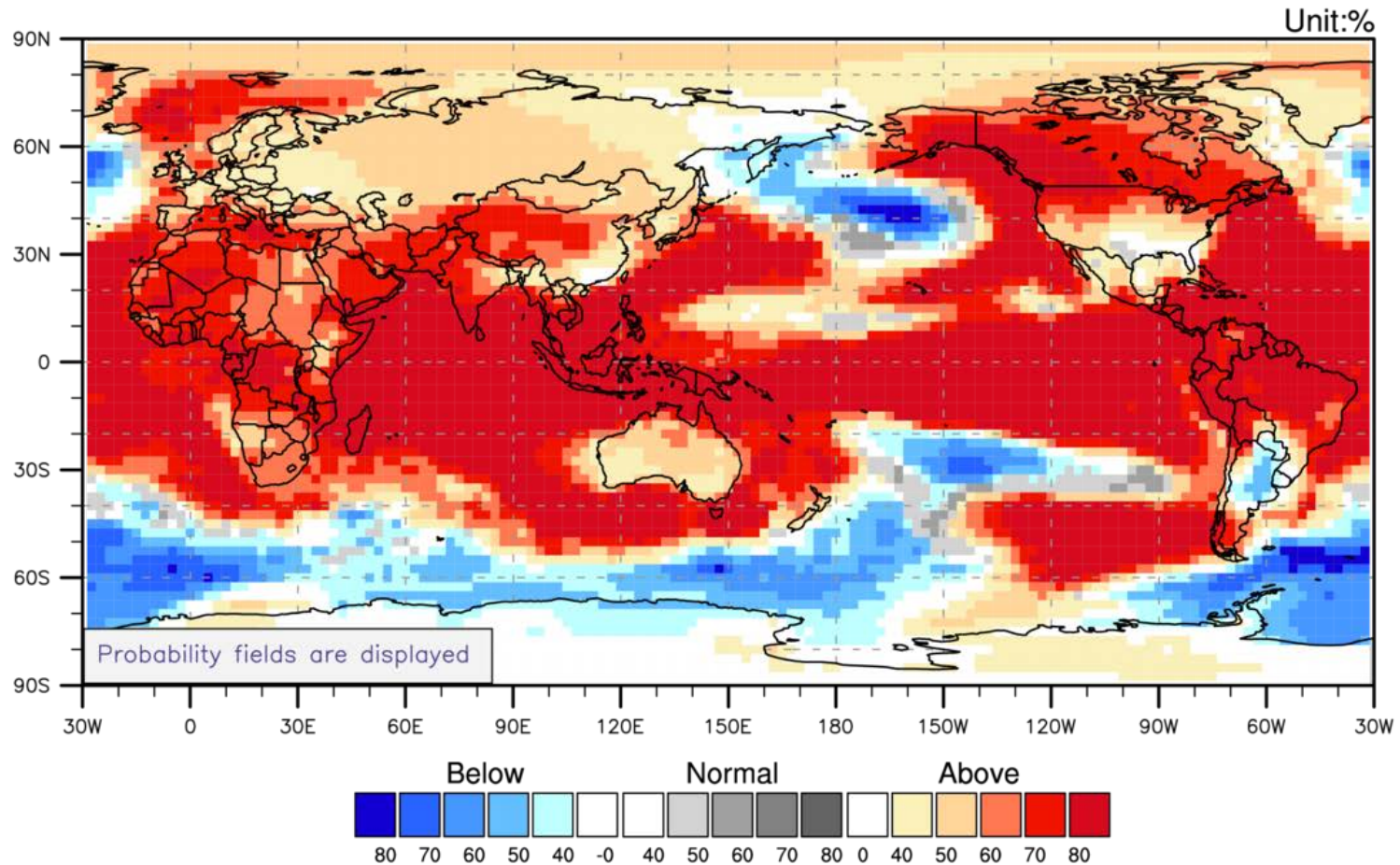


Enhancing Energy Resiliency



Dr. Phyllis Genter Yoshida
Asia Pacific Energy Leaders' Summit
Wellington, New Zealand / March 2016

Temperature at 2m for March-May 2016



© APEC Climate Center

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?

