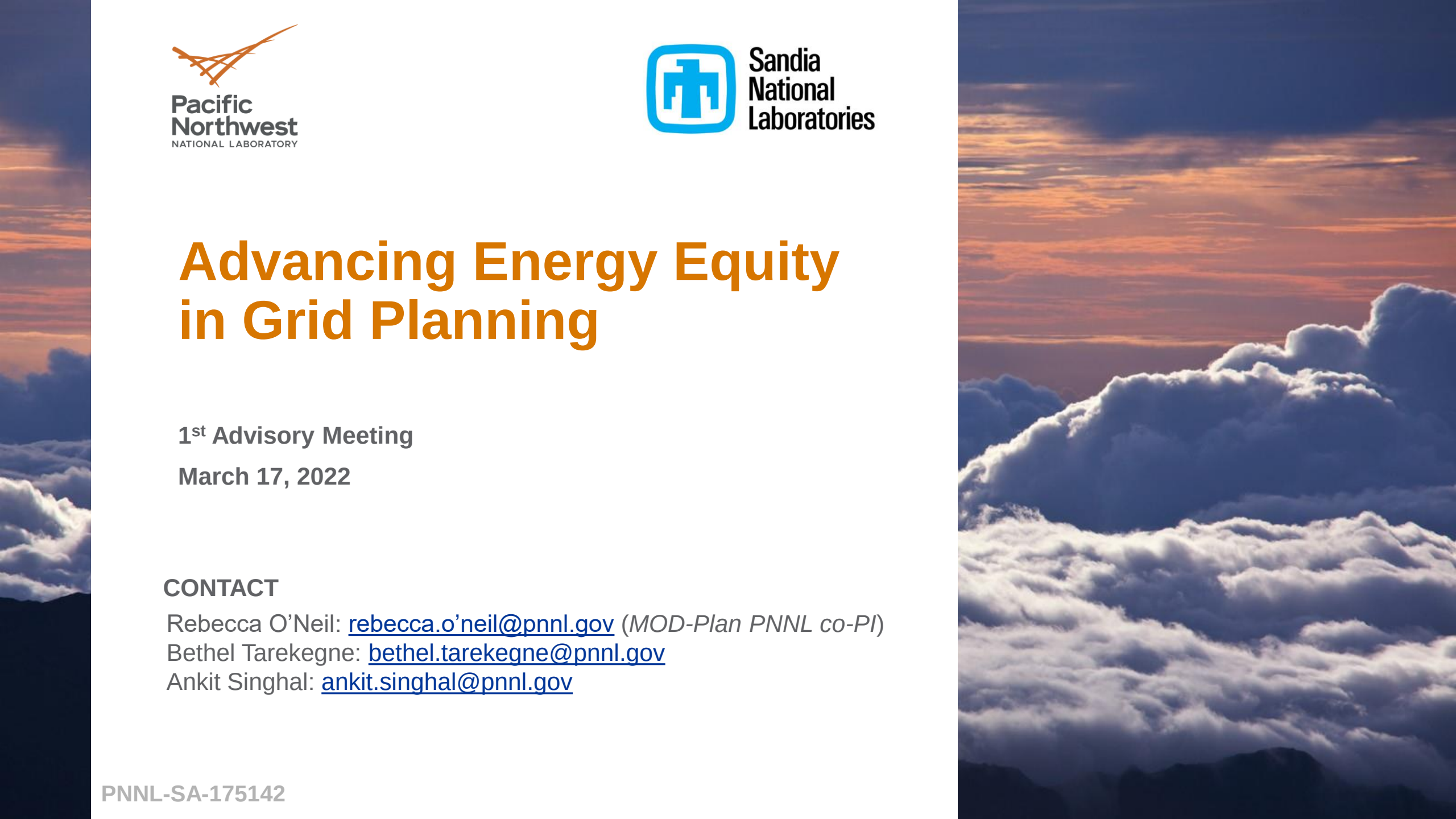

Advancing Energy Equity in Grid Planning

1st Advisory Meeting

March 17, 2022

CONTACT

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Bethel Tarekegne: bethel.tarekegne@pnnl.gov
Ankit Singhal: ankit.singhal@pnnl.gov

PNNL-SA-175142

Agenda

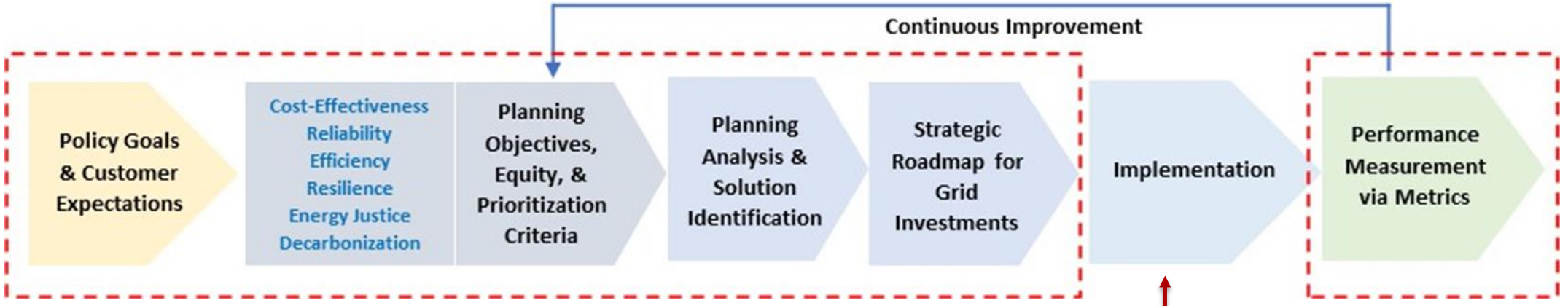
March 17th, 2022, 1:00 PM - 2:30 PM EST (10 AM - 11:30 AM PST)
Welcome, Introductions, Project Overview Joe Paladino, Rebecca O'Neil
Energy Justice and Equity in Grid Planning Bethel Tarekegne, Jennifer Yoshimura
Open Discussion: Equity in Grid Planning, White Papers Jennifer Yoshimura, Bethel Tarekegne
Simulation Pathways for Equity in Grid Planning Ankit Singhal
Open Discussion: Simulation Pathways for Equity in Grid Planning Ankit Singhal, Bethel Tarekegne
Next Steps Rebecca O'Neil
Adjourn

