Enhancing Energy Resiliency

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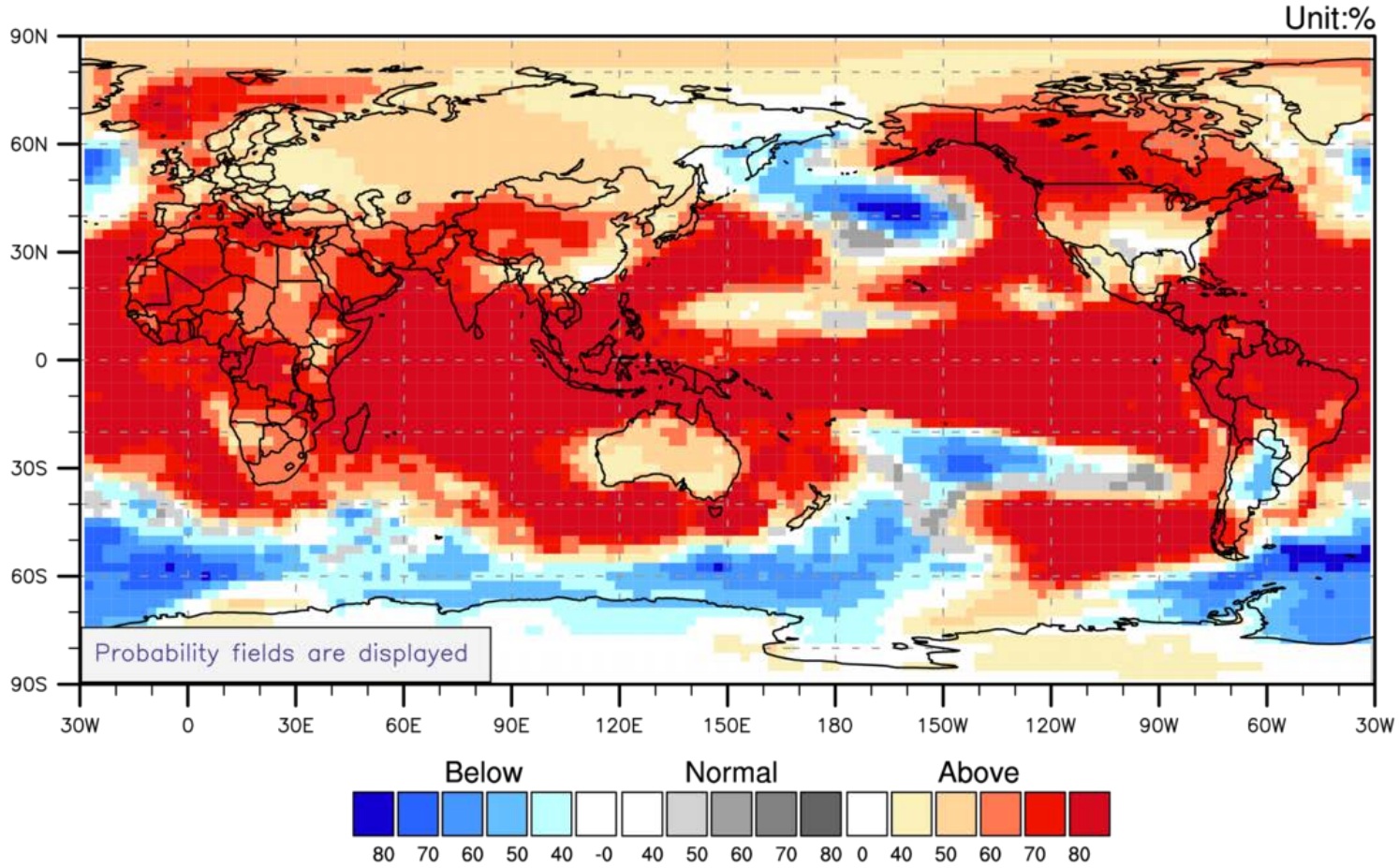
Temperature at 2m for March-May 2016



Opportunities

- Development and deployment of innovative low-carbon energy technologies.
- Improved data and models to better inform stakeholders of vulnerabilities and response opportunities.
- Design rate structures and create incentives that encourage distributed generation and smart grid.
- Harden existing facilities and structures to better withstand impacts of future climate change and extreme weather.

