Building US Power Grid Resiliency

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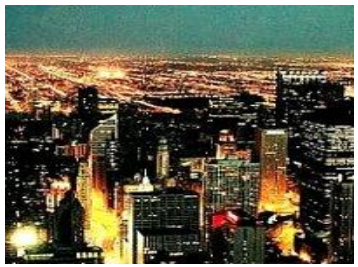
S&C Electric Company

- Employee-owned
- Headquartered in Chicago, IL
- Additional operations in:
  - Canada
  - Mexico
  - Brazil
  - China
  - Australia
  - United Kingdom
- 2500 employees

Overview

- Grid Trends and Drivers
- Recent investments
- Making the case for reliability
- National energy goals
- Grid characteristics enables our future



Grid Trends and Drivers

Growing Population, More Electronics

Infrastructure is more prone to failure

Increasing Environmental Requirements

Escalating Security Concerns

Heightened Investor Demands

Resiliency For:

- **Sustainability**
- **Carbon Management**
- **Electric Transportation**
- **Distributed Sources**
- **Efficiency**
- **Reliability**

Are We Prepared for the Change?

- Customer demand and expectations increasing, yet…
- Load factor is decreasing
- Vulnerabilities are increasing
- Build for ≤ 1% of the time
- Assets and employees are aging

- Grid development and modernization is inevitable for increased resiliency

Climate Change: Weather related power outages have increased ten fold per year in the last five years in the US.

Physical and Cyber-security: Increased attacks

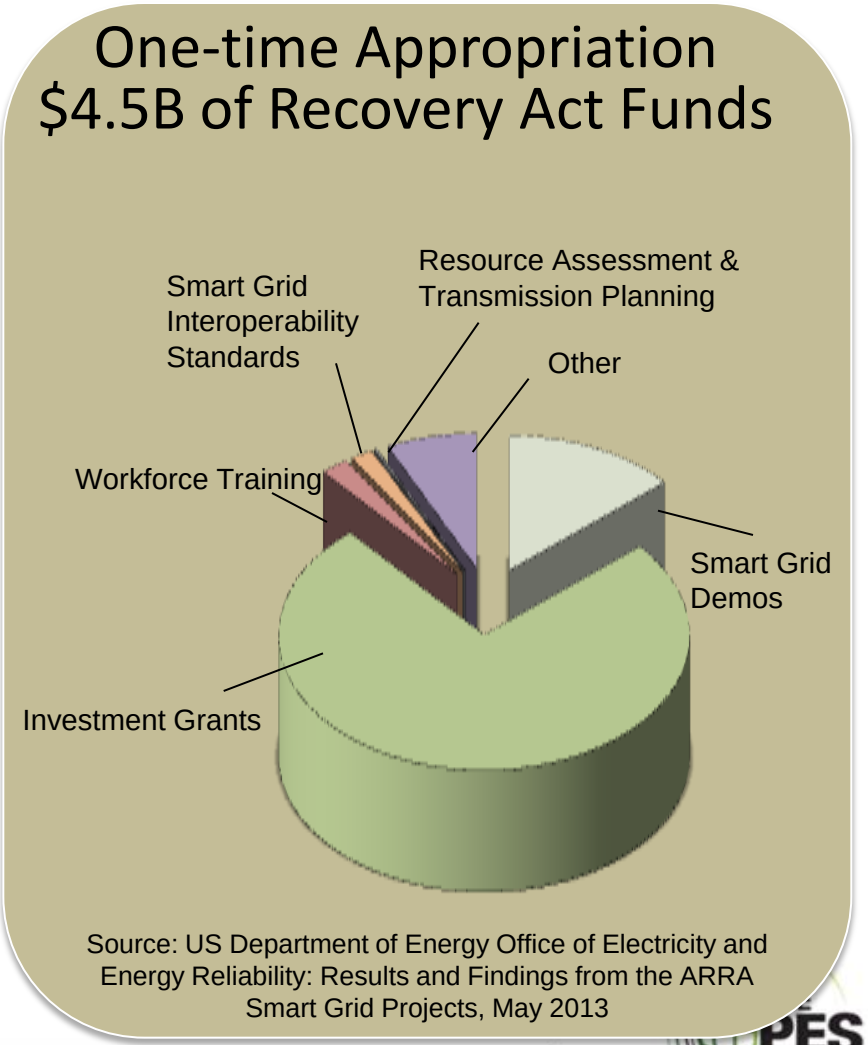
Visibility, Flexibility, Transparency: Increasing complication from infrastructure interdependency, intermittent sources, changes in supply mix, and distributed activity.