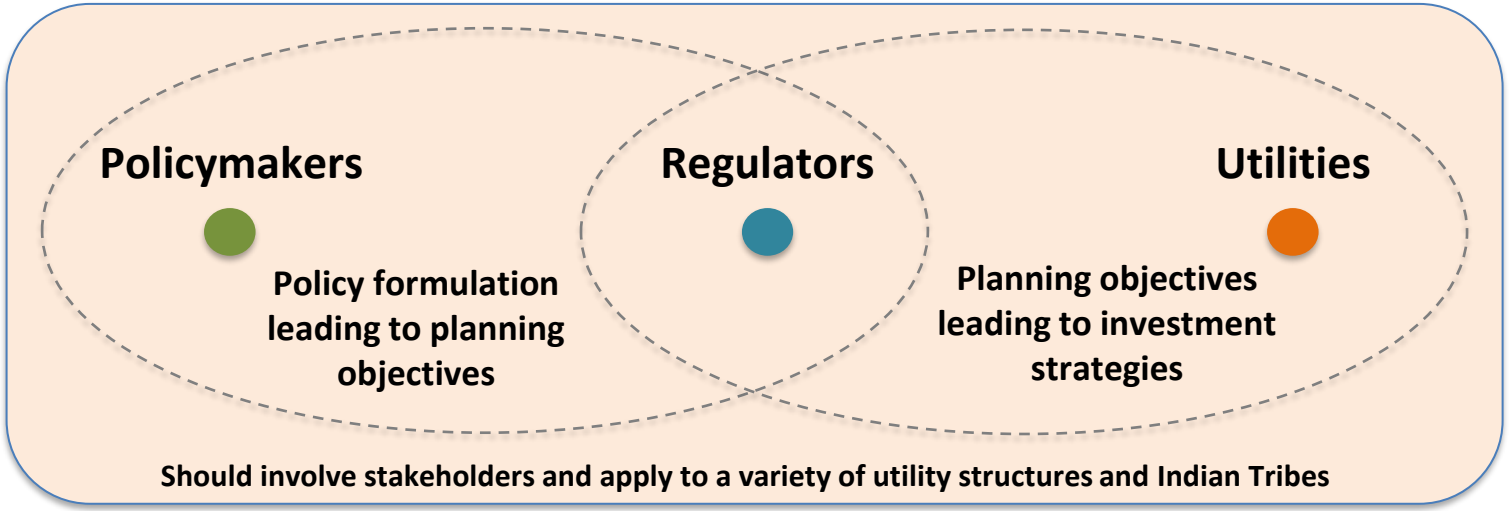
Advisory Committee

- National Association of State Energy Officials (NASEO)
- Clean Energy Group
- Puget Sound Energy
- Strategen

