Performance-Based Regulation State Working Group (PBRSWG)
June Virtual Meeting
Performance Incentive Mechanisms (PIMs) for Resilience

Speaker Bios and Presentations

Moderator: Commissioner Michael T. Richard, Maryland Public Service Commission

Michael T. Richard was first appointed to the Maryland Public Service Commission in January 2016 and reappointed in 2020. Prior to his appointment, he served as Deputy Chief of Staff to Governor Larry Hogan, advising the Governor on a portfolio of issues and helping to manage cabinet agencies that included Agriculture, Energy, Environment, Lottery and Gaming, Natural Resources and Transportation.

Commissioner Richard worked for more than 10 years at the Nuclear Energy Institute as Legislative Programs Director and Congressional Information Program Director. He then served in Governor Robert Ehrlich's administration as Deputy Secretary of Appointments and as Director of the Maryland Energy Administration.

In 2005, he was appointed to a post at the U.S. Department of Energy—first serving as Executive Director of the Secretary of Energy Advisory Board and later as Deputy Assistant Secretary for Congressional and Intergovernmental Affairs where his issues included nuclear energy, radioactive waste management, and legacy environmental remediation. In 2008, Commissioner Richard was hired by Westinghouse Electric Company as Director of Government and International Affairs. He rejoined Maryland state government in 2015.

Commissioner Richard is a past President of the Organization of PJM States, Inc. (OPSI) and currently serves as its Treasurer, is a member of the Committee on Energy Resources and the Environment for the National Association of Regulatory Utility Commissioners (NARUC), and was appointed by Governor Hogan as the Commission's representative on the Washington Metropolitan Area Transit Commission (WMATC), where he serves as Vice-Chairman.

Commissioner Richard earned his B.A. from Brigham Young University in Provo, Utah, and an M.B.A. from the University of Maryland, College Park. He attended a French language program at L'Université Laval in Québec City, Canada.

Commissioner Lillian Mateo Santos, Esq., Puerto Rico Energy Board

Lillian Mateo-Santos obtained her Bachelor's Degree in Business Administration from the University of Puerto Rico, Río Piedras Campus, in 1993 and a Juris Doctor degree from the University of Puerto Rico School of Law in 1996. In 1999, she obtained a degree of Masters of Laws (LLM) in Environmental and Energy of the Tulane University Law School. Before joining the Puerto Rico Energy Bureau, Ms. Mateo-Santos was a member of various law

firms. Her private practice was focused on energy, environmental, land use and permitting matters, including administrative law litigation.

On June 5, 2019, Ms. Mateo-Santos was elected 2nd Vice President of the Southeastern Association of Regulatory Utility Commissioners (SEARUC). She is a member of the American Bar Association and is admitted to practice law and notary law in Puerto Rico, and the United States Court of Appeals for the First Circuit.

Mark Newton Lowry, PhD, President, Pacific Economics Group

Mark Newton Lowry, President of PEG Research, has more than thirty years of experience as an industry economist. Best known for his work on the economics of energy utilities, his specialties include performance-based regulation ("PBR"), other alternatives to traditional rate regulation ("Altreg"), and statistical research on utility performance. A focus of his current work is the role that PBR can play in regulating the electric "utility of the future." He recently authored two white papers on this topic for Lawrence Berkeley National Laboratory.

In addition to his managerial responsibilities, Dr. Lowry supervises empirical research on utility performance and industry price and productivity trends, designs Altreg mechanisms, and gives expert witness testimony. He has testified dozens of times on Altreg and his utility performance research. His testimony has featured path-breaking applications of production economics in the regulatory arena.

His practice is multinational in scope and has included dozens of projects in Canada, where PBR is used in most populous provinces. He can assist clients in French and Spanish as well as his native English.

Work for diverse clients has given his practice a reputation for objectivity and dedication to good regulation. He has for many years advised the Edison Electric Institute on Altreg issues and leads a Regulatory Strategy workshop at EEI's Advanced Rates Course. He has advised regulators in Australia, Canada, and Latin America.

Dr. Lowry was previously a Vice President at Christensen Associates. He also taught energy economics as an Assistant Professor at the Pennsylvania State University and was a Visiting Professor at l'Ecole des Hautes Etudes Commerciales in Montréal. His research and teaching featured the use of mathematical theory and econometrics in industry analysis.
A northeast Ohio native, Mark attended Princeton University and holds a BA in Ibero-American Studies and a Ph.D. in applied economics from the University of Wisconsin. He has authored numerous professional publications and chaired many conferences on Altreg and benchmarking.

David Littell, Esq., Senior Advisor with Regulatory Assistance Project, Bernstein Shur and former Commissioner at the Maine PUC

David Littell brings more than 25 years of regulatory experience to RAP. He provides advice to state officials, public utility commissions, and environmental regulators on complex energy, pollution, and economic issues. These include renewable resources and integration, demand response, energy efficiency and renewable portfolios, rate-making and rate design, economic assessment of energy and environmental resources, power, transmission, and non-transmission alternatives, as well as innovative approaches to air, water, land, and cross-media pollution.

From 2010 through 2015, Mr. Littell served as a commissioner of the Maine Public Utilities Commission, participating in the resolution of more than 2,000 cases involving energy efficiency, distributed generation, rate-making, rate design, and consumer protection issues. During his tenure, he became the longest-serving officer of the Regional Greenhouse Gas Initiative (RGGI) and served as vice-chairman of the National Association of Regulatory Utility Commissioners' Task Force on Environmental Regulation and Generation. Mr. Littell previously served as commissioner (2005 through 2010) and deputy commissioner (2003 through 2005) of the Maine Department of Environmental Protection, where he established RGGI, oversaw Maine's greenhouse gas reduction initiatives, energy and industrial permitting, wildlife habitat protection, and toxics reduction initiatives. As environmental commissioner, he oversaw approval of more energy and economic investments in the State than any previous time period in the state's history.

During his 12 years of public service, Mr. Littell chaired the New England Governors' Committee on the Environment and co-chaired the New England Governors and Eastern Canadian Premiers' Committee on the Environment. He also represented Maine on the Eastern Interconnection States' Planning Council (EISPC) and chaired the EISPC Energy Zones Workgroup that identified clean energy resource zones and sensitive bird and wildlife and ecological areas in 38 U.S. states. Mr. Littell also served on the board of the National Regulatory Research Institute, chaired the Environmental Council of the States' Cross-Media Committee, and served for five years on the executive board of The Climate Registry.

