Pacific Northwest NATIONAL LABORATORY

Sandia National Laboratories

Advancing Energy Equity in Grid Planning

2nd Advisory Meeting

May 24, 2022

CONTACT

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Agenda

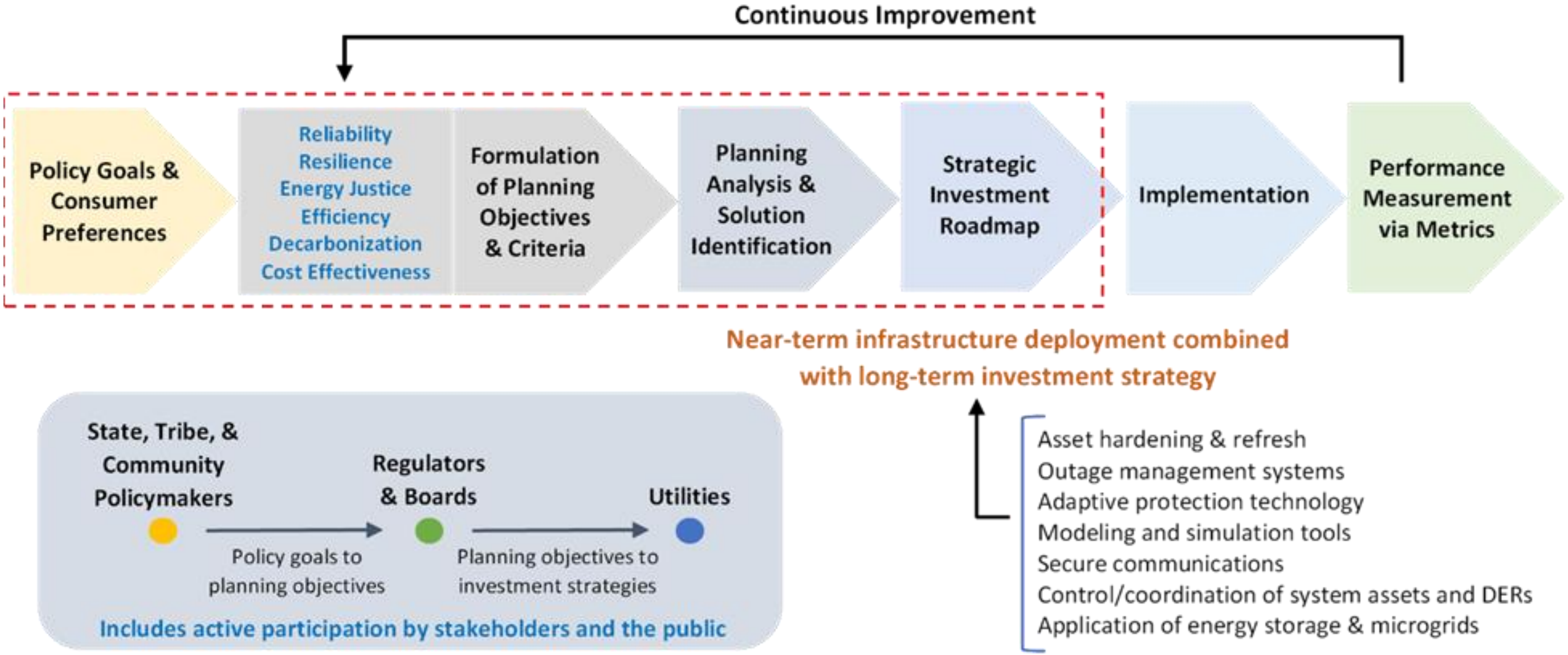
May 24, 2022, 12:00 PM - 2:00 PM EST (9:00 AM - 11:00 AM PST)
Welcome, Introductions, Project Overview (15 mins) Joe Paladino, Rebecca O’Neil
Equitable Resilience Planning (25 mins) Jeremy Twitchell
Open Discussion (20 min) Jeremy Twitchell
Simulation Pathways for Equity in Grid Planning (25 min) Ankit Singhal
Open Discussion (30 min) Ankit Singhal
Next Steps (5 min) Rebecca O’Neil, Brian Pierre
Adjourn

Advisory Committee

- American Public Power Association (APPA)
- Clean Energy Group
- Iowa State University Electric Power Research Center (ISU EPRC)
- National Association of State Energy Officials (NASEO)
- New Hampshire Electric Co-op (NHEC)
- New York Power Authority (NYPA)
- Portland General Electric
- PSE Healthy Energy
- Puget Sound Energy
- Seattle City Light (SCL)
- Southern California Edison (SCE)
- Strategen

