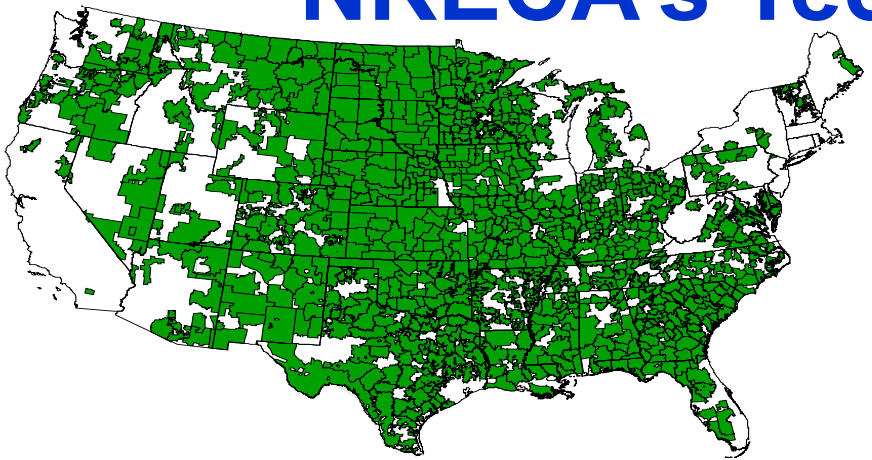
September 2012

National Rural Electric Cooperative Association
A Touchstone Energy® Cooperative

ENERGY & POWER

NRECA CRN™ COOPERATIVE RESEARCH NETWORK

NRECA's Technical Focus



- Over 900 Electric Cooperatives
- Serve 42 million Americans in 47 States
- Cover >70% of Nation's land mass
- Own 42% of all Distribution Line
- Totals 2.4 Million Line Miles

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Identify and Adopt Beneficial Technologies:

- Improve Productivity
- Enhance Service
- Control Cost

NRECA CRN™ COOPERATIVE RESEARCH NETWORK

Timely Energy Innovations

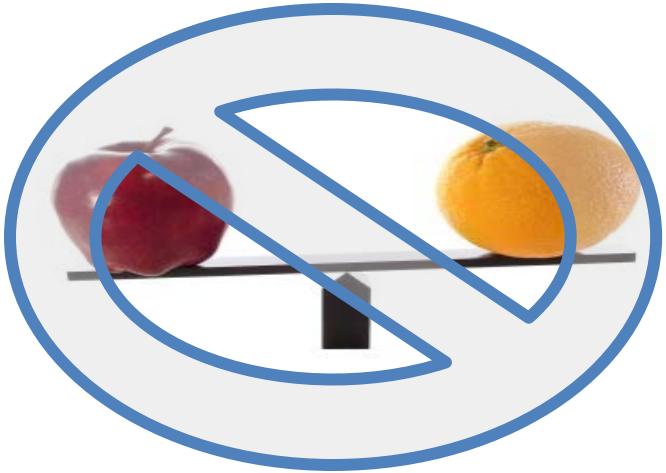
Not for Profit, Consumer Owned, Consumer Controlled

Choosing the Right Technologies

Motivations & Methods

Uncovering Smart Grid ROI

- Technology Investments Hinge on Cost Benefit
- Accelerate Beneficial Adoption Rate
- Precision



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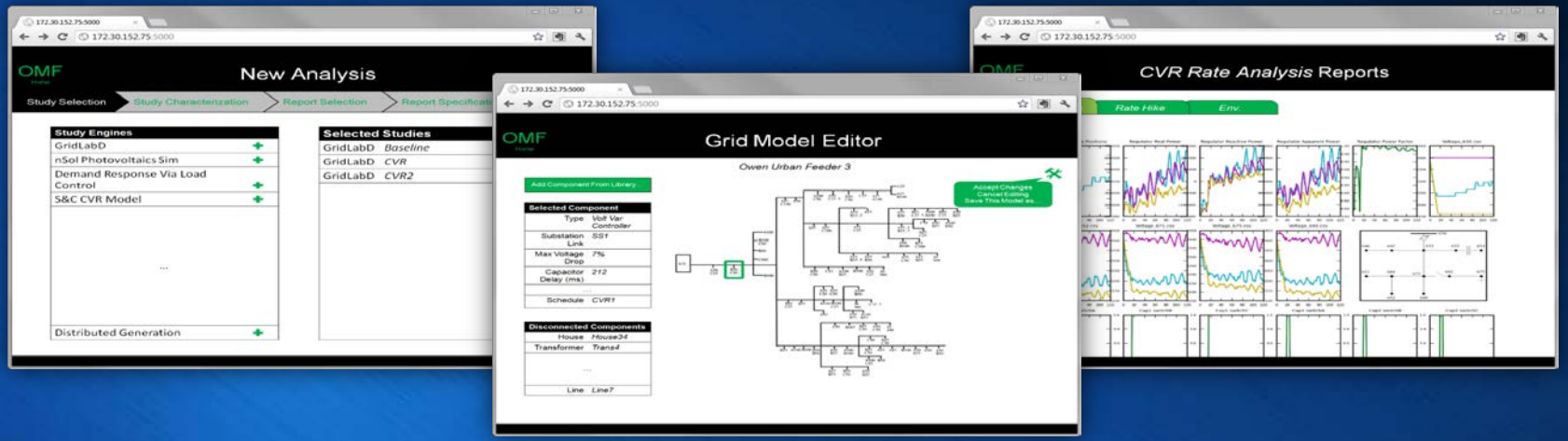
Modular Evaluation Tool