Mr. Littell is also a shareholder at Bernstein, Shur based in Portland, Maine where he advises clean energy, renewable, merchant and distributed resource clients on regulatory matters. From 1994 through 2003, he was an intelligence officer in the U.S. Navy Reserves, resigning his commission as Lieutenant Commander. Mr. Littell holds a law degree from Harvard Law School and a bachelor's degree from Princeton. He was named a Distinguished Policy Scholar by the University of Maine in 2010.

Performance Incentive Mechanisms (PIMs) for Resilience

NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS

CENTER FOR PARTNERSHIPS AND INNOVATION

PERFORMANCE-BASED REGULATION STATE WORKING GROUP

JUNE 24, 2021

About the PBRSWG and NARUC

- **The Performance-Based Regulation State Working Group is facilitated by the National Association of Regulatory Utility Commissioners' Center for Partnerships and innovation (NARUC CPI).**

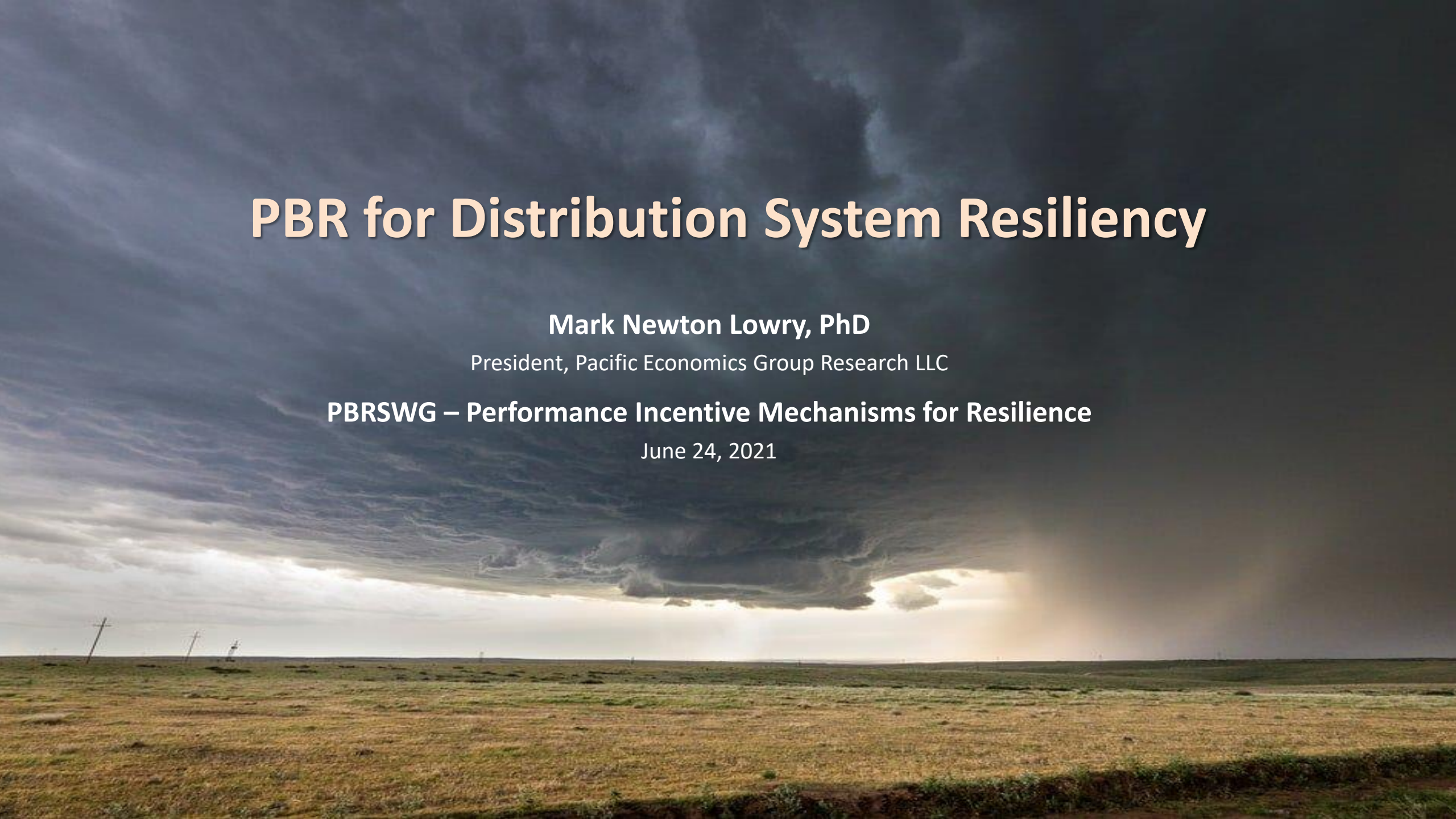
- **NARUC CPI thanks the US department of Energy for their ongoing support.**

- **Materials are posted to the CPI website at https://www.naruc.org/cpi-1/electricity-system-transition/valuation-and-ratemaking/**

Hon. Michael Richard

Commissioner at the Maryland Public Service Commission

Mark Lowry, PhD
Pacific Economics Group



PBR for Distribution System Resiliency

Mark Newton Lowry, PhD

President, Pacific Economics Group Research LLC

PBRSWG – Performance Incentive Mechanisms for Resilience

June 24, 2021

Introduction

Resilience is the susceptibility of a system to major unplanned service disruptions that are triggered by extraordinary events

Resiliency of distribution systems concerns many US regulators today

- Risk of severe storms, wildfires, and cyberattacks is mounting
- Some utilities have unusually old systems and/or chronically poor reliability that makes them more vulnerable to catastrophes
- Need for resiliency grows as the economy becomes more digitalized and climate-neutral

This presentation briefly discusses how PBR can encourage better resiliency management

Resiliency Issues

Resiliency regulation raises many issues

- How resilient are our utilities?
- What is the least cost way to improve resiliency?
- Is better resiliency worth the incremental cost?
- How best to fund resiliency improvements?
- Was resiliency campaign successful?
    - How much did resiliency improve?
    - Was its cost reasonable?