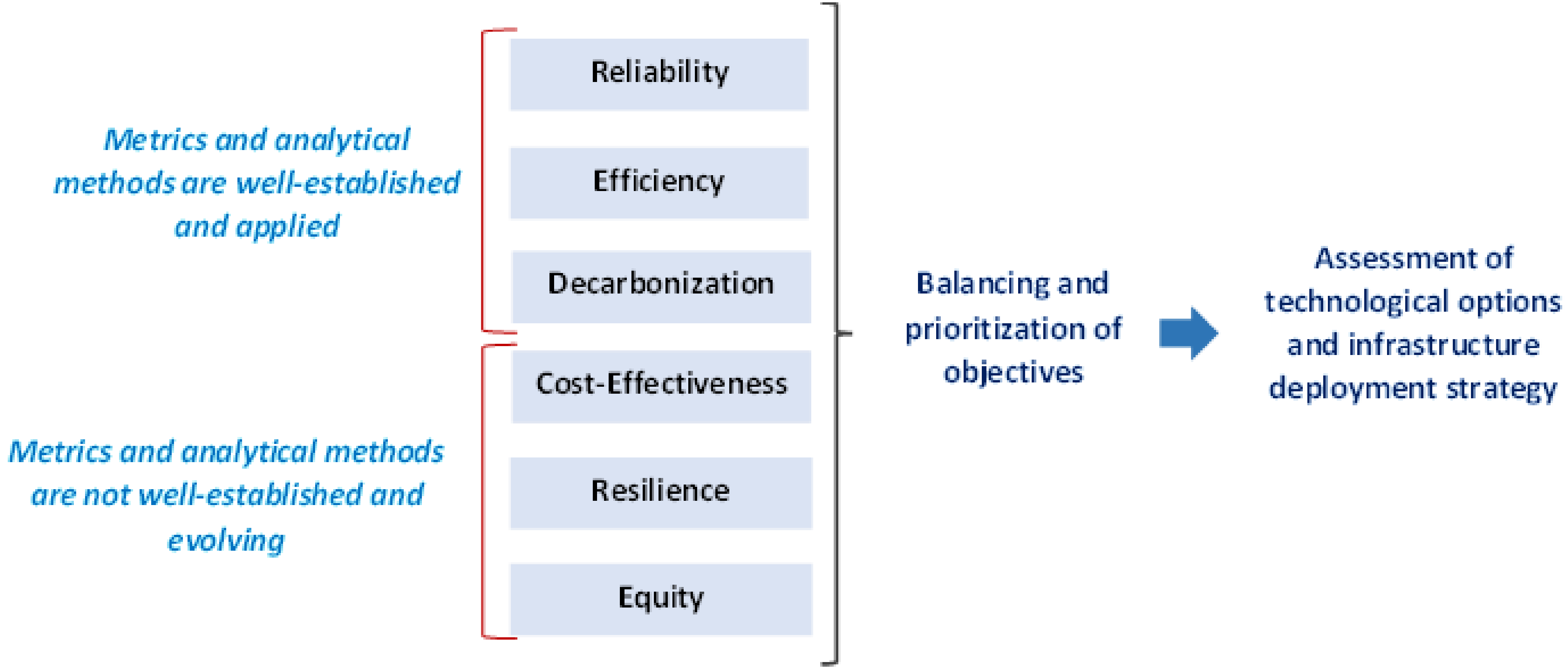
MOD Plan Overview

Creating a shared understanding among stakeholders of strategies for grid transformation needed to meet myriad objectives, including those addressing resilience, decarbonization, and equity



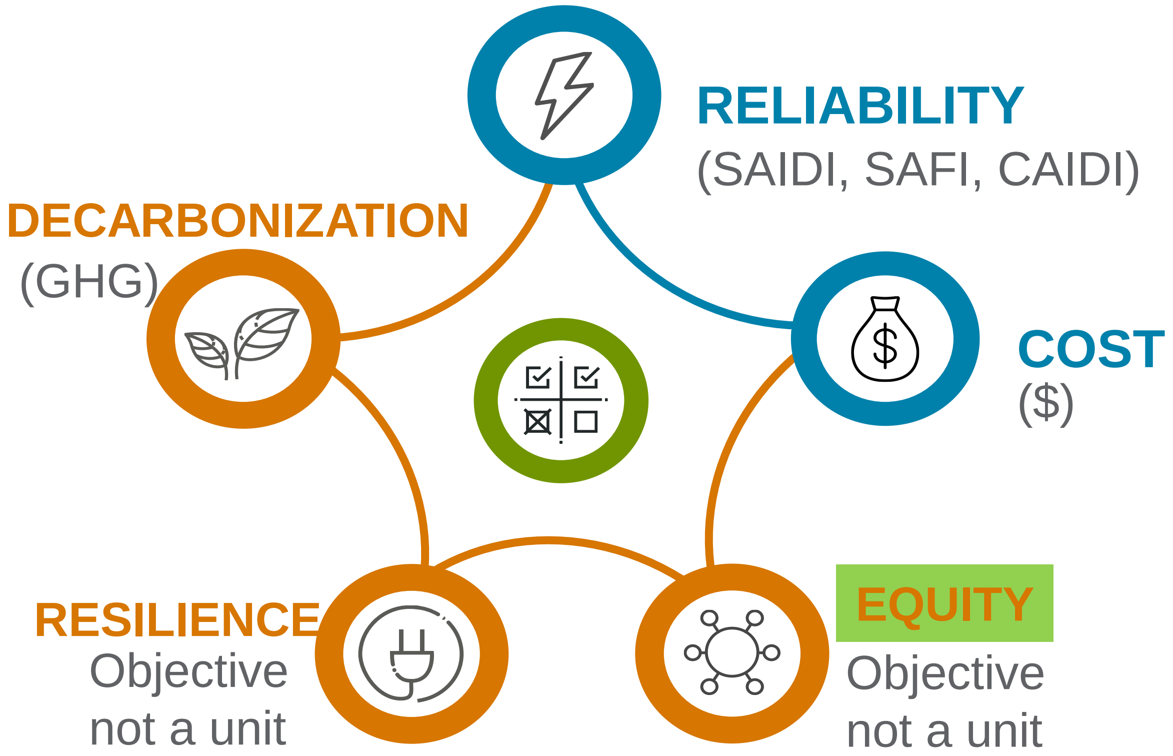
Planning Objectives

A well-designed integrated distribution system planning process provides a framework for translating policy objectives into holistic infrastructure investment strategies



