Pacific Northwest
NATIONAL LABORATORY

Policy and Planning for Resilience

February 9, 2021

Jeremy Twitchell

New Mexico PRC Energy Storage Workshop Series

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

Acknowledgment

The work described in this presentation is made possible through the funding provided by the U.S. Department of Energy's Office of Electricity, through the Energy Storage Program under the direction of Dr. Imre Gyuk.

Agenda

- Reliability and Resilience
- Proposed Resilience Planning Framework
- Resilience Case Studies
- Summary and Takeaways

Reliability and Resilience

Pacific Northwest NATIONAL LABORATORY

Obstacles to Resilience

Problem Statement:

“Reliability” is an objective concept, defined by these standards:

- Mandatory Enforcement Standards (NERC has 98 of them),
- Additional Voluntary Standards (NERC has 484 of them), and
- Reporting Metrics (IEEE 1366-2012)

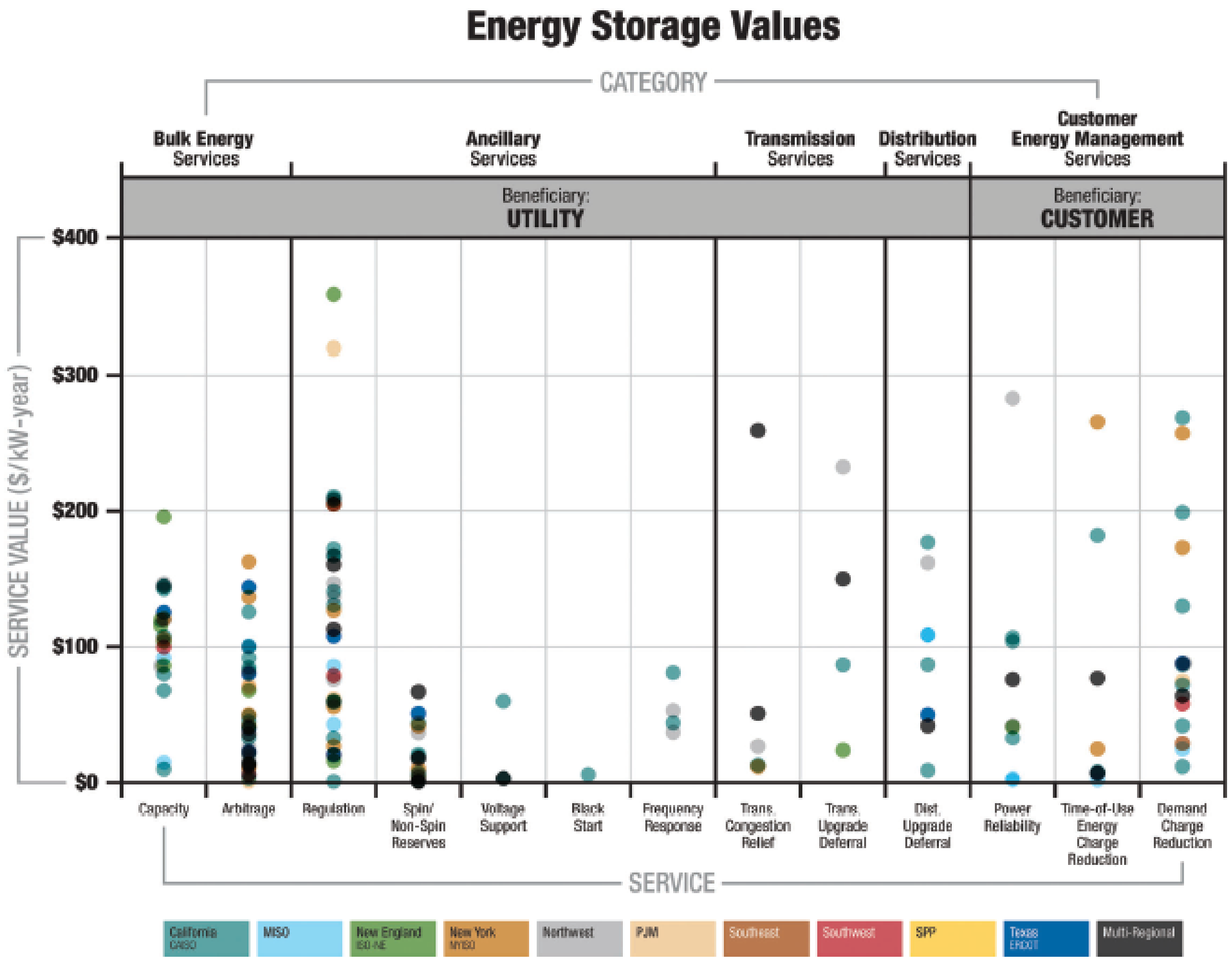
Standards facilitate the development of tangible planning objectives and make reliability a monetizable service. Reliability standards are firm requirements that a utility **must** meet at the least cost.

