EPRI's Resilience Initiative

Expanding Perspectives in Energy System Resilience

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USEA Resilience Briefing
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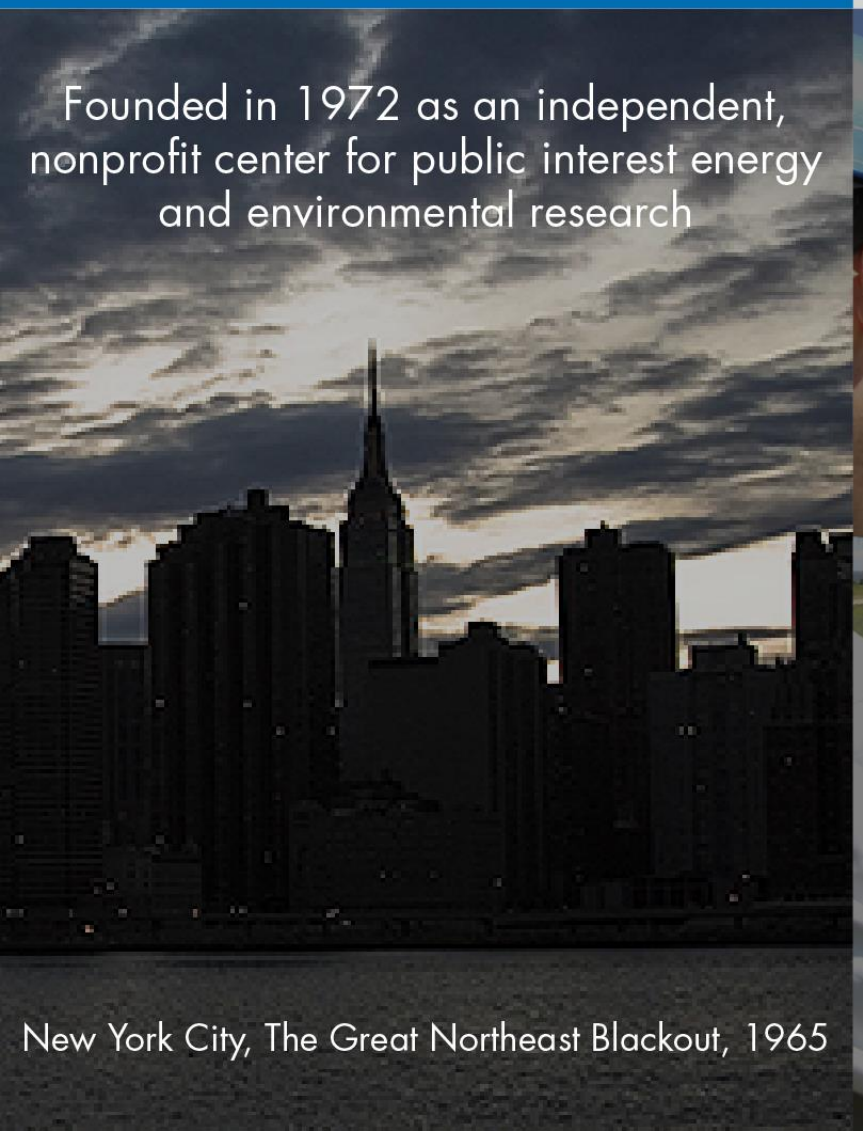
Introduction to EPRI

BORN IN A BLACKOUT

Founded in 1972 as an independent, nonprofit center for public interest energy and environmental research