Focus of Integrated Planning

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

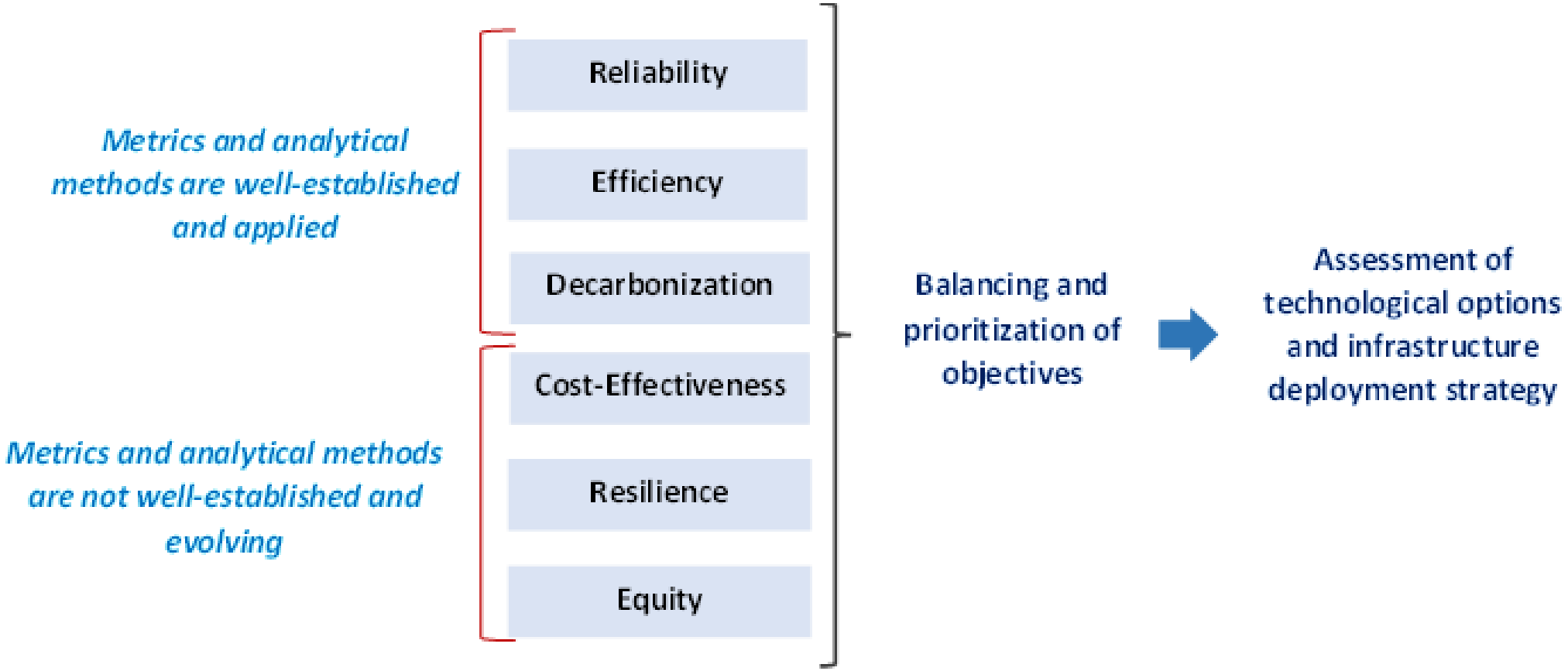




- Advanced (smart) grid technologies and capabilities
- Energy efficiency
- Energy storage
- Demand response
- Electric vehicles
- Flexible loads
- Microgrids

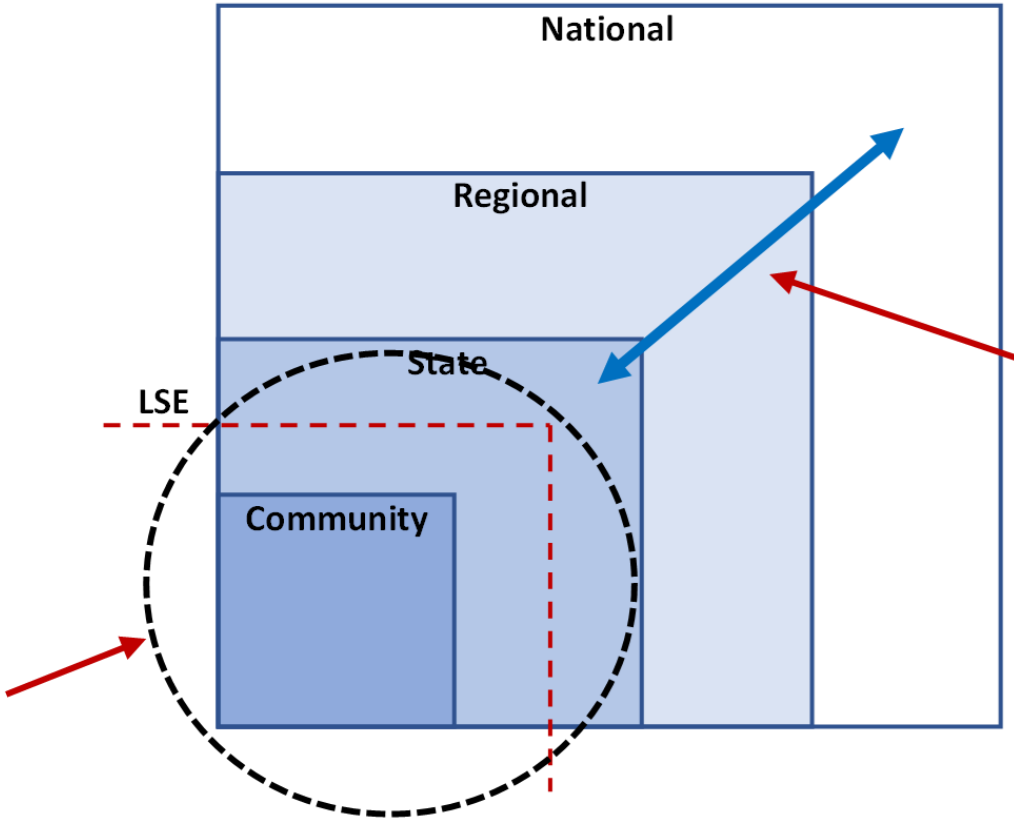
Planning Objectives

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



Addressing Scale within Integrated Planning Processes

Address state/community objectives through an IDP process and align with regional planning efforts

