Enhancing Resilience of the Nation’s Electricity System: Leveraging Federal Assistance

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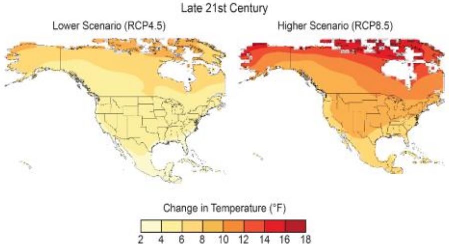
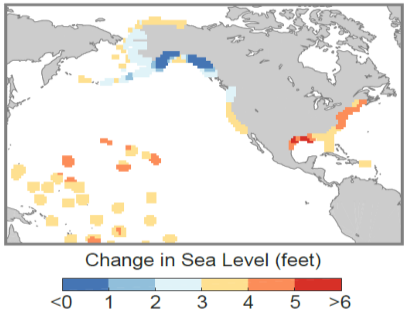
Defining Resilience?

How the Risk Profile is Changing

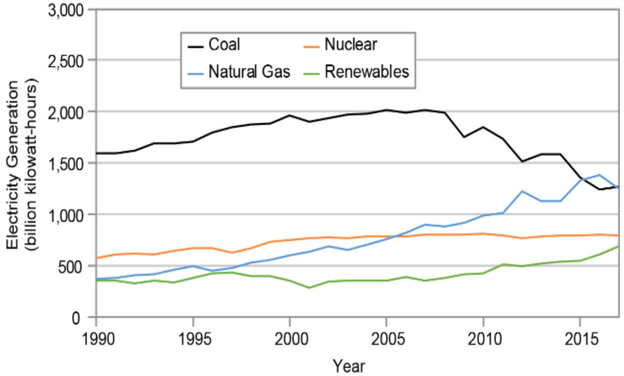
- Temperature extremes and drought, heavy precipitation events, high tide flooding events and sea level rise, and wildfires expected to continue to increase