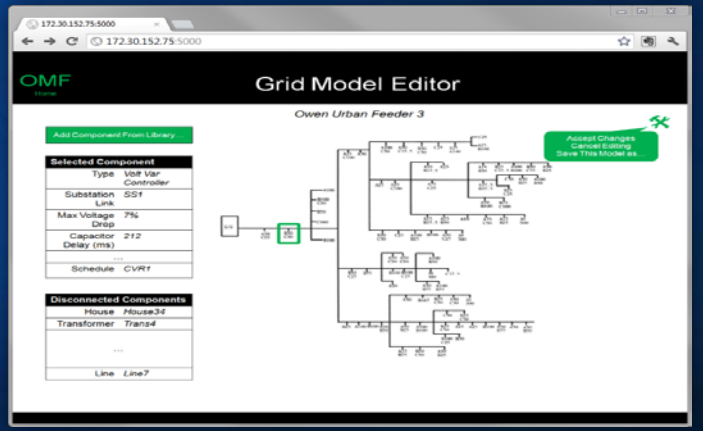


- Run cost-benefit analyses on smart grid investments, either individually or in arbitrary combinations.
- Available via the Internet, it will integrate and extend all of the best grid modeling tools available.

Open Modeling Framework

Underway – CVR in Smart Grid Demo Study

- Impact of Volt/VAR Optimization on power factor, peak demand and revenue?
- What feeder characteristics are correlated with high return on investment?
- What influences performance?



Participating Cooperatives

Adams, Menard,

Owen, Iowa Lakes

Optimizing Systems

Controlling Costs - Enhancing Service

Distribution Efficiency

Improve distribution efficiency, including:

- circuit diversity;
- energy and peak demand losses;
- voltage optimization;
- phase balancing and reactive power improvements; and
- economic optimization

Smart Feeder Switching

Smart Grid Demonstration

- Data & Communications Intensive
- Lessons Learned
- Advanced Distribution Automation
- Advanced Sectionalizing Scheme

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Wise Energy & Strategic Use

Efficient Delivery & Use

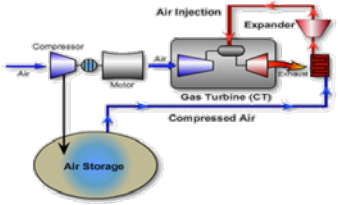
Complementing the Existing Portfolio

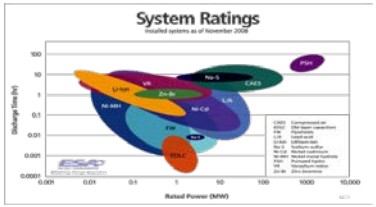
Integration Challenges

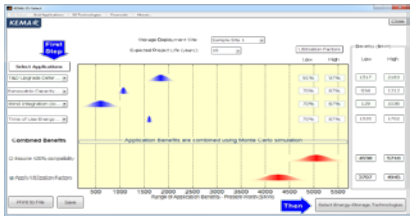
Utility Ownership Advantages

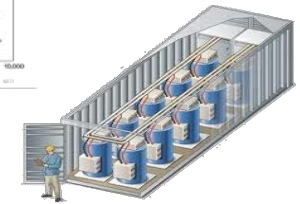
Potential for Energy Storage

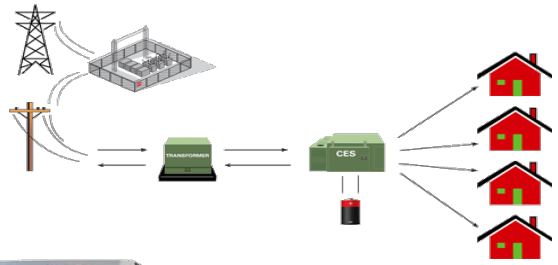
Energy storage has huge potential, but there are too many choices and not enough knowledge