Three Global Trends

Globalization of Research and Development

Low-Carbon Energy Technology Innovation

Reductions in Cost

Where is R&D Performed?

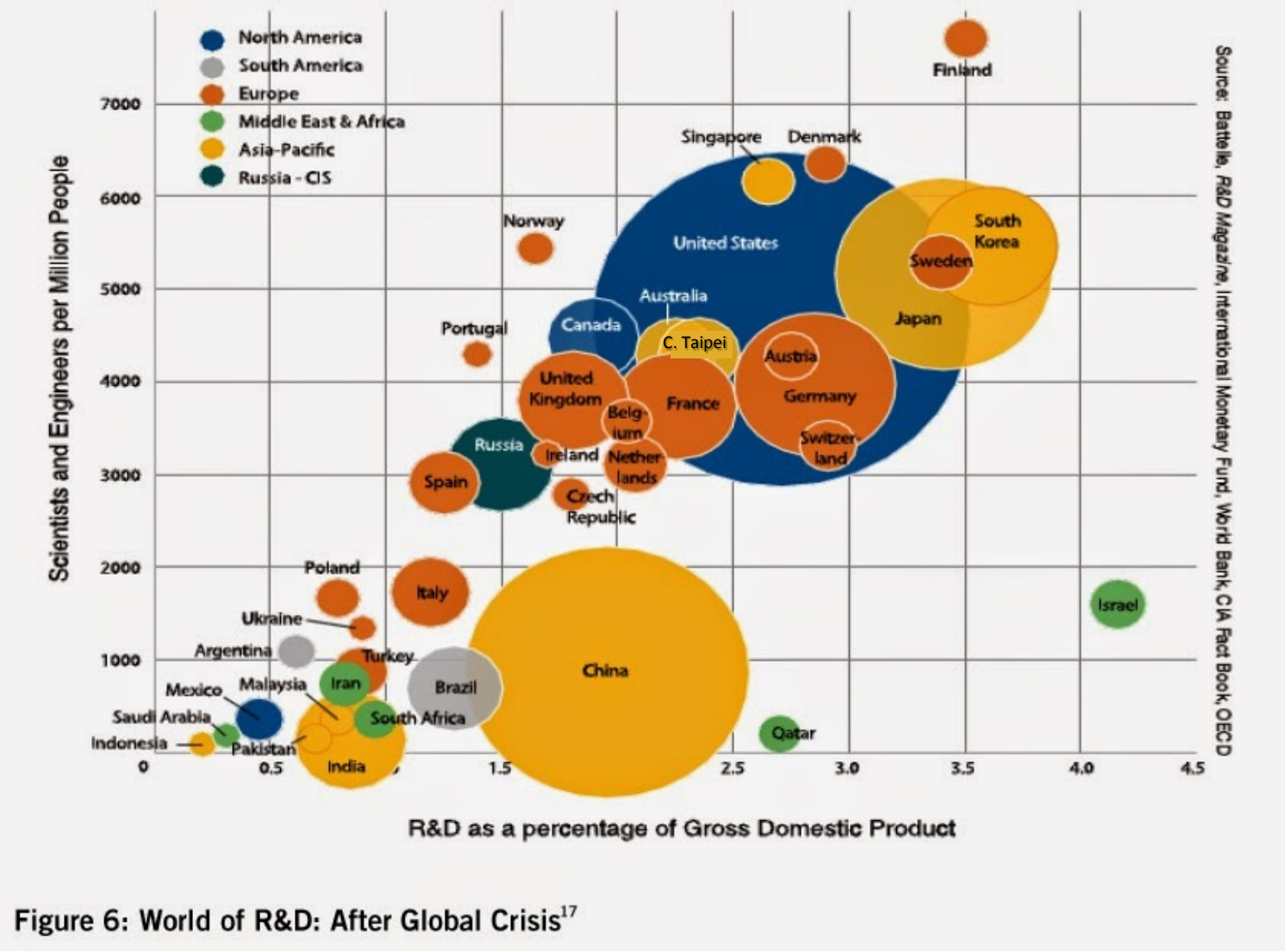