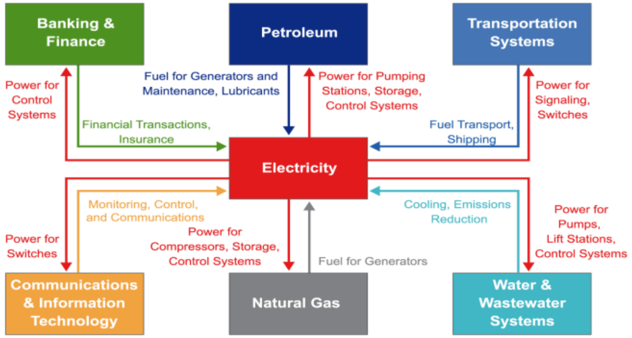




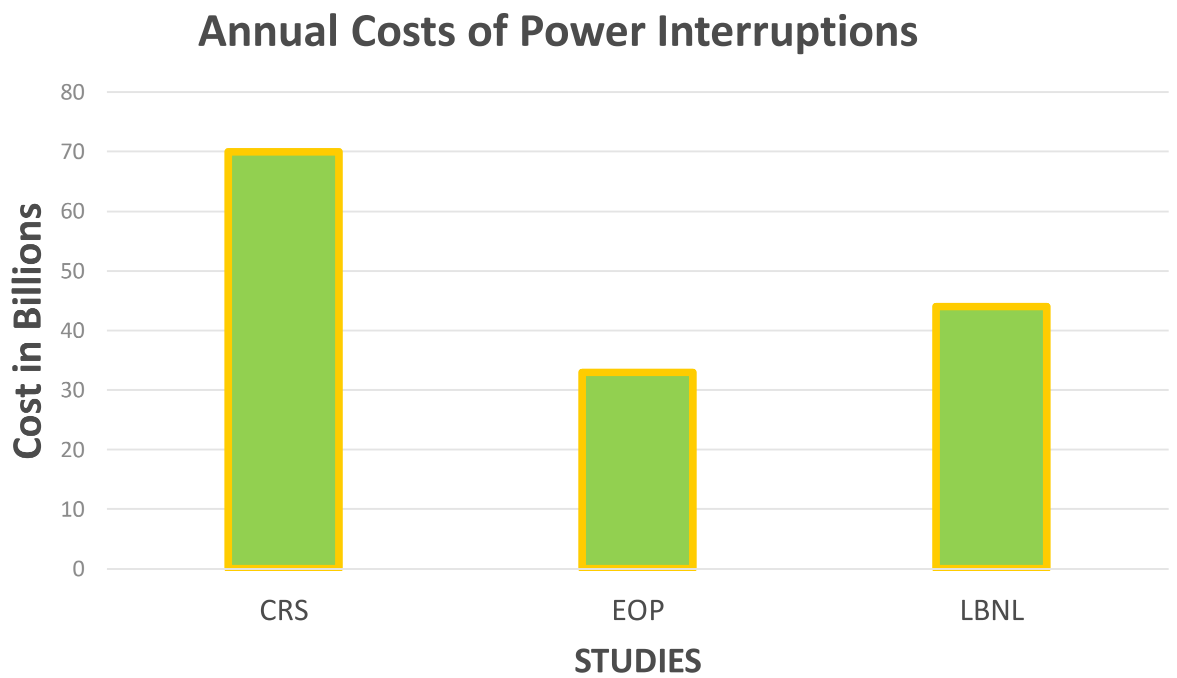
- Cyber and physical threats increasing

- Changes in energy technologies, markets, and policies are affecting the energy system's vulnerabilities
  - Natural gas is increasingly used for power
  - Renewables expanding market share
  - Energy efficiency efforts increase
  - Electrification of other sectors and more interconnected





Annual Costs of Power Interruptions



- Congressional Research Service: $25-70 billion. Campbell, R. J., 2012. *Weather-Related Power Outages and Electric System Resiliency.* Congressional Research Service.
- Executive Office of the President: $18-33 billion. Executive Office of the President, 2013a. *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages, W*ashington D.C.: The White House.
- Lawrence Berkeley National Laboratory: $44 billion. LaCommare, K., Eto, J.H., Dunn, L.D., Sohn, M.D., 2018. *Improving the estimated cost of sustained power interruptions to electricity customers.* Energy 153 (2018) 1038e1047

Actions to Improve Electricity System Resilience

- Progress occurs through:
  - Improved data collection, modeling, and analysis to support resilience planning
  - Development and deploymer of innovative energy technologies for adapting energy assets to extreme weather hazards
  - Private and public-private partnerships supporting coordinated action

Flood Protection
- Building/strengthening berms, levees, and floodwalls
- Elevating substations, control rooms, and pump stations
- Expanding wetlands restoration
- Installing flood monitors

Wind Protection
- Inspecting and upgrading poles and structures
- Burying power lines underground
- Improving vegetation management efforts

Drought Protection
- Adopting water efficient thermoelectric cooling
- Utilizing non-freshwater sources
- Expanding low water-use generation

Modernization
- Deploying sensors and control technology
- Installing asset databases/tools, including supervisory control and data acquisition (SCADA) system redundancies
- Deploying energy storage and microgrid infrastructure (distributed energy resources, demand response programs, islanding capabilities)

Advanced Planning and Preparedness
- Conducting extreme weather risk assessment planning, preparedness, and training
- Participating in mutual assistance groups and public–private partnerships
- Purchasing or leasing mobile transformers and substations
- Utilizing geographic information systems (GIS) analysis to help identify vulnerabilities and plan for new builds and relocations

Storm-Specific Readiness
- Coordinating priority restoration and waivers
- Securing emergency fuel contracts
- Improving communication during outages to assist customers

Federal Assistance Programs Applicable to Energy Systems

Key: FEMA HUD

Pre-Disaster Mitigation (Sec. 203)

Building Resilient Infrastructure and Communities

Hazard Mitigation Grant Program (Sec 404)

Public Assistance (Sec 406)

Flood Mitigation

Community Development Block Grant – Disaster Recovery

Community Development Block Grant – Mitigation

Characteristics of Assistance Programs

- Program Funding
  - Annual Appropriations: Pre-Disaster and Flood Mitigation
  - Supplemental Appropriations: Public Assistance, CDBG-DR, CDBG-MIT
  - Set asides: Hazard Mitigation Grant Program; BRIC (6% of Disaster Relief Fund--will vary from year-to-year because disaster costs will vary each year)

- Eligibility
  - State Agencies (e.g., state utilities)
  - Indian Tribal Governments
  - Local Governments/communities (e.g., municipal utilities)
  - Certain Private Non-Profits that meet specific criteria (Cooperatives)
  - State and local may apply on behalf of investor-owned utilities

- Program Availability
  - Many programs triggered under a Presidential Major Disaster Declaration (Hazard Mitigation Grant Program, Public Assistance, CDBG-DR, CDBG-MIT)