New York City, The Great Northeast Blackout, 1965

EPRI'S VALUE

To provide value to the public, our members, and the electricity sector

THOUGHT LEADERSHIP

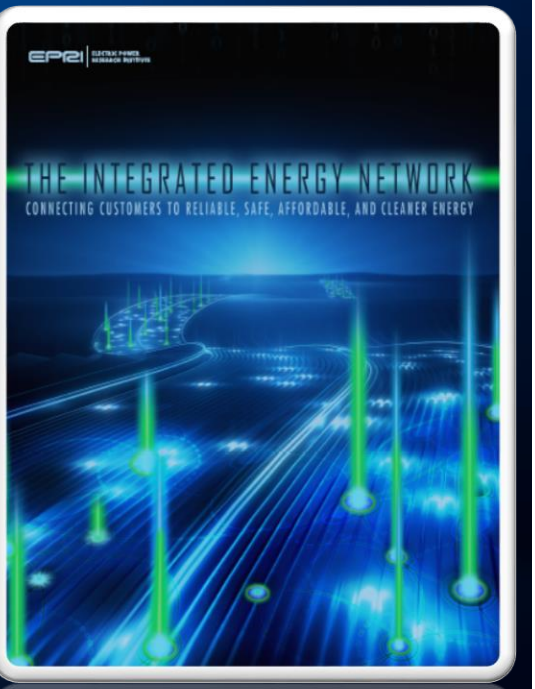
INDUSTRY EXPERTISE

COLLABORATIVE MODEL

OUR MEMBERS…

- 450+ participants in more than 30 countries
- EPRI members generate approximately 90% of the electricity in the United States
- International funding – nearly 25% of EPRI's research, development, and demonstrations
- $415M Annual Funding

Integrated Energy Network



Source: EPRI 3002009917
February 2017

Integration of Interdependent Energy Resources:

Improves Reliability, Resiliency, Efficiency, Productivity, Create New Opportunities, and Expand Customer Choice

Aspects of Energy System Resilience

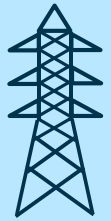
- Infrastructure Interdependencies
- Threats Assessments
- System Vulnerabilities (N-k, PRA)
- Mitigate, Adapt, Recover
- Metrics and Resilience Adequacy
- Infrastructure Investment Support
- Maturity Models
- Valuation Frameworks
- Who Implements
- Who Pays

North America—United States

- 200,000 miles of transmission line over 230 kV.
- 58,000 substations between bulk transmission and distribution feeder systems.