“Resilience” is more subjective, lacking specific metrics and standards, or even an agreed-upon definition. It is therefore difficult to develop planning objectives for resilience or to monetize it.

- Resilience, as a standalone application, is expensive and rarely needed
- Resilience investments must provide other value-add services to the grid (e.g., energy storage)
- Costs must be assigned based on benefits

Absent similar standards, resilience is a goal that is pursued subject to cost effectiveness, and it is rarely cost effective.

Reliability Standards Create Grid Values



Due to its flexible nature, energy storage is uniquely capable of providing a broad range of those services

Balducci et al, *Assigning Value to Energy Storage Systems at Multiple Points in an Electric Grid,* Energy Environ. Sci 2018, 11, 1926-1944.

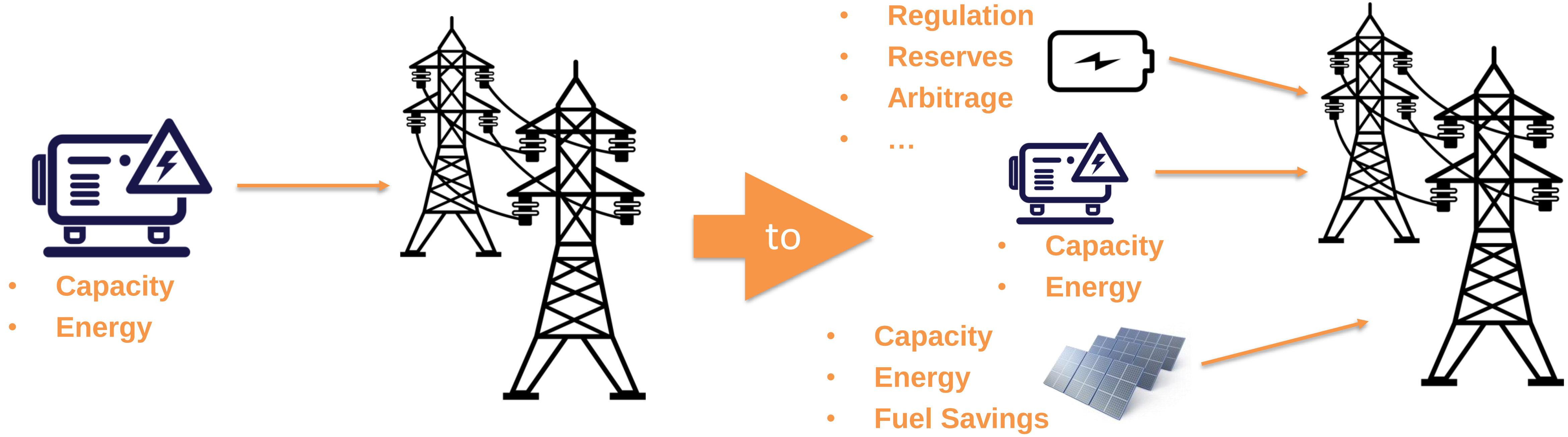
Pacific Northwest NATIONAL LABORATORY

Storage and Resilience: A New Paradigm

The advent of cost-competitive energy storage options has enabled us to go from:

Mission-critical resilience

Economic Resilience



- Limited opportunities for grid participation
- High cost
- Limited to facilities in which resilience is mission critical

- Increased opportunities for grid participation
- Offsetting revenues reduce system costs
- Viable resilience for broader range of facilities

Full report: [Planning Considerations for Energy Storage in Resilience Applications]

Proposed Resilience Planning Framework

Where to Begin: Proposed Framework Overview

By rethinking resilience as a locational value, specific risks and optimal means of addressing them may be more easily identified:

1. **Select site**
2. **Identify risks**
3. **Define critical loads**
4. **Engage in iterative planning between project and grid levels**

Step One: Select Site

Questions for consideration:

- Thought exercise: If there is a complete blackout, what facilities need to be kept online?
- Some are obvious
  - Hospitals, emergency shelters, command centers
- Some are not
  - Pumping stations, prisons, ports, hotels

Key Takeaway
Resilience is a local value

Step Two: Identify Risks

Questions for consideration:

- What major events has the site experienced?
  - High winds, lightning, equipment failure
- What are the potential major events?
  - Earthquakes, tsunamis, wildfires
- Information sources
  - Utility reliability reports, local emergency management

Key Takeaway
Resilience risks are site specific

Pacific Northwest NATIONAL LABORATORY

Step Three: Define Critical Loads

Questions for consideration:

- What are the functions that must be maintained?
  - Entire facility, critical subset of functions?
- For how long must those loads be maintained?
  - Informed by the risk profile – what are the outage risks associated with the identified major events?
- What is an acceptable level of risk?
  - A system that has a 90% chance of meeting the desired resilience level will be much less expensive than one that is guaranteed to meet it. What are the acceptable tradeoffs?