FEMA Public Assistance (PA) Grant Program

- **Post-disaster focus**
- Supplemental cost reimbursement program with specific eligibility requirements. Cost share typically 75%.
- Eligible Recipients: State and local government, federally-recognized Indian tribal governments, certain private non-profit (PNP) organizations
  - For Electric Power -- state and municipal utilities, and cooperatives. Possible funding of IOUs if done in collaboration with Eligible Recipients
- Examples: Elevate pad transformers above the Base Flood Elevation; Replace damaged poles with higher-rated poles of different material; Add guy-wires to power lines for support

Eligible FEMA Public Assistance Work

- Must be required as a result of the disaster
- Must repair, restore, or replace disaster-damaged facilities in accordance with regulations
- May include cost effective hazard mitigation measures
- Must restore to pre-disaster capacity and function in <u>accordance with applicable codes and standards</u>

Case Study: Long Island Power Authority

- LIPA suffered extensive damage in Hurricane Sandy
- FEMA granted
  $1.4 billion to LIPA in fixed-cost estimate grants
  - $705 million was granted in Public Assistance grants for restoration and repair
  - $729.7 million in Public Assistance grants for additional hazard mitigation

- Example activities: Strengthening damaged transmission lines to resist loads from a 130 mph wind event; Elevate or relocate substation equipment; Strengthening priority 3-phase mainline circuits (storm harden and/or elevate lines to reduce exposure to tree/tree limb damage); Install automatic sectionalizers to isolate faulted sections of power and reduce customer outages.

DRRA 1235(b) Interim Policy: Overview

- **Section 1235(b) of the Disaster Recovery Reform Act requires FEMA to fund repair, restoration, reconstruction, or replacement in conformity with the latest published editions of relevant consensus hazard-based codes, specifications, and standards**

- **FEMA interim policy "*Consensus-Based Codes, Specifications and Standards for Public Assistance*" issued on November 6, 2019**

- **Requires all Applicants to implement the applicable codes, specifications and standards that address various applicable facility types (buildings, electric power, roads, bridges, potable water and wastewater)**

- **Allows Applicants to use more stringent locally adopted codes and standards and meet FEMA criteria.**

DRRA 1235(b) Codes and Standards: Electric Power

Facility Type	Standard Setting Organization and Consensus-Based Codes, Specifications and Standards
Electric Power	• **U.S. Department of Agriculture Rural Electric Service (RUS):** RUS Bulletins Transmission - 1724D-106, 1724E-200, 1724E-203, 1724E-204, 1724E-205, 1724E-206, 1724E-214, 1724E-216, 1724E-224, 1724E-226, 1728F-810, 1728F-811, 1728H-701, 1730-B2 Distribution - 50-4, 1724D-106, 1724E-150, 1724E-151, 1724E-152, 1724E-153, 1725E-154, 1728F-700, 1728F-803, 1728F-804, 1728F-806, 1730B-121, 1730-B2 Substations - 724E-300 • **International Code Council:** International Building Code (IBC); International Existing Building Code (IEBC); International Residential Code (IRC); International Energy Conservation Code (IECC) • **American Society of Civil Engineers (ASCE):** (ASCE/SEI 7-16) Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE MOP 74) Guidelines for Electrical Transmission Line Structural Loading, Third Edition • **Institute of Electrical and Electronics Engineers:** National Electric Safety Code (NESC) • **National Fire Protection Association (NFPA):** National Electric Code (NEC)