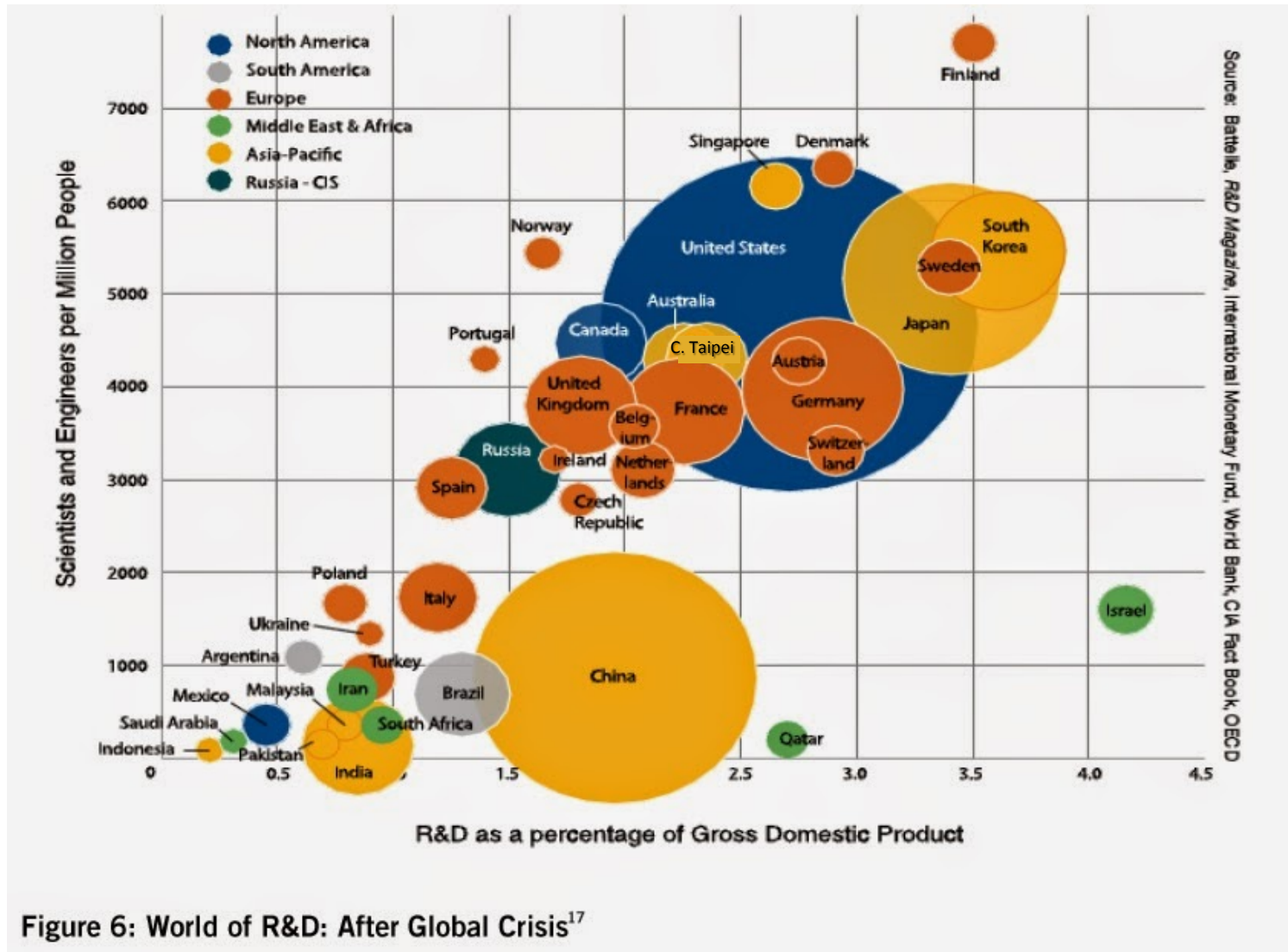