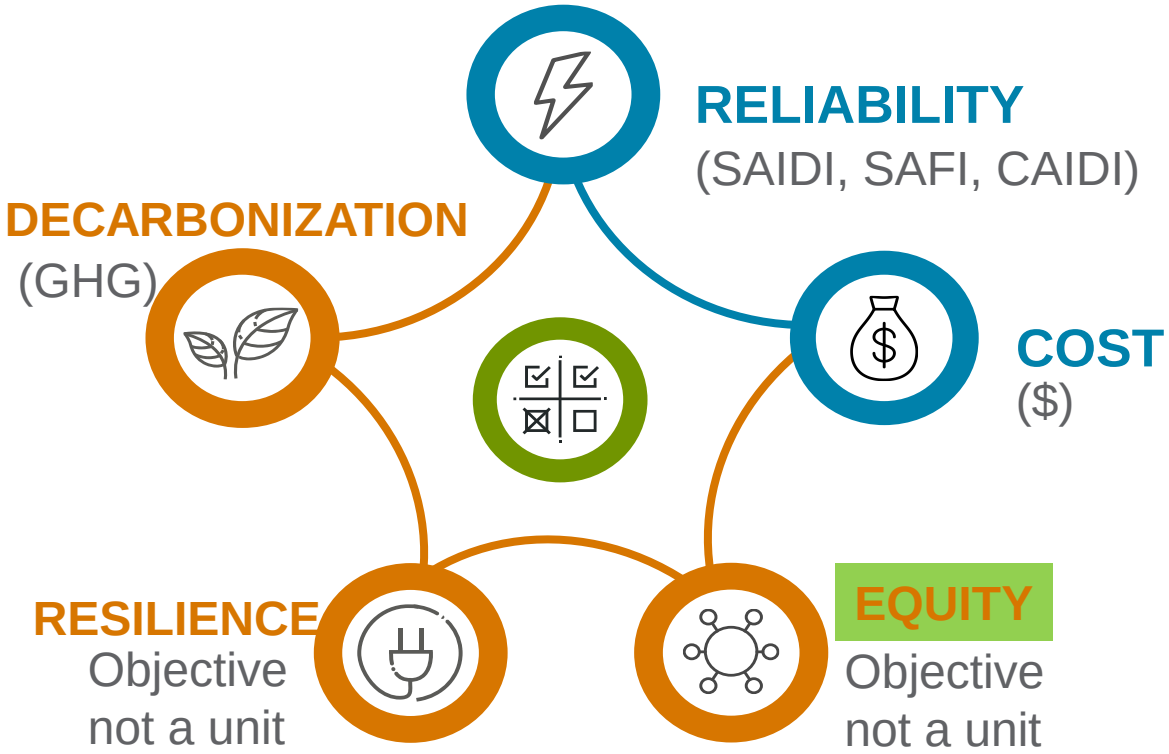


Alignment of community and state strategies with regional, multi-state strategies

IDPs align community and state policy goals into multi-year investment strategies

Emerging Objectives in Grid Planning

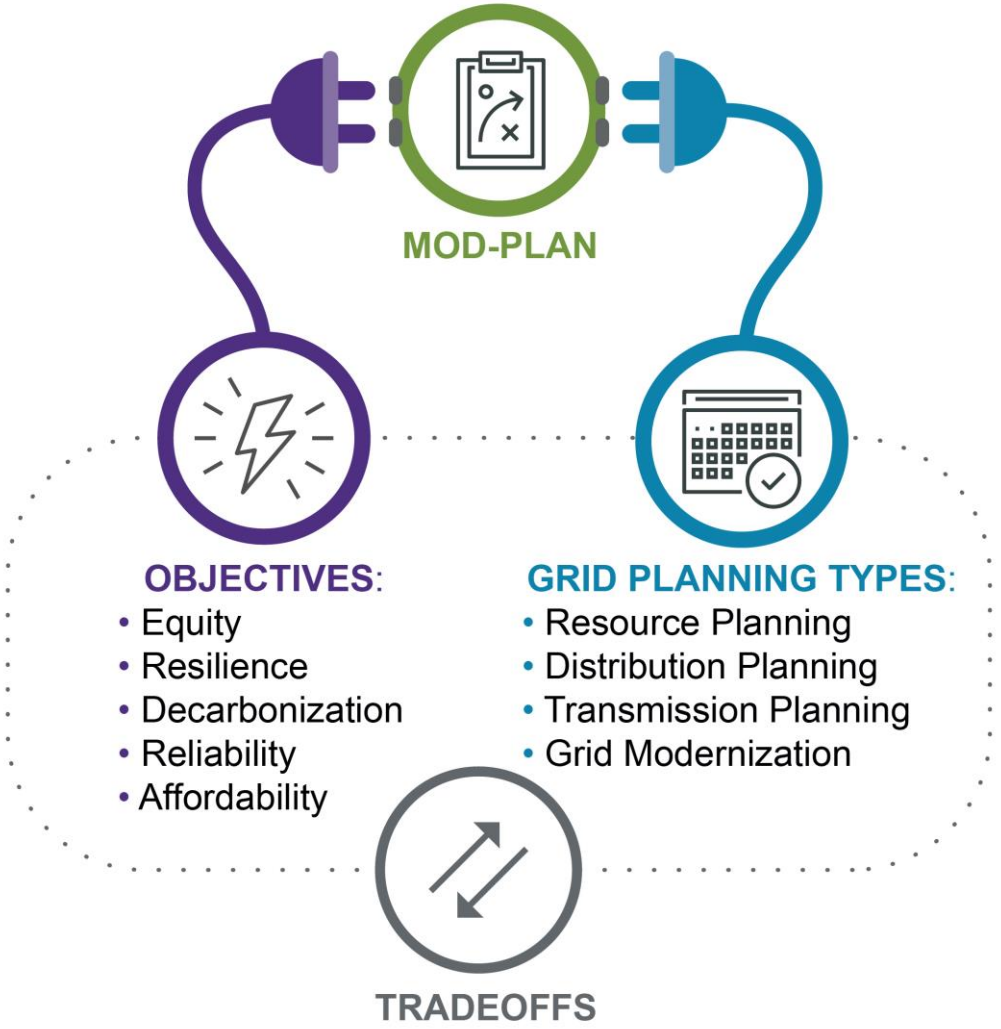
- Traditionally electric grid planning strives to maintain **safe, reliable, efficient, and affordable** service for current and future customers.
- As policies, social preferences, and the threat landscape evolve, additional considerations for power system planners are emerging, including **decarbonization, resilience, and energy equity and justice**.
- 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



Dimensions & Approaches of Energy Equity

Distributive Justice (where?)

- The unequal allocation of benefits and burdens and unequal distribution of the consequences

Recognition Justice (who?)

- The practice of cultural domination, disregard of people and their concerns, and misrecognition

Procedural Justice (how?)