Emerging Objectives in Grid Planning

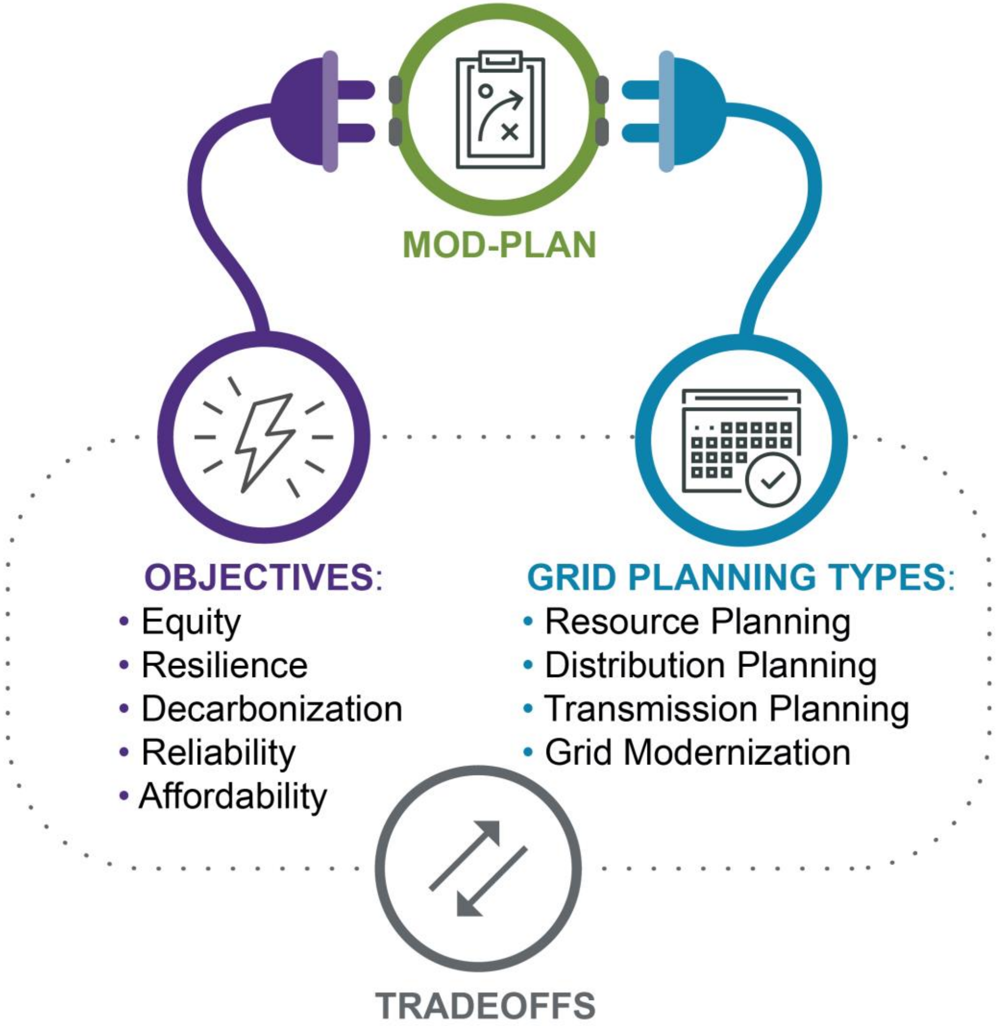
- Traditionally electric grid planning strives to maintain **safe, reliable, efficient, and affordable** service for current and future customers.
- As policies, social preferences, and the threat landscape evolve, additional considerations for power system planners are emerging, including **decarbonization, resilience, and <u>energy equity and justice</u>.**
- Relative to traditional objectives, these emerging objectives are not well integrated into grid planning paradigms.



MOD-Plan: Multi-Objective Decision making

Funded by the Office of Electricity

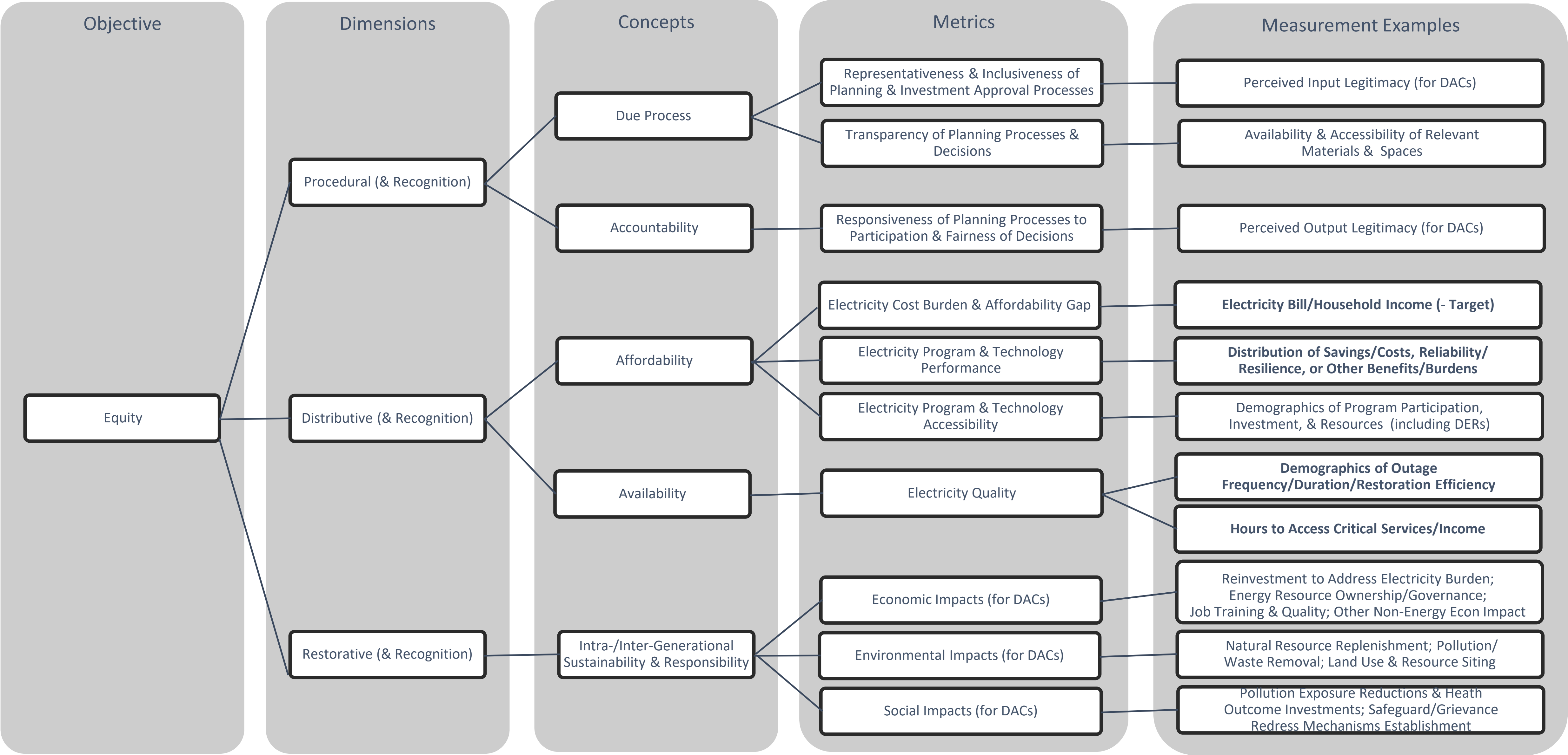
- **Planning frameworks with stakeholder roles.** Develop a framework that applies multiple emerging objectives in the electric grid planning processes with stakeholder roles throughout
- **Emerging objectives and trade-offs.** Advance innovative and practical methods for formulating planning objectives for decarbonization, resilience, and energy equity to indicate trade-offs
- **Metrics for success.** Develop and report on metrics that can measure the performance of the grid with respect to these emerging objectives