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Tools Available to Regulate Resiliency

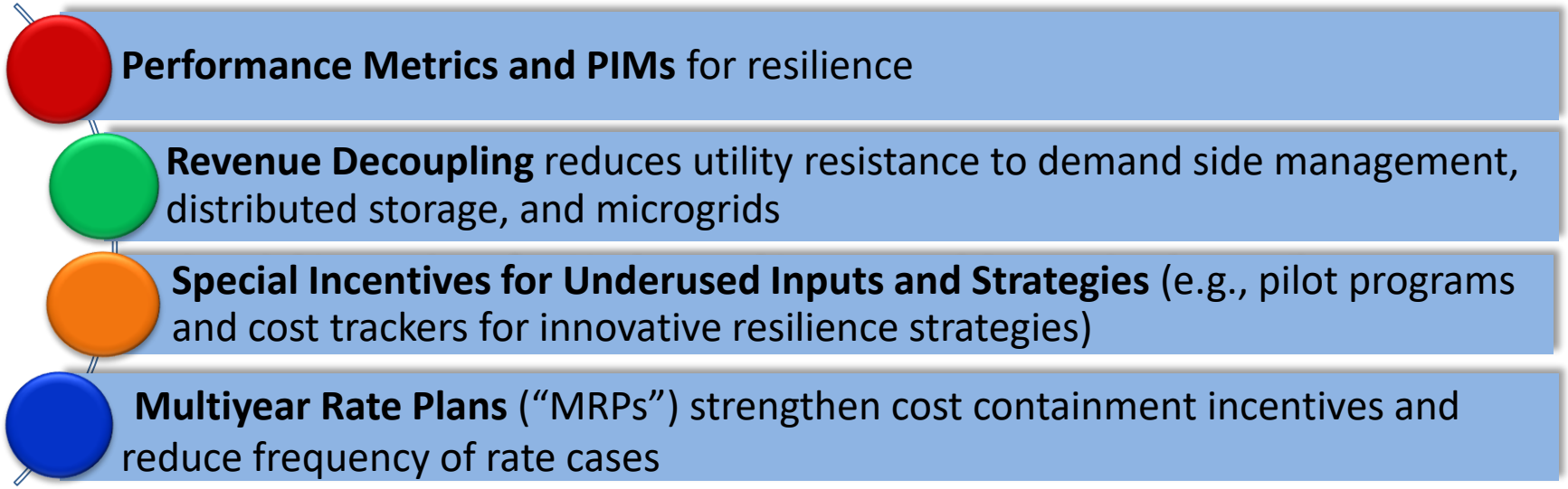
Traditional Rate Cases and Prudence Reviews

Grid Planning

Alternative Regulation ("Altreg") Options

Cost Trackers

PBR options: Forms of Altreg that use incentives to encourage better performance



Resiliency Metrics

Numerous recent studies of resiliency metrics

Performance Metrics				*Attribute* Metrics				
Outputs		Consequences		System Attributes that Affect Resiliency		Cost-Effective Practices to Achieve Resiliency		
Numbers and types of customers affected by outages	Duration of their outages	Economic	Safety etc.	Under grounding	Asset health etc.	Planning	Response	Recovery etc.

Resiliency Output Metrics

Resiliency is chiefly a matter of outage *duration and prevalence,* so measures like SAIDI are pertinent

Overall Reliability

	Normal Reliability	Resiliency
Scope	Ordinary Operating Conditions	Extraordinary Conditions
Metrics	$SAIDI^{No\ MED}$	$SAIDI^{MED}$ (e.g. STAIDI)

SAIDI (System Average Interruption Duration Index) = Customer Minutes of Interruption/Total Customers
STAIDI = "Storm SAIDI"
MED = major event day

Resilience is especially important for critical services (e.g., hospitals, IN-N-OUT BURGER)

Resiliency PIM Design

Need for resiliency PIMs bolstered by multiyear rate plans

Several potential approaches to resiliency PIM design

Focus on *outputs* e.g., ($SAIDI^{MED}$, $SAIDI^{No\ MED}$) *All* services

($SAIDI^{MED}$, $SAIDI^{No\ MED}$) *Essential* services

- Outputs are what ultimately matter
- Utility freed to choose cost-effective solutions

Focus on good resiliency management *attributes*

Resilient system characteristics (e.g., asset health)

Good O&M practices (e.g., best practice scorecards for grid planning, emergency preparedness)

Focus on *programs*

e.g., Utilities awarded 5% of estimated net benefits from resiliency campaign

Reliability Output PIMs

Reliability output PIMs are common in multiyear rate plans

A typical PIM adjusts revenue (or earnings) to penalize utility for bad performance using reliability output metrics (e.g. SAIDI)[1]

e.g.,

$$Revenue\ Adjustment = \alpha\, x\, (SAIDI^{Actual} - SAIDI^{Target})$$

where

α = award/penalty rate

These PIMs often have a "deadband" where revenue isn't affected by small SAIDI variances

[1] Reliability PIMS may also reward good performance

Reliability Output PIMs (cont'd)

Difficult to establish good targets for resiliency "output" PIMs since outage duration depends on many external business conditions, some of which are hard to measure

In developing SAIDI benchmarking models, PEG has studied impact of these conditions on duration of normal outages

- Normal Business Conditions
  - Extent of distribution system overheading
  - Ruralness, forestation, and typical weather in service territory
- Major events
  - Nature (e.g., hurricane, ice storm, wildfire, or cyberattack?)
  - Severity

Reliability also depends on the age and cost of distribution system

Older, less costly systems less likely to have good resiliency

Conclusions

PIMs are one implement in a toolkit for regulating resiliency which also includes…

- traditional prudence reviews
- other PBR tools
- grid planning

Resiliency output PIMs are problematic

Practical alternatives include…

- Basing PIMs on alternative (e.g. attribute) metrics
- Relying on resiliency metrics without PIMs
- Establishing duration PIMs for normal operating conditions (e.g., $SAIDI^{No\ MED}$)

Further research and experimentation on resiliency metrics needed

Appendix

Many Ways to Maintain/Improve Resiliency

Grid improvements

- Harden system (e.g., increase undergrounding)
- Replace unreliable assets
- Acquire smart grid hardware and software

