Regulators' Financial Toolbox on Resilience Technologies
Aug. 25, 2021

The Regulator's Financial Toolbox series examines regulatory issues where technology meets bookkeeping. In this 90-minute webinar, speakers will address technology, economic, and accounting considerations for resilience technologies. This webinar will explain current resilience technologies, utilities benefits, and regulatory considerations such as useful life, inclusion in rate base, and other decision-making information.

Moderator: Commissioner Carrie Zalewski, Illinois Commerce Commission
Speakers:
Julio Romero Aguero, Quanta Technology
Dr. Robert "Bobby" Jeffers (Sandia National Labs)
Jennifer Kallay (Synapse Energy)
Leuwam Tesfai (California Public Utility Commission)

Chairman Carrie Zalewski
Chairman, Illinois Commerce Commission
Carrie Zalewski is a utility regulator, attorney, and trained engineer with over 15 years of experience in environmental and energy regulation with an extensive background in public utility regulation, environmental policy and compliance, wholesale power issues and policy, and corporate governance. She was appointed Chairman of the Illinois Commerce Commission on April 15, 2019, by Governor JB Pritzker to a 5-year term.

Chairman Zalewski came to the Commission from the Illinois Pollution Control Board where she had served since 2009. At the Board, Zalewski adjudicated complex environmental cases under the Illinois Environmental Protection Act, shaped critical rulemaking and worked to properly balance the interests of Illinois businesses and residents while protecting Illinois' land, air, and water.

Zalewski authored 2020 articles titled "Reflecting on 5 years of Supplier Diversity Spend by Illinois Utilities," published in Diversity Plus Magazine; "A Historic Effort in Illinois: Safeguarding Consumer Protections During Post-COVID Recovery," published in Energy Central News, and "Illinois Commerce Commission Chair promotes STEM for World STEM Day," published in the Daily Herald.

Julio Romero Agüero
Vice President, Strategy & Business Innovation & Executive Advisor, Quanta Technology
Dr. Julio Romero Agüero has over 20 years of experience working with electric utilities and regulatory boards. He has developed solutions for numerous electric utilities in the USA, Canada, Latin America, The Caribbean and Asia. His experience includes full P&L responsibility, business and technical leadership of utility and consulting projects in the areas of technology strategy, emerging technologies, innovation, planning, reliability, regulation, operations, engineering, asset management, Smart Grid, automation, renewable energy, integration of distributed energy resources, and plug-in electric vehicles.

Dr. Romero Agüero is former Commissioner of the National Energy Commission of Honduras, Chair of the IEEE Distribution Subcommittee, Chair of the IEEE Working Group on Distributed Resources Integration, Editor of IEEE Transactions on Smart Grid, Editor of IEEE Transactions on Power Delivery, Member of the Advisory Committee of DistribuTECH, and Senior Member of the IEEE. He is the author of over 60 technical papers and presentations.

Robert "Bobby" Jeffers
Senior Member of Technical Staff, Sandia

Dr. Robert "Bobby" Jeffers has been with Sandia since 2013 and has helped them build a growing body of energy resilience research. Bobby applies techniques such as system dynamics, power systems modeling, interactive visualization, agent-based modeling, and spatial network modeling to diverse problems concerning the intersection between human, natural, and engineered systems – particularly energy systems. He currently works directly with programs in 8810 and 8720, interacting with multiple customers within DOE-OE, DOE-EERE, and DoD energy offices, and has strategically crafted several successful proposals in the energy resilience space. Bobby's passion for improving real-world sustainability and resilience has been demonstrated by his ability to form large teams working collaboratively with external partners and stakeholders such as city governments, electric utilities, non-profit organizations, and national laboratories.

Prior to working at Sandia, Bobby was a research scientist at Idaho National Laboratory where he served as Principal Investigator on three diverse projects simulating the energy-water nexus, critical material supply chain economics, and novel concepts for integration of renewable energy on the power grid.

Jennifer Kallay
Senior Associate, Synapse

Jennifer Kallay researches and analyzes ways to improve utility, regulator, and community coordination and collaboration in key energy planning areas such as grid resilience, distributed energy resources, greenhouse gas emission reductions, equity, and energy justice. Ms. Kallay led Synapse Energy Economics' work on behalf of Sandia National Laboratories to research the integration of community and electric grid resilience investment planning. This entailed developing of a series of interconnected reports to explore the challenges and opportunities in several key areas including regulatory mechanisms, resilient public-purpose microgrids, benefit-cost analysis, and performance metrics.

Leuwam Tesfai
Chief of Staff and Legal Advisor to Commissioner Genevieve Shiroma, California Public Utilities Commission

Leuwam Tesfai serves as Commissioner Genevieve Shiroma's Chief of Staff and Legal Advisor at the California Public Utilities Commission. Prior to her governor's appointment to this role, Leuwam practiced in the federal section of the CPUC's Legal Division representing the CPUC

before the Federal Energy Regulatory Commission and advising on energy matters including ratemaking, transmission and distribution planning, energy procurement, reliability, and climate change mitigation and adaptation. Leuwam also previously served as an advisor to Commissioner Liane Randolph. Prior to joining the CPUC, Leuwam worked in the private sector on electric generation planning and environmental permitting, energy trading and market development, and water resource planning. Leuwam is a graduate of the University of San Francisco School of Law and Emory University.

Regulators' Financial Toolbox: Resilience Technologies

WEDNESDAY, AUGUST 25, 2021

NARUC CENTER FOR PARTNERSHIPS AND INNOVATION

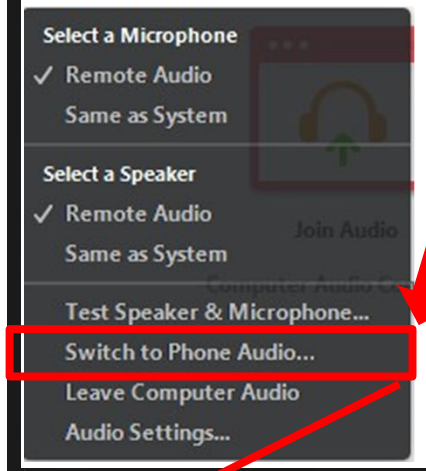
Recording

Zoom Webinar 101

If you have audio issues, dial in using your phone. You can find dial in information with a unique pin here.

Click **Chat** to show the chat window.

Click **Q&A** to type a question during Q&A sessions.



NARUC
Center for Partnership and Innovation (CPI)

https://www.naruc.org/cpi-1/electricity-system-transition/valuation-and-ratemaking/

NARUC

The National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization founded in 1889.

Our Members are the state regulatory Commissioners in all 50 states & the territories. FERC & FCC Commissioners are also members. NARUC has Associate Members in over 20 other countries.

NARUC member agencies regulate electricity, natural gas, telecommunications, and water utilities.

CPI

Grant-funded team dedicated to providing technical assistance to members.

CPI identified emerging challenges and connects state commissions with expertise and strategies.

CPI builds relationships, develops resources, and delivers trainings.

CPI thanks the US Department of Energy for support in today's session.

NARUC CPI Regulators Toolbox Series

https://www.naruc.org/cpi-1/electricity-system-transition/valuation-and-ratemaking/

The Regulator's Financial Toolbox series examines regulatory issues where technology meets bookkeeping.

During the Communications Networks Toolbox webinar, regulators will hear multiple perspectives on how communications networks work; what is unique about distribution system and grid edge communications vis a vis the distribution system and bulk power system communications; what their benefits are to the electricity system; and considerations specifically for regulators. Like many things, the perfect communications solution will be up to the jurisdiction, but this webinar will provide a framework for making decisions and help regulators be prepared to engage with utilities on this thorny issue.

After the webinar, the recording and a summary brief will be posted on the CPI website, www.naruc.org/cpi-1. Presentations are available now.

SERIES TOPICS

- ✓ Cloud Computing (Fall 2020)
- ✓ AMI (Spring 2021)
- ✓ Network Communications (Spring 2021)
- ✓ Communications Network for DER Integration (Summer 2021)
- ✓ Resilience Technologies (Today, August 25, 2021)

Join our listserv for all CPI events.

Agenda & Housekeeping

AGENDA

3:00 ET	Introduction by NARUC Staff and Moderator Hon. Carrie Zalewski
3:05 ET	Julio Romero Aguero (Quanta Technology)
3:20 ET	Robert “Bobby” Jeffers (Sandia)
3:35 ET	Jennifer “Jenn” Kallay (Synapse Energy Economics)
3:50 ET	Leuwam Tesfai (California Public Utilities Commission)
4:05 ET	Q&A with Moderator and audience
4:30 ET	Close

DURING THE WEBINAR

The webinar is being recorded.

Chat the organizers anytime for questions on the logistics or discussion.

AFTER THE WEBINAR

Please allow a few business days to process and post the webinar recording to https://www.naruc.org/cpi-1/electricity-system-transition/valuation-and-ratemaking/.

A written summary will become available.

Chairman
Carrie Zalewski

PENNSYLVANIA PUBLIC UTILITY COMMISSION (PA PUC)

PANEL MODERATOR

Up next…

Julio Romero Aguero

QUANTA TECHNOLOGY

QUANTA TECHNOLOGY

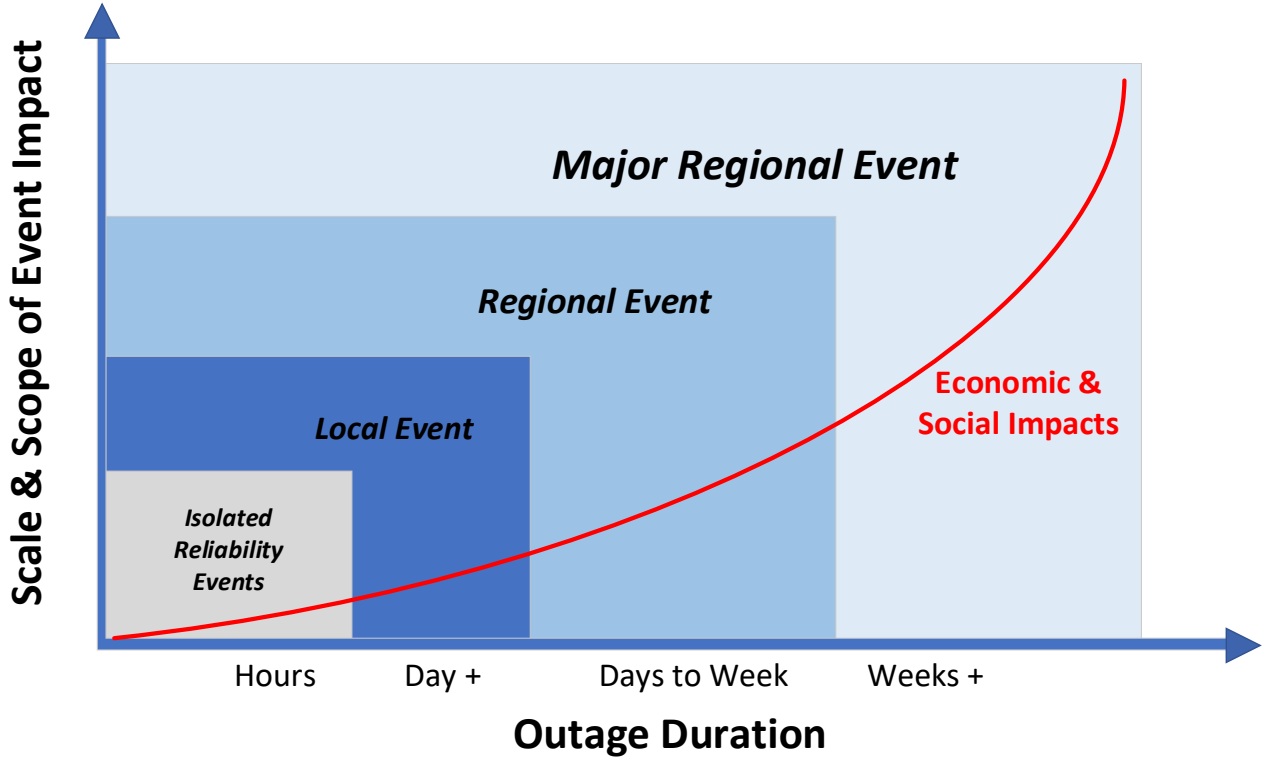
Resilience of Power Systems

Dr. Julio Romero Agüero
Vice President, Strategy and Business Innovation

August 25, 2021

Reliability and Resilience

- **Reliability** is commonly acknowledged as a system performance measure
- **Resilience** is a system characteristic/capability encompassing all hazards and events, including high-impact low-probability events that are excluded from reliability calculations
  - While reliability metrics (SAIDI, SAIFI, etc.) can still be used to gauge larger scale impacts, they do not provide the complete picture of the restoration process
- **Reliability and Resilience** often improve each other (e.g., system hardening), however, there could be opposing tradeoffs
  - Traditional reliability practice of reclosing power lines could have negative resilience impact with ignitions from foreign debris during wildfire season)



Source: IEEE Resilience TR83 PES Webinar

Resilience – Industry Definitions

Dictionary definition of resilience is "The capacity to recover from difficulties: toughness."