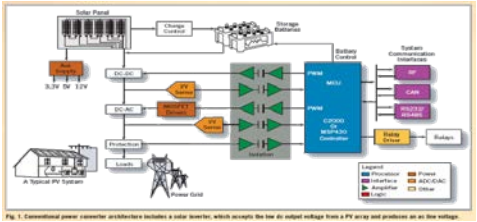


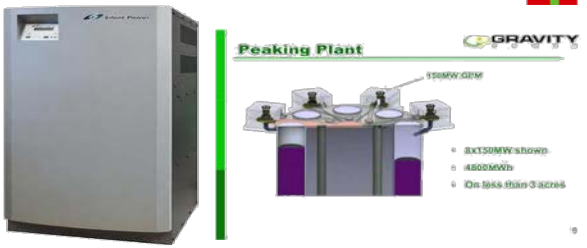












Energy Storage & Demand Response

NRECA Demonstration

- Thermal Storage Demo
- Battery Storage Pilot
  - Energy Arbitrage
  - Frequency Regulation
  - Distributed Scale
  - Bridge Renewables in an era of mixed results for energy storage

Advanced Analytics

Raising the Bar

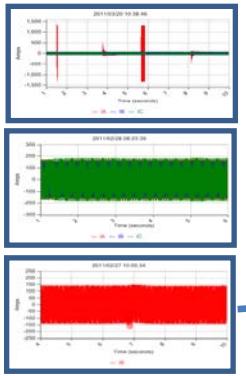

Storage Arbitrage
Outage Management
O&M Cost Reduction
Load Forecasting
Improved Safety
Micro Weather Forecasting
Communications Planning
Fault Anticipation
Renewable Forecasting
Cyber Forensics
Condition Based Maintenance
Improved Power Quality
Edge Voltage Control
Asset Management
Workforce Management
Physical Forensics

Distribution Fault Anticipator

The Challenge

- **Failures are dangerous and costly**
- **Interruptions in power can harm customers, physically and financially**
- ***But* … interruptions can be avoided and costs of repair reduced if failure can be anticipated**

Substation CT and PT waveforms



DFA

On-Line Signal Processing and Pattern Recognition Algorithms

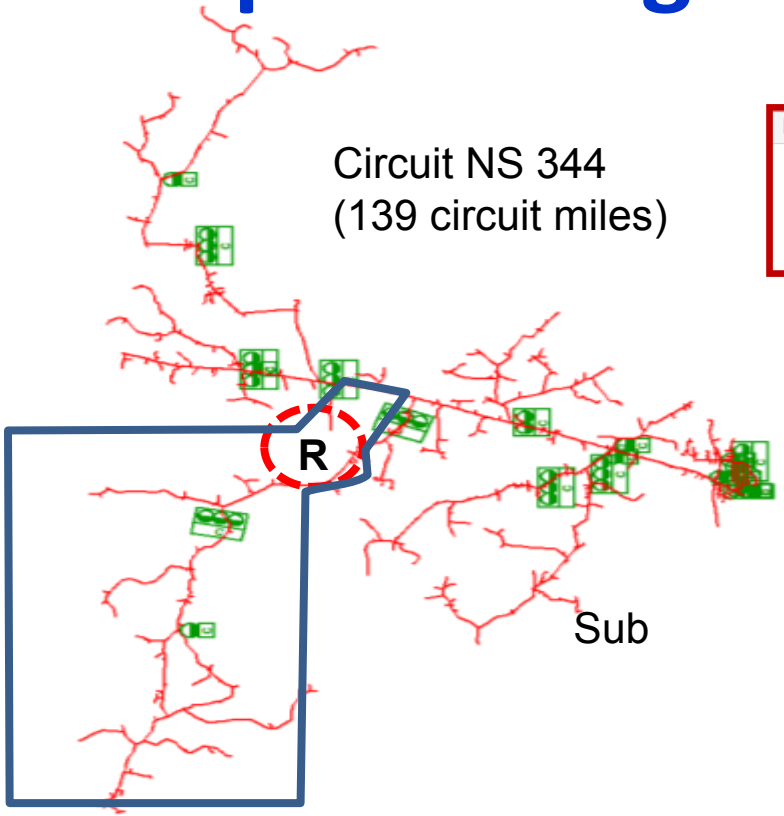
Typical notices

Line recloser* tripped 8% of phase-A load twice, but reclosed and did not cause outage