- The fairness of the decision-making process

Restorative Justice

- The response to those impacted by the burdens of energy projects

Key Principles:

- Availability
- Transparency and accountability
- Due process
- Intergenerational equity
- Affordability
- Sustainability
- Intragenerational equity
- Responsibility

Key Terms	Definition
Energy Burden	Percent of household income spent to cover energy cost.
Energy Insecurity	The inability to meet basic household energy needs.
Energy Poverty	A lack of access to basic, life-sustaining energy.
Energy Vulnerability	The propensity of a household to suffer from a lack of adequate energy services in the home.

Justice40 Policy Priorities

Reducing energy burden
- Reduction in energy costs due to technology adoption

Reducing environmental burden
- Reduction in local pollutant emissions

Increase clean energy access
- Increase access to clean energy serving DACs

Increase access to low-cost capital
- Increase loans to MBEs/DBEs

Increase enterprise creation
- Increase contracts to MBEs/DBEs

Increase clean energy jobs & training
- Increase clean energy jobs in DACs

Increase resilience
- Increase community resilience

Increasing energy democracy
- Increased stakeholder engagement

https://www.energy.gov/sites/default/files/2021-12/Justice40%20FAQS%20Deck.pdf

Equity in Grid Planning Current Practice

Emerging Objective White Paper Findings

Remain tied to decarbonization goals and/or environmental justice.

- **Michigan**: 2020 Executive Order requires PUC to expand its environmental review of IRPs to evaluate whether utilities are meeting state decarbonization goals
    - Also requires PUC to assess whether IRPs consider environmental justice and health impacts
- **Washington**: 2019 Clean Energy Transformation Act requires IRPs to include an assessment of energy and non-energy benefits and reductions of burdens to vulnerable populations
- **Connecticut**: 2019 Executive Order requires the Public Utilities Regulatory Authority to analyze decarbonization pathways consistent w/ the state's goal of 100% carbon-free electricity by 2040
    - EO also calls for PURA oversight to ensure energy affordability and equity for all ratepayers during the resource planning process (but this is loosely outlined)
- **California**: 2018 CPUC decision requires IRPs with LSEs to assess their impacts on disadvantaged communities
    - CA defines disadvantaged communities as those w/ the highest pollution burden (top 25% statewide)

Planning Paradigm	Treatment of Equity Within Paradigm
Integrated Resource Planning	**Limited**
Transmission Planning	**None**
Distribution System Planning	**None**
Reliability Planning	**None**
EE & DSM Planning	**Limited**
Integrated Distribution Planning	**Limited**

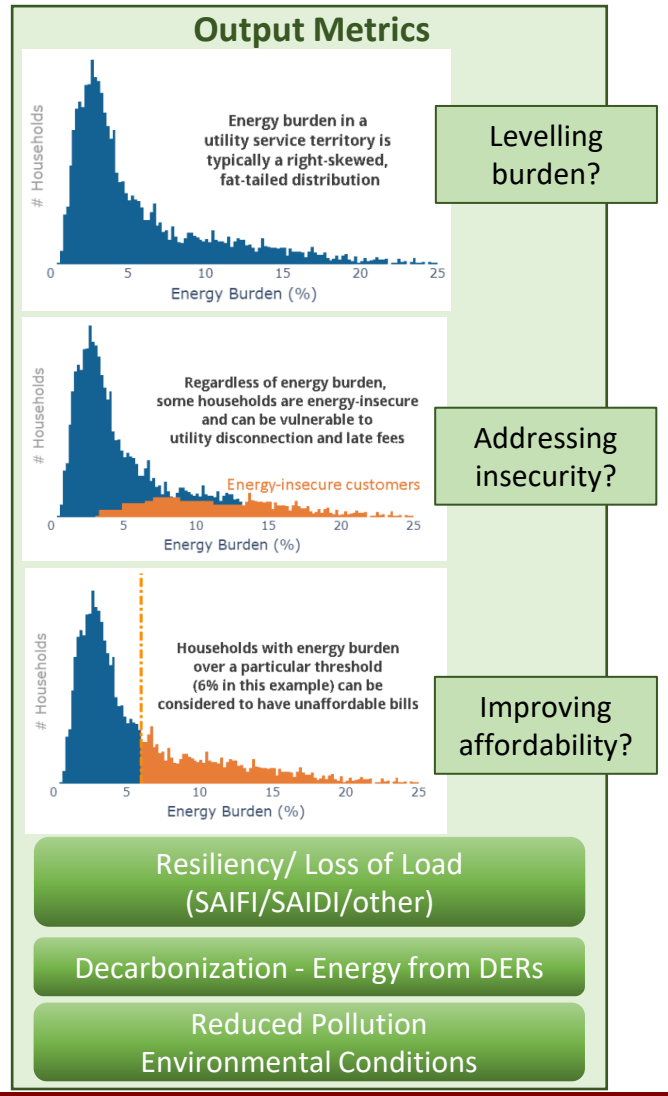
Equity in Grid Planning Current Practice

Transmission planning processes incorporate elements of procedural justice (through stakeholder engagement), but have never been tasked with addressing equity considerations such as:

- Cost allocation as it relates to customer rates and household energy burden and insecurity in disadvantaged communities (DACs).
- NERC TPL-001 standards and impacts to DACs.
- Comprehensive evaluation of siting impacts (beyond disruptions to viewsheds and land value), such as resettlement and tribal and cultural impacts.
- Transmission Expansions to support Renewable Energy Generation and Electrification of Transportation requiring redesigning of existing infrastructure to meet demands. Impacts to DACs.