- **FERC**: "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such event." Examples of high-impact, low frequency (HILF) disruptive events are fuel supply interruptions, extreme weather events, and HEMP attack/GMD.
- **DOE**: "The ability of a power system and its components to withstand and adapt to disruptions and rapidly recover from them."
- **NATF**: "The ability of the system and its components (i.e., both the equipment and human components) to minimize damage and improve recovery from non-routine disruptions, including high impact, low frequency events, in a reasonable amount of time."

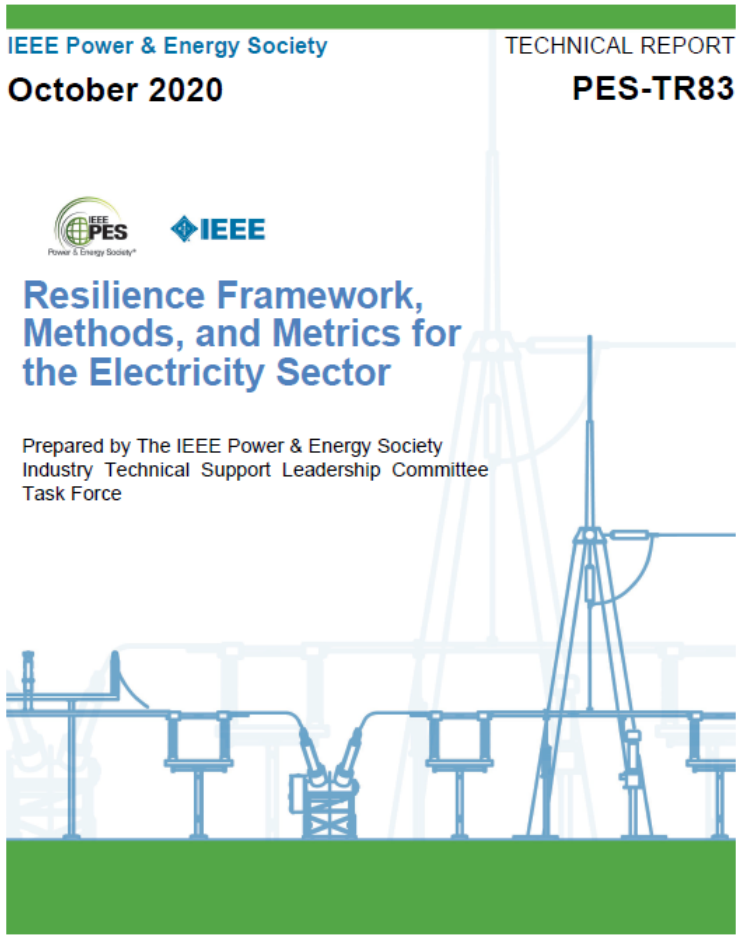
As the frequency of weather-related or security events has increased, those cannot be treated as low-probability events

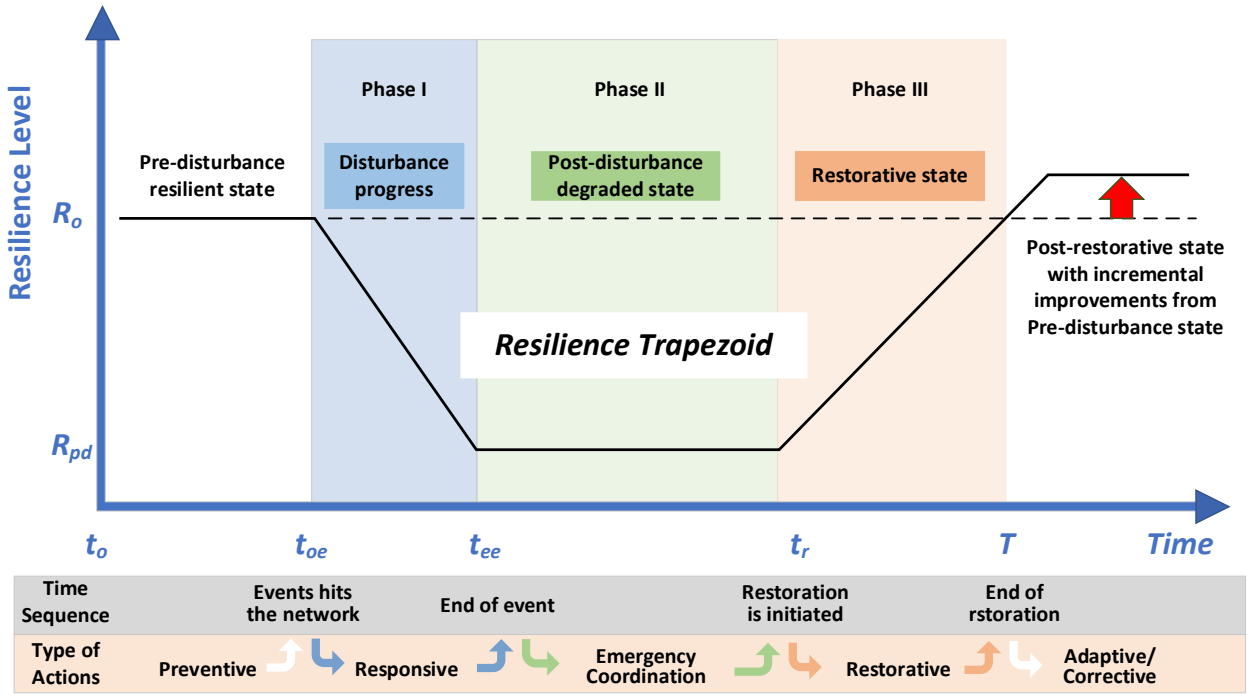
The ability to protect against and recover from any event that would significantly impact the grid.

Source: IEEE Resilience TR83 PES Webinar

Resilience – IEEE Definition

- **IEEE PES (PES-TR65 and PES-TR83):** "The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event."





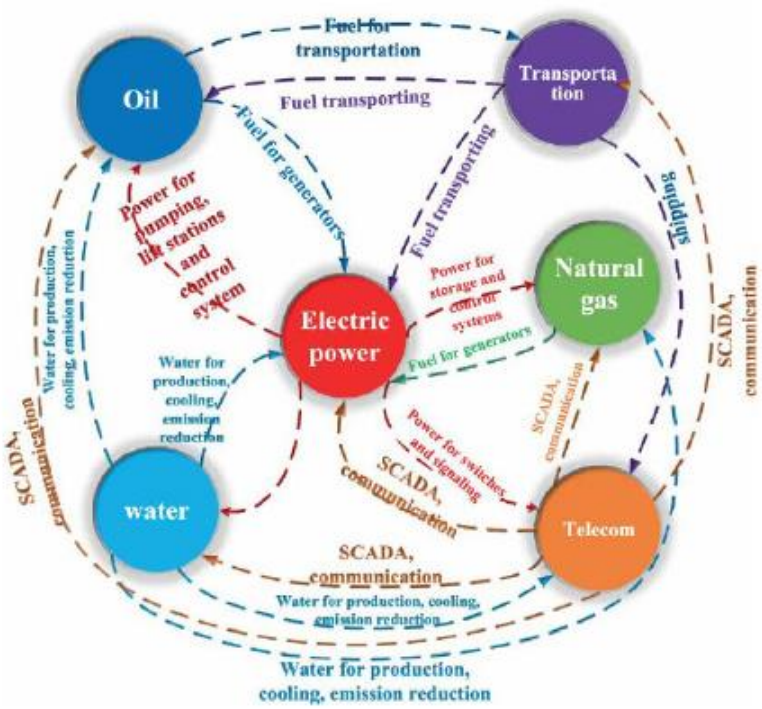
Source: The Definition and Quantification of Resilience, Technical Report PES-TR65
http://grouper.ieee.org/groups/transformers/subcommittees/distr/C57.167/F18-Definition&QuantificationOfResilience.pdf

The Importance of Power Grid Resilience

- As threats are evolving, there is more emphasis on the resilience of the electric grid
- Protect against and recover from any event that would significantly impact the grid
  Prepare => Withstand => Reduce magnitude and duration
- But it's not just about providing resilience; we need to be able to measure it
- Resilience metrics enable benchmarking across industry participants and facilitate continuous improvements

Energy Sector, including power grids, is uniquely critical because it provides an "enabling function" across all critical infrastructures

Critical infrastructure interdependencies



Source: IEEE Resilience TR83 PES Webinar

Resilience Scope

Resilience Metrics

IEEE PES Distribution Resilience Working Group

- Storm resilience that focuses on the speed of recovery during the first 12 hours of a storm from customers losing power
- Non-storm, gray sky day (GSD) resilience that focuses on robustness and the ability to withstand most weather events
  - Total number of GSD in a year with no more than the threshold interruptions

$$Storm\ event\ X = \frac{Sum\ of\ customers\ without\ power\ for\ more\ than\ 12\ hr}{Sustained\ Customer\ Interruptions + Avoided\ Customer\ Interruptions}$$

Y is the threshold: If X < Y, the storm met expectations. If X ≥ Y, the storm did not

Challenges: (1) Critical loads (2) Long duration disruptions (e.g., flooding, earthquakes) (3) Social impacts

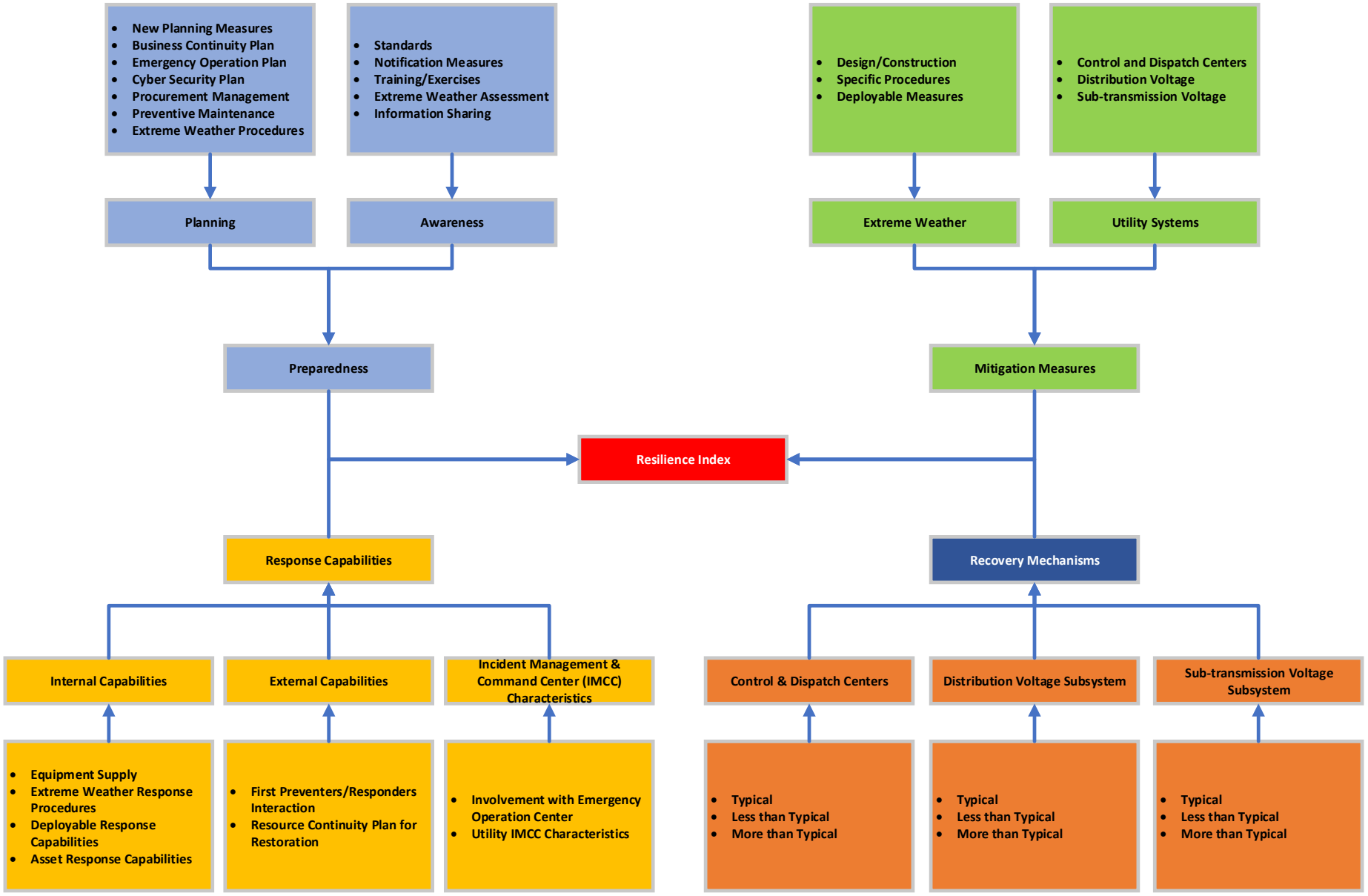
DOE performance-based metrics

- Multi-criteria decision analysis (MCDA):
  - Survey based data collection and analysis with weighted factors
  - Calculate a resilience index (RI) that accounts for ~1,200 attributes grouped in 350 categories
- Performance-based metrics:
  - Quantify the system consequence/performance during events
  - Suitable for benefit-cost and planning analyses associated with proposed improvements and investments