Old and New: Delivery assets were largely constructed decades ago. Updates needed to transport, accommodate load growth and enable new technologies… Also, many utility workers are likely to exit in a decade and need to be replaced.

Source: US DOE (2013) Energy Sector Vulnerabilities to Climate Change

US Recovery Act: Grid Modernization

- US Spent $7.9B in ARRA Smart Grid Projects
  - Includes $4.5B Federal stimulus and industry matching funds
  - Five year grants starting in 2010
- Results are being posted
  - www.smartgrid.gov
  - Several reports are posted
- Developing a platform for significant grid modernization investment



EPB of Chattanooga: Value of Reliability

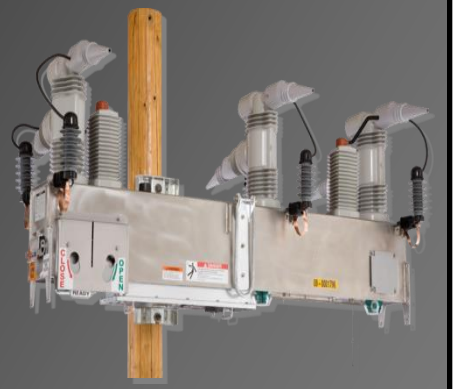
EPB of Chattanooga estimated that outages cost of $100 million
Saved with 1200 IntelliRupters® with IntelliTeam® SG

2011 Labor Day Storm (20% technology configured):

- 63,000 homes interrupted; however, 16,000 (25%) experienced no outage and 9,000 (7%) experienced a 2-second interruption
- Utility avoided 1,917,000 customer minutes of interruption

July 2012 wind storm:

- EPB estimates they avoided 500 truck rolls and reduce total restoration time by 1.5 days with automated feeder switching
  Represents $1.4 million in operational savings