Improve O&M (e.g., vegetation management, inspections, system analysis, maintenance, and outage response)

More backups to grid service (e.g., distributed storage and microgrids)

PBR For System Resiliency

PBR can encourage resiliency in many ways

- Resiliency metrics and PIMs
- Special incentives to use disfavored resiliency inputs (e.g., pilot programs & cost trackers for innovative resiliency strategies)
- Revenue decoupling encourages utilities to embrace DSM, distributed storage & microgrids
- Multiyear rate plans
  - Can include resiliency PIMs and decoupling
  - Add “pop” to special incentives for underused resiliency inputs and strategies
  - Infrequent rate cases free up regulatory resources to better consider resiliency (e.g., grid planning) issues
  - Better cost management ameliorates rate impact of resiliency campaign

Funding accelerated capex is *major* issue in MRP design

Illustrative SAIDI Benchmarking Model from PEG

Dependent Variable
SAIDI without MED or loss of supply, IEEE standard

VARIABLE KEY

PCTOH = Percent of Distribution Plant Overhead
AREA = Total Service Territory Area
SUMMER = Summer Weather Severity
FORESTATION = Percent of Service Territory Forested
ELEVATION = Standard Deviation of Elevation in Service Territory
PCTAMI = Percent of Customers with Automated Metering Infrastructure
Trend = Time Trend

EXPLANATORY VARIABLE	PARAMETER ESTIMATE	T-STATISTIC	P-VALUE
PCTOH	1.985215	72.388	0.0000
AREA	0.077304	19.01	0.0000
SUMMER	0.021975	6.771	0.0000
FORESTATION	0.065147	2.272	0.0237
ELEVATION	0.044626	8.449	0.0000
PCTAMI	0.05463	3.03	0.0026
Trend	0.009424	2.536	0.0116
Constant	4.574717	1.797	0.0732
Rbar-Squared		0.354	
Sample Period		2013-2019	
Number of Observations		370	

NOTES:

Model developed by PEG Research LLC with EIA 861 data

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About Dr. Lowry

- President, Pacific Economics Group Research LLC
- Active in PBR since 1989
- Specialties: PBR mechanism design, input price and productivity research, statistical benchmarking of cost and reliability, expert witness testimony
- Former Penn State University energy economics professor
- PhD Applied Economics, University of Wisconsin

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June 24, 2021

Performance-Based Regulation for Resilience

NARUC

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Overview

- Performance-based regulation background
- Need to define what the goal is, only then to performance criteria, and then how to measure in metrics
    - What do we mean by resilience?
    - Set the goal and the performance criteria (expectation)
    - Metrics follow to measure progress to goal(s)
    - Performance incentives come later
- PBR for Resilience: State examples represent leading thinking

1 Performance-Based Regulation Basics

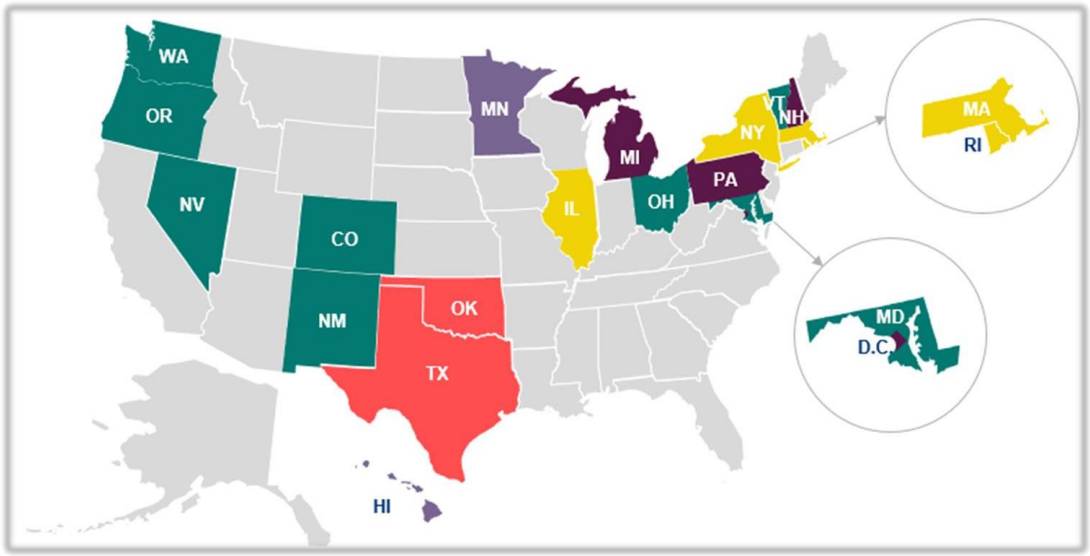
Performance-based regulation (PBR) is…

- A regulatory framework to connect achievement of specified objectives to utility financial performance and executive compensation
- A PBR plan can include a collection of **performance incentive mechanisms (PIMs)**, namely, metrics and formulas that determine the levels of financial rewards or penalties (i.e., adjustments to allowed revenues) for achievement of the specified objectives

States' progress in grappling with PBR is uneven

Various combinations of drivers are advancing PBR in 19 states and D.C.

- **Early Exploration:** Initial inquiries often marked by a report examining PBR options
- **Initial Stakeholder Engagement:** Soliciting comments and/or conducting workshops assessing PBR options
- **Advanced Stakeholder Engagement:** Soliciting comments and/or conducting workshops in discussing specifics of PBR options
- **Implementation:** Decisions have been made or are close to being made to deploy PBR options
- **Conclusion of Inquiry:** Decisions have been made not to consider the PBR framework



Source: EnerKnol and Wood Mackenzie Power & Renewables; Tracking of the proceedings available on the EnerKnol Platform