Addressing Gaps in Hazard-Based Codes and Standards

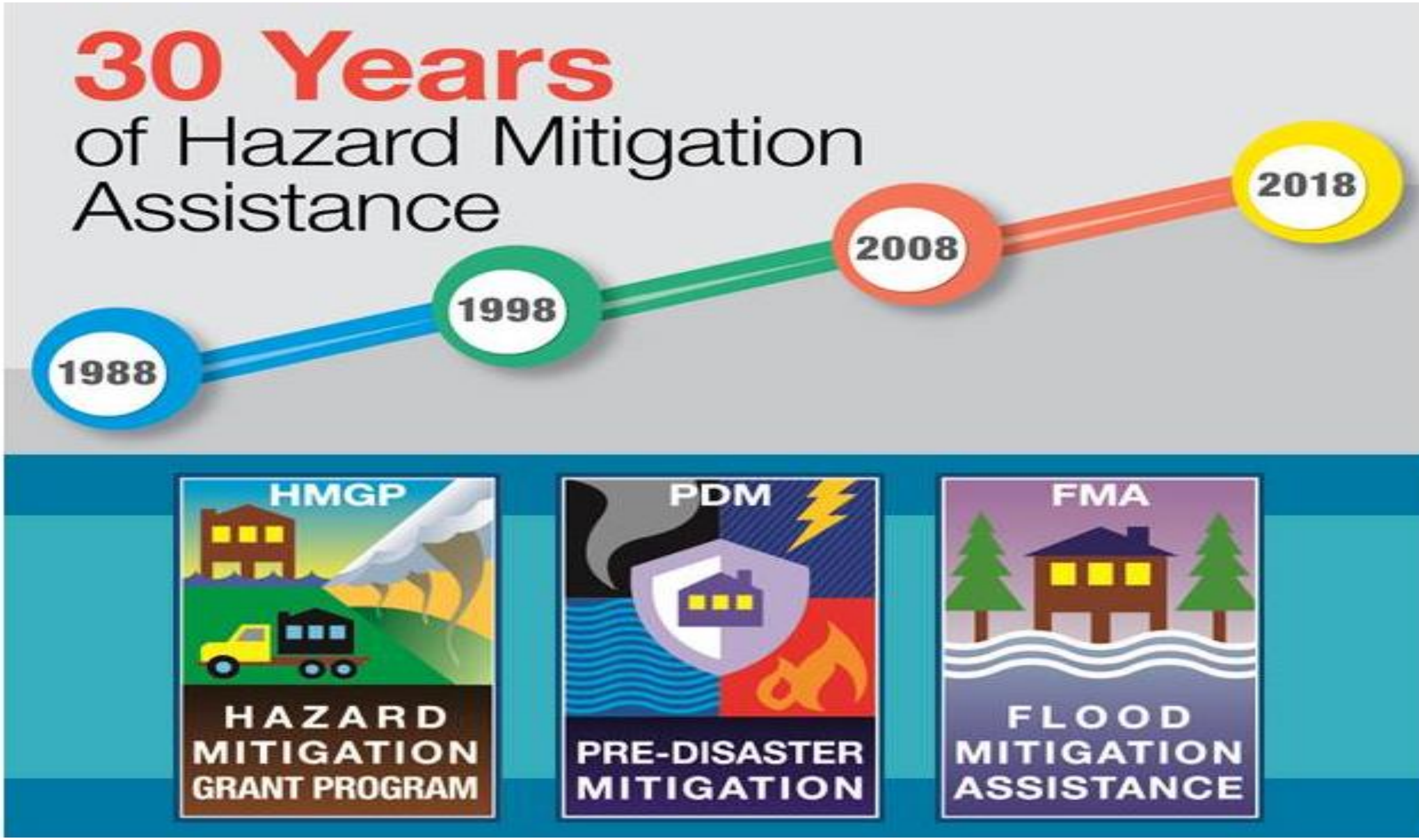
- DOE and FEMA propose to establish an Electric Power Resilience Design Standards Work Group to support the development of codes and standards for electricity resilience :

  -- Prioritize and facilitate the development of hazard-based codes and standards accounting for adversarial/extreme weather threats to electricity infrastructure

- Multiple gaps identified in existing hazard based codes and standards (e.g., missing for specific assets, and specific threats)

  -- Include representatives from government, standard development organizations (e.g., NIST, USDA/RUS, ICC, IEEE, ASHRAE) and the electricity sector (e.g. **NARUC**, NASEO, NRECA, EEI).

Hazard Mitigation Assistance Programs



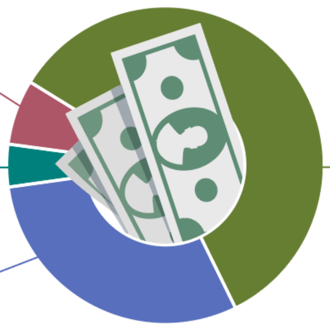
FY2018 Hazard Mitigation Funding

In FY 2018 more than **$1.3B** in pre- and post-disaster **Hazard Mitigation Assistance Grants** was delivered to states, tribes, and territories, resulting in mitigation actions that will **reduce risk**