Impact	Consequence Category	Resilience Metrics
Direct	Electric Service	Cumulative customer-hours of outages Cumulative customer energy demand not served Average number (or percentage) of customers experiencing an outage during a specified time period
	Critical Electrical Service	Cumulative critical customer-hours of outages Critical customer energy demand not served Average number (or percentage) of critical loads that experience an outage
	Restoration	Time to recovery Cost of recovery
	Monetary	Loss of utility revenue Cost of grid damages (e.g., repair or replace lines, transformers) Cost of recovery Avoided outage cost
Indirect	Community Function	Critical services without power (e.g., hospitals, fire stations, police stations)
	Monetary	Loss of assets and perishables Business interruption costs Impact on Gross Municipal Product (GMP) or Gross Regional Product (GRP)
	Other critical assets	Key production facilities without power Key military facilities without power

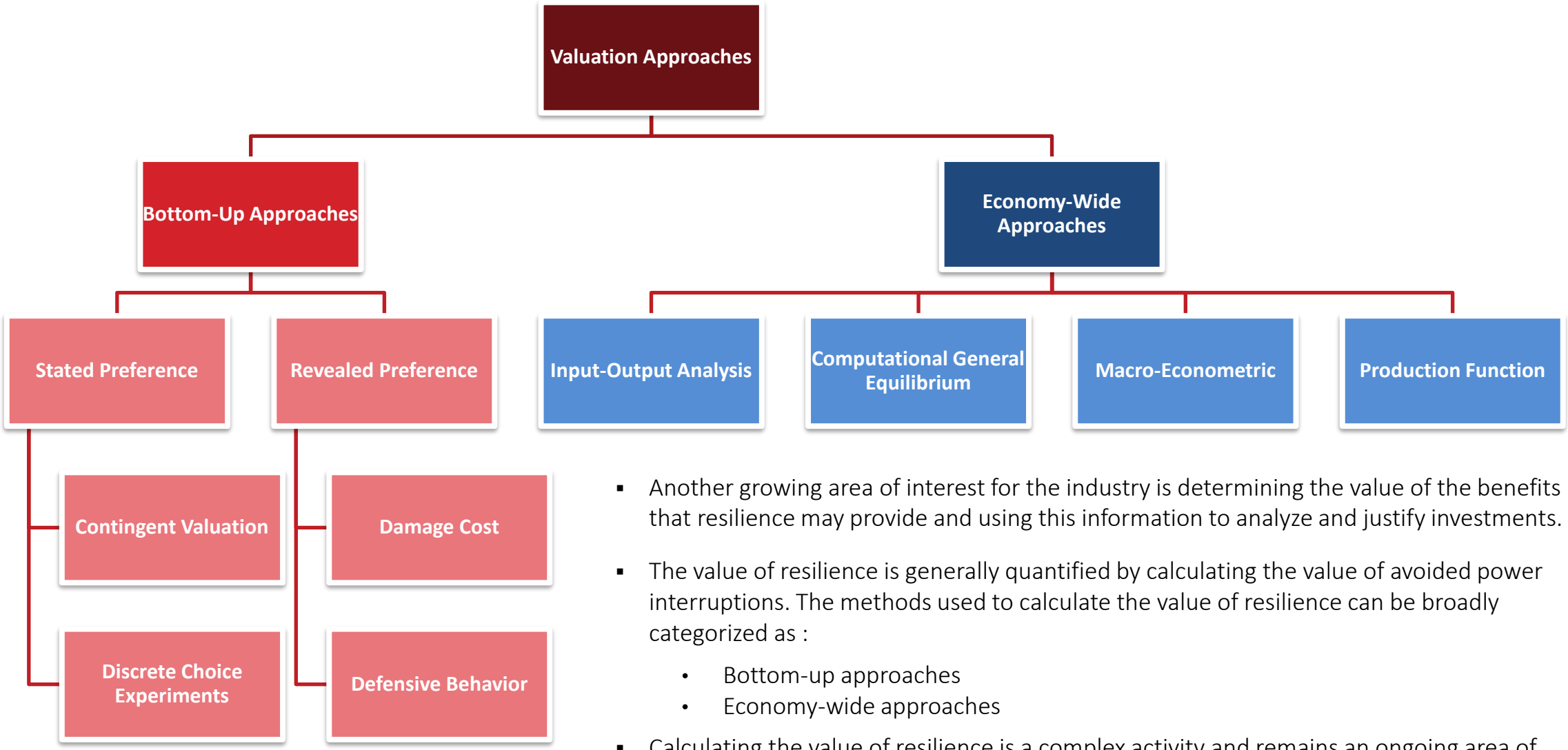
Source: IEEE Resilience TR83 PES Webinar

Multi-Criteria Decision Analysis (MCDA) Metrics



Source: Grid Modernization: Metrics Analysis (GMLC1.1) – Resilience Reference Document Volume 2, Mar 2019

Value of Resiliency



- Another growing area of interest for the industry is determining the value of the benefits that resilience may provide and using this information to analyze and justify investments.
- The value of resilience is generally quantified by calculating the value of avoided power interruptions. The methods used to calculate the value of resilience can be broadly categorized as :
  - Bottom-up approaches
  - Economy-wide approaches
- Calculating the value of resilience is a complex activity and remains an ongoing area of research for the industry.

Source: National Association of Regulatory Utility Commissioners (NARUC), The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices, Apr. 2019 https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198

Resilience Improvement Solutions

- Upgrade infrastructure/assets for wind, ice, snow and flood protection (e.g., installing tree wire, aerial bundled and spacer cable, upgrading crossarms and poles, installing submersible equipment, etc.)
- Vegetation management
- Targeted undergrounding
- Review/update overhead and underground infrastructure design

Weather Hardening and Climate Change Preparedness

- Enhanced line inspection programs
- High reliability/resiliency distribution system design (primary loop, primary and secondary selective, etc.)
- Digital/mobile workforce management
- Advanced inspection and damage assessment

Reliability, Outage Management and Restoration

- Redundant infrastructure (e.g., backup control center and supply to critical cust., etc.)
- Distribution and DER physical and cyber security standards
- Reinforced buildings and fences
- Shield assets from outside attacks
- Gas insulated and underground substations

Physical and Cyber Security

- Underground cable replacement
- Protective, switching and volt-VAR equipment replacement
- Pole inspection and replacement

Aging Infrastructure Replacement

- Spare equipment (e.g., PPE, distribution poles, wires, cables, switches, and distribution transformers)
- Mobile transformers and generators
- Mutual assistance agreements, contractors/service provider agreements and onboarding, staff augmentation, etc.
- System and business recovery/remediation plans and processes (e.g., blackstart, contingency plans, storm restoration, safety, etc.)

Logistics, Staffing and Processes

- Shielding of T&D control centers, mitigation of radiated threats at substations, mitigation of conducted threats at protection and control equipment

Electromagnetic and Geomagnetic Pulses

- Distributed generation, energy storage, and microgrids
- Advanced DER monitoring and control
- Non-Wires Alternatives (NWA) and value of DER
- Hosting capacity management and optimization

DER Integration

- Real-time asset monitoring and condition assessment/prioritization
- Predictive/prescriptive asset health assessment via advanced analytics
- Optimal asset upgrade/replacement strategy
- ISO Certification

Asset Management

Resiliency

Advanced Modeling, Planning & Analytics

- Data collection, processing, storage and analysis
- Advanced T&D system modeling, simulation, planning and analysis
- Resiliency analytics
- Performance analytics
- Asset health analytics

Real-Time Operations

- Real-time monitoring and control
- Management and monitoring systems (Advanced Distribution Management Systems – ADMS, Outage Management Systems – OMS, Network Monitoring Systems – NMS, etc.)
- DER and Demand Response Management Systems (DERMS and DRMS)
- Microprocessor-based controllers (voltage regulators, load tap changers, capacitor banks)

Optimized System Capacity

- New substations, feeders, line extensions, and feeder ties
- Reconductoring and rephasing
- Phase balancing
- Distribution class series and shunt FACTS devices for power flow control

Advanced Automation & Control

- Smart protective and switching devices (e.g., smart reclosers/switches, self-resetting interrupters, etc.)
- Advanced reclosing (single-phase reclosing, pulse reclosing, etc.)
- Fault Location, Isolation and Service Restoration (FLISR)
- Substation automation

Advanced Protection

- Substation and feeder protective devices
- Bidirectional network protectors
- Adaptive protection and control of overcurrent protection devices

Sensors and Intelligent Devices

- Smart Meters and Advanced Metering Infrastructure (AMI)
- Sensors and advanced meters (voltage, current, power flow, temperature, irradiance, wind speed, fault circuit indicators, PMUs, power quality meters, etc.)
- Power electronics-based volt-VAR control devices (e.g., low-voltage SVCs)

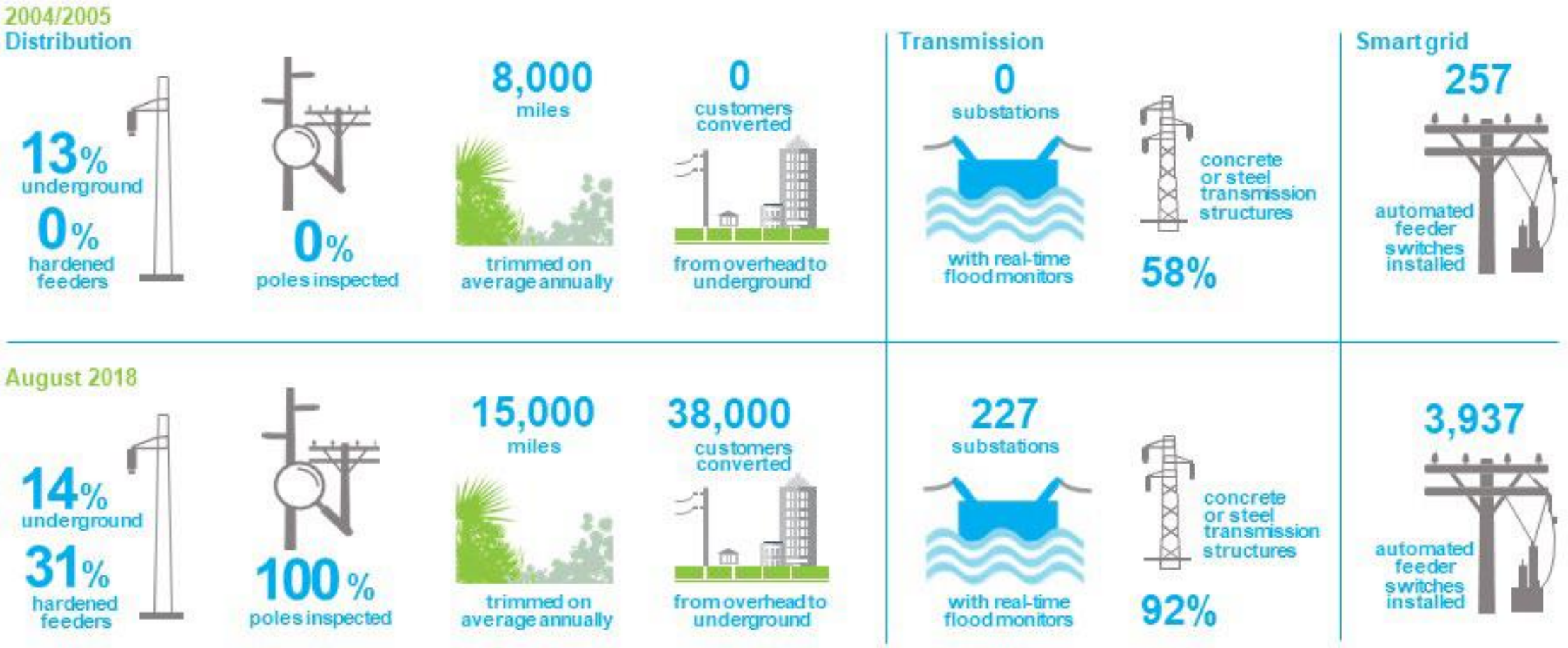
Telecom, Gas and IT Critical Infrastructure

- Remote/virtual operations
- Backup IT systems (Network Operations Center – NOC, Security Operations Center – SOC)
- Substation, feeder and last-mile telecommunications infrastructure