Set guiding goals

Photo: Heidi Sandstrom

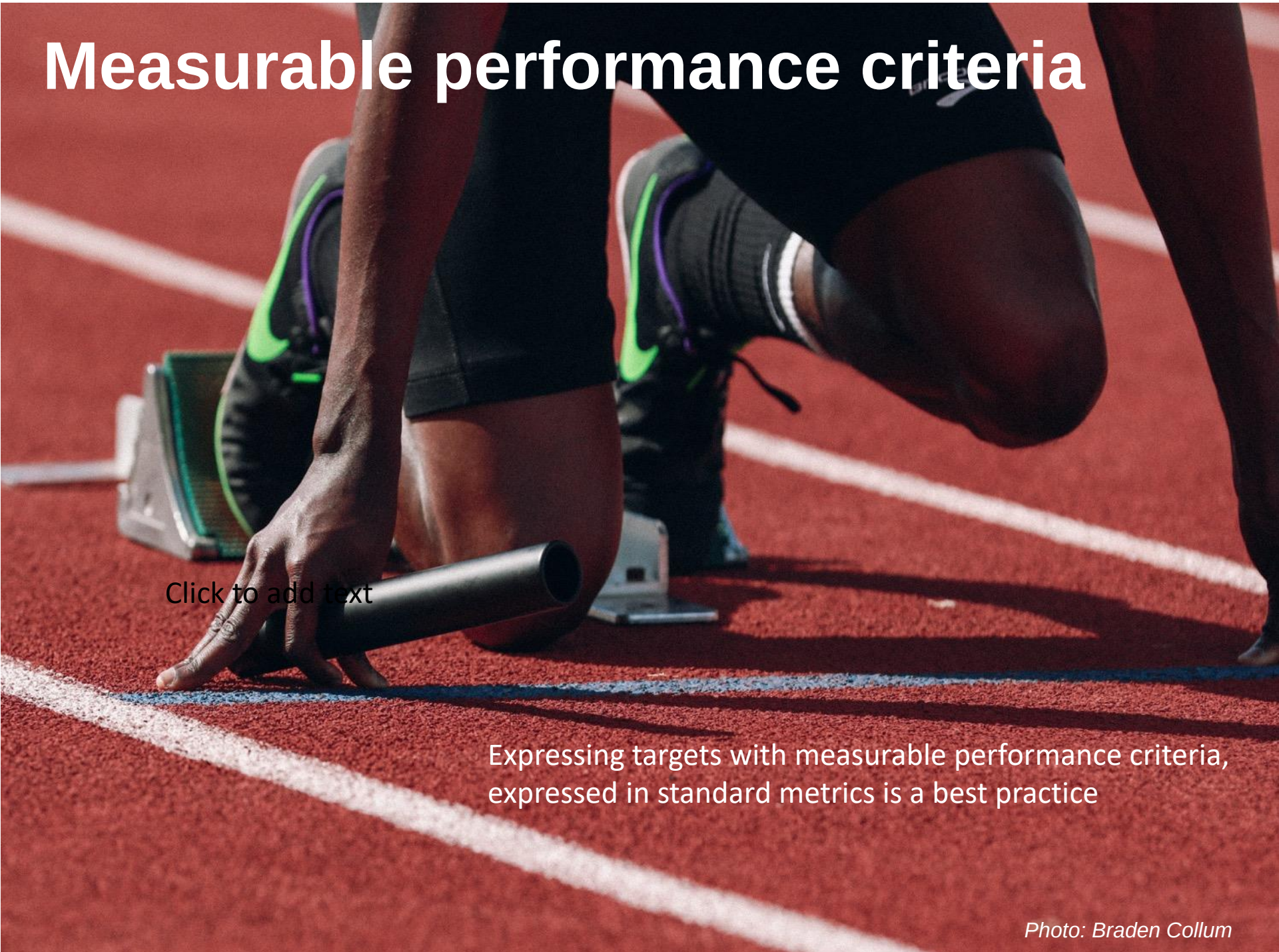
From the goals consider performance criteria (directional targets)

Guiding goal: improve distribution system reliability

Directional target: 5% improvement in SAIFI from baseline value

Photo: Shirley Niv Marton

Measurable performance criteria



Click to add text

Expressing targets with measurable performance criteria, expressed in standard metrics is a best practice

Photo: Braden Collum

Metrics

- Quantifiable measure of a specified performance
- Typically expressed as standard **power system measures** or **consumer impact measures**