FLOOD MITIGATION ASSISTANCE GRANT PROGRAM **7%** $88.2M

PRE-DISASTER MITIGATION GRANT PROGRAM * **4%** $57.7M

406 MITIGATION FUNDING **30%** $400M

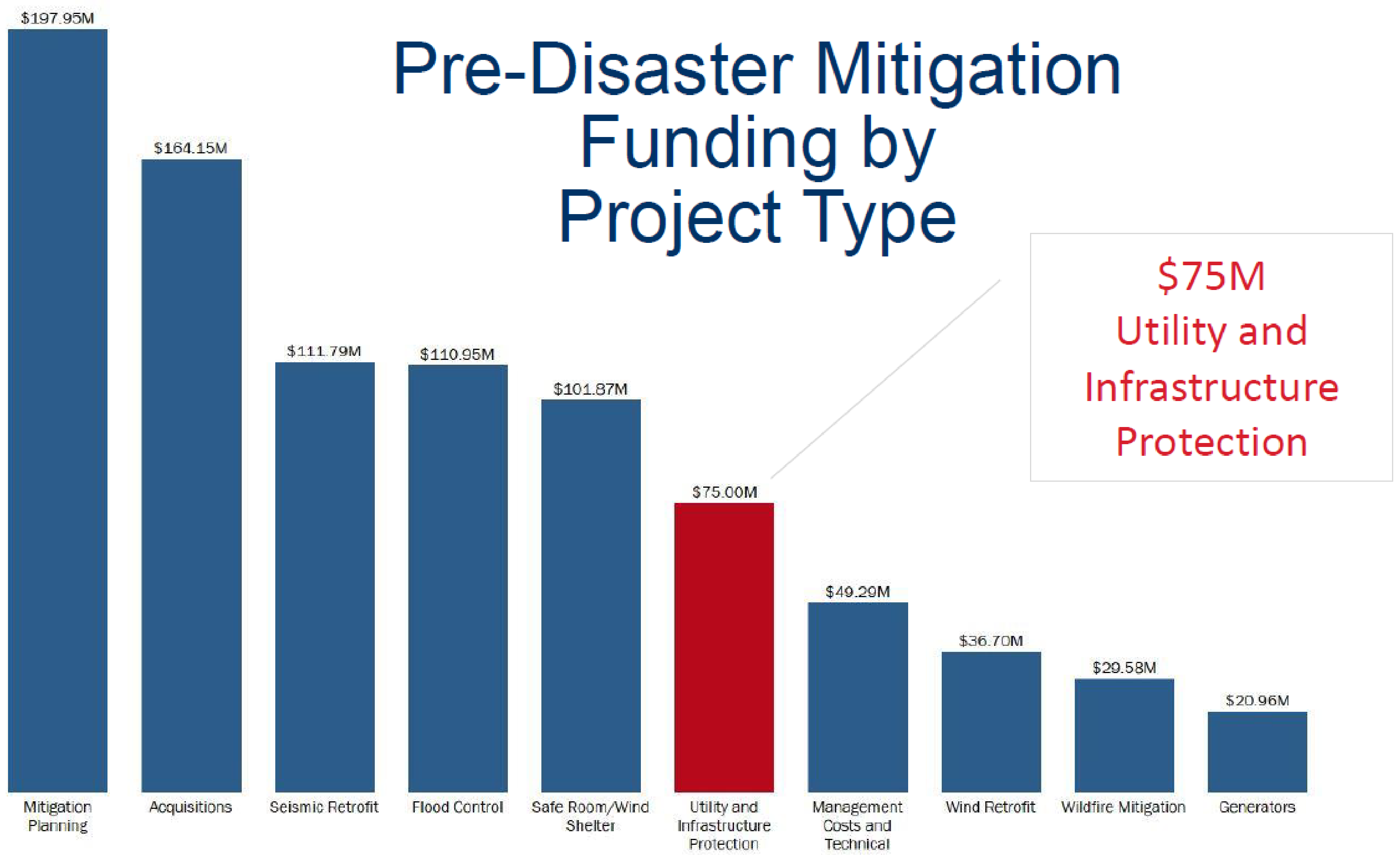


59% HAZARD MITIGATION GRANT PROGRAM $784.5M

FY 2018 data

* This figure includes legacy PDM program funding

PDM Funding by Project Type



Pre-Disaster Mitigation Grants

PRE-DISASTER MITIGATION

FY 2019 -- $250M

- Authorized to provide resources to assist states, tribal governments, territories and local communities in their efforts to implement a sustained pre-disaster natural hazard mitigation program.

- PDM funds all hazard mitigation activities to reduce overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations.