Planning Paradigm	Treatment of Equity Within Paradigm
Transmission Planning	**None**

Translating Energy Equity Policy to a More Equitable Grid



- **New Analytical Framework Required:** Different from siting a facility or a discrete decision under environmental justice framework
- **Grid Planning Scales:** Distribution system planning is useful first framework – spatial in nature, closely connected to community experience
- **Missing Insights on Investments to Effects:** No one single attribute of the grid is sufficient for energy equity – may be composite or index until clearer insights about which are the most meaningful in practice
- **Tradeoffs and Co-Optimization:** Strong relationships, including tradeoffs, with other objectives

Measuring Equity

Target Population Identification

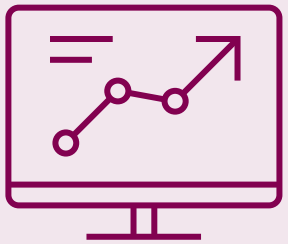
- Program equity index
- Program accessibility
- Energy cost index
- Energy burden index
- Late payment index
- Appliance performance
- Household-human development index

Investment Decision Making

- Community acceptance rating
- Program funding impact
- Energy use impacts
- Energy quality
- Workforce impact

Program Impact Assessment

- Profits
- Program acceptance rate
- Energy savings (MWh)
- Energy cost savings ($)
- Energy burden change
- Change in household-human development index score



See *Review of Energy Equity Metrics*
https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-32179.pdf

Effects and More Equitable Outcomes

Recognition	• Ending disconnections (e.g., commitment to reduce or end disconnections, moratorium on shutoffs for customers with severe or extreme energy burdens) • Maximizing resilience, minimizing vulnerabilities (e.g., targeted program investments for communities and households facing severe climate and health risks)
Distributive	• Maximizing co-enrollments in affordable rates, payment plans, and clean energy programs (e.g., notify disadvantaged customers of the programs they qualify for) • Enabling energy affordability (e.g., commitment for reducing the distribution of high energy burdens)
Restorative	• Integration in cross-sector and long-term planning (e.g., quantitative and qualitative treatment of equity in long term plans and models) • Wealth building (e.g., on-bill financing with special terms for disadvantaged customers, no caps on DERs and storage)
Procedural	• Enabling participation (e.g., participation stipends, intervenor funding for disadvantaged community engagement) • Unbiased evaluation (e.g., no conflict-of-interest w/ third party evaluators, evaluation open for public input, access to original data)

Extending Energy Equity Metrics

Procedural and Recognition (due process and accountability)	**Distributive** (affordability and availability)	**Restorative** (intra- and inter-generational sustainability and responsibility
• Representativeness and inclusiveness of planning processes for all affected stakeholders • Responsiveness of planning processes to public participation and fairness of decisions • Transparency of planning processes and decisions	• Electricity cost burden (i.e., household electricity bills/income) • Electricity affordability gap • Electricity quality (e.g., geographic disaggregation of outage frequency/severity; restoration efficiency) • Electricity program (e.g., tax credits; energy efficiency) and technology (e.g., BTM solar and storage) accessibility and performance (e.g., participation/investment demographics; distribution of savings/costs, reliability/resilience, or other benefits/burdens) • Social burden (i.e., effort and ability to access critical services)	• Economic (e.g., job training/job quality; energy resource ownership/governance; reparation of electricity cost burden shouldered by energy burdened communities) • Environmental (e.g., natural resource replenishment; generation/storage resource siting) • Social (e.g., improvements in household-human development index; establishment of safeguard/grievance redress mechanisms)

Creating Transparent Process with Stakeholders

Identify Stakeholders

- Community members
- Disadvantaged Communities
- National Agencies
- Regional Agencies
- State Agencies
- Local Agencies
- Policy Makers
- Regulators
- Utilities
- Industry Experts

Roles & Responsibilities

- Meet with stakeholders to:
  - Define roles for each stakeholder
  - Identify responsibilities for stakeholders in relation to timing in IDSP process

Iterative Feedback Process

- Incorporate stakeholder feedback in creation of iterative process
- Include policy and regulation schedules.
- Address accessibility of community members in feedback process (ex: transportation, technology, language, etc.)
- Incorporate feedback into policies

Implementation into Planning Objectives & Criteria

- Transparency and communication of the following:
  - Final policies and regulations
  - Planning Objectives and timing of implementation
  - Criteria, metrics, and reporting
  - Performance and feedback to stakeholders

Community Engagement to Define Equity Considerations

Opportunities to Identify and Include Communities & Stakeholders

- Recognition of communities not participating
- Addressing processes that impact equity
- Education of processes to participate

Identify Key Equity Considerations

- Gather stakeholder feedback for defining equity considerations
- Consolidate identified equity considerations
- Incorporate equity considerations in planning process

Thoughts and Feedback

- Energy justice and energy equity
  - How are your organizations defining energy equity? Do you see consistency with other organizations' definitions?
- Emerging grid objectives (*equity*) white paper
  - How is equity being included in grid planning? Are there any best practices we should look at?
- Equitable stakeholder and community engagement in grid planning
  - What types of challenges are you seeing in equitably engaging underserved/DAC communities?

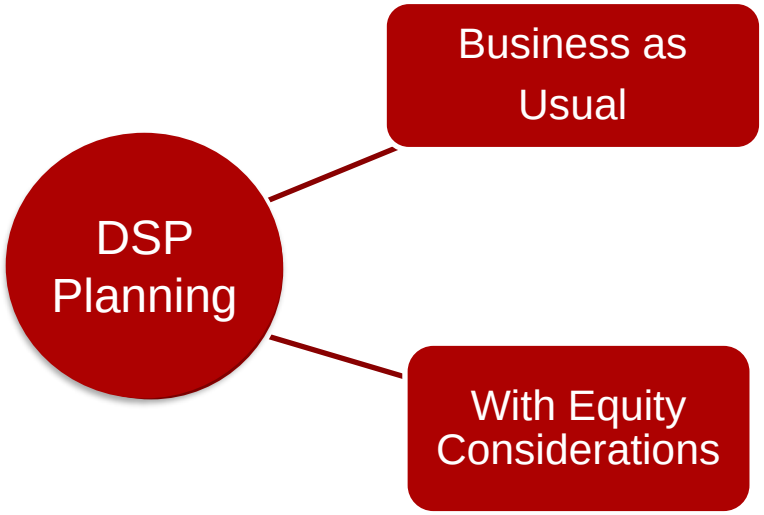
The Need for Energy Equity Simulation Analysis

- Inclusion of ***energy equity*** in planning is a complex process and is not yet well explored by utilities or existing literature.
- Most utilities are not likely to have sufficient data and approaches to model energy equity effects.
- Utilities prefer *insights* into trade-off among emerging objectives such as equity/resiliency and traditional objectives such as affordability/efficiency etc.