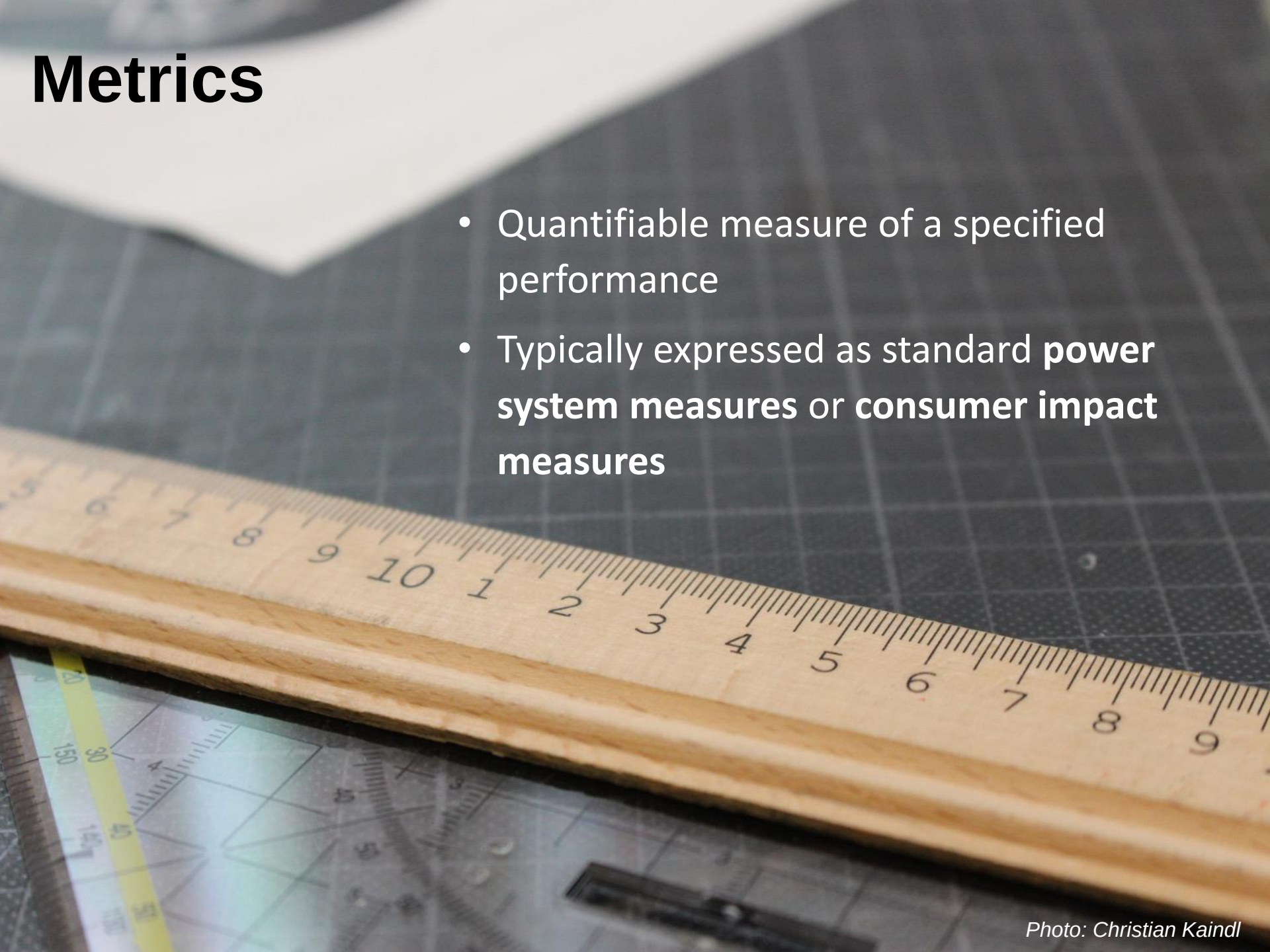


Photo: Christian Kaindl

Performance criteria to metrics

- Quantifiable measure of a specified performance
- Typically expressed as standard **power system measures** or **consumer impact measures**
- Examples:
  - Customer minutes with electricity during outage
  - Time to restore x% of customers following outage
  - SAIDI / CAIDI / during outages
  - Critical service without power

Photo: Christian Kaindl

What form of performance-based regulation is right for the situation? Where to start?

Public Metrics Only

- Metrics are publicized on a publically available "dashboard."
- Examples: HI Renewable Energy Performance Metrics, HI Solar DG distribution, Puerto Rico Customer Satisfaction, Illinois Response Times report metric

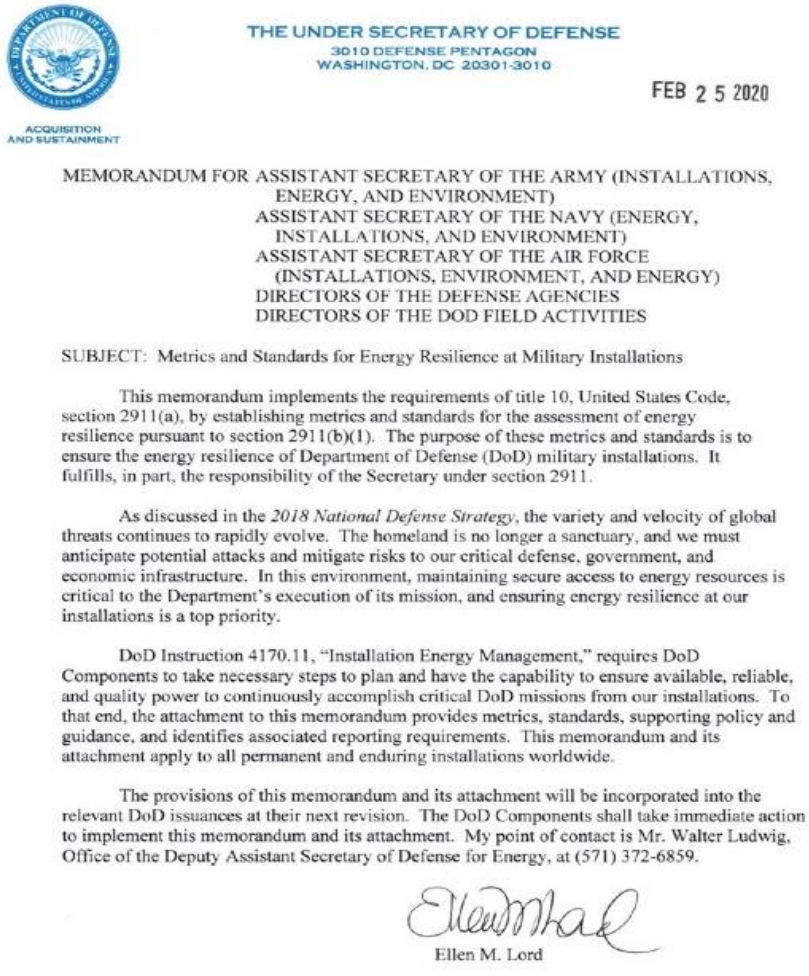
Public Metrics with Ranking

- Metrics are publicized and ranked
- Examples: Denmark DSO efficiency ranking, RIIO

Public Metrics with Financial Incentives

- Metrics are publically available, and utilities receive financial awards or penalties depending on achievement of the metrics.
- Examples: NY REV

U.S. DOD Metrics and Standards for Resilience at Military Installations



THE UNDER SECRETARY OF DEFENSE
3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

ACQUISITION AND SUSTAINMENT

FEB 25 2020

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, ENERGY, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY (ENERGY, INSTALLATIONS, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATIONS, ENVIRONMENT, AND ENERGY)
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: Metrics and Standards for Energy Resilience at Military Installations

This memorandum implements the requirements of title 10, United States Code, section 2911(a), by establishing metrics and standards for the assessment of energy resilience pursuant to section 2911(b)(1). The purpose of these metrics and standards is to ensure the energy resilience of Department of Defense (DoD) military installations. It fulfills, in part, the responsibility of the Secretary under section 2911.

As discussed in the *2018 National Defense Strategy*, the variety and velocity of global threats continues to rapidly evolve. The homeland is no longer a sanctuary, and we must anticipate potential attacks and mitigate risks to our critical defense, government, and economic infrastructure. In this environment, maintaining secure access to energy resources is critical to the Department's execution of its mission, and ensuring energy resilience at our installations is a top priority.