Maintenance

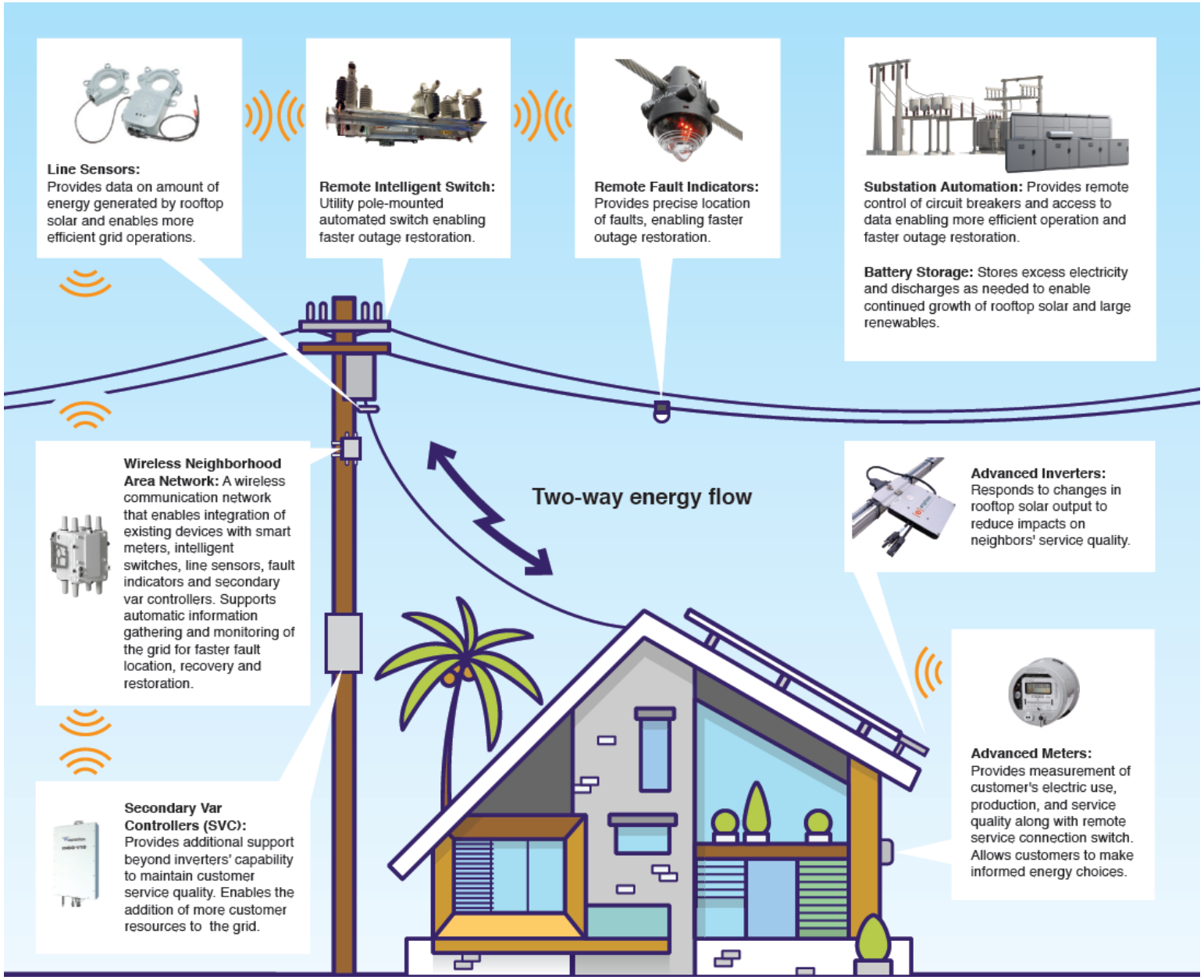
- Advanced inspection techniques (e.g., LIDAR)
- Predictive/prescriptive maintenance via advanced analytics
- Efficiency improvement via digital/mobile workforce solutions

Examples of Solutions – Florida Power and Light



Source: B. Olnick, DOE Electric Advisory Committee – Grid Resiliency
https://www.energy.gov/sites/prod/files/2018/10/f56/1.1%20Resilience%20Panel_Olnick_10-17-18.pdf

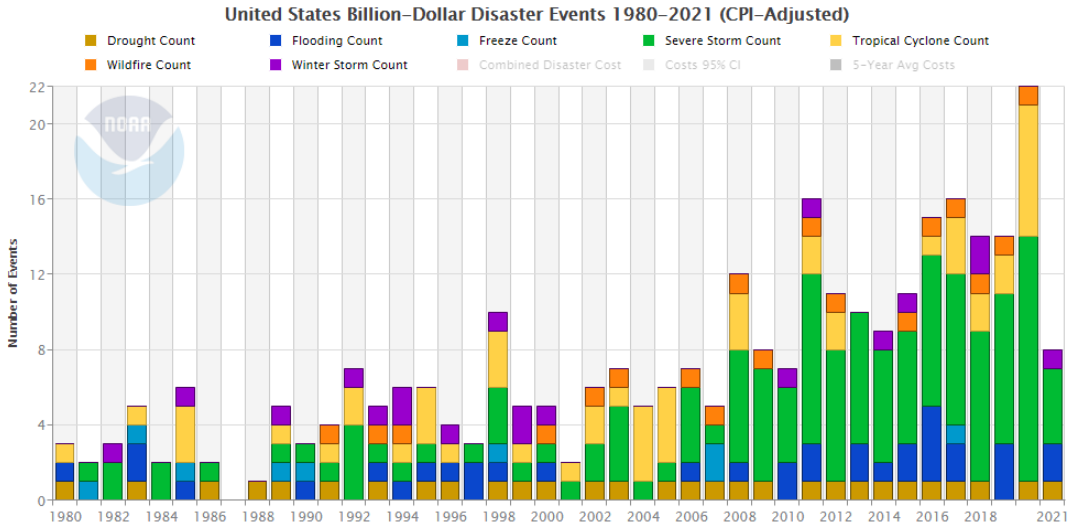
Examples of Solutions – Advanced Technology



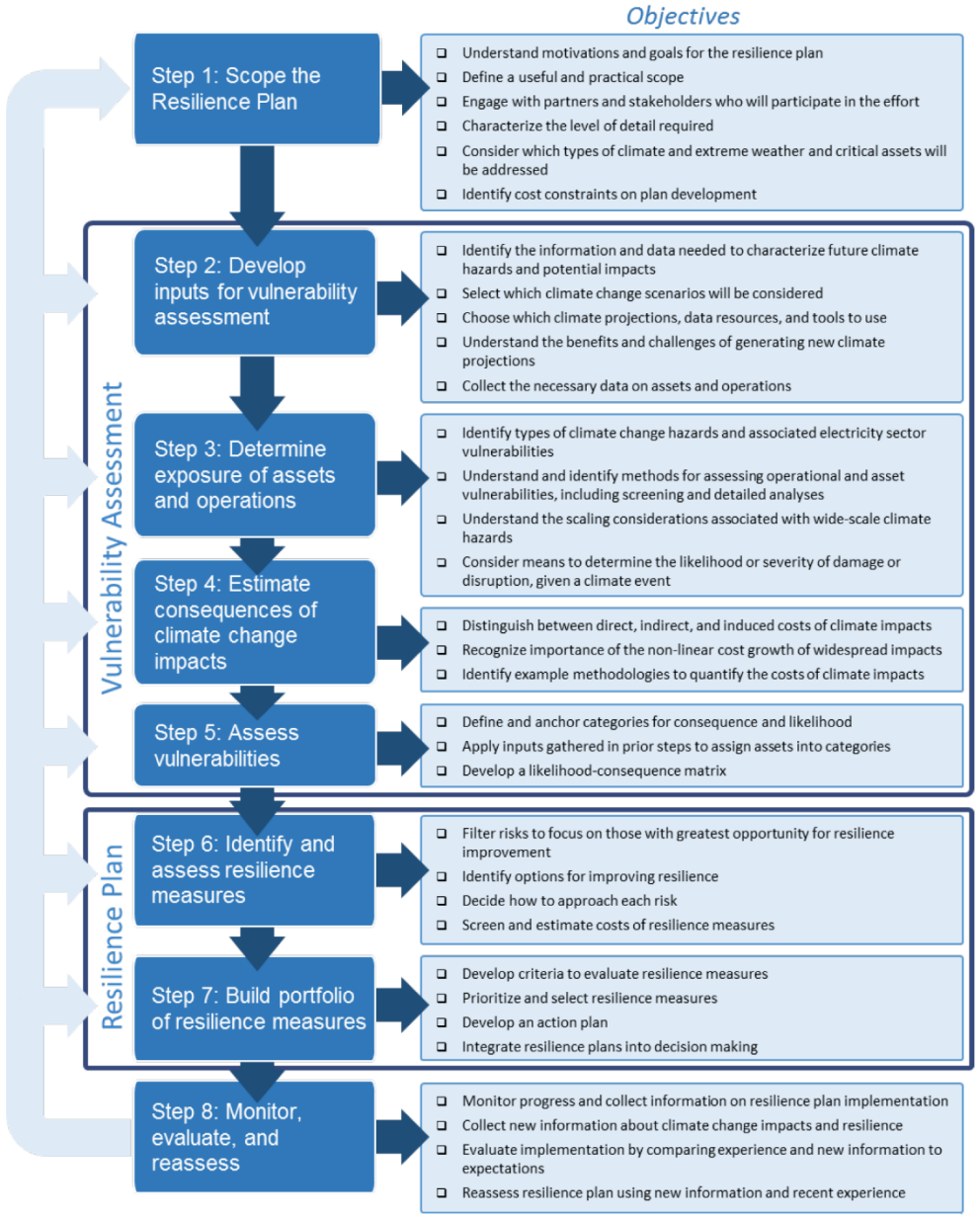
Source: M. Asano, Grid Modernization Applications in a High DER Environment, 2018 IEEE PES T&D Conference and Exposition, Denver CO

Resilience and Climate Change

- **Water stress risk:**
  - According to Moody's 11 utilities (red flag risk) have a combined $31 billion in exposed rate base with a 22-year average depreciation life (Edison International, Xcel Energy Inc., Sempra Energy, Fortis Inc., Berkshire Hathaway Energy, Black Hills Corp., Pinnacle West Capital Corp., Exelon, IDACORP Inc., American Electric Power Co. Inc. and Alliant)
  - About two-thirds of U.S. utilities are at high risk or red-flag risk of intense rain and flooding risk in their service territories. Parts of the Midwest, Southeast and Pacific Northwest are projected to face the sharpest increases
  - Utilities facing red-flag risk represent almost $21 billion in rate base with a 23-year average depreciation life (AEP, AES' U.S. utilities, PPL Corp., FirstEnergy Corp., Duke Energy Corp., Avangrid Inc. and Dominion Energy Inc.)
- **Hurricanes:**
  - Projected to continue to put critical infrastructure at risk along the East Coast and the Gulf of Mexico
  - Six utilities serving regions with red flag hurricane risk represent over $55 billion in rate base with a 20-year average depreciation life (NextEra, Dominion, Duke, Entergy, Cleco Corp. and Southern Co.)



Source: Billion-Dollar Weather and Climate Disasters: Overview https://www.energy.gov/policy/downloads/climate-change-and-us-energy-sector-regional-vulnerabilities-and-resilience



Source: Climate Change and the U.S. Energy Sector: Guide for Climate Change Resilience Planning

Resilience Strategy

Prepare and Adopt (Emergency Preparedness)

- Risk Identification, Prioritization, Mitigation
- Situational Awareness and Information sharing
- IT System Stress Testing
- Logistics Management
- Resource Planning, Acquisition and Training
- Redundancy of Critical Infrastructure/Systems
- Contingency Planning
- Customer Care Preparation
- Workforce/Public Safety Planning

Withstand

- Asset Management
  - Asset Condition Assessment
  - Preventive and Predictive Maintenance
  - Corrective Maintenance
  - Asset Replacement Programs
  - Program Implementation, Including Funding
- T&D System Design
- T&D System Construction
- T&D System Operation
- Physical Facilities Hardening

Resilience

Recover

- T&D System Design
- T&D System Construction
- T&D System Operation
- Logistics Management
- Workforce including Mutual Assistance
- Workforce and Family Care
- Customer Care
- Other Stakeholder Care

Measure and Improve

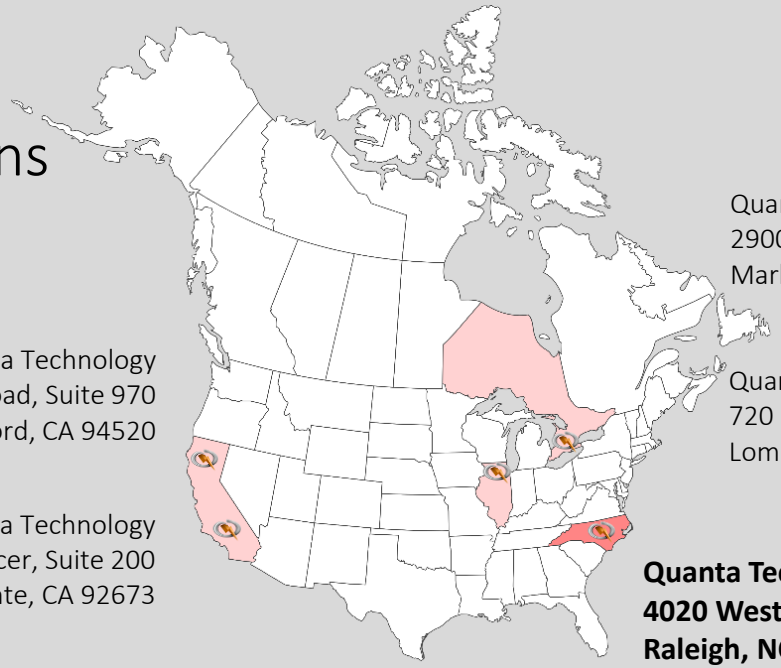
- Overall Performance (Resilience Metrics)
- Lessons learned from Major Events

Conclusions

- The concept of resiliency is complex and requires a detailed characterization of the preparation, operational, and response processes related to an event
- Resiliency evaluation methods and metrics are key areas of research, however, there is no widely accepted industry standard in this area yet
- Development of a Resiliency improvement strategy and roadmap is recommended to guide an organization in improving resiliency and ensure all functions are moving in the same coordinated direction
- Resiliency improvement solutions are multifaceted and span hardware, software, human, and new technology resources
- In addition to climate change, recent environmental phenomena that must be considered include pandemics

Thank you!