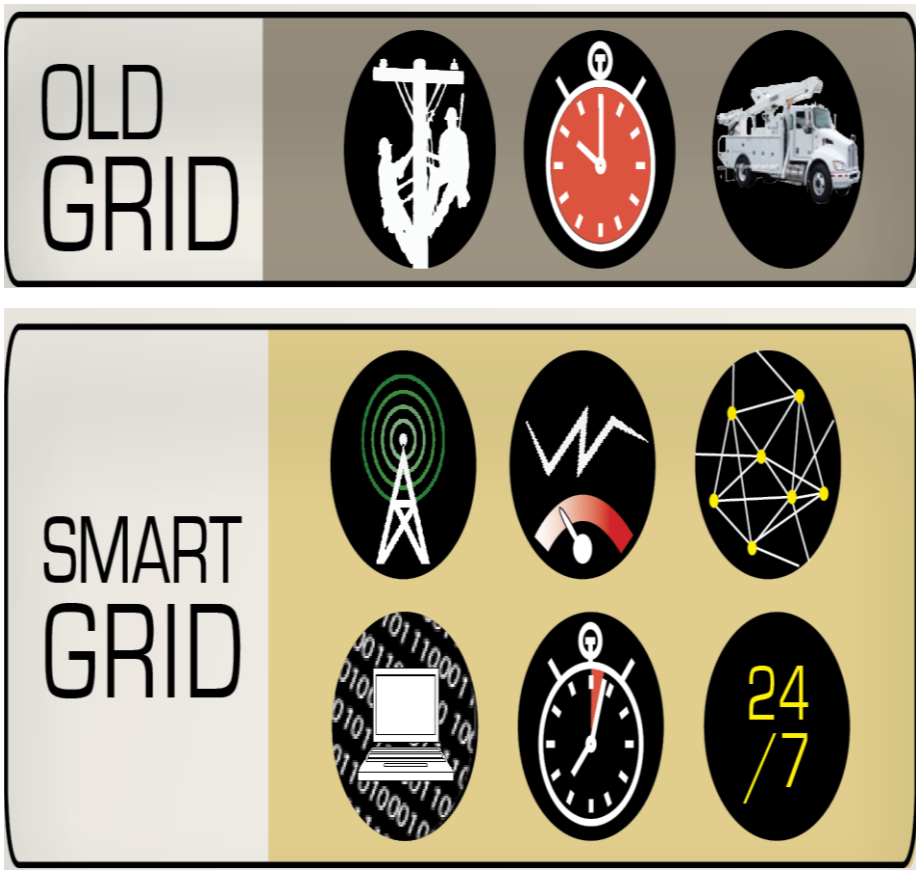


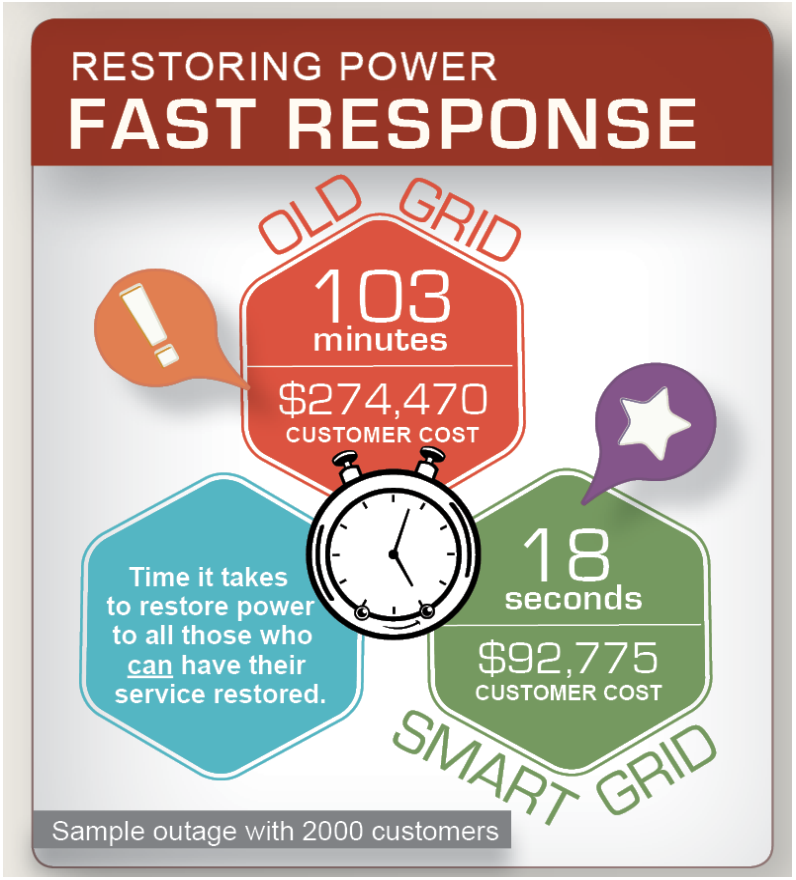
EPB Chattanooga saved $100MM per year, avoided 58 million customer minutes in July 2013 storm

Source: US DOE Office of Electricity and Energy Reliability: Results and Findings from the ARRA Smart Grid Projects, May 2013

Making the Case for a Self-Healing Grid

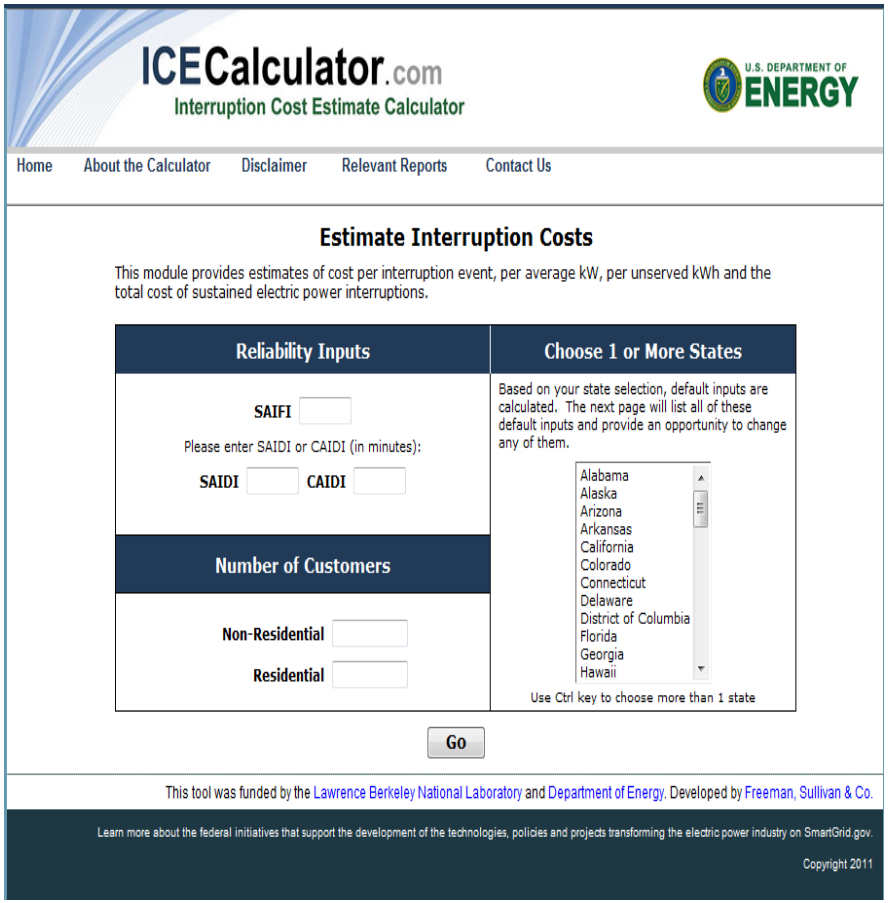
Business case video at: www.sandc.com/rsgs