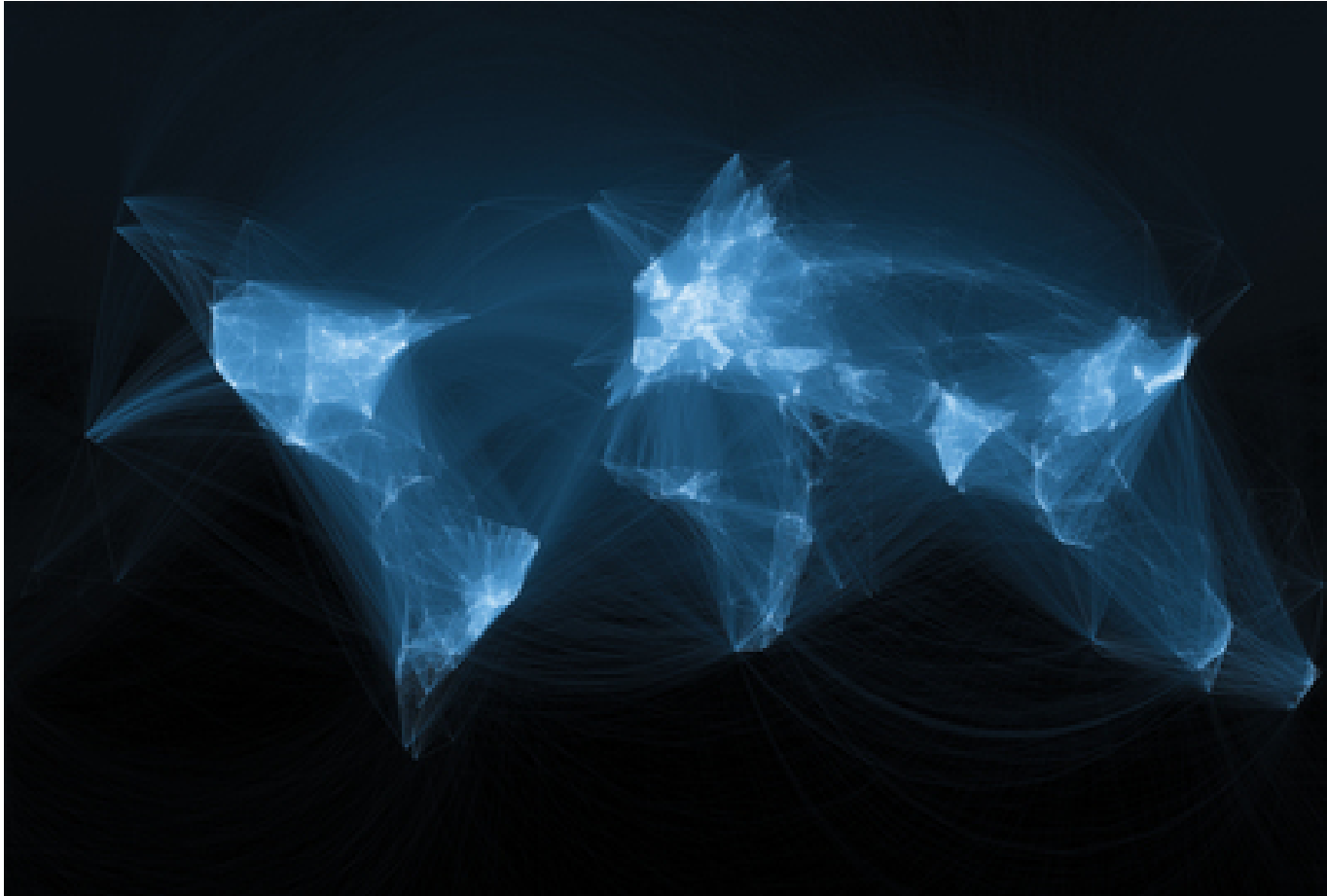