Key Takeaway
Define success first. What are the resilient outcomes that planning should pursue?

Step Four: Engage in Iterative, Bi-Level Planning

Questions for consideration:

- What are local grid conditions?
  - Are there specific grid services (transmission/distribution infrastructure deferral, regulation) that the grid operator needs in the area of the facility?
  - Does the local infrastructure have sufficient communications capability to support a microgrid?
- What are the specific project needs?
  - What is the portfolio of resources that will meet the project’s needs? Have stochastic models been used to consider a wide range of potential circumstances? Have utility tariffs (demand charges, net metering, etc.) been reflected in the planning?

Key Takeaway:
Optimal configuration will vary by location.

Pacific Northwest NATIONAL LABORATORY

Resilience Case Studies

Emerging Models for Resilience: Military

- Marine Corps Air Station Yuma (AZ)
  - 25 MW diesel generators
  - MCAS Yuma hosts the project (in-kind donation of land)
  - Arizona Public Service built, operates the equipment
  - As project host, MCAS Yuma is guaranteed backup power in the even of a grid outage
  - 25 MW can support full facility functionality

U.S. Marine Corps/APS

Emerging Models for Resilience: Military

- **Pacific Missile Range Facility** (HI)
  - 19 MW PV array
  - 70 MWh battery
  - PMRF provides land
  - AES Distributed Energy builds, owns and operates the facility
    - Sells output to Kauai Island Utility Cooperative during normal operations (25-year power purchase agreement)
    - Supports PMRF during outages
  - Under development

U.S. Navy

Emerging Models for Resilience: Civilian

- Green Mountain Power (VT)
  - Distributed storage through cost sharing with customers
  - Customers pay $1,500 up front or $15/month
    - Receive a 7kW/13.5kWh Tesla Powerwall
  - Utility controls the devices; uses them for peak shaving
    - Shaved ~3.5 MW off 2018 peak; saved $500k
  - Customers receive backup power and time-of-use rate management
  - Fully subscribed (2,000 customers); has evolved into a bring-your-own device program

Green Mountain Power

Emerging Models for Resilience: Civilian

- Sterling Municipal Light Department (MA)
  - 2.4 MW Solar
  - 2 MW/3.9 MWh battery
  - Provides emergency backup power to police station and dispatch center
  - During normal operations, utility uses the microgrid to reduce monthly peaks (reduces transmission network charges) and annual peaks (ISO-NE capacity market revenue)
    - Projected annual benefits: $400,000
    - Year one benefits: $419,000
  - Supported by $250,0000 grant from U.S. DoE and analytical support from national labs
  - Projected 7-year payback

Clean Energy Group

Summary and Takeaways

Emerging Models Summary

These projects represent a wide range of microgrid designs and uses. Despite those differences, there are several consistencies among successful projects:

- Resilience benefits are hyperlocal
  - Limited to a single facility, in some cases as small as a single residence
- Projects made economically feasible through grid services
  - Utility, grid operator, or knowledgeable third party operates projects to maximize value
- Key grid value drives each project
  - Peak shaving, reduced operating costs, grid constraint management
- Energy storage is a key enabling technology
  - Three projects included storage in initial project construction; fourth (AZ) studying its addition

Summary: Resilience in a Reliability-Constrained World

- Resilience as a standalone service is expensive
  - Unlike reliability, we have no standards for resilience
  - Projects must pay their own way through reliability-based services
- Energy storage represents a paradigm shift for resilience, microgrids
  - Flexible, scalable resource can provide a wide range of valuable grid services
  - Increased value reduces the net cost of resilience, broadens its availability
- Deliberate planning is needed
  - Grid level: Local grid communication and controls must be identified; local grid values must be considered
  - Project level: Stochastic analysis necessary to ensure portfolio robustness; consider values created by utility rate and tariff structures
- Resilience can be done – and it is happening with increasing frequency

Pacific Northwest
NATIONAL LABORATORY

Additional Resources

- PNNL Energy Storage (energystorage.pnnl.gov)
- Sandia National Laboratories (www.sandia.gov/ess/)
- DOE Global Energy Storage Database (www.energystorageexchange.org)
- Energy Storage Association (www.energystorage.org)

U.S. DEPARTMENT OF ENERGY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

NRECA

Pacific Northwest
NATIONAL LABORATORY

Thank you

Jeremy Twitchell
jeremy.twitchell@pnnl.gov
971-940-7104