EPRI's Power System Resilience R&D

Supply Resilience

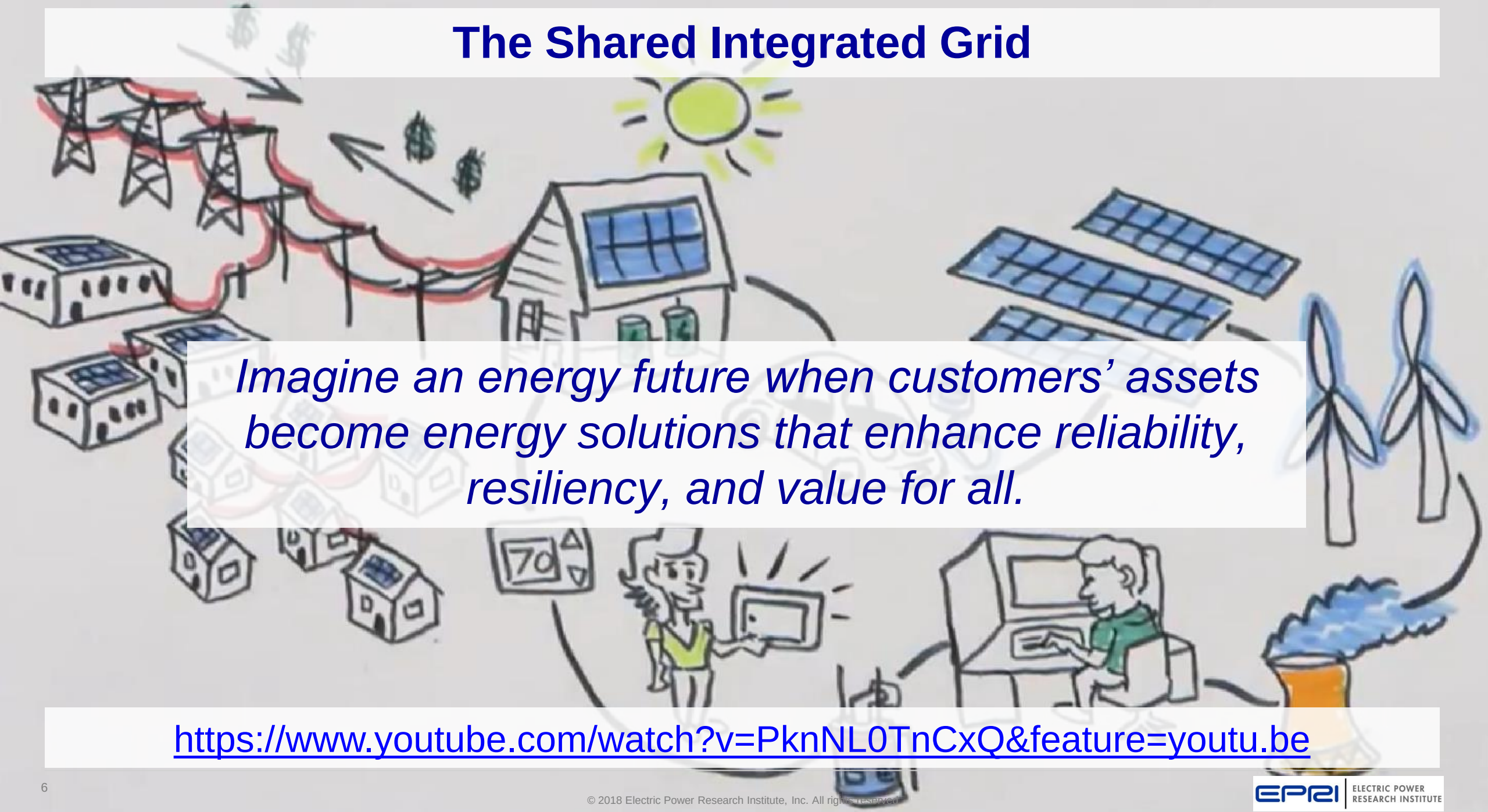


Transmission, Substation and Distribution Resilience

Communications Resilience

	Supply Resilience	Transmission, Substation and Distribution Resilience	Communications Resilience
Events	• Extreme weather (i.e., extreme cold) • Natural disasters (hurricanes, flooding)	• EMP, GMD events • Natural disasters & extreme weather • Manmade threats	• Cyber attacks • Natural disasters
Strategy	• Generator hardening • Fuel supply assurance • Local supply: DER and microgrids	• Line hardening & network redundancy • Strategies for reliable network architecture & communications • Local supply: DER and microgrids	• Enhanced cyber security • Strategies for reliable network architecture & communications
EPRI Work	• Nuclear risk assessments • 2018 supply resilience white paper • Environmental impacts of backup generation • Markets impacts and opportunities	• Frameworks & metrics assessments • EPRI/NATF/DOE maturity model • Investment decision support • Decision support tools for system emergency & restoration	• Cyber security cross-cutting program • Black sky communications • Customer data outage initiative • Integrated security operations center

The Shared Integrated Grid



Imagine an energy future when customers' assets become energy solutions that enhance reliability, resiliency, and value for all.

https://www.youtube.com/watch?v=PknNL0TnCxQ&feature=youtu.be

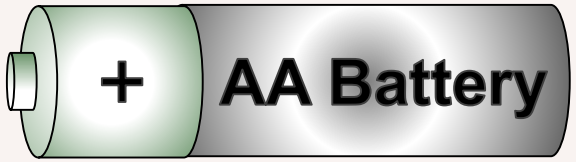
Why pay more for the one kilowatt-hour?

Grid-Supplied Electricity

- About 10 cents for 1 kWh in the United States

Standard AA Battery

- 250 AA = 1 kWh
- At 1000x the cost*



Customer Preferences Extend Beyond Costs—Control, Comfort, Certainty, Connectivity, and Choice Contribute to the Value Proposition

* Retail price, on sale for $25 per cell ($1 per 4-pack) at local Powell, TN grocery store, 5/27/2018.

A portable light for nights spent up with a newborn baby—non-stimulating, illuminating, and right where you need it, it's worth it!

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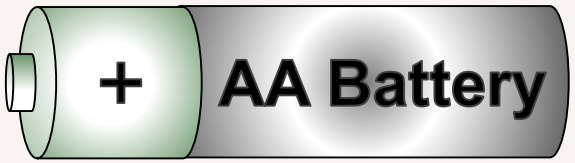

Customer Preferences Extend Beyond Costs—*Control, Comfort*, Certainty, Connectivity, and Choice Contribute to the Value Proposition

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Customer Resilience in the Shared Integrated Grid

Residential Advanced Heating System—space heating during a power outage

Rooftop PV with Off-Grid Inverter—opportunity power supply while solar resource is available

Backup Generation/Microgrids for Critical Services—opportunity for additional customer value streams

Key Areas of EPRI's Resiliency Focus

1. *The Value of Resiliency and Flexibility in the Integrated Energy Network*
2. *Supply and T&D Threats Assessments (including EMP and GMD), Impacts Modeling, Maturity Models (joint EPRI/NATF/DOE), Nuclear Risk Assessments, and Decision Support Tools*
3. *Cyber and ICT Resiliency in the Shared Integrated Grid*
4. *Customer Resilience Technologies—Opportunities to Empower and Enable Customers to be more Self-Resilient, and in doing so Increase Community and Overall Grid Resilience*

Questions?

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Together…Shaping the Future of Electricity