Figure 6: World of R&D: After Global Crisis¹⁷

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

Revolution Now

Accelerating Clean Energy Deployment



LAND-BASED WIND

Wind accounted for **31%** of all new generation capacity installed in the U.S. from 2008 through 2014.

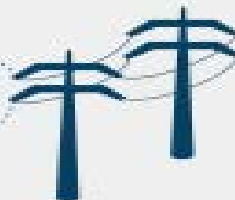
DISTRIBUTED SOLAR PV

Over **8 GW** installed by 2014, equal in capacity to 16 typical coal-fired power plants.



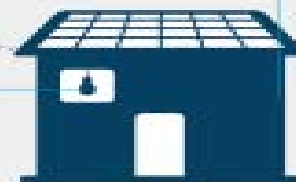
UTILITY-SCALE SOLAR PV

Grew by **68%** in 2014 to 9.7 GW total—over 99% of this total has been installed since 2008.



LEDs

78 million total LED bulbs installed through 2014—a six-fold growth since 2012.



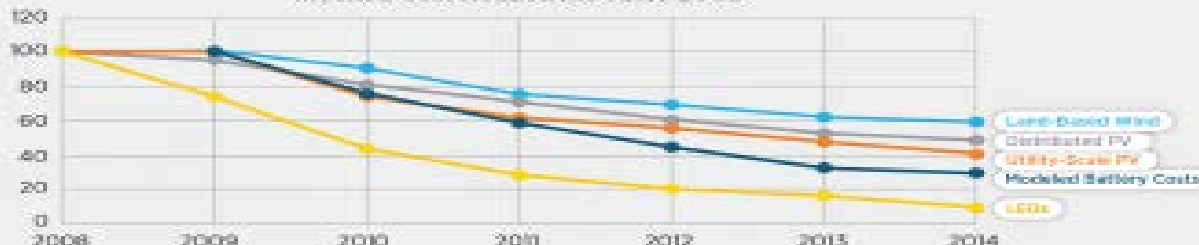
EVS

Nearly **300,000** EVs sold through 2014.



Falling Costs for Clean Energy Technologies

Indexed Cost Reductions Since 2008



Deployment Sources:

Land-Based Wind: Wiser, R., Bollinger, M., 2014 Wind Technologies Market Report, LBNL, August 2015, <http://go.usa.gov/228F7D>

Utility & Distributed PV: EWE & NREL, U.S. Solar Market Insights 2014 Year-to-Review, March 2015, assuming one cost point is typically 0.5 GW.

LEDs: U.S. Department of Energy, Solid State Lighting Program, Adoption of Light-Emitting Diodes in Common Lighting Applications, Prepared by Navigant Consulting, July 2015, <http://go.usa.gov/228F7D>

EVA Argonne National Laboratory, 2014 Vehicle Technologies Market Report, March 2015, <http://go.usa.gov/228F7D>

Cost Sources:

Land-Based Wind: Wiser, R., Bollinger, M., 2014 Wind Technologies Market Report, LBNL, August 2015, <http://go.usa.gov/228F7D>, Ballinger, M., Wiser, R., NREL/2015/02/01 - Decomposition of a Historical LCOE Curve for Wind in Texas to Evaluate Wind Resource Sites, LBNL, June 8, 2012, Updated Feb. 10, 2014, and Mani, C., Lantz, E., Paoletti, R., 2015 Wind PV LCOE Reporting Methodology, NREL, September 2015.

Utility-Scale PV: Ballinger, M., Lee, J., Utility-Scale Solar 2014: An Economic Analysis of Project Cost, Performance, and Pricing Trends in the United States, LBNL, 2014, <http://go.usa.gov/228F7D>

Distributed PV: Barbose, G., Dargatzis, H., Tracking the Sun 102: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States, LBNL, 2015, <http://go.usa.gov/228F7D>

LEDs: U.S. Department of Energy, SSL Program, LED Lamp & Luminaire Product Tracker - 4th Update, 02/2015.

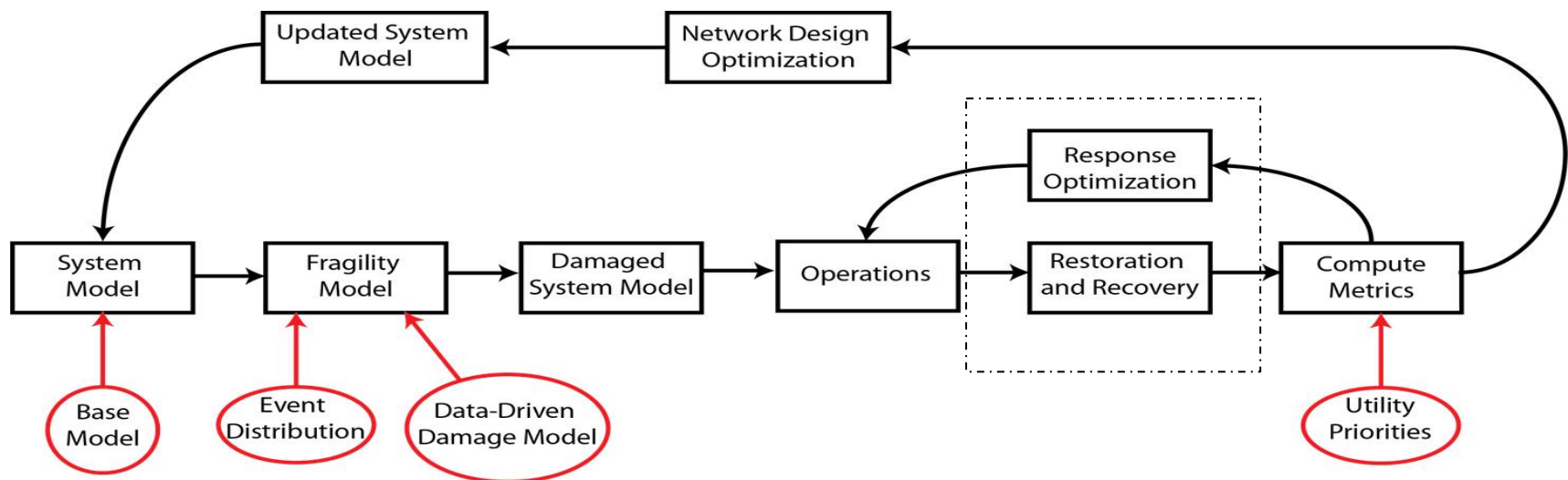
Modeled Battery Costs: are modeled costs for high-value battery systems, derived from DOE/US Advanced Battery Consortium (ABC) battery development projects.