DoD Instruction 4170.11, "Installation Energy Management," requires DoD Components to take necessary steps to plan and have the capability to ensure available, reliable, and quality power to continuously accomplish critical DoD missions from our installations. To that end, the attachment to this memorandum provides metrics, standards, supporting policy and guidance, and identifies associated reporting requirements. This memorandum and its attachment apply to all permanent and enduring installations worldwide.

The provisions of this memorandum and its attachment will be incorporated into the relevant DoD issuances at their next revision. The DoD Components shall take immediate action to implement this memorandum and its attachment. My point of contact is Mr. Walter Ludwig, Office of the Deputy Assistant Secretary of Defense for Energy, at (571) 372-6859.

Ellen M. Lord

Attachment:
As stated

2 What is “Resilience”?

Regulators cannot set the goals, performance expectations, and metrics if the system resilience we seek is only vaguely understood.

Resilience

The ability of energy systems & operations to minimize service interruptions during extraordinary events and threats

- Robustness against threats and disruptions
- Ability to recover from disruptions
- Ability to continue operations during extraordinary events, threats and disruptions
- Ability to adapt operations and modify the system to continue service

Resilience Definitions: Whose Resilience? Whose perspective?

Customer Abilities

- Customer ability to operate and maintain life functions when grid is down
  - Residential
  - Commercial
  - Industrial
  - Essential services: Hospitals, police, military

Grid Recovery

- Ability to recover from major event
  - Storm
  - Cyber event
  - Failure
  - Physical attack

Grid Ability to Withstand Events

- Reliability metrics in a major event, e.g., resilience through an event
  - Measure with major event exclusions
  - Measure “all-in”
  - Measure just during major events

Resilience Definitions: Scale(s) of Focus & Measurement: Goals, Criteria, Metrics

Customer	Grid	Microgrids
Residence • House with generator switch • Buildings Business Industrial/Military Facility	Transmission Distribution Both? Generation (EFORd) Whole grid, which grid(s)?	Microgrids fully grid connected Microgrids that can island (campuses) Operationally independent - grid backup/standby

3 Performance-Based Regulation For Resilience (and Reliability):

Maryland
Minnesota
North Carolina

Minnesota Reliability and Resilience Metrics

- System Average Interruption Duration Index (SAIDI)
- System Average Interruption Frequency Index (SAIFI)
- Customer Average Interruption Duration Index (CAIDI)
- **Customers Experiencing Long Interruption Duration (CELID)**
- **Customers Experiencing Multiple Interruptions (CEMI)**
- **Average Service Availability Index (ASAI)**
- **Equity – Reliability by geography, income, or other relevant benchmarks**
- Momentary Average Interruption Frequency Index (MAIFI)
- Power Quality

Source: C. Linville, M. Anderson, D. Littell, C. Kadoch, D. Farnsworth, Regulator Assistance Project. *Sharing the Good Stuff: Best Practices From Three Minnesota Initiatives* (June 2021): https://www.raponline.org/knowledge-center/sharing-good-stuff-best-practices-three-minnesota-initiatives/ , citing Minnesota Public Utilities Commission, Docket No. E-002/CI-17-401, Order on September 18, 2019, establishing performance metrics. https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7B0082456D-0000-CA1F9241-23A4FFF7C2FB%7D&documentTitle=20199-155917-01

Maryland Reliability and Resilience Metrics for Battery Pilots**pending @ MD PSC*

- **Customer resiliency**: Utilities will report the minutes of energy provided while grid power is unavailable (islanding) by energy storage assets. This quantification could lead to calculating the value to customers of having use of such necessities as lighting and refrigeration during major outage events.
- **Grid resiliency**: To help quantify the value of the energy storage assets to grid resilience, the utilities will report the amount of time (hours or days) for restoration of feeders/circuits and the entire grid after a major outage event.

Source: MD PSC, PC 44 (Case No. 9619), Submission of the PC44 Energy Storage Working Group, Maillog No. 234481 (March 31, 2021).

Maryland Reliability and Resilience Metrics for Battery Pilots**pending @ MD PSC*

- For traditional reliability metrics, the workgroup also recommended that the Maryland Utilities report on battery pilot metrics:
- System Average Interruption Duration Index (SAIDI) - no event exclusions
- System Average Interruption Frequency Index (SAIFI) - no event exclusions
- Momentary Average Interruption Frequency Index (MAIFI) – no exclusions
  - $MAIFI_E$ is the ratio of the total number of customer momentary interruption events divided by the total number of customers served, where E is equal to the number of interruption events

All "should be computed on the feeder(s) that are affected by the energy storage installation"

Source: MD PSC, PC 44 (Case No. 9619), Submission of the PC44 Energy Storage Working Group, pages 14-15, Maillog No. 234481 (March 31, 2021).

North Carolina DEQ Stakeholder Group

Outcome: Resilience

Preferred metrics:

- Number of critical assets (see note below) without power for more than N hours in a given region (# of assets), N may be set as 0 hours or greater than the number of hours backup fuel is available
- Critical asset energy demand not served (cumulative kW)
- Critical asset time to recovery (average hrs)

Alternative metric:

- Cumulative critical customer hours of outages (hrs)

Notes:

- Recommended metrics revolve around impacts on critical community assets since that is the framework used in the PARSG (Planning an Affordable, Resilient and Sustainable Grid) project and in the state Resilience Plan. This approach is also being integrated into the NARUC-NASEO comprehensive system action plan that the NC delegation is considering.
- Critical assets may include hospitals, fire stations, police stations, evacuation shelters, community food supply distribution centers, production facilities, military sites, etc.
- Since resilience study is very much a work in progress in North Carolina, it is recommended that these initially be tracked metrics, with no incentive attached.
- Efforts to develop resilience metrics are currently underway across organizations such as the DOE, FERC, EPRI and multiple state public utility commissions. The industry is lacking agreed-upon performance criteria for measuring resilience, as well as a formal industry or government initiative to develop consensus agreement.[27] As such, there are currently no standardized metrics to measure resilience efforts or to quantify the extent or likelihood of damage created by a catastrophic event. Resilience is addressed state-by-state, and oftentimes event-by-event. If different metrics, benchmarks, rewards or incentives are identified and developed for reliability and resilience,[28] there is a need to properly distinguish each, take into account the benefits for each, and differentiate how to separately determine the benefits, rewards and penalties for each.[29]
- The metrics identified above are based on community impact driven resilience needs for critical infrastructure. It is based on current North Carolina state and local government led application of energy vulnerability and risk analysis framework that uses the Resilience Analysis Process (RAP) developed by the Sandia National Lab, which includes prioritization of grid-modernization