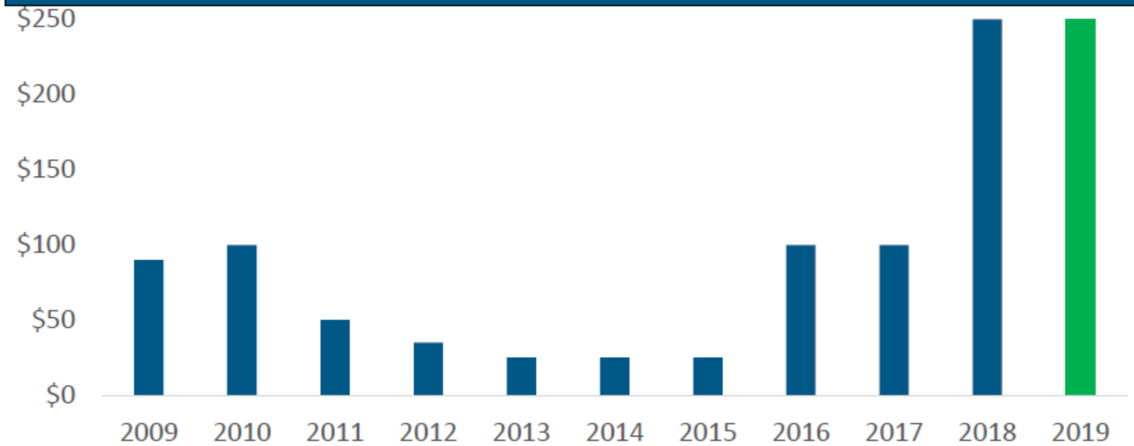
- <u>Example projects</u>: Elevating vulnerable generators -- As of 2017, total of $212 million spent on almost 500 generator projects alone

BRIC -- Building Resilient Infrastructure and Communities

DRRA Section 1234

- ✓ Leverage 6% set-aside funding mechanism
- ✓ Encourage community-wide mitigation of critical lifelines
- ✓ Prioritize resilient infrastructure projects
- ✓ Competitive, risk informed projects
- ✓ Build capacity and capability

Since 2009, FEMA has received approximately $1 billion in Pre Disaster Mitigation grant appropriations, of which 48% has been in the last 2 years.



Average amount from 2009-2016: $56M/year.

Avg. from 2017-2019: $200M/year.

BRIC funds will vary based on disasters. FIMA estimates that annual funds will average $300-500M per year, with significantly greater amounts following years with catastrophic disasters.

Hazard Mitigation Grant Program – FEMA

- Funded as-needed after a disaster by supplemental Congressional appropriation, BUT recipients do not need to have been directly affected by the declared disaster
    - Can be used to fund resilience projects anywhere in the state to prepared for future disasters
- Example projects: Purchasing and installing natural gas generators and PV panels to provide backup-power for critical facilities (municipal buildings, emergency community shelters, etc.)

Example Mitigation Project: Underground Utility

Replaces overhead electrical distribution system

500 CONSUMERS AFFECTED

20,000 OUTAGES MITIGATED

2,000 FEET OF UNDERGROUND CONDUIT & INFRASTRUCTURE REPLACING AERIAL TRANSFORMERS & POLES

15,000 FEET OF CONDUIT FROM NEW TRANSFORMERS TO BUILDINGS

\$3.2M FED SHARE

+

\$1M NON-FED SHARE

Community Development Block Grant – Disaster Recovery

- Focus on long-term recovery efforts

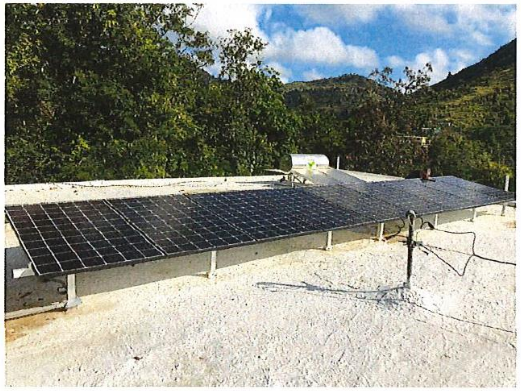
- No annual appropriation for CDBG-DR -- statutory authority is via individual supplemental appropriations -- to address unmet needs other federal programs have not yet addressed

- Example electricity projects: PV panels on low-income housing or wastewater treatment plants in rural communities to reduce utility bills

- Funding Levels:
  - FY 2019 - $2.4 billion to assist recovery from Events in 2018 and 2019
  - FY 2018 - $28 billion to assist recovery from Events in 2017 and to assist Community Mitigation in areas effected by Events in 2015, 2016 and 2017

HUD Community Development Block Grant Mitigation (CDBG-MIT)

- August 2019 FR Notice (Docket No. FR-6109-N-02J) Announces $6.75 billion in Community Development Block Grant Mitigation (CDBG-MIT) funds to grantees recovering from qualifying 2015, 2016, and 2017 disasters