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):

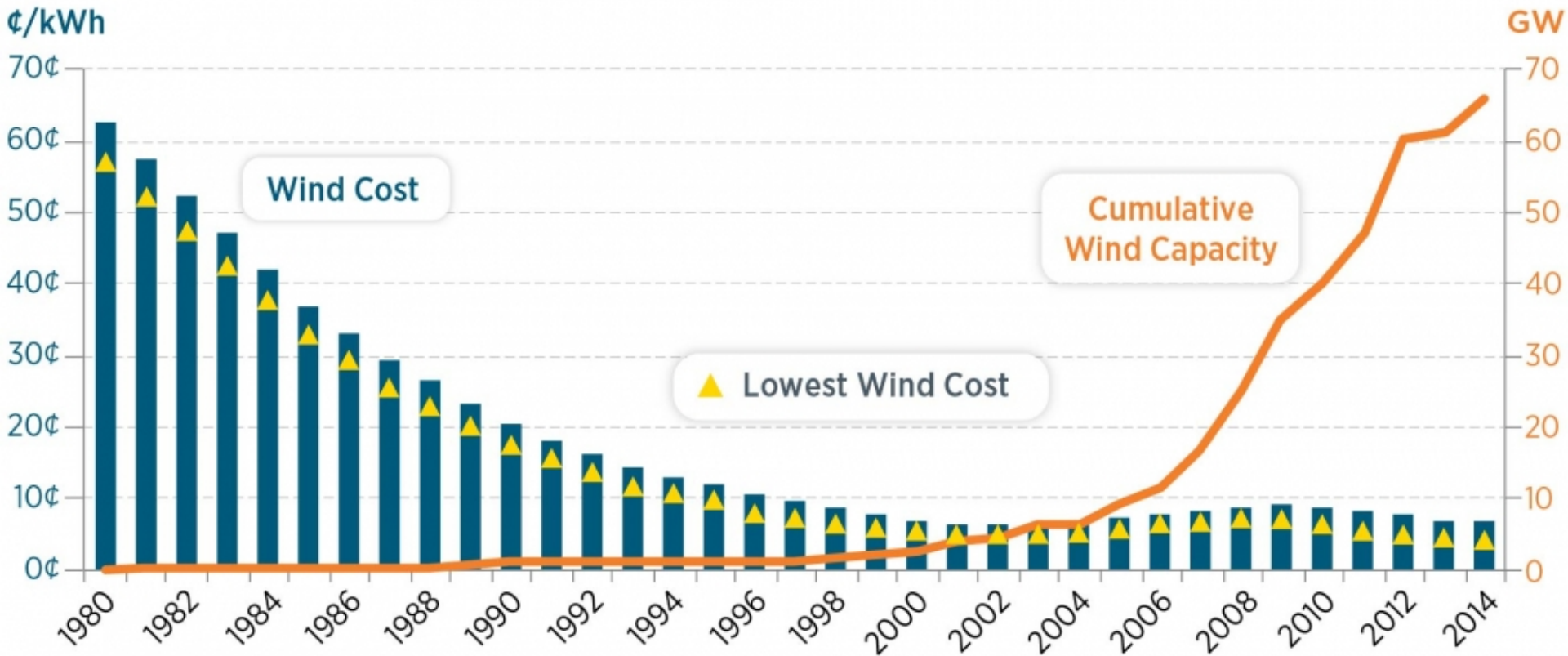
- Developed a prototype resilience design tool for multiple hazards (ice and flooding) in FY15.
- Begin developing “recovery” modules in FY16.