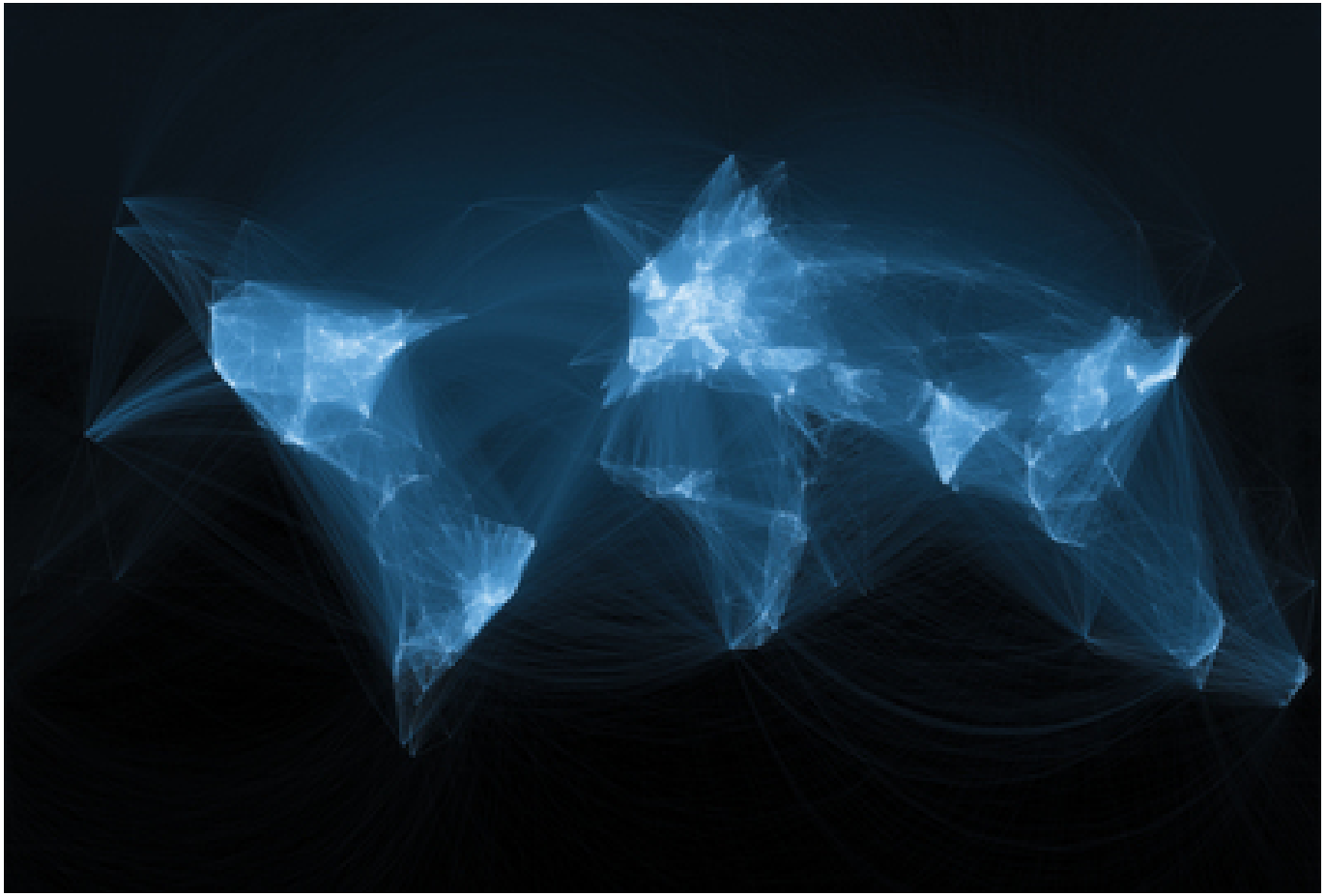


Figure 6: World of R&D: After Global Crisis[17]

International Networks



Source: Nature 490, 335-335 (18 October 2012); Computed by O.H. Beauschene Science-Matrix Data: SCOPUS.