Office Locations



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That was…

Julio Romero Aguero

QUANTA TECHNOLOGY

Up next…

Robert “Bobby” Jeffers

SANDIA

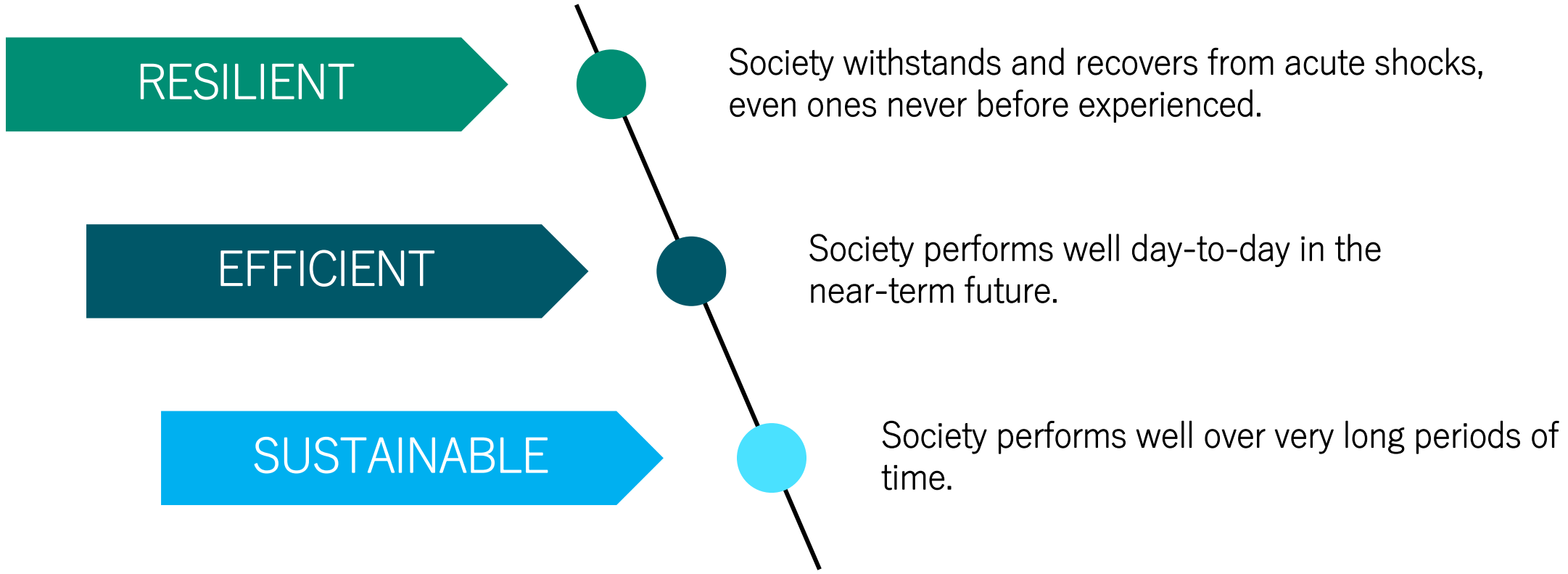
A Performance-Based Approach to Equitable Resilience Planning

PRESENTED BY

Bobby Jeffers, PhD

August 25, 2021

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



At all scales (T, D, Buildings), there are very real tradeoffs between performance in these dimensions.

Resilience Metrics

Attribute-based:

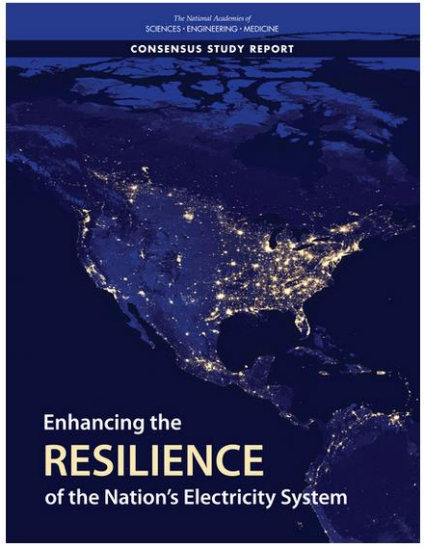
- What makes the system more/less resilient?
- Things you can count now (on a blue-sky day)
- Often grouped into categories that describe some aspect of resilience
  - Robustness, adaptivity, recoverability, etc.
- Often populated via surveys or checklists
  - Relatively simple to populate

Performance-based:

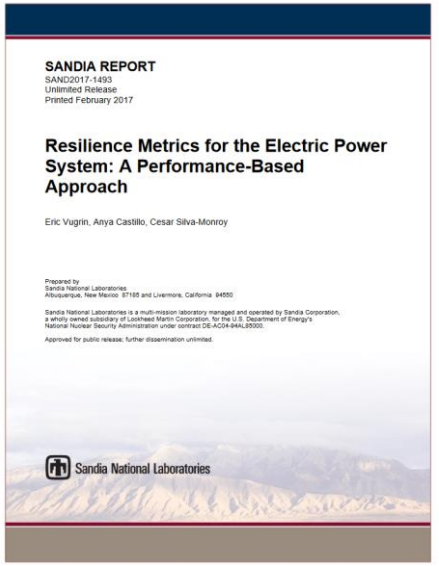
- How resilient is/was the system?
- Things you can measure only during disruption
- Often uses data from an event or a model of an event
  - Can be difficult to populate for planning
- Useful to weigh resilience against other goals
  - (e.g. within benefit cost analysis)

Either approach can be:

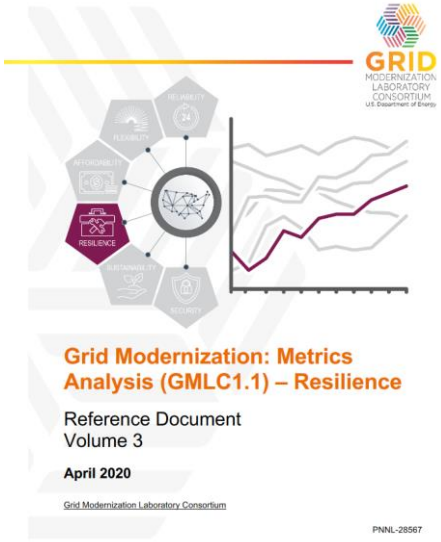
- Retrospective or forward-looking
- Power-focused or consequence-focused
- Threat-informed or threat-agnostic



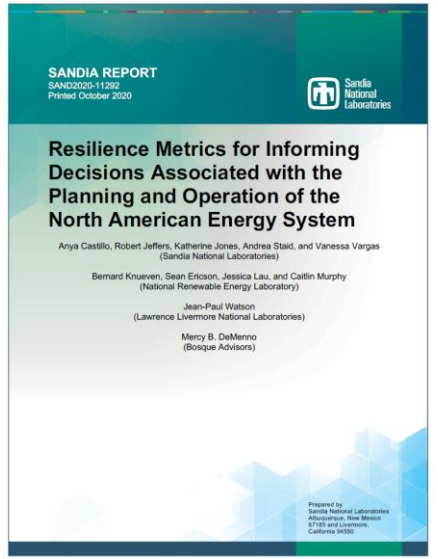
National Academies (2017), Recommendation #1 to DOE: "Improve understanding of customer and societal value associated with increased resilience and review and operationalize metrics for resilience…"



Vugrin et al. (2017) under GMLC 1.1 Foundational Metrics: First power-focused discussion of attribute-based and performance-based resilience metrics.

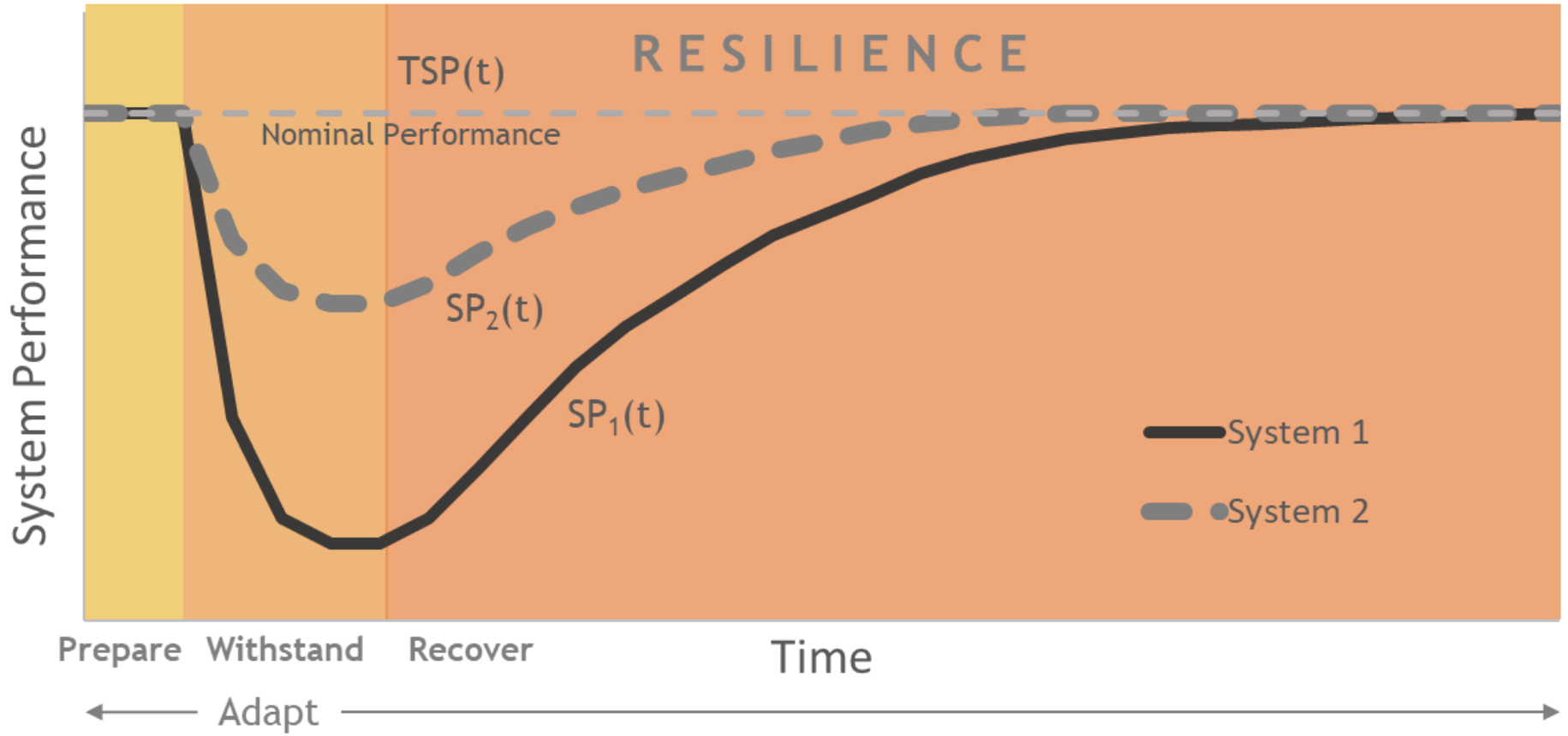


GMLC 1.1 Final Report (2020): Begins to clarify how attribute and performance-based approaches can complement.



NAERM Metrics Report (2020): Describes consequence dimensions and metric formulation

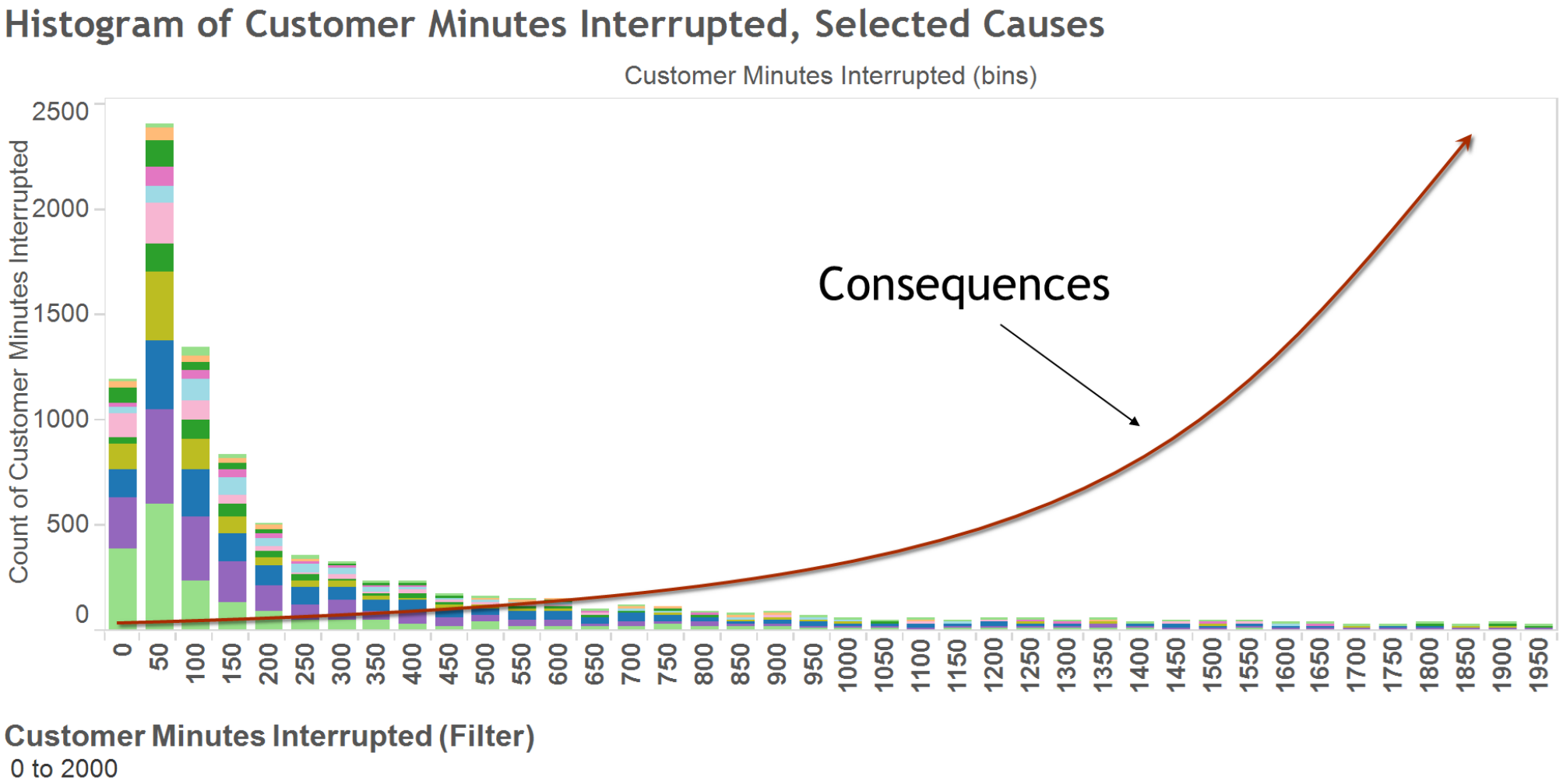
Measuring and forecasting resilience



Resilience metrics should:

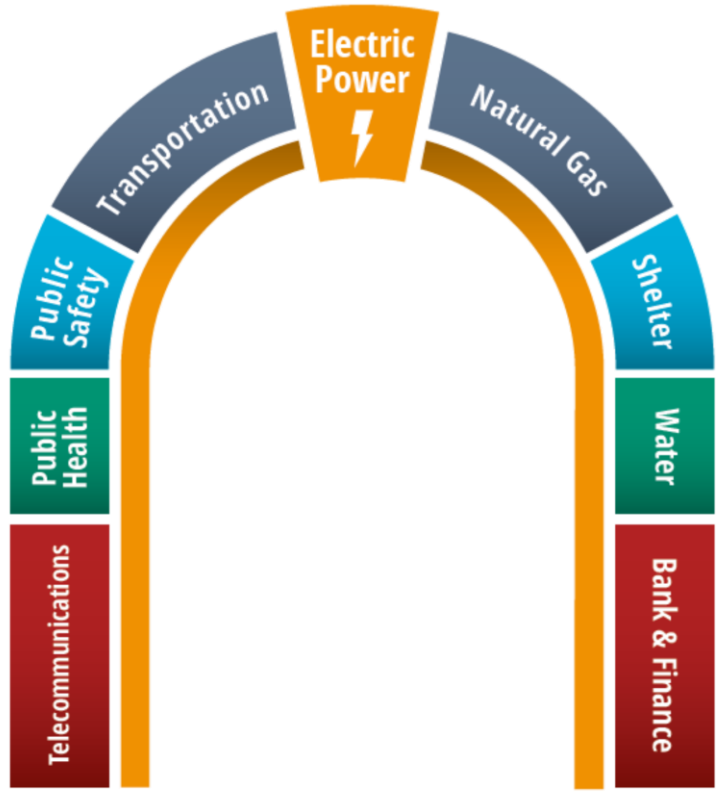
- Convey the wide variance among outages in terms of size, duration, and impact on customers
- Capture the context of the threat environment
- Translate system performance into consequence, where the severity of consequences can change nonlinearly over time

Beyond infrastructure performance – to consequence



Societal Consequence

- The grid is the keystone infrastructure – central to the web of interconnected systems that support life as we know it.
- Consequence-focused **resilience is an externality** in power markets



9 months after Hurricane Maria, thousands of Puerto Ricans still don't have power

The grid is in worse shape than it was before Hurricane Maria.

By Umair Irfan | Updated Jun 20, 2018, 8:06am EDT

"It took Cardona 11 days to find a working phone and a cellular signal to let her mother in Florida know that she was okay. In the weeks following the storm, she woke up at 2 am to get in line for diesel fuel to run the generator at her father's home in Sabana Grande on the southwest coast of the island. After waiting for 13 hours, she went home empty-handed. She stood in lines that stretched blocks to get cash, since no electricity meant credit card readers weren't running."





Designing Resilient Communities

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

Overarching Goal:

- Demonstrate an actionable path toward more resilient communities through consequence-based approaches to grid planning and investment

Objectives:

- Solidify – through demonstration, outreach, verification, and gap analysis – a framework for community resilience planning focused on grid modernization and investment involving the key stakeholders in the community including electric utilities
- Set a clear, actionable path toward widespread adoption of community-focused resilience planning within the grid community

City + Utility Stakeholder Advisory Group

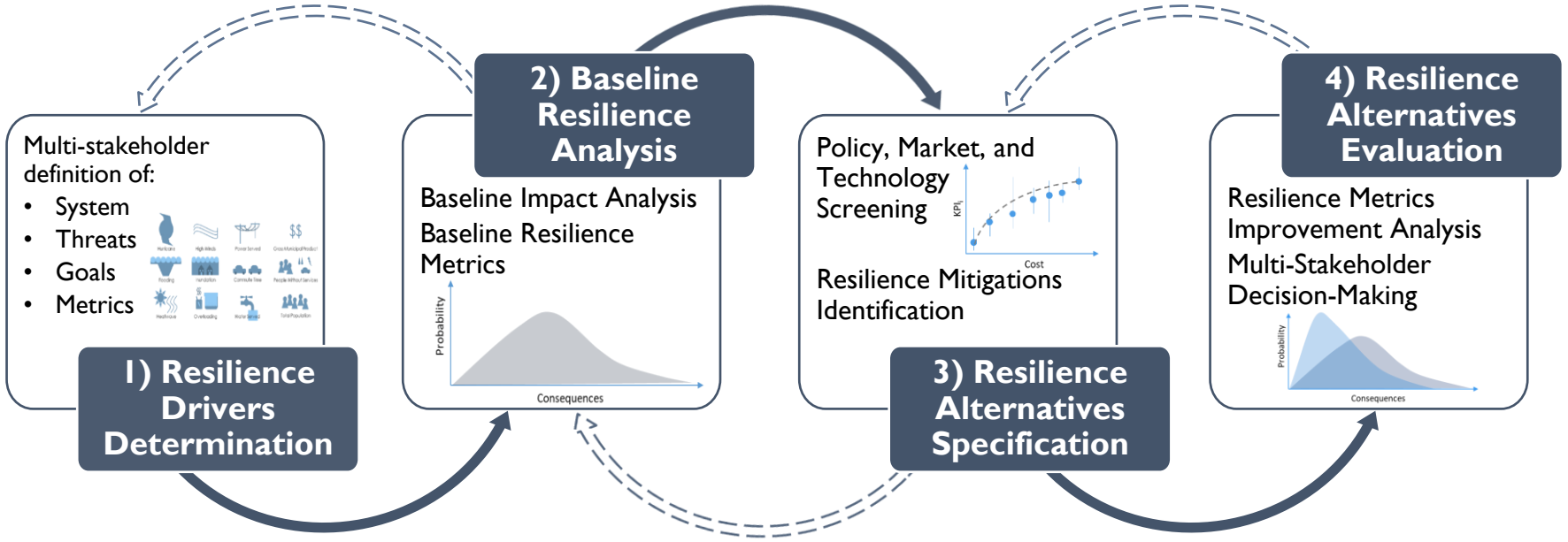
Norfolk, Dominion Energy, City and County of Honolulu, Hawaiian Electric, City of Los Angeles, LA DWP, Boston, Eversource, New York City, Con Edison

Project and Demonstration Partners

U.S. Department of Energy, Sandia National Laboratories, 100 Resilient Cities, National Grid, University at Buffalo, NM State, CPS Energy, The University of Texas at San Antonio, City of San Antonio, Clemson University, Converge Strategies, Bosque Advisors, caño 3.7, Recinto Universitario de Mayagüez, Synapse Energy Economics, Inc.

The Resilient Community Design framework

Defines resilience planning roles for communities, regulators, and utilities



Cities	• Define Consequence • Define Threats	• Map system performance to consequence	• Connect initiatives • Open new opportunities	• Re-evaluate consequence given alternatives
Utilities	• Define interdependent infrastructures	• Threat to system performance	• Design for triple-bottom-line	• Evaluate system performance under alternatives
Regulators	• Set goals • Determine Metrics	• Balance technical rigor with analysis burden	• Ensure designs address goals	• Ensure final portfolios meet goals, are feasible, and equitable

Social Burden

A new metric for resilience and equity that measures how hard society is working to meet their basic needs