Cost Reduction = Deployment

Deployment and Price for LED A-Type Lamps Installed 2008-2014



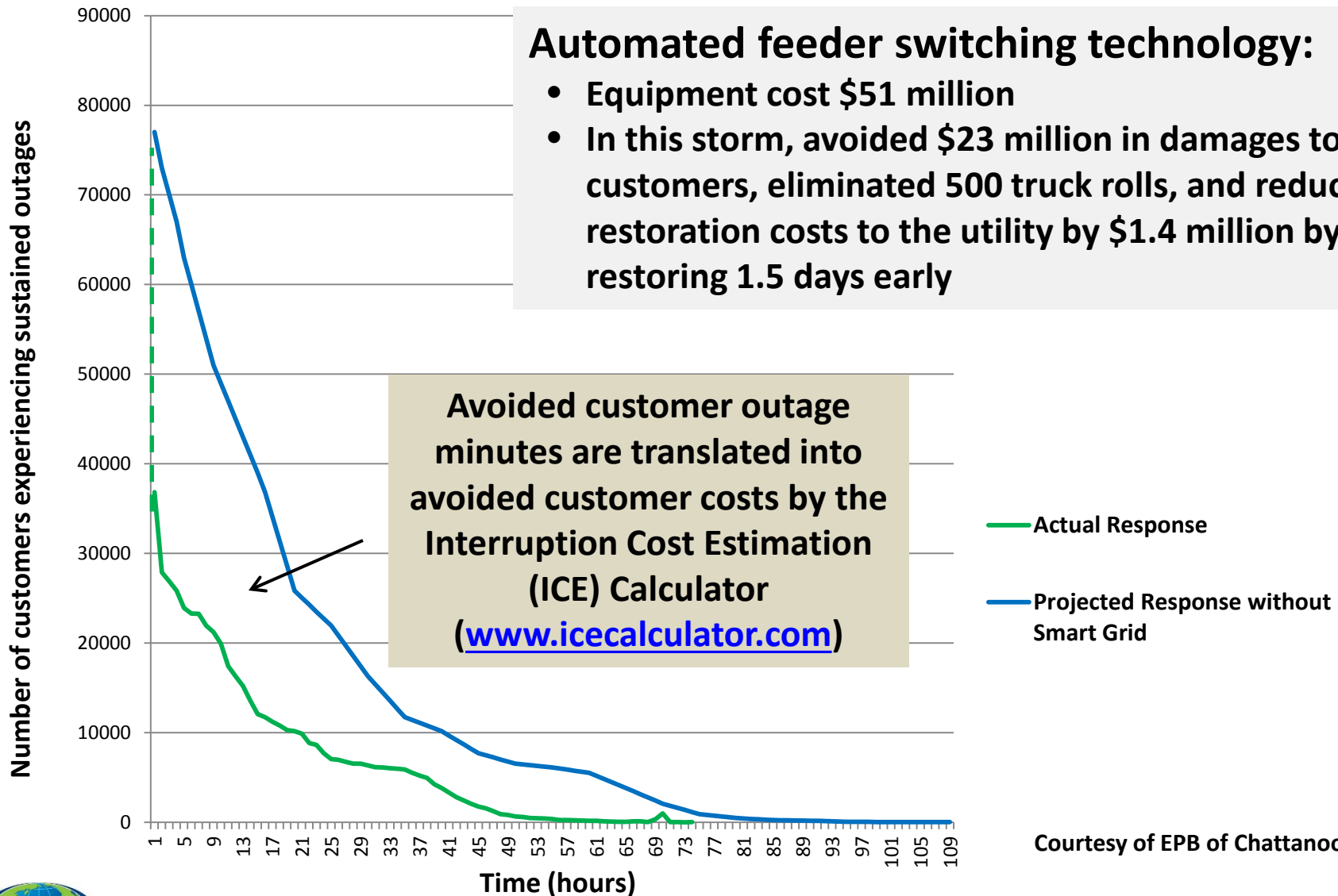
Cost Reduction = Deployment



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



Courtesy of EPB of Chattanooga

Resilience Going Forward



OPPORTUNITY
KNOCKS