APEC Task Force for Energy Resilience

Member Economies and companies pursuing action on resilience can receive recognition for, and share, their achievements.

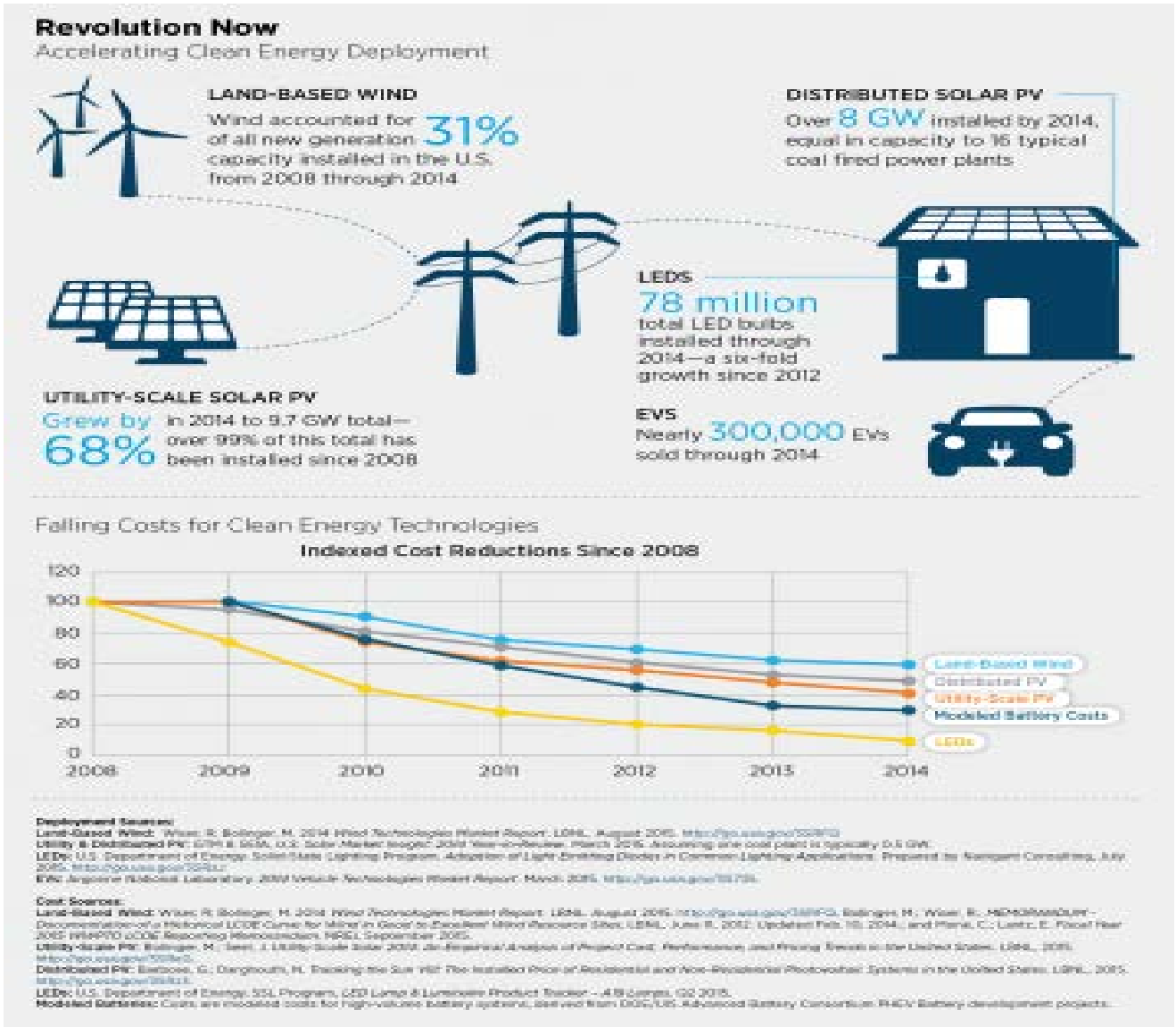
Provides a mechanism for sustained regional engagement to facilitate discussion, cooperative activities and exchange of information on:

- ✓ Policies and Regulations
- ✓ Human Capital Development through Education, Training, Workshops
- ✓ Innovations/Technology Development of Energy Resilient Infrastructure
- ✓ Emergency Preparedness and Contingency Plans

Potential Areas for Cooperation

- Vulnerability assessments of energy infrastructure and facilities in the oil and gas sector, renewable energy, the power sector, etc.
- Impact assessment of energy supply and service disruption.
- Impact on the water-energy nexus.
- Identification and impact assessment of natural and/or man-made disasters to other sectors that affect provision of energy services such as roads, bridges, communication facilities, fuel distribution.
- Exchange of information, including best practices.
- Capacity building and training including the organization of symposia, conferences and seminars.
- Tracking of global developments on renewable energy, energy efficiency and innovation, and undertaking of various types of projects.
- Conduct of peer reviews and emergency preparedness exercises.

Revolution Now

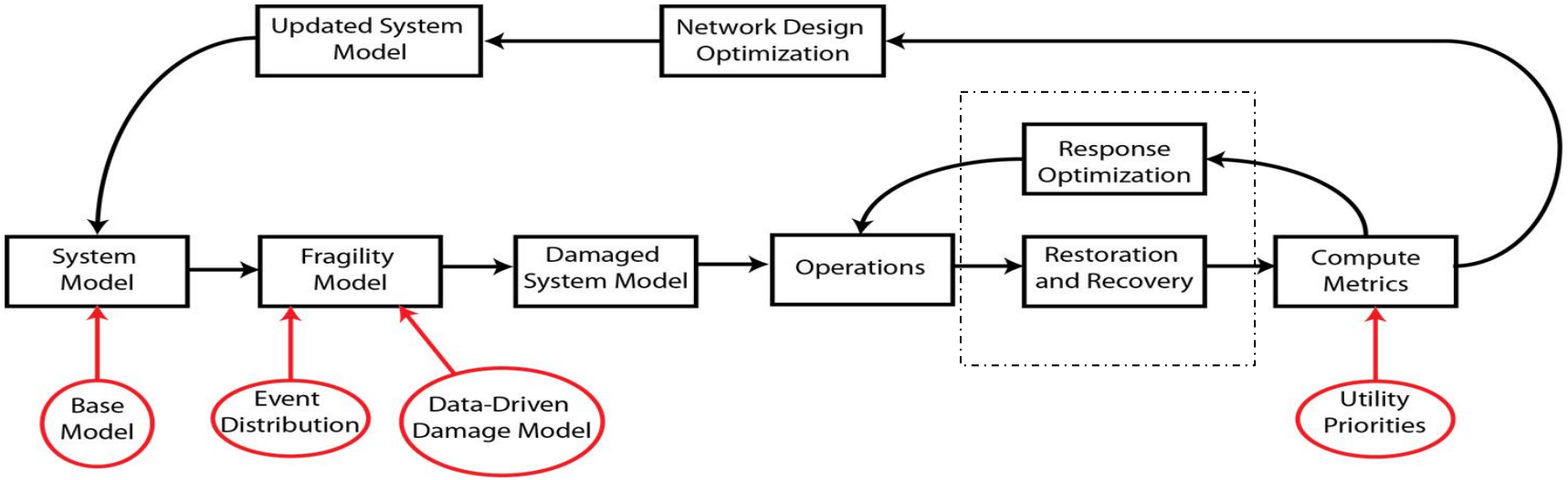


Examples of ARPA-E Technology Programs

- Agile Delivery of Electrical Power Technology
- Accelerating Low Cost Plasma Heating & Assembly
- Full Spectrum Optimized Conversion and Utilization of Sunlight
- Robust Affordable Next Generation Energy Storage Technologies
- Transportation Energy Resources from Renewable Agriculture
- Innovative Development in Energy-Related Applied Science