Equity Definition

- Equity is the ability of the electric system to fairly distribute burdens and benefits and to ensure that electricity decision-making procedures are inclusive of and responsive to *all* affected stakeholders, including those historically burdened by and excluded from planning for the electricity system.
- To achieve equity in the electricity system—especially in the transition to a more sustainable energy sector—systems, technologies, procedures, and policies must be designed in a way to enable the fair and just distribution of benefits in the energy system through:
  - **Procedural and recognition justice** (i.e., due process, accountability, and transparency of grid planning processes);
  - **Distributive justice** (i.e., affordability and availability of electricity services and transition-enabling programs and technologies); and
  - **Restorative justice** (i.e., intra- and inter-generational sustainability and responsibility, including rectifying economic and environmental inequities in the electricity system).

Equity Objective, Dimensions, Concepts, Metrics, and Measurement Approaches



Performance Metrics

- Energy Burden — *Equity*
- Energy Vulnerability to Outages — *Resiliency, Equity*
- Access to black-start DERs — *Resiliency, Equity*
- Loss of load (SAIFI/SAIDI) — *Reliability, Equity*
- Energy Served from DERs — *Decarb, Equity*
- Cost of Assets Upgrade — *Cost, Equity*
- Impact on Energy Consumption due to Energy Efficiency Program — *Efficiency, Equity*

Example Metrics	
Energy Burden	$\frac{Annual\ utility\ bills}{Annual\ household\ income}$
SAIFI	$\frac{Total\ \#\ of\ customers\ interrupted}{Total\ \#\ of\ customers\ served}$
E3B Investment*	% of $low\ income\ population\ \times$ $Total\ residential\ EE\ investment\ (\$)$

*Energy Efficiency Equity Baseline (E3B)

DSP Plan and Modeling Equity

Go to step 1 and repeat process with improved inputs

0 Base Case Assessment

system awareness- equity, DER levels

Identification of critical loads, DAC

1 Load/BTM-DER Forecast

energy assistance

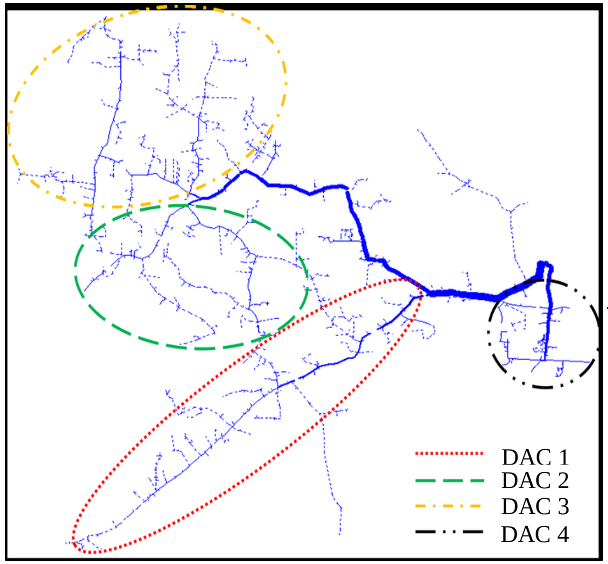
load growth
EV adoption
DER adoption

decarb goals → 2 U-DER investment (total capacity & mix)