- Funds used to assist areas impacted by recent disasters to carry out activities to mitigate disaster risks and reduce future losses

- CDBG-MIT funds:
  - Reduce risks attributable to natural disasters, with particular focus on community lifelines **such as Energy (Power & fuel)** and repetitive loss of property and critical infrastructure;
  - Build the capacity of States and local governments to comprehensively analyze disaster risks and to update hazard mitigation plans;
  - Consider future disaster costs (e.g. adoption of forward-looking land use plans that integrate the hazard mitigation plan, latest edition of the published disaster resistant building codes and standards, and policies that encourage hazard insurance for private and public facilities; and
  - Maximize the impact of available funds by encouraging leverage, private-public partnerships, and coordination with other Federal programs (e.g., FEMA HMGP).

Making the Business Case for Investments

- Tools and opportunities for improvement of cost-benefit analysis and methods for characterizing the cost effectiveness of resilience enhancements
  - FEMA's BCA Tool – Used by FEMA/HUD
  - DOE's ICE Calculator

FEMA's BCA Toolkit

- Newest version – Version 6.0 – is an Excel-based add-in.
- Download instructions at www.fema.gov/benefit-cost-analysis.
- The tool calculates a BCR for a project by estimating the damages before and after mitigation (i.e. the benefits of the project) and dividing by the costs.

$$\frac{\textbf{Benefits}}{\textbf{Costs}} = \textbf{BCR}$$

Benefits = Damages Before Mitigation – Damages After Mitigation

FEMA BCA Tool - Quantifying Loss of Service

- Electrical Service = $148 per person per day

- This is an estimate of the value to society of electrical service.
  - Takes into account residential, industrial, and commercial users
  - More information about how this value was developed, request the Standard Values Methodology Report from the BCA Helpline (bchelpline@fema.dhs.gov)

- FEMA updates these values periodically.

FEMA Public Assistance Cost-Effective Measures: Electric Power Systems

A. Provide looped distribution service or other redundancies in the electrical service to critical facilities, such as hospitals and fire stations.

B. Install surge suppressors and lightning arrestors.

C. Transformers:

- Elevate pad transformers above the Base Flood Elevation.
- Support pole-mounted transformers with multiple poles.

D. Power Poles:

- Replace damaged poles with higher-rated poles (preferably two classes stronger) of the same or different material. When replacing poles with higher-rated poles, install guys and anchors to provide lateral support for poles supporting pole-mounted transformers, regulators, capacitor banks, reclosers, air-break switches, or other electrical distribution equipment.
- Remove large diameter lines.
- Add cross-bracing to H-frame poles to provide additional strength.
- Power Lines: Add guy-wires or additional support.

Limitations of FEMA's BCA Toolkit

Garbage in = garbage out

Intended to perform BCA for physical projects, not programs or plans

Assumes hazard risk is static over the project useful life

Assumes costs associated with power outages are simply a factor of the service population and outage duration, whereas in reality long-term power outages may have additional, escalating costs

Focuses only on risk reduction from damages. Co-benefits of resilience investments ignored (e.g., emission reductions, ecosystem benefits, safety and health),

DOE's Interruption Cost Estimate (ICE) Calculator

The **Interruption Cost Estimate (ICE) Calculator** is an online tool, sponsored by DOE's Office of Electricity Delivery and Energy Reliability and hosted by DOE's Lawrence Berkeley National Laboratory. This tool:

- Enables users to estimate the economic costs of actual or hypothetical service outages to consumers.
- Is based on customer data collected by more than 30 major utilities across the U.S.
- Is easy to use. The user specifies the number of affected customers (by type), the location, and the duration of the outage. (ICE is not applicable for outages lasting longer than 24 hours.)
- ICE has more than 5,000 users, some outside the U.S.
- More information is available at https://icecalculator.com/home

Cost-Benefit Methodologies

- Recent publication provides information for utilities and regulators to evaluate the costs and benefits of extreme weather resilience investments

- Compendium of current extreme weather- resilience cost and benefit methods

- Characterization of benefit categories that are typically not considered

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journal homepage: www.elsevier.com/locate/tej

Monetization methods for evaluating investments in electricity system resilience to extreme weather and climate change

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ARTICLE INFO

Keywords:
Electricity resilience
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Adaptation

ABSTRACT

Extreme weather events and associated damages have been increasing and these trends are expected to continue. Actions are being taken to enhance electricity system resilience. However, the justification for capital investments on resilience requires utilities to justify that the economic benefits outweigh the costs. This paper reviews the types of resilience measures being analyzed in cost-benefit analyses and addresses opportunities for improvement in characterizing the benefits for investments that enhance the resilience of electricity systems.