Resilient Distribution Grid Design Tool

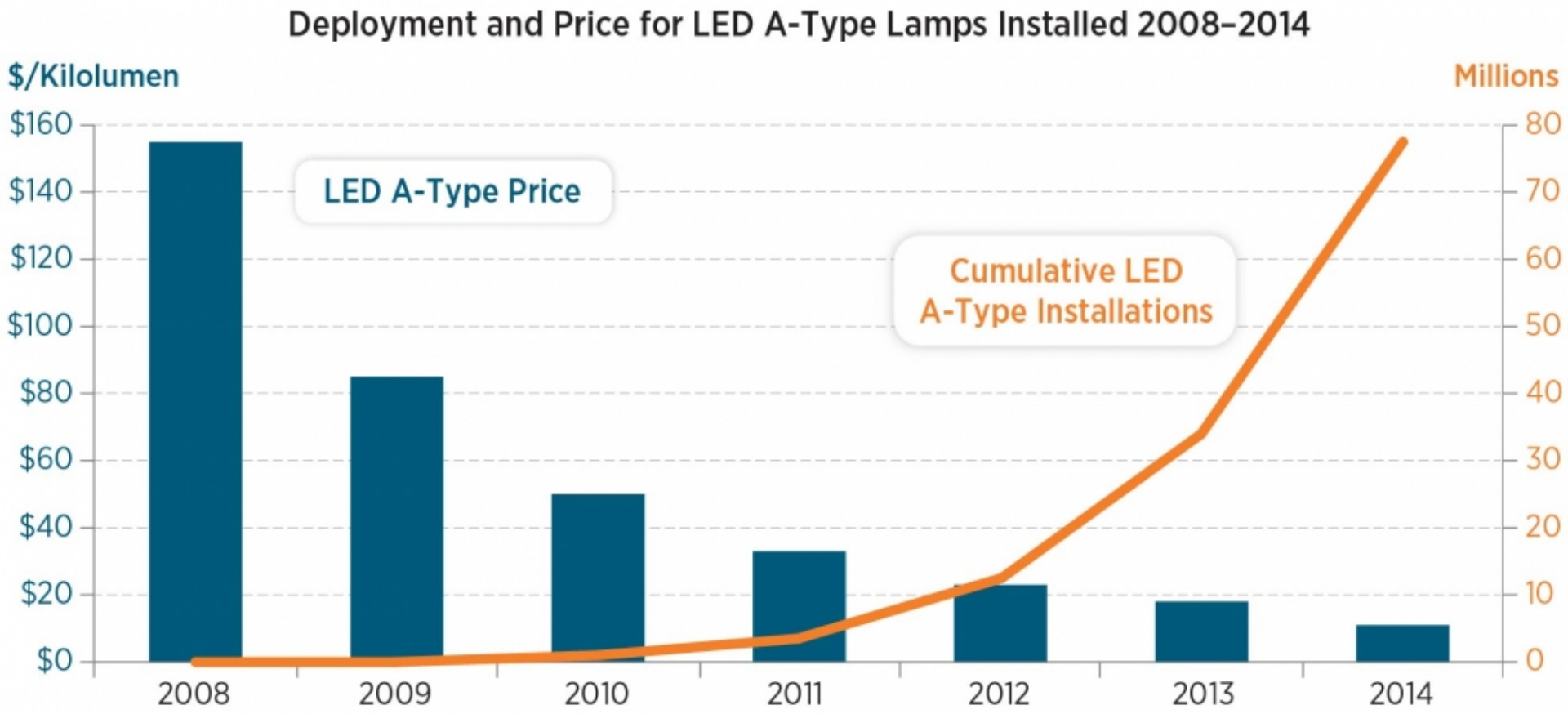
Enable distribution grid designers to prioritize cost-effective system upgrades and expansions to minimize future damage to their grid and outages to customers.