Investment strategy

energy access
energy security

3 U-DER Optimal Locational Distribution



DER locational profile to minimize infra upgrades with equity constraint

4 Infrastructure Upgrades Assessment

list of transformers, lines, voltage devices upgrades

5 Monte-Carlo Simulation Analysis

statistical post-processing

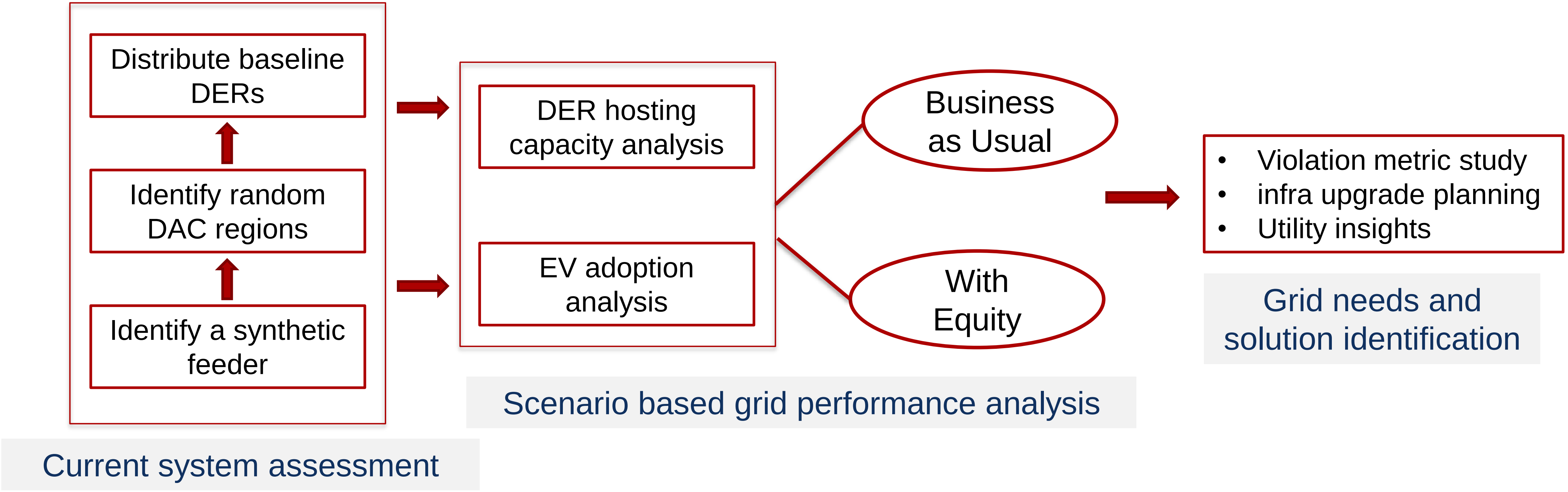
6 Performance Measurement via Metrics

Equity input
Distribution system planning
Output metrics generation

Equity Consideration: System Readiness

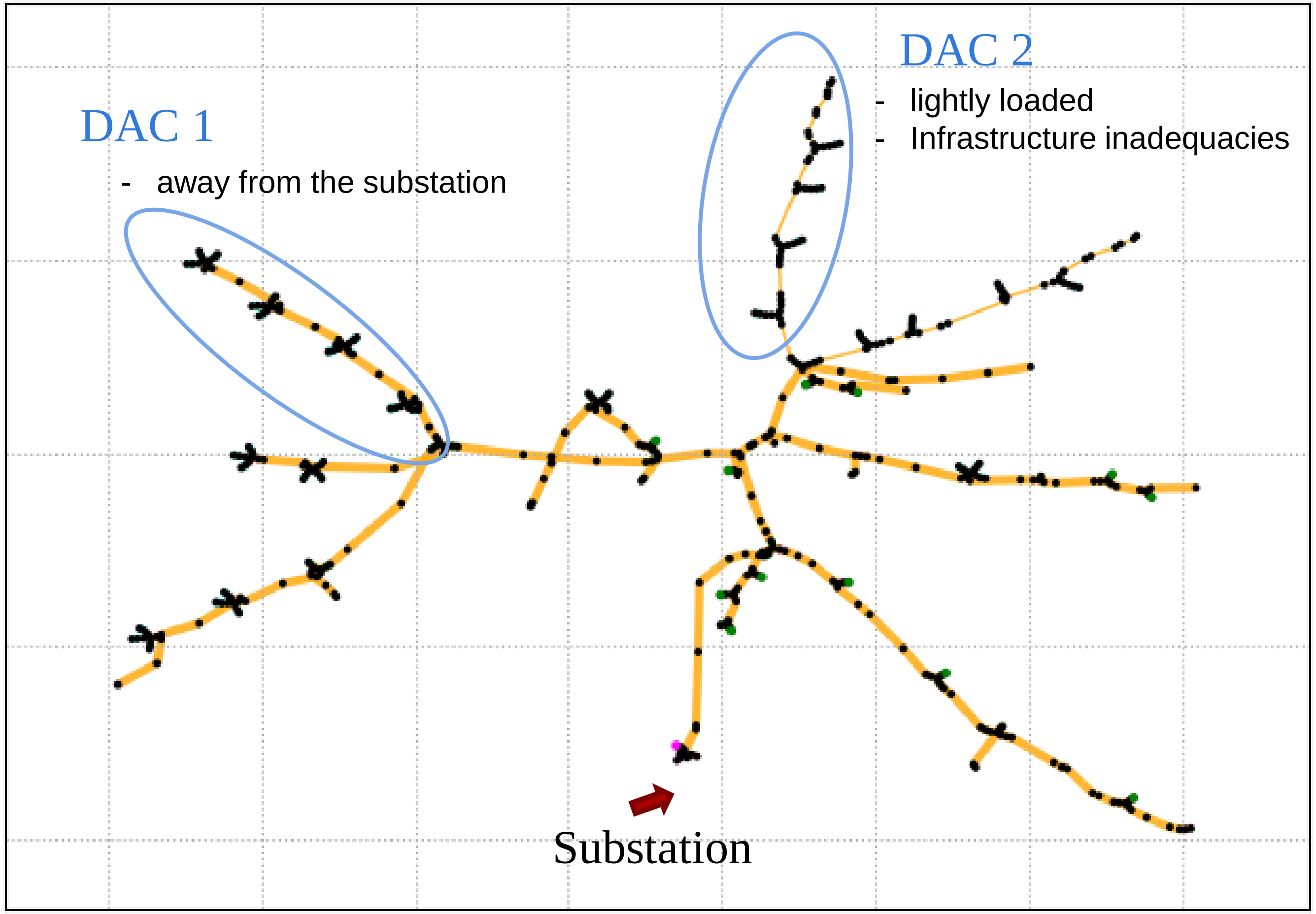
- Sub-problem:

To analyze the *technical readiness* of the distribution system with the inclusion of equity parameters in DER hosting and EV adoption



PNNL Prototype Feeder

Layout of Feeder Power Components for R1-12.47-4



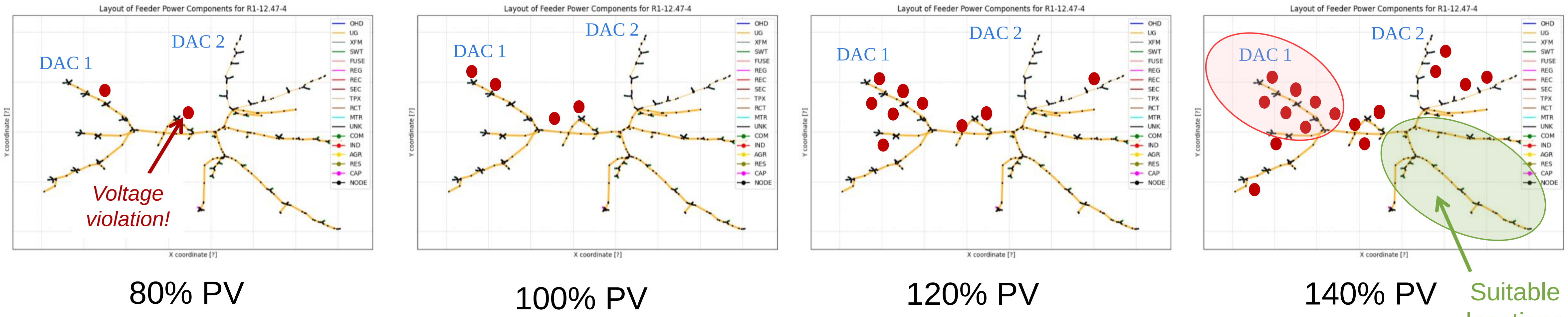
- A 300-node taxonomy feeder representing west-coast heavy sub-urban area

Service transformers	50
Residential customers	380
Commercial customers	12
Total load	5.3 MW

- Randomly identified 2 DAC regions
  - DAC:130 customers
  - Non-DAC: 250 customers

PV Hosting Capacity Analysis

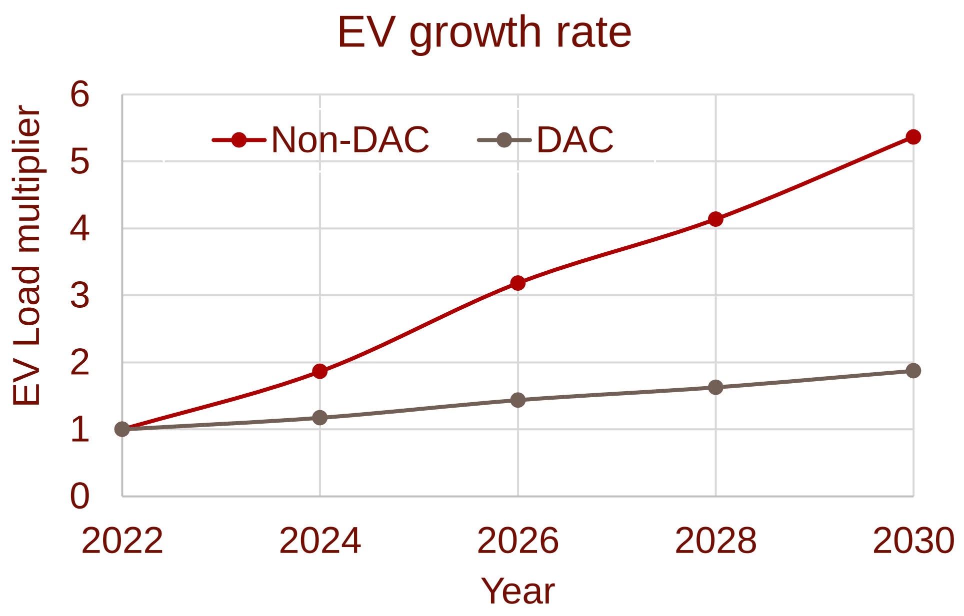
- A simplified PV hosting analysis to identify unsuitable PV locations with over-voltage violations
- Voltage violations: voltage at a node violating ANSI limits (~ 0.95-1.05 pu)



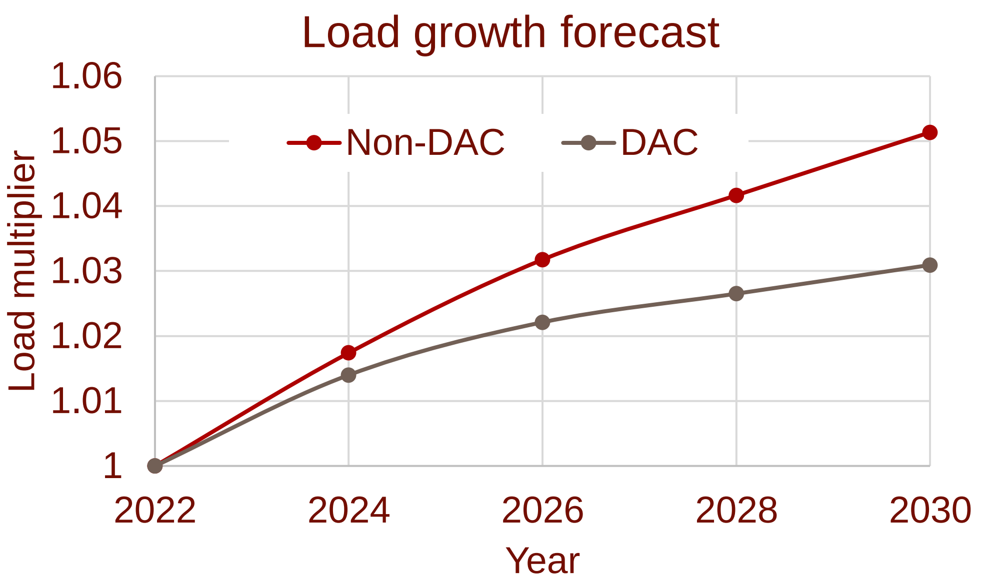
- DAC-1 turns out to be a region with high voltage violations with increasing solar PV penetration, making it unsuitable for hosting solar PV
- Bottom right region of the feeder is better location for solar PV installments