What Benefits (avoided costs) to Include?

Potential Benefits	
Avoided Utility Costs	Avoided Restoration, Repair and Replacement Costs
	Avoided Legal Liabilities
	- Borne only by Shareholders
	- Passed onto Ratepayers
	Avoided Vegetation Management Costs
	Avoided Revenue Losses
	Avoided Penalties
	Avoided Wholesale Power Purchases
	Avoided Supply and Capacity Costs from Distributed Energy Resources
Avoided Costs from Short-Duration Outages	Avoided Customer Interruption Costs Avoided Power Quality Degradation
Avoided Costs from Long-Duration Outages	Avoided Economic and Job Losses Avoided Impacts to Critical Facilities/Lifelines Avoided Interruptions to Government Systems
Non-Outage Societal Benefits	Safety & Health: Avoided Illnesses, Injuries and Fatalities Avoided Property Damage Ecosystem Benefits Avoided Emissions

Key Takeaways

- ❖ The frequency, severity and cost of natural disasters impacting the electricity systems is increasing
- ❖ The current pace, scale, and scope of efforts to enhance electricity system resilience are likely to be insufficient given the nature of the challenge
- ❖ Multiple Federal Assistance Programs exist to cost-share electricity resilience investments but are typically under accessed
- ❖ The majority of federal funding has been appropriated after disasters for use in the impacted regions. Funding for pre-disaster mitigation is increasing.
- ❖ Eligibility of electricity resilience projects under current policies and authorities is not always clear. Benefits are typically under-monetized.
- ❖ A lack of resilience-focused design codes and standards undermines federal initiatives to build back stronger.

Contact Information and Resources

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- FEMA Public Assistance 406: https://www.fema.gov/public-assistance-policy-and-guidance
- FEMA Hazard Mitigation Grant Program: https://www.fema.gov/hazard-mitigation-grant-program
- FEMA Hazard Mitigation Assistance (HMA): https://www.fema.gov/hazard-mitigation-assistance
- FY19 Pre-Disaster Mitigation (PDM) General Information: https://www.fema.gov/pre-disaster-mitigation-grant-program
- FY19 PDM Notice of Funding Opportunity (NOFO) and Fact Sheet: https://www.fema.gov/media-library/assets/documents/182171
- HUD CDBG-MIT Notice: https://www.hudexchange.info/news/hud-publishes-cdbg-mitigation-notice/
- ICE calculator: https://icecalculator.com/home
- BCA toolkit: www.fema.gov/benefit-cost-analysis

❖ Zamuda, C., D.E. Bilello, G. Conzelmann, E. Mecray, A. Satsangi, V. Tidwell, and B.J. Walker, 2018: Energy Supply, Delivery, and Demand. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 174–201. doi: 10.7930/NCA4.2018.CH4. https://nca2018.globalchange.gov/chapter/energy

❖ Zamuda, C.D, T. Walls, L. Guzowski, J. Bergeson, J. Ford, L.P. Lewis, R. Jeffers, S. Derosa. 2019. *Resilience management practices for electric utilities and extreme weather*. The Electricity Journal 32 (2019) 106642

❖ Zamuda, C.D., P.H. Larsen, M.T. Collins, S. Bieler, J. Schellenberg, S. Hees. 2019. *Monetization methods for evaluating investments in electricity system resilience to extreme weather and climate change.* The Electricity Journal 32 (2019) 106642

Additional Slides

Characterizing Attributes of a Resilient Utility

- **Collaborated with utilities and regulators to establish a common framework for characterizing extreme weather resilience program implementation**

- **Recent publication describes key characteristics of a resilient utility:**
  Governance and Accountability; Stakeholder Engagement; Communication; Risk Management; Investments; Supply Chains; Services, Employees

- **Uses a maturity model approach for evaluating progress on enhancing resilience**

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Resilience management practices for electric utilities and extreme weather

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ABSTRACT

This paper describes management practices of a model resilient electric utility that can serve as a framework for advancing planning and preparation for extreme weather and climate hazards. The framework focuses on practices grouped into eight domains progressing through five levels of maturity. For each domain, a discussion of resilience management practices is provided along with examples. By assessing its maturity level and taking steps to increase it, a utility can realize increased resilience benefits.