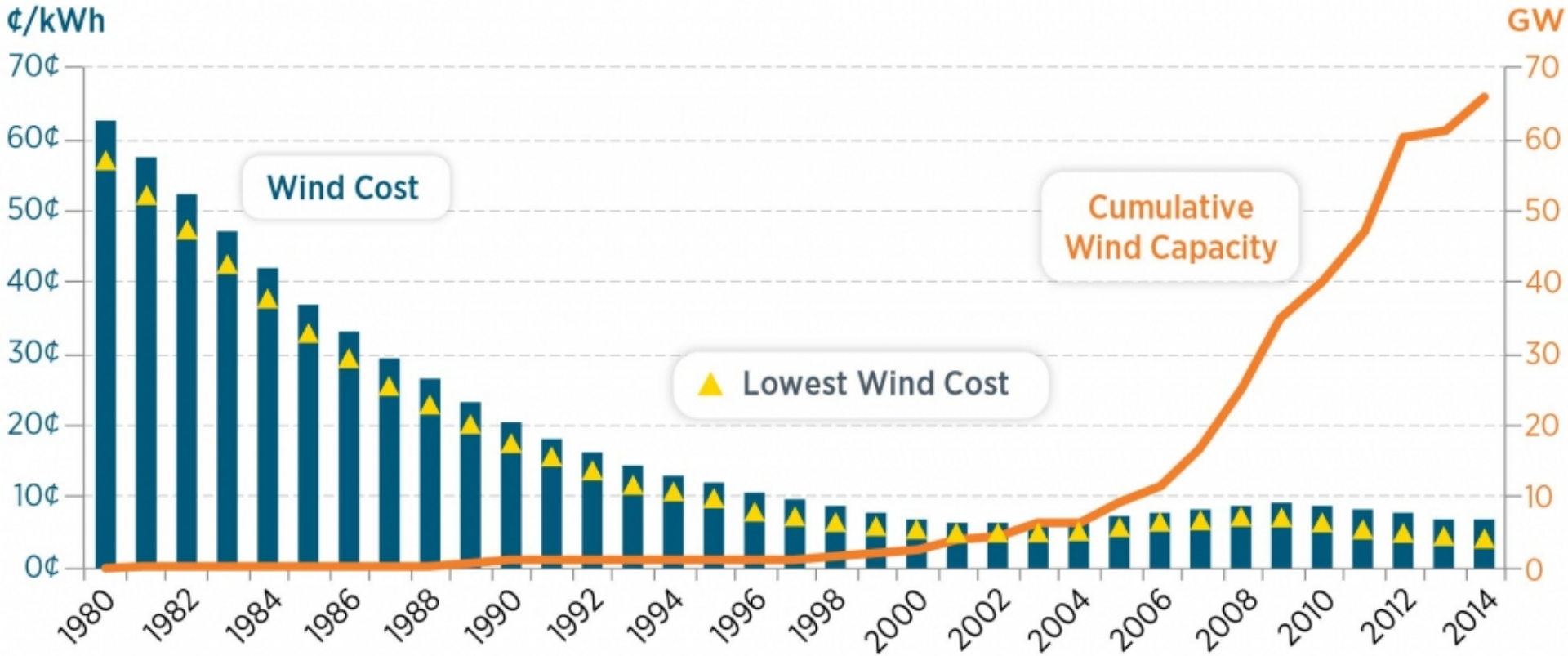
Leverage modules developed under U.S. DHS National Infrastructure Simulation and Analysis Center (NISAC):

- Developed a prototype resilience design tool for multiple hazards (ice and flooding) in FY15.
- Begin developing “recovery” modules in FY16.