DOE Grid Modernization Lab Consortium metrics: Resilience

GMLC Resilience Metrics	Data Requirements
Cumulative customer-hours of outages	customer interruption duration (hours)
Cumulative customer energy demand not served	total kVA of load interrupted
Avg (or %) customers experiencing an outage during a specified time period	total kVA of load served
Cumulative critical customer-hours of outages	critical customer interruption duration
Critical customer energy demand not served	total kVA of load interrupted for critical customers
Avg (or %) of critical loads that experience an outage	total kVA of load severed to critical customers
Time to recovery	
Cost of recovery	
Loss of utility revenue	outage cost for utility ($)
Cost of grid damages (e.g., repair or replace lines, transformers)	total cost of equipment repair
Avoided outage cost	total kVA of interrupted load avoided
	$ / kVA
Critical services without power	number of critical services without power
	total number of critical services
Critical services without power after backup fails	total number of critical services with backup power
	duration of backup power for critical services
Loss of assets and perishables	
Business interruption costs	avg business losses per day (other than utility)
Impact on GMP or GRP	
Key production facilities w/o power	total number of key production facilities w/o power (how is this different from total kVA interrupted for critical customers?)
Key military facilities w/o power	total number of military facilities w/o power (same comment as above)

Source: Petit, F., V. Vargas, J. Kavicky. Grid Modernization: Metrics Analysis (GMLC 1.1) – Resilience. April 2020 https://gmlc.doe.gov/sites/default/files/resources/GMLC1.1_Vol3_Resilience.pdf

About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org

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Resources

- Next-Generation Performance-Based Regulation: Volume 1 (Introduction—Global Lessons for Success)
- Next-Generation Performance-Based Regulation: Volume 2 (Primer—Essential Elements of Design and Implementation)
- Next-Generation Performance-Based Regulation: Volume 3 (Innovative Examples from Around the World)
- Performance Incentives for Cost-Effective Distribution System Investments
- Protecting Customers from Utility Information System and Technology Failures
- Metrics to Measure the Effectiveness of Electric Vehicle Grid Integration
- Sharing the Good Stuff: Best Practices From Three Minnesota Initiatives
- raponline.org

David Littell, Esq.
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Hon. Lillian Mateo-Santos, Esq. Commissioner at the Puerto Rico Energy Board

GOBIERNO DE PUERTO RICO

JRSP JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

PIMs for Resilience

The Puerto Rico Experience

Lillian Mateo-Santos, Esq.
Associate Commissioner
Puerto Rico Energy Bureau

Puerto Rico Electric Power Authority

The Puerto Rico Electric Power Authority was created by law in 1941 as a vertically aligned public instrumentality to provide electric service to all citizens.

Customers	1.48 Million
Customers Per Square Mile	417
Distribution Lines	16,035 miles
Service Territory	3,515 square miles
Substations	340 (distribution) 178 (transmission)
Transmission Lines	1,110 (230/115 kv) 1500 miles (38 kv)

Energy Sector Transformation

Act 120-2018

Establishes the framework for the divestment of the PREPA generation fleet and the operation and maintenance of the T&D System by a third party. On June 22, 2020, PREPA, LUMA Energy and the P3 Authority enter into an agreement under which PREPA retains the ownership of the T&D System and transfer its operation and maintenance to LUMA Energy for a period of 15 years.

PBR's Mandate

Act 57-2014

Section 6.25B of Act-2017-2014 requires the Puerto Rico Energy Bureau to prescribe by regulations, on or before December 31, 2019, such incentive and penalty mechanisms that take into account electric power companies' performance and compliance with the performance metrics set forth in the energy public policy.

Regulation

On December 2, 2019, the Energy Bureau adopted ***Regulation for Performance Incentive Mechanisms***. The Regulation establishes a process for the establishment of targets applicable to a specific entity and annual process for the audit of the compliance with the required targes and the assessment of incentives or penalties.

NEPR-MI-2019-0007

On 2019, the Energy Bureau opened this docket to start gathering enough information regarding a vast array of metrics covering, among other things, reliability, safety, customer service, generation and other operational matters.

NEPR-AP-2020-0025

On 2020, the Energy Bureau opened this docket to establish the targets for LUMA. This processes will be adjudicative. As such, it will allow the participation of interveners, the holding of evidentiary hearing and public hearings.

PIMs for Resilience - Challenges

Attributes vs. Quantifiable Metrics	**There is no silver bullet or panacea**
Indirect Indicators	**Measure and verify progress or compliance with goals through somehow operational areas that impact resilience**
No Customer Left Behind	**Strive for metrics that benefit all customers to the extent possible**
Avoid gold plating	**Prudency and adequate consideration of actual benefits and costs should permeate the process**
Science as a Tool	**Modeling, adequate data gathering and research may facilitate the process**

THANKS

JRSP

JUNTA REGLAMENTADORA
DE SERVICIO PÚBLICO

NEGOCIADO DE ENERGÍA DE PUERTO RICO

NEGOCIADO DE TRANSPORTE Y OTROS SERVICIOS PÚBLICOS

NET NEGOCIADO de TELECOMUNICACIONES DE PUERTO RICO

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Hon. Lillian Mateo-Santos, Esq. Commissioner at the Puerto Rico Energy Board

Q&A
Discussion

End Prepared Presentations

Q&A
Discussion

Housekeeping

During the Webinar

- The webinar is being recorded
  - Panelists presentation slide deck and recording will be posted for public viewing
  - A non-attributable transcript of the Q&A & Discussion will be made available to working group members (and will not be posted online)
- **Chat** the organizers anytime for questions on the logistics or discussion.
- **Raise Hand** during the discussion to be unmuted to share your experience verbally
  - The "view" tab toggles the chat box on and off.

After the Webinar

- This presentation will be e-mailed to the listserv.
- Unanswered comments and questions will be addressed via e-mail or future phone call.
- Please allow 7-10 business days to process and post the webinar recording and transcript.

Anything else?

Thank you!

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