Failed 1200 kVAR line capacitor* (phase B inoperable)

Failing hot-line clamp on phase B*

Example: Outage Avoided With DFA



Possible recurrent fault	C	Single-Phase reclose, 510 Amps	2 (18 days)	09/28/11 13:45:22

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Event Type	Phases	Comments	Occurred
Single-Phase reclose	C	F-(3.0c,510A,CG)-T(0,0,19)S 2.1s-C	09/28/11 13:45:22
Single-Phase reclose	C	F-(3.0c,510A,CG)-T(0,0,21)S 2.0s-C	09/10/11 14:19:25

- DFA reported four individual faults, with recloser operations.
- DFA then identified that these four faults were the same fault.
- DFA also provided location information.

Another Role for Analytics

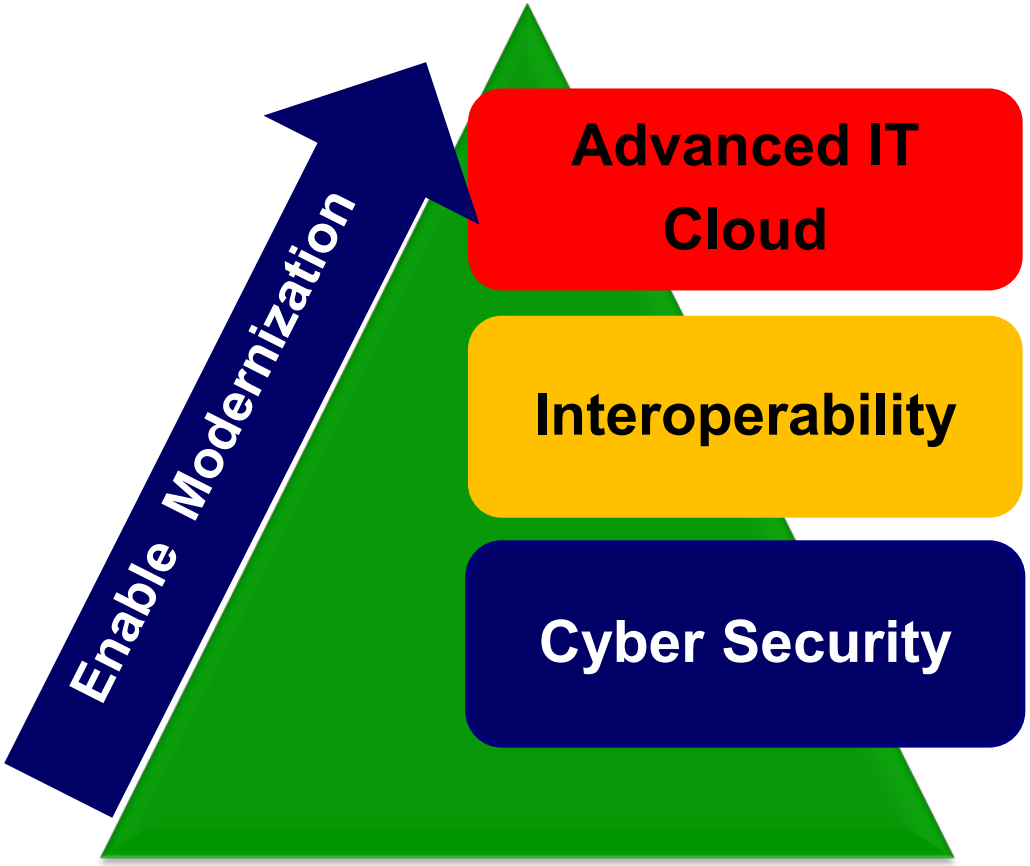
- Research Practices and Opportunities to Use AMI systems to Identify Losses
- Develop a Series of Recommended Practices
- Highlight Success Stories

Solid State Sensors

Interoperability

Timely – Affordable - Secure


AMI
Sensors
MDM
HAN
Remote Disconnect
DA
Interoperability – Can You go the Distance Without It?
Auto Switching
Volt/VAR
Pre-Pay
Consumer Portal
Mobile Dispatch
DSM
MultiSpeak