* *Note that the results are only for a specific feeder with assumed definitions of DAC regions*

EV Adoption Analysis



Source: Historical sales data, Evadoption.com



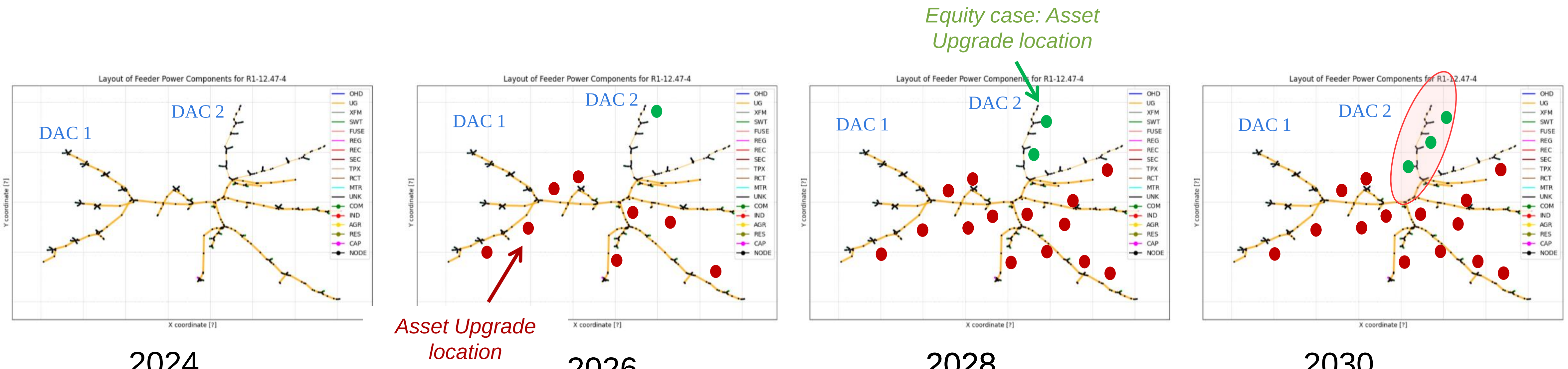
Source: https://www.eia.gov/outlooks/aeo/electricity/sub-topic-01.php

- Current (2022) EV adoption is assumed to be 25% and 5% for non-DAC and DAC regions
- DAC region growth is assumed to be 20% of non-DAC
- Base load (kW) for DAC and non-DAC are different
- DAC are assumed to have lower growth rate for loads

With Equity: DAC regions are assumed to have same growth as non-DAC region for EV and load

** Note that the results are only for a specific feeder with assumed definitions of DAC regions*

EV Adoption Analysis



2024 2026 2028 2030

# of assets that need upgrade due to EV adoption

Year	Transformers		
	Non-DAC	DAC-BAU	DAC-Equity
2022	0	0	0
2024	0	0	0
2026	8	0	1
2028	23	0	3
2030	30	0	4

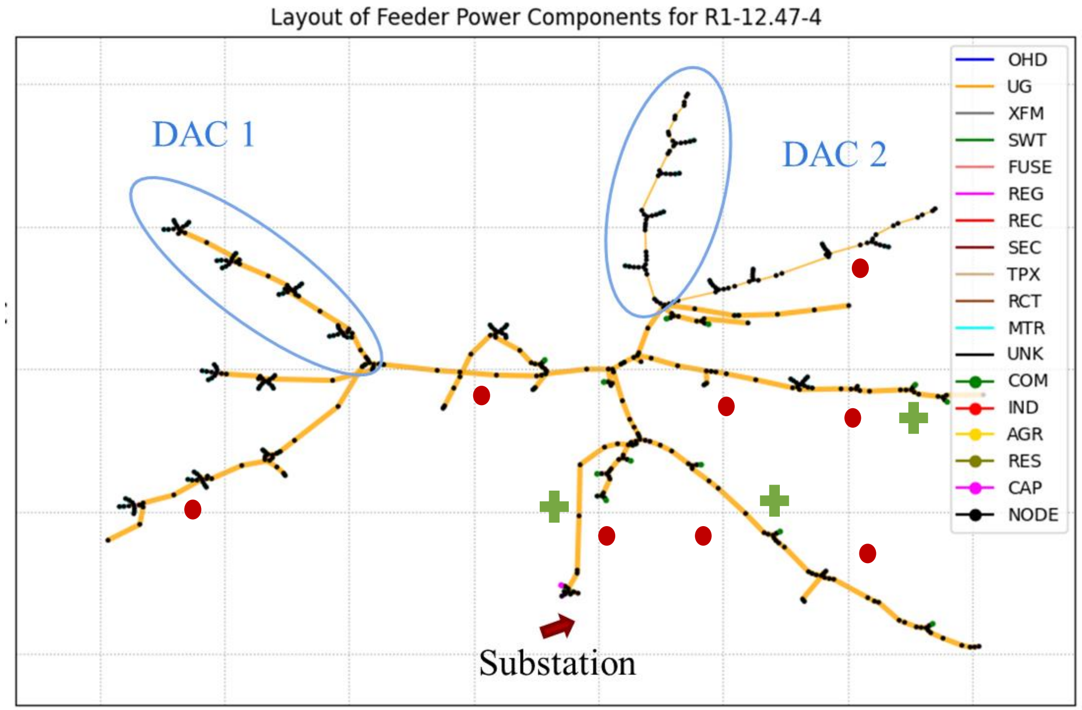
Year	Line conductors		
	Non-DAC	DAC-BAU	DAC-Equity
2022	0	0	0
2024	0	0	0
2026	2	0	0
2028	6	0	2
2030	8	0	3