Cost-Justifying Self-Healing

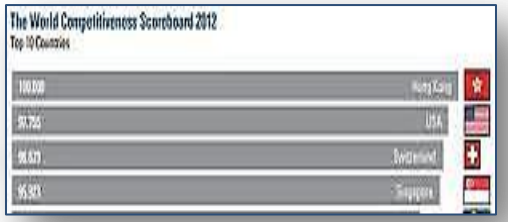
- Societal cost is often not factored into the reliability business case
- Connects infrastructure investment to the overall economic value
- Use the Interruption Cost Estimate Calculator
  - Estimates interruption costs
  - Calculates the value of reliability improvements
- www.ICECalculator.com



Developed by US DOE and Lawrence Berkeley National Laboratory


Efficient Building Systems
Utility Communications
Renewables
Internet
PV
Consumer Portal & Building EMS
Advanced Metering
Control Interface
Dynamic Systems Control
Distribution Operations
Plug-In Hybrids
Smart End-Use Devices
Distributed Generation & Storage
Data Management

National Energy Goals



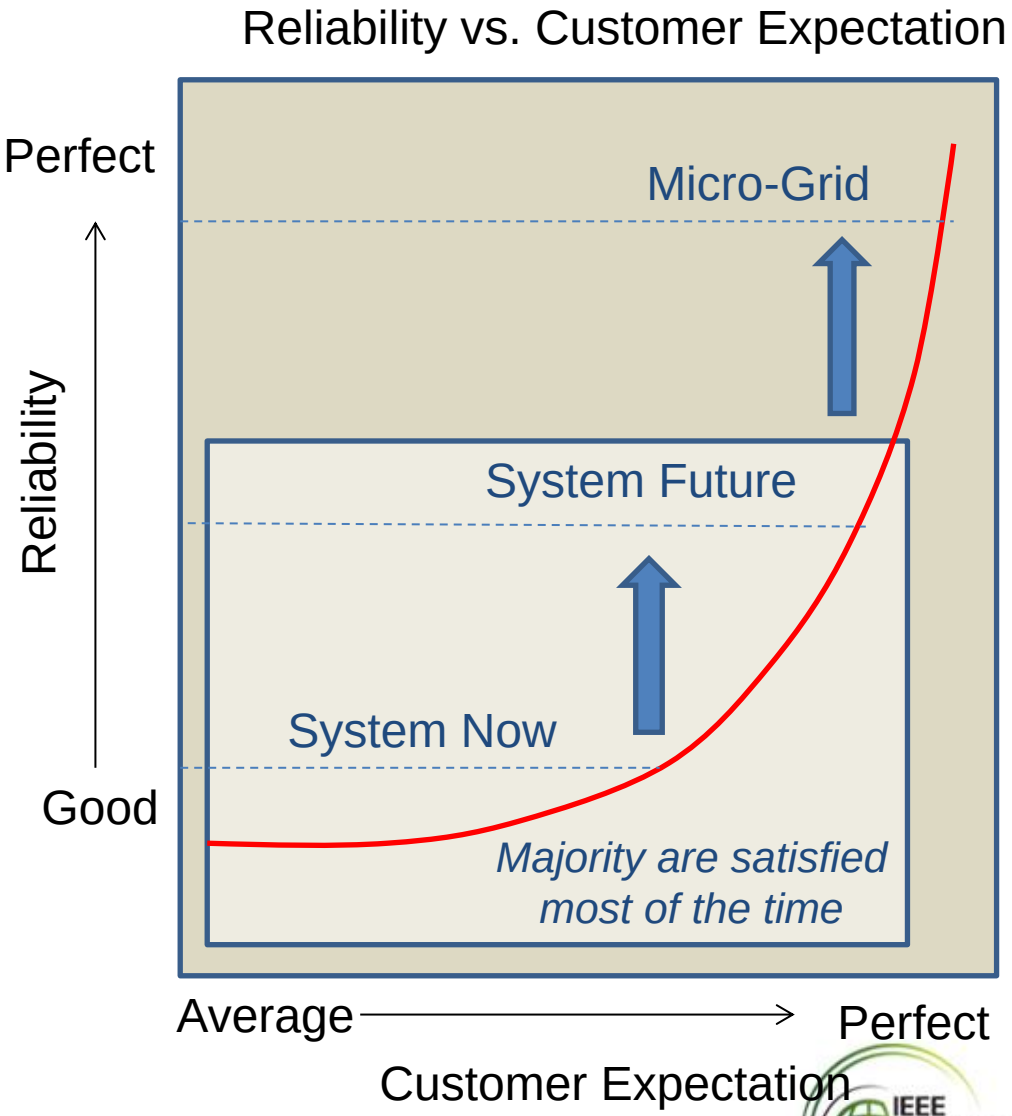
Economic Competitiveness: Energy infrastructure should enable the nation to, under a level playing field and fair and transparent market conditions, produce goods and services which meet the test of international markets while simultaneously maintaining and expanding jobs and the real incomes of the American people over the longer term. Energy infrastructures should enable new architectures to stimulate energy efficiency, new economic transaction, and new consumer services.