Enable Modernization
Advanced IT
Cloud
Interoperability
Cyber Security

MultiSpeak®

Keys to Modernization of the Grid

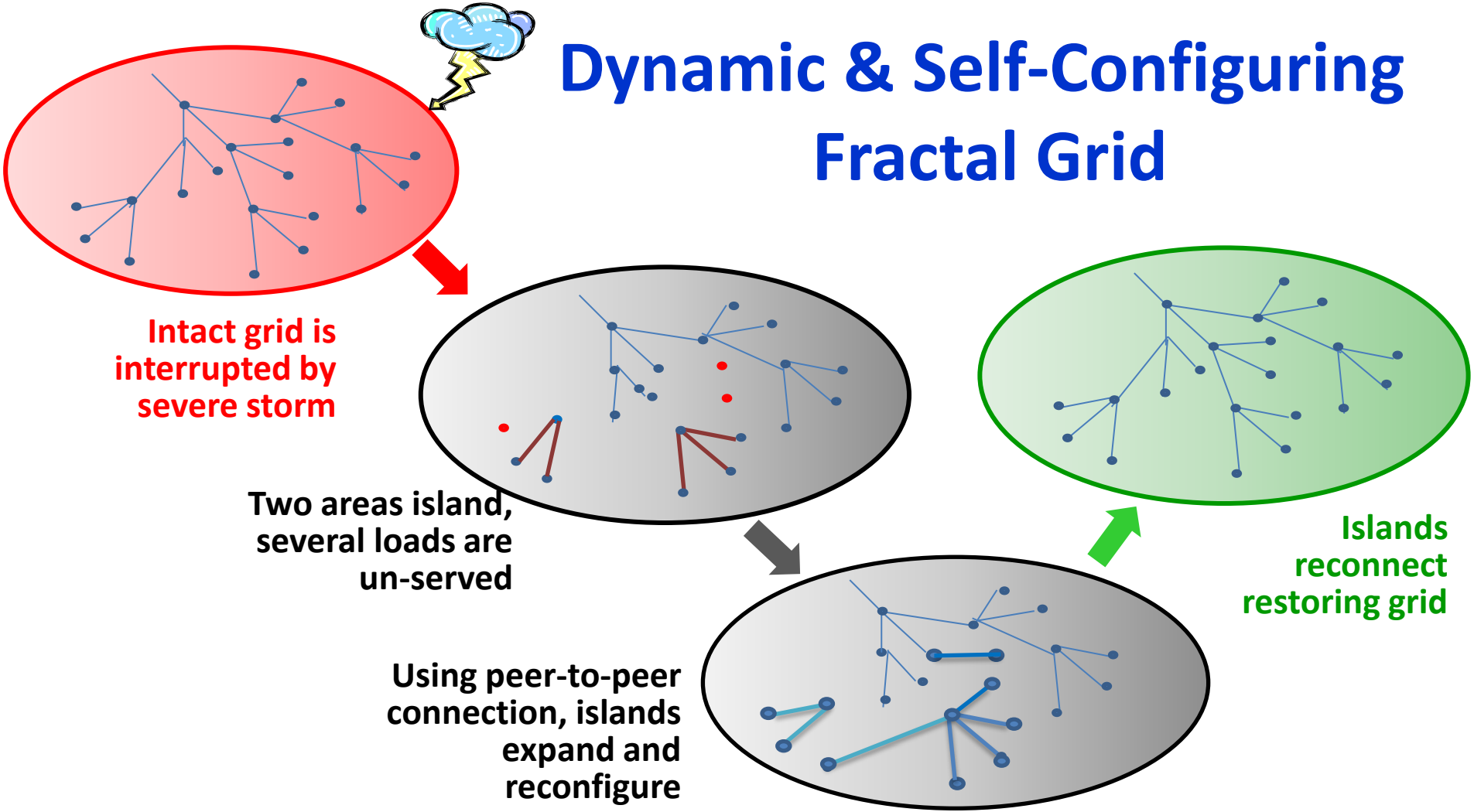
Advanced IT & The Cloud

Cyber Security

Interoperability

MultiSpeak®

Dynamic & Self-Configuring Fractal Grid



Challenges Ahead

- Cost Benefit Tools
- Analytics
- Secure Interoperability
- Telecommunications
- Energy Storage

NRECA Focus: Deployment

Accelerating The Path to Commercialization & Adoption Thru Demonstration -Hard Data - Analysis

Powering Electric Cooperatives

www.nreca.org

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