- Power-flow analysis for each year provides thermal violations of transformer and conductors due to EV adoption.
- In BAU: all upgrades are needed in non-DAC region;
- With equitable EV adoption: DAC region also need upgrade

** Note that the results are only for a specific feeder with assumed definitions of DAC regions*

Planning: BAU

- Utility-level DER allocation: Most DERs should be located at
  - High hosting capacity locations to avoid voltage mitigation solutions
  - closer to high EV load locations to avoid asset upgrade
- Asset Upgrade: Transformers and lines should be upgraded at locations obtained from the analysis in non-DAC region to manage EV adoption
- In this particular case, DAC regions
  - do not qualify for DERs due to low PV hosting capacity and
  - do not qualify for upgrades due to low EV adoption forecast



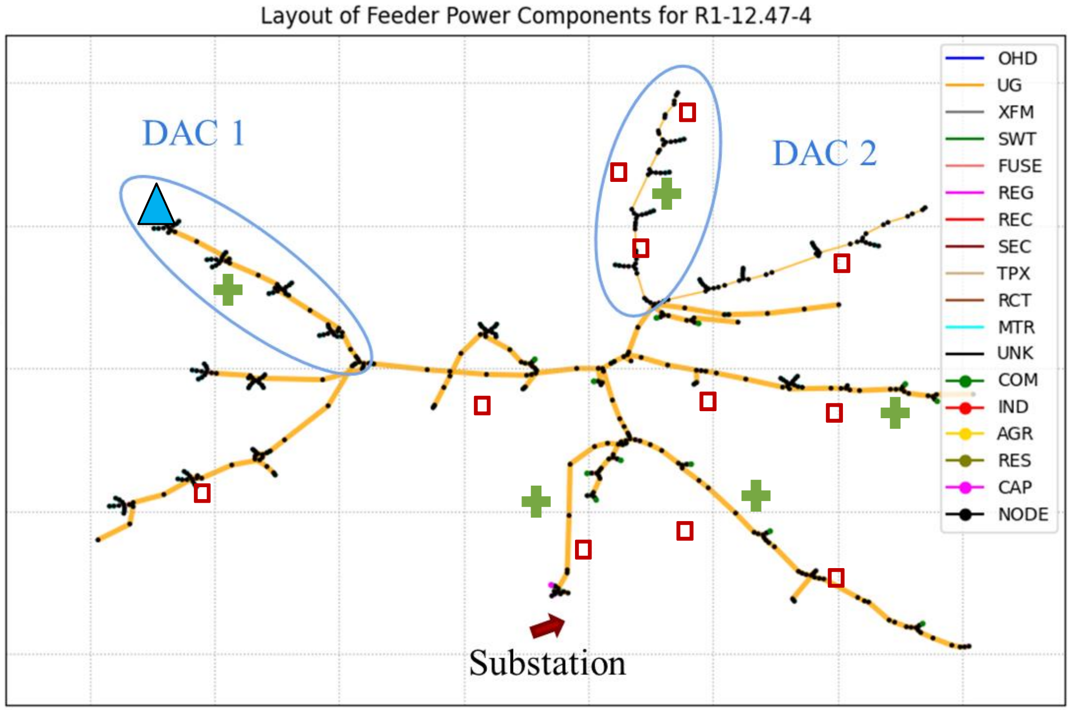
- Transformer and line upgrade
- Utility-level DER allocation

** Note that the results are only for a specific feeder with assumed definitions of DAC regions*

Planning: with Equity

- Utility-level DER allocation: DACs should have equitable PV hosting capacity
  - A voltage mitigation solution needs to be applied e.g. voltage regulator installation
- Asset Upgrade: DACs should have equitable EV hosting capacity
  - Transformers and lines should be upgraded in DAC-2 region to ensure technical readiness to host equitable EV adoption

In a different feeder with different DAC definitions, we may have different solution identification.



- Transformer and line upgrade
- Utility-level DER allocation
- Voltage regulator installation

** Note that the results are only for a specific feeder with assumed definitions of DAC regions*

Planning: with Equity

- Planning with equity has higher upgrade cost than BAU in order to ensure equitable DER and EV hosting capacity of DAC regions.

- However, in long-term, it has potential to provide following benefits:
  - Ancillary services from DER inverters such as volt/var, freq/watt
  - Equitable DER access
  - Improved hosting capacity of DAC regions likely to make system more equitable and resilient

- Impact analysis of system readiness for equitable DER hosting on various other performances such as cost, and resiliency will reveal the trade-off.

Conclusion and Next Steps

- DAC regions may have relatively lower DER hosting capacity due to locational disadvantage. This leads to reduced DER access to DAC region
- BAU EV adoption prediction in DAC regions causes relatively slower infrastructure upgrade compared to the rest of the feeder which may not be sufficient for equitable EV adoption future. Its impact on DAC regions' resiliency need to be analyzed.
- Next steps:
  - Work with utilities to gather real-world data for further analysis
  - Cost and benefit analysis of equitable hosting capacity of DAC regions
  - Impact of low EV adoption and associated slower infra upgrade on the resiliency of DAC regions
  - Develop metrics to quantify equity and resiliency impact

Acknowledgment and Resources

Support provided by Joseph Paladino, Program Manager, Office of Electricity, US DOE

MOD-Plan: https://www.pnnl.gov/projects/mod-plan

PNNL Project Team
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