Environmental Responsibility: Energy infrastructure should take into consideration a full accounting (on a life-cycle environmental costs and benefits) in order to minimize their environmental footprint.

Energy Security: Energy Infrastructure should be minimally vulnerable to the majority of disruptions in supply and mitigate impacts, including economic impacts, of disruptions by recovering quickly or with use of reserve stocks. Energy security should support overall national security.

Facilitates "System" Optimization

- Performance expectations are increasing, and yet…
- There are affordable limits
- View of "System" is changing to include the customer
- Needs distributed intelligence
- Satisfies multiple objectives
  - Service differentiation
  - Reliability / Resiliency
  - Demand response
  - Renewable integration



Grid Enables the Future

Make Energy:

- Reduce fossil fuel usage
- Increase use of renewables
- Facilitate change of mix
- Accommodate load growth

Move Energy:

- More flexible, adaptable, intelligent and resilient
- Increase visibility, awareness, analytics, plug-and-play

Use Energy:

- Increase efficiency
- Empower customers

Technologies:

- Energy storage
- Advanced power electronics
- Self-healing, intelligence
- Adaptive protection
- Layered control architecture

Requires collaboration, research, standards…

IEEE Smart Grid

IEEE is leveraging its foundation to develop standards, share best practices, publish developments and provide educational offerings to advance technology and facilitate successful Smart Grid deployments worldwide.

- IEEE Smart Grid portal
- Monthly e-newsletter http://smartgrid.ieee.org/resources/smart-grid-news
- Webinar Series
- Peer-reviewed publications
- Conferences
- Standards
- Linked-In
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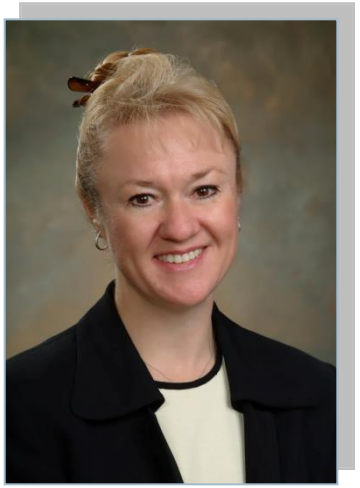
http://smartgrid.ieee.org

Conclusion for Building Grid Resiliency

- Recognize the trends and drivers
- Enable the future by looking forward...
  - Make it
  - Move it
  - Use it
- Distributed intelligence is key
- Collaboration is needed
  - Research and standards
  - Sharing best practice



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