Effort

Time + money spent to achieve basic level of human needs

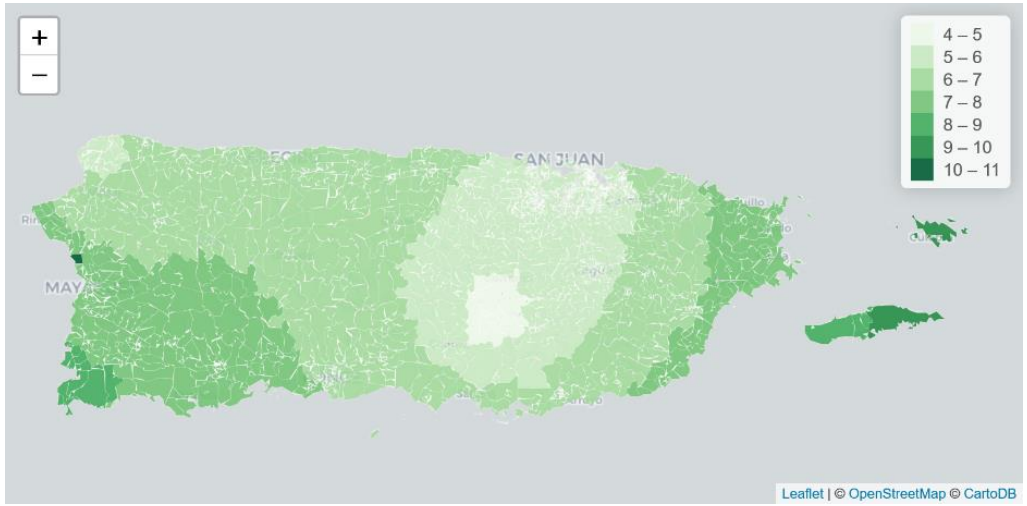
Ability

Median household income,
additional predictors

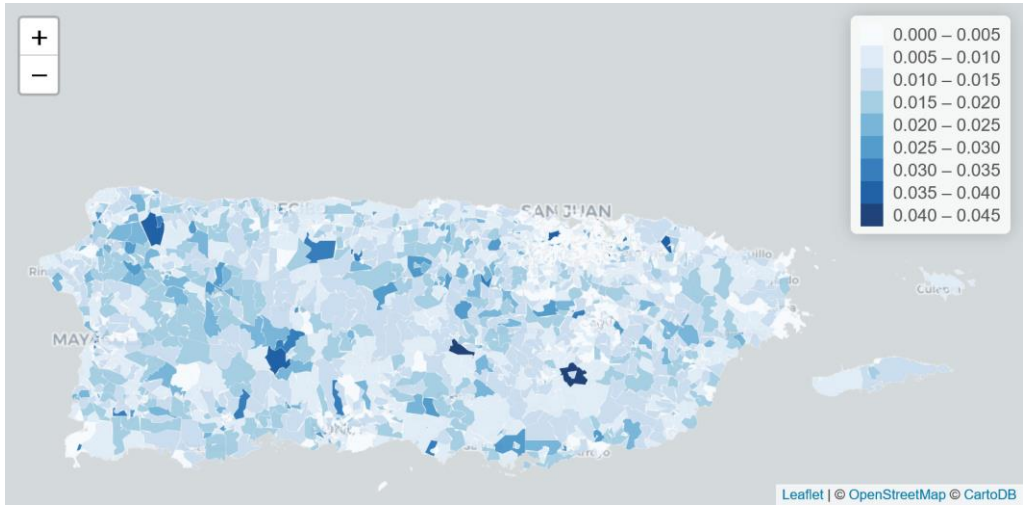
Social Burden

$$B_C = \sum_{inf} \sum_{pop} \frac{E_{inf,pop}}{A_{pop}}$$

Effort during outage: 80 (out of 159 sited) microgrids



Burden during outage: 80 (out of 159 sited) microgrids

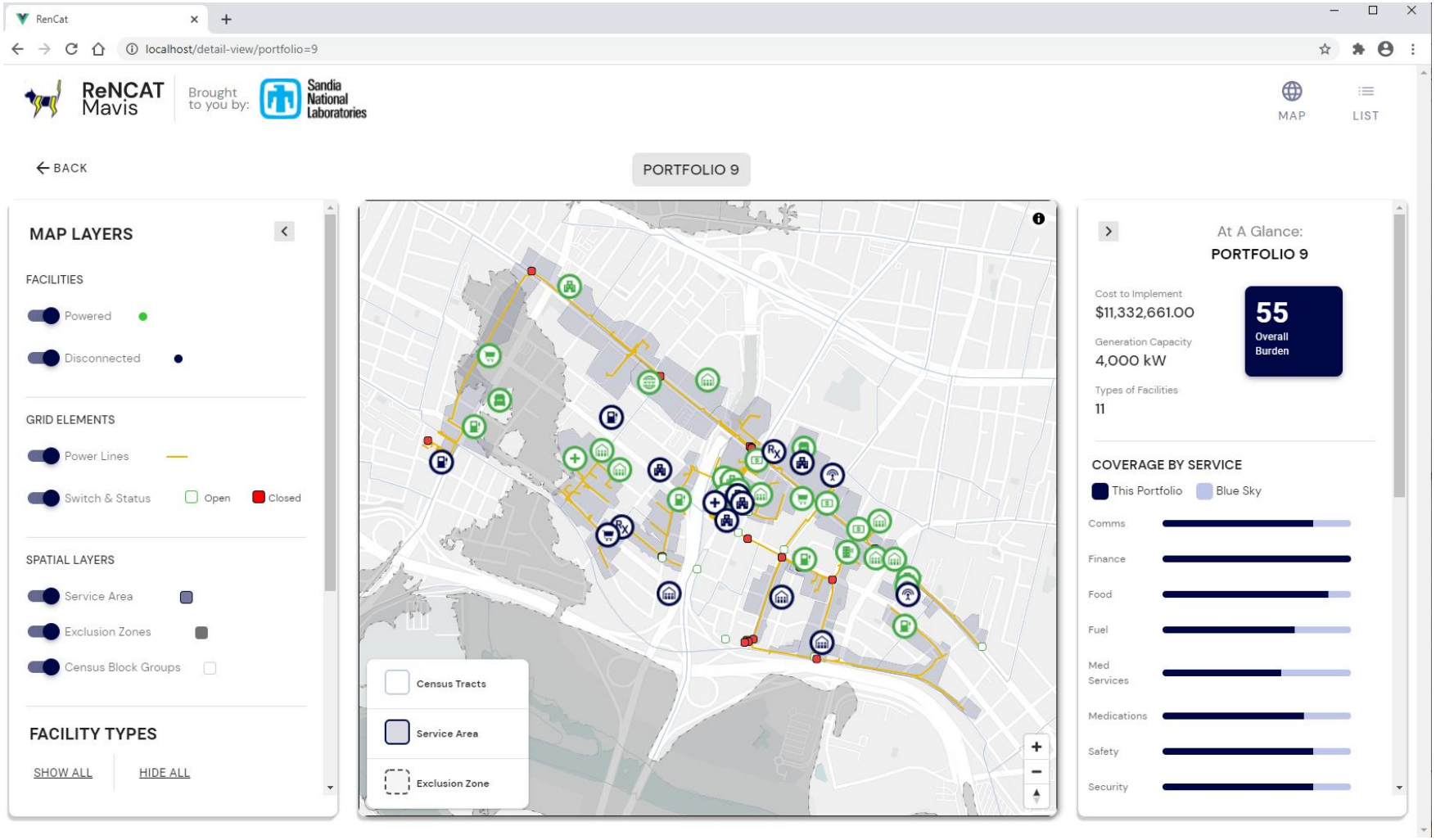


Jeffers et al. (2018) Analysis of Microgrid Locations Benefitting Community Resilience for Puerto Rico. SAND2018-11145

Social Burden Applied to Grid Planning

Resilience Node Cluster Analysis Tool (ReNCAT)

- Uses genetic algorithm to site and size resilience solutions across a broad landscape
- Creates portfolios of resilience solutions that optimize for social burden vs. cost
- Outage-induced risk is explicitly considered
- Grid and other critical infrastructure are explicitly modeled

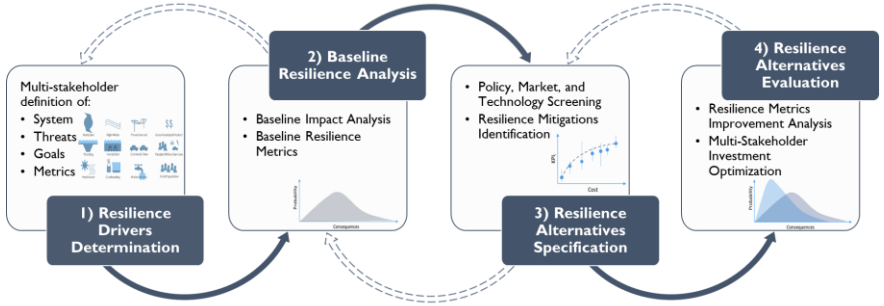


Validating, Applying, Socializing

Validate

1. **Data**: Do we have the data to calculate social burden ex post?
2. **Surveying**: What data can we receive directly from those impacted?
3. **Mod/Sim**: Improve connection between theory and calculation

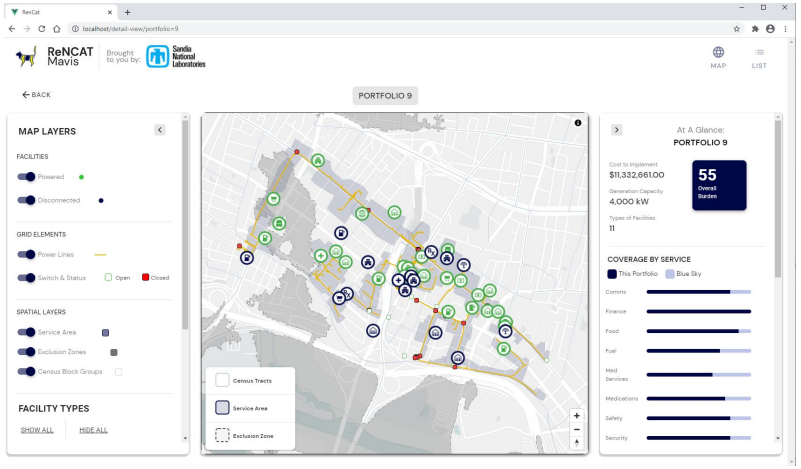
Socialize



DRC Stakeholder Advisory Group:

- New York + ConEd
- Los Angeles + LADWP
- Norfolk + Dominion Energy
- Boston + Eversource
- Honolulu + HECO
- San Antonio + CPS Energy
- National Association of Utility Regulatory Commissioners (NARUC)

Apply



Current:
Puerto Rico (3 x)
San Antonio

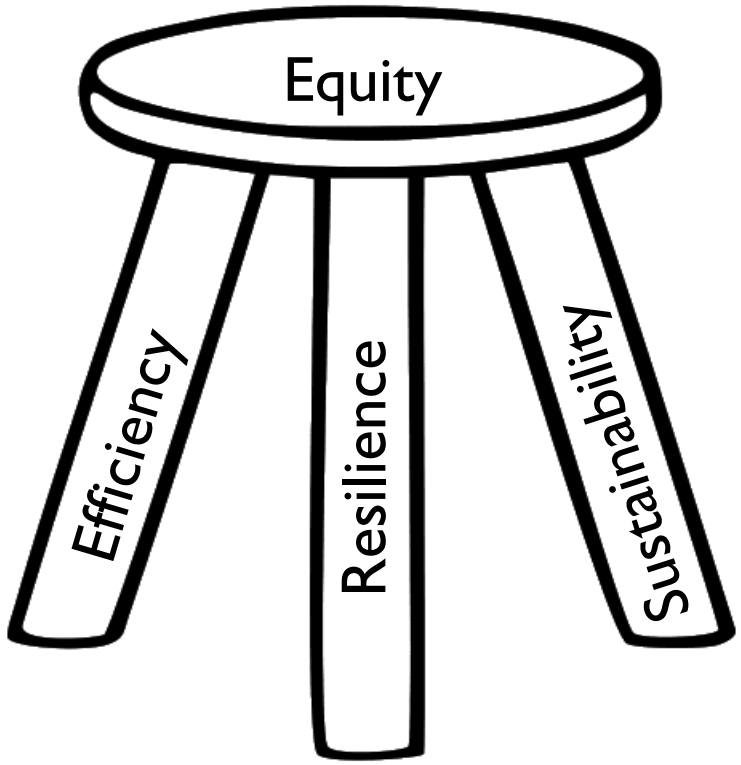
Future:
Texas
Colorado Springs

Resilience is a component of equity

Acute Social Burden

Energy Burden,
Chronic Social Burden,
…

Equitable access to clean energy solutions,
Chronic environmental injustices,
…



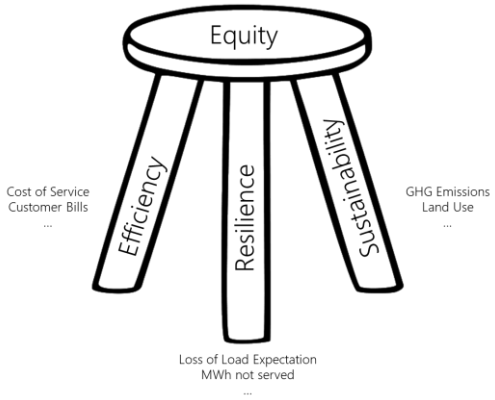
Cost of Service,
Customer Bills
…

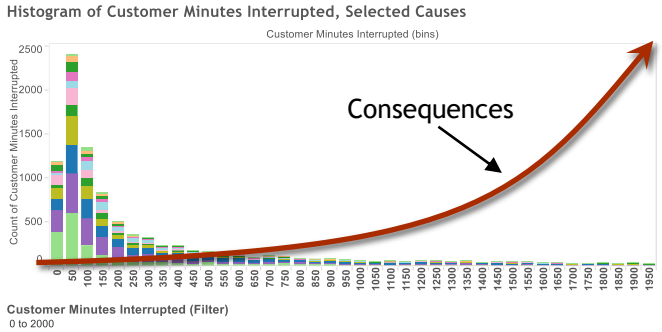
GHG Emissions,
Land Use
…

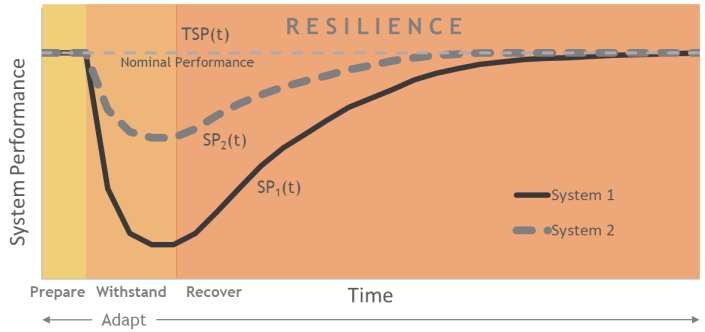
Loss of Load Expectation
MWh not served
…

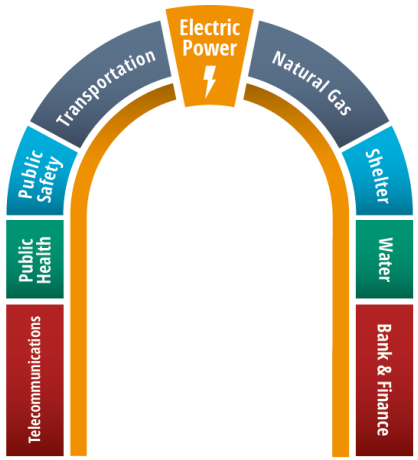
Thank You!