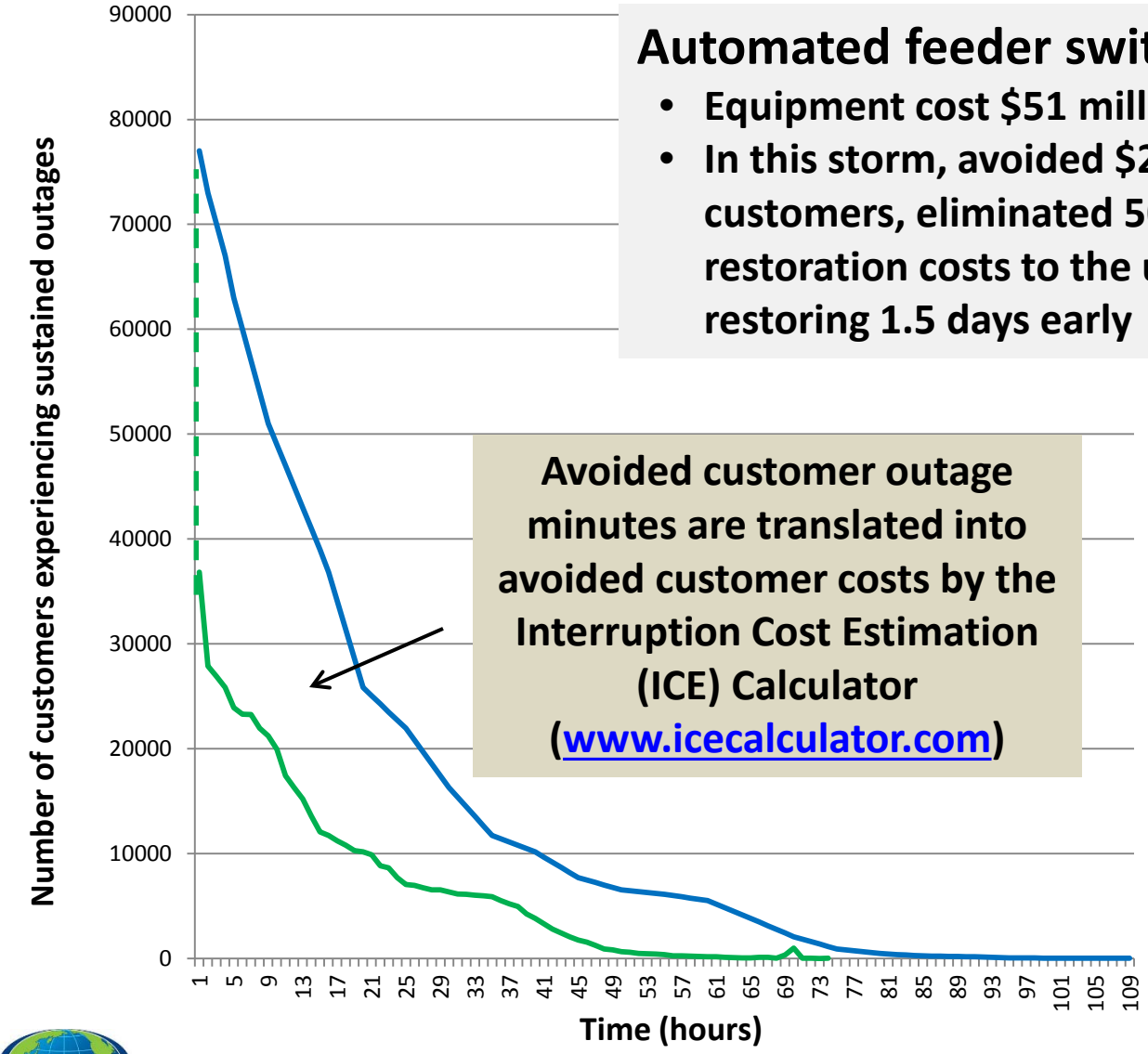
Cost Reduction = Deployment



Cost Reduction = Deployment



July 5, 2012 Storm Response in Chattanooga



Automated feeder switching technology:

- **Equipment cost $51 million**
- **In this storm, avoided $23 million in damages to customers, eliminated 500 truck rolls, and reduced restoration costs to the utility by $1.4 million by restoring 1.5 days early**

Avoided customer outage minutes are translated into avoided customer costs by the Interruption Cost Estimation (ICE) Calculator (www.icecalculator.com)

Actual Response

Projected Response without Smart Grid

Courtesy of EPB of Chattanooga

Resilience Going Forward

OPPORTUNITY KNOCKS