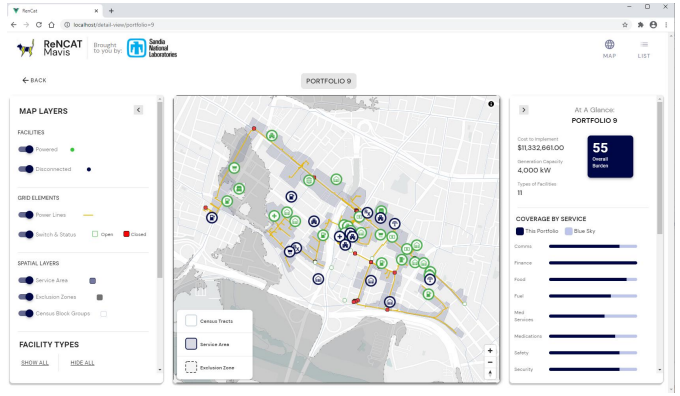
rfjeffe@sandia.gov











That was…

Robert “Bobby” Jeffers

SANDIA

Up next…

Jennifer “Jenn” Kallay

SYNAPSE ENERGY ECONOMICS

Regulatory Mechanisms to Enable Investments in Electric Utility Resilience

Regulators' Financial Toolbox: Resilience Technologies

NARUC Center for Partnerships and Innovation

August 25, 2021

Jennifer Kallay
Synapse Energy Economics
jkallay@synapse-energy.com

 |

Designing Resilient Communities (DRC): A Consequence-Based Approach for Grid Investment

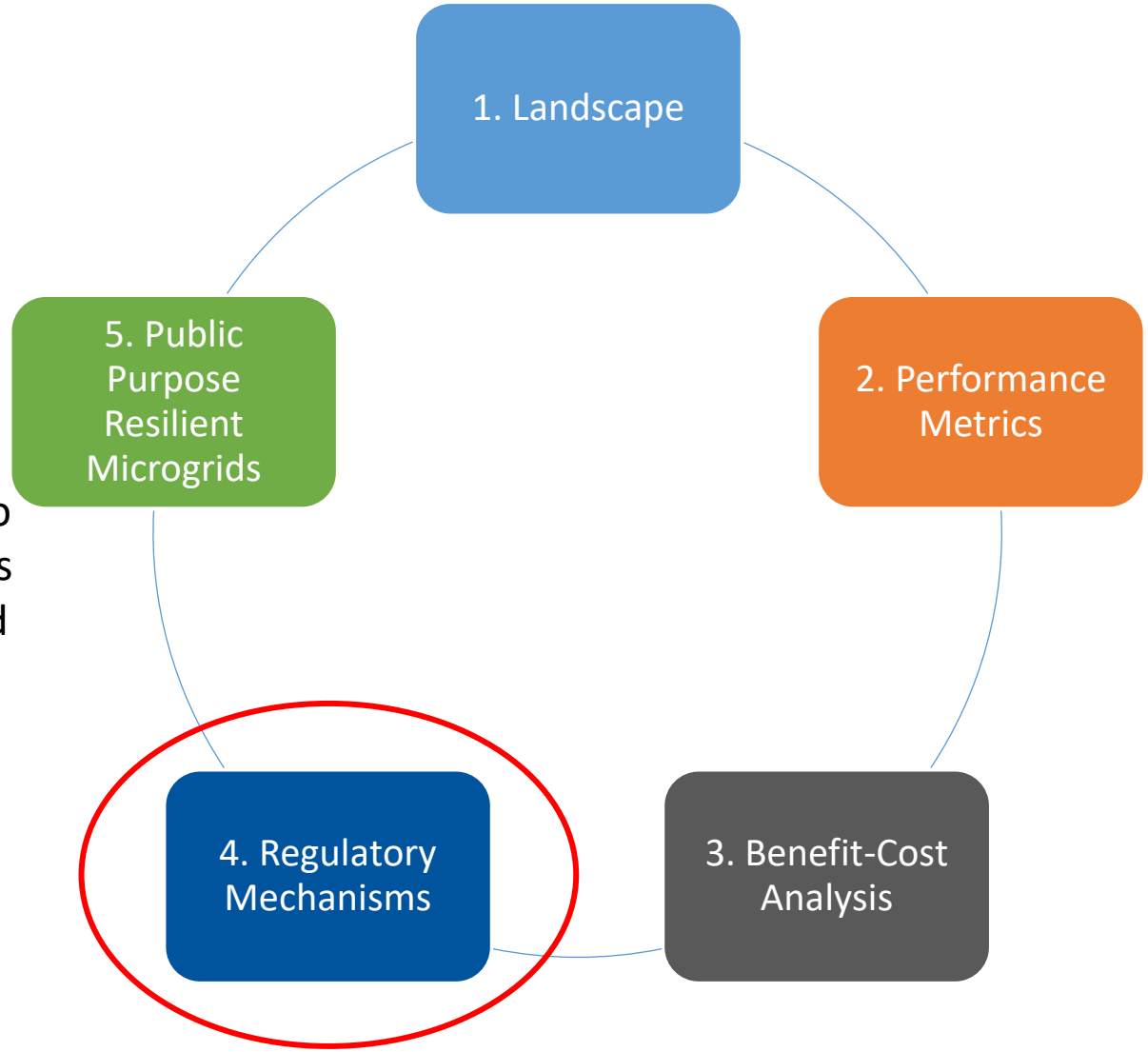
Improve the integration of community energy and electric utility resilience planning

- Understand the challenges and opportunities experienced by communities and electric utilities coordinating energy-related resilience efforts
- Inform better coordination of community and utility resilience efforts moving forward, with a focus on how to best engage with utilities and utility regulators

Synapse Energy Economics Role

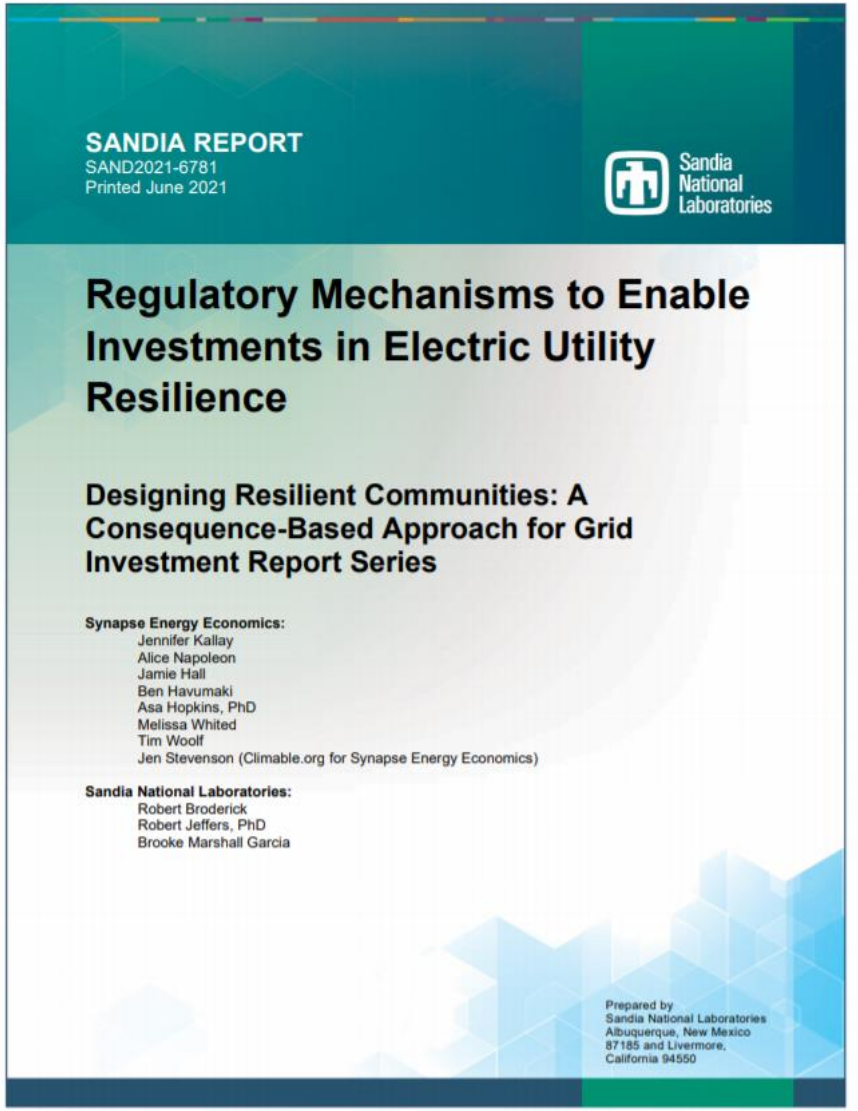
Five interrelated reports focused on important topic areas

- All reports discuss how regulators, utilities, communities, and other stakeholders can work together to advance investments that can achieve grid resilience, among other goals.



Today's Focus

Regulatory Mechanisms to Enable Investments in Electric Utility Resilience report, available at: https://www.synapse-energy.com/project/improving-electric-utility-and-community-grid-resilience-planning



Purpose of the Report

Cost-of-service regulation may fail to provide utilities with adequate guidance or incentives regarding community priorities for infrastructure hardening and disaster recovery. The application of other types of regulatory mechanisms can help.

This report:

- characterizes regulatory objective as they apply to resilience;
- identifies several regulatory mechanisms that are used or can be adapted to improve the resilience of the electric system;
- provides a case study of each regulatory mechanism;
- summarizes findings across the case studies; and
- suggests how these regulatory mechanisms might be improved and applied to resilience moving forward.

Regulatory Objectives

Continuity of Electric Service

Reasonable Rates

Customer Equity

In the Public Interest

Measured and Measurable

Regulatory Mechanisms

- Mechanisms that electric utility regulators can use to align utility, customer, and third-party investments with resilience interests and priorities include:
  - Performance-based regulation (Hawaii),
  - Integrated planning (Puerto Rico),
  - Tariffs and programs to leverage private investment (Vermont),
  - Alternative lines of business for utilities (Vermont),
  - Enhanced cost recovery (New Jersey), and
  - Securitization (California).

Findings

- Application of regulatory mechanisms to resilience investments is in the early stages and there are few case studies
- Mechanisms are not currently structured or applied to effectively address resilience as resilience is not a primary goal.
- As currently implemented, each mechanism has shortcomings and therefore may not enable full resilience investments. With improvement, these regulatory mechanisms have the potential to address resilience goals.
- Jurisdictions will likely use different regulatory mechanisms to achieve their resilience goals.
- Multiple approaches may need to be implemented together to address resilience more fully.

Case Study: Performance-Based Regulation in Hawaii

- Resilience events: Many threats, frequent
- Goals: Advance grid transformation through promotion of renewable and distributed generation/policy goals include resilience (1 of 12 goals)
- Components:
  - Integrated grid planning process (IGP),
  - Multiyear rate plan (MRP),
  - Revenue decoupling,
  - Performance metrics and earnings-sharing mechanism,
  - Cost recovery mechanism for exceptional investments (Major Project Interim Recovery or MPIR), and
  - Microgrid services tariff.

Case Study: Performance-Based Regulation in Hawaii (cont'd)

- Potential areas for monitoring/improvement:
  - Many policy goals articulated but unclear how policy goals will be addressed/prioritized by the utility
  - No performance metrics to improve resilience
  - Little scrutiny of utility spending by regulators
  - Not clear the extent to which MPIR will encourage resilience investments
  - No focus on critical customers

Case Study: Energy Storage Tariffs in Vermont

Bring Your Own Device (BYOD) tariff (owner: third party or customer)

Energy Storage System (ESS) tariff (owner: utility)

- Resilience events: Fewer threats, less frequent
- Goals: Reduce peak demand-related utility costs (GMP has access during peak times)/provide customers with backup power during outages
- Incentives: Scale with capacity and for customers in constrained areas (for BYOD only)
- Potential areas for monitoring/improvement:
  - Incentive caps at 10kW per customer limit participation to smaller, residential customers
  - No requirement for distributed generation
  - No islanding requirement
  - No focus on critical customers
  - No performance metrics to improve resilience

That was…

Jennifer “Jenn” Kallay

SYNAPSE ENERGY ECONOMICS

Up next…

Leuwam Tesfai

CALIFORNIA PUBLIC UTILITIES COMMISSION

Microgrids in California

Regulator's Financial Toolbox: Resiliency Technologies

Leuwam Tesfai – Chief of Staff to Commissioner Shiroma | California Public Utilities Commission

August 2021

California Public Utilities Commission

Microgrids in California: Regulator's Toolbox

California Case Study

1

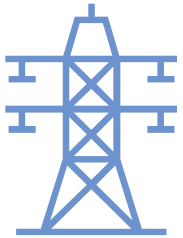
CPUC's approach to understanding microgrid technology

2

Regulatory treatment Options

3

Lessons learned on supporting resiliency



CPUC's approach to understanding microgrid technology

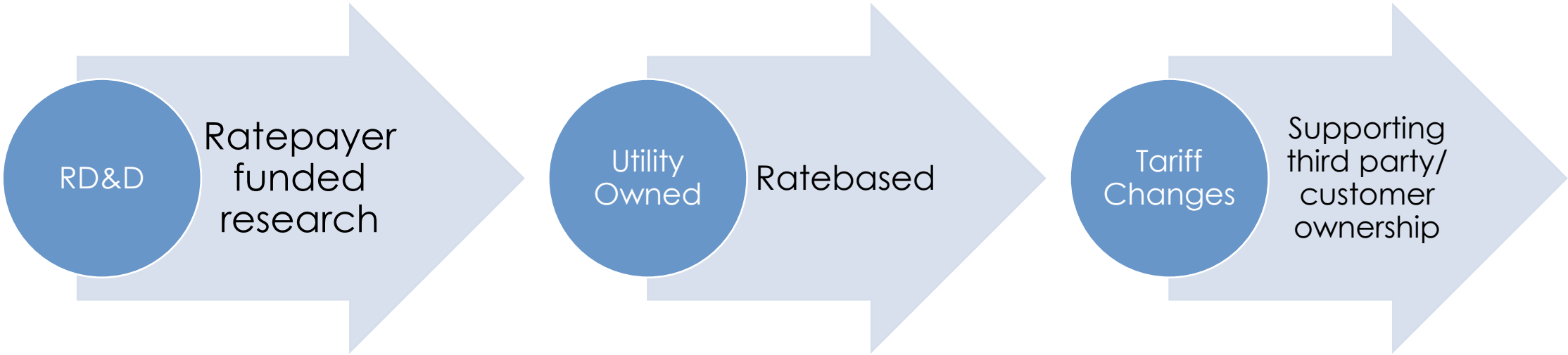
R&D

Formal Proceeding

National Labs & State Working Groups

Staff Working Groups

Regulatory Treatment Options



Lessons Learned: Microgrids for Supporting Resiliency

Leveraging R&D microgrids in real world scenarios

Deploying back up power to create microgrids to support substations

Transitioning to clean microgrids to support substation resilience & disadvantaged communities

California Public Utilities Commission

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That was…

Leuwam Tesfai

CALIFORNIA PUBLIC UTILITIES COMMISSION

Q & A

Thank you!

WWW.NARUC.ORG/CPI