Purposes of simulation work in MOD-Plan

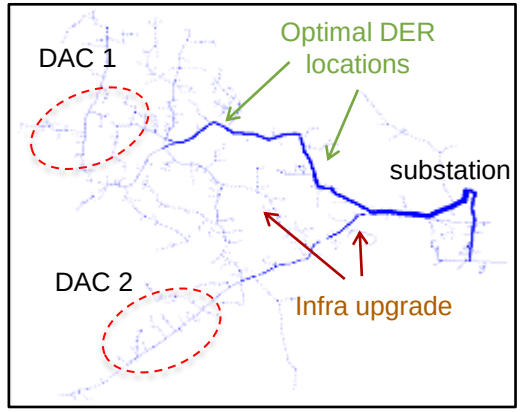
1) Lab-simulation to offer high-level insight to utilities without expansive data and complex approaches.
2) To validate equity in planning practice in partnership with utilities.

Potential Impact of Equity Analysis Outcome



Impact on Outcome

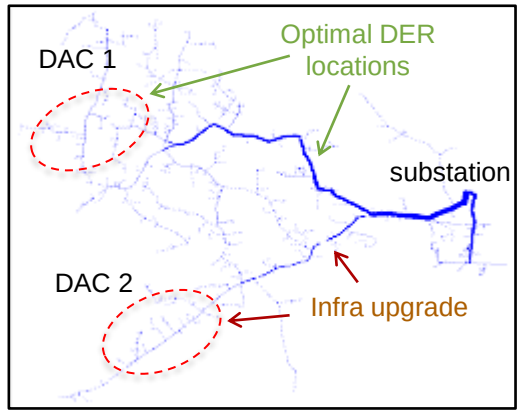
Major focus on cost and reliability



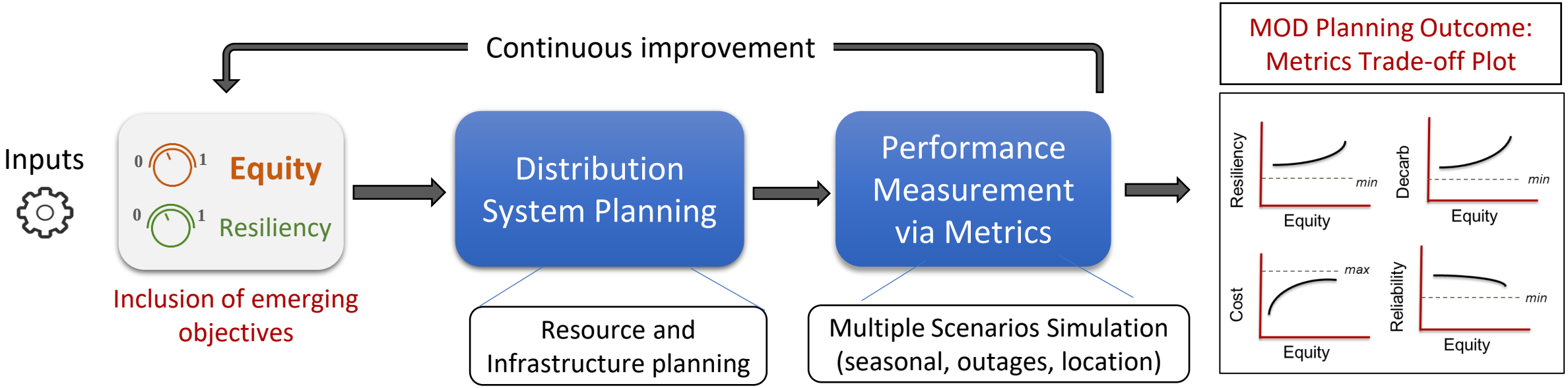
Potentially different investment strategy

Insights into what part of the feeder needs to be prioritized

Insights into how to reduce energy burden and increase DAC resiliency



Simulation Framework



Different investment strategies can be analyzed by adjusting the dial of emerging objective considerations:

- ✓ Equity = 0 : business as usual
- ✓ Equity = 1: high equity consideration

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

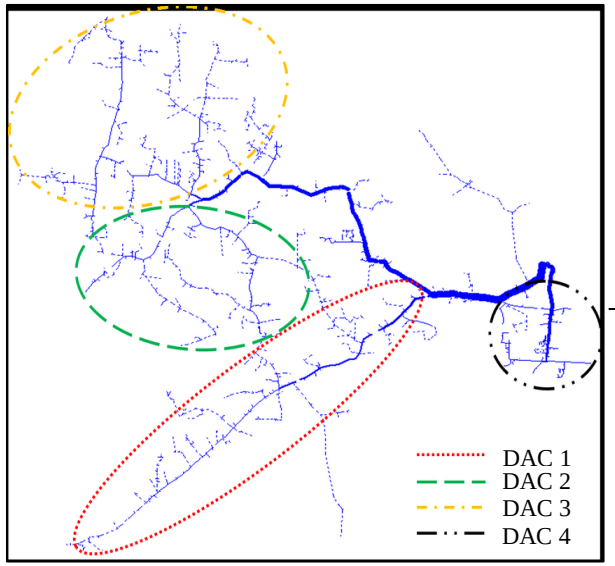
energy assistance

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

Modeling Equity in DSP Process

	Equity Characteristics		Planning process	Potential Impact on Outcome
1	Energy assistance/demand response to DAC	→	Load Forecast	Reduced energy burden for DAC
2	DER incentives/rebates	→	DER adoption	Increased DER adoption in DAC
3	$x\%$ of DAC load served from DER	→	Utility DER locational distribution	Improved energy access and security
4	A community center with black-start DER units for outages	→	Utility DER locational distribution/ microgrid planning	Improved resiliency in DAC and reduced energy vulnerability
5	Necessary infra upgrade to host DERs in DAC regions	→	Infrastructure upgrade planning	Improved resiliency in DAC

Monte-Carlo Methodology

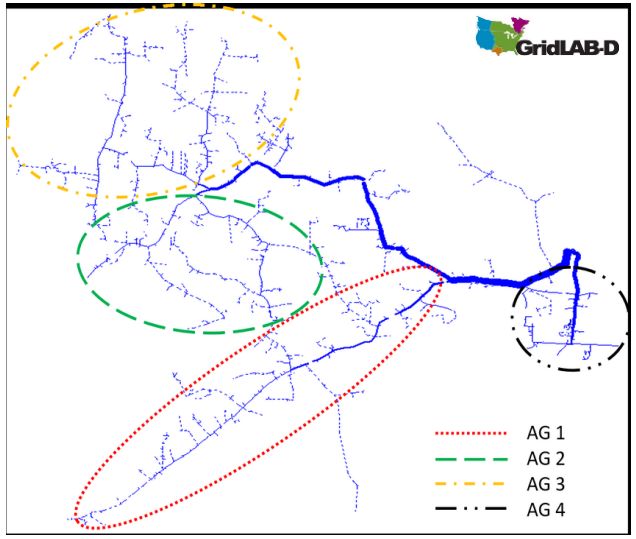
- An alternative to expansive real-world data requirement from utility
- Provides statistical insights with bounded parameters range

Uncertain Parameters

- House-level load growth
- List of possible outages/ contingencies
- House-level DER adoption
- Boundaries for DAC regions
- Potential utility-owned DER locations
- Load and DER profiles

100s of scenarios

Monte Carlo simulation on feeder



Metrics

- Losses
- Energy served from renewables
- SAIFI/SAIDI
- Energy burden
- Energy access
- Energy security
- Cost analysis

Overview of MOD Planning

Planning Considerations

- DAC identification
- **Equity constraints**
- Projected Net Load Growth
- Projected DER adoption
- Energy Assistance Program
- Demand Response Incentive
- Decarbonization mandates
- Asset life cycle assessment
- Critical asset identification
- Budget

Planning Process: Monte Carlo Method

House-level load growth | House-level DER adoption | Boundaries for DAC regions

List of possible outages/ contingencies | Potential utility-owned DER locations | Load and DER profiles

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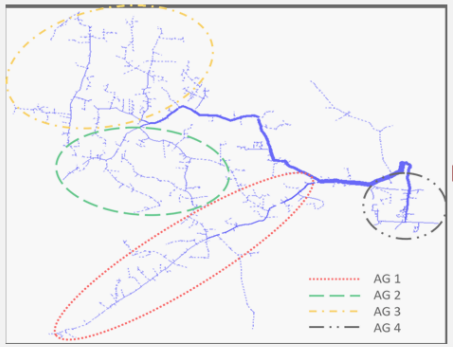

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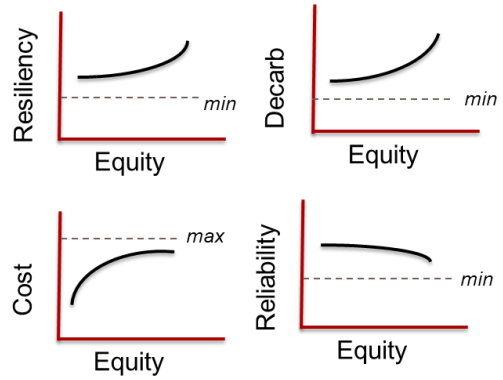
MOD Planning Outcome



Trade-off Analysis Plot

+

Insights on how equity inclusion changes the investment priorities

Thoughts and Feedback

- Proposed simulation framework feasibility
  - What part of the simulation framework are utilities able to do considering their respective policy/other constraints?
- What actionable insights do utilities look for that the simulation framework can support?
  - How can the proposed simulation framework help stakeholders understand short/long-term investments?
- What are the current challenges for utilities in integrating equity in grid planning?
  - Data accessibility?

    Suggested identification of foundational data types:
    - Energy burden data — household income and energy costs
    - Energy poverty data — # of households who do not have power
    - Infrastructure assets (Bulk & Distribution systems and components)
    - Customers served by REs and DERs in relation to DACs
    - Outage data (SAIDI, SAIFI, CAIDI in relation to DACs)
    - Equity considerations — community engagement (DACs, utility customers, consumer advocates)
- Utility interest to participate as a partner

Continuation of Energy Equity and Simulation Work

Partnering with utilities:

- Develop base case assessments
- Perform insight driven prioritization of utility portfolios to include energy equity
- Adapt the simulation approach to utility planning needs integrated with emerging objectives
- Stakeholder identification and inclusion mapping specifically for DACs

DSP Plan and Modeling Equity

Go to step 1 and repeat process with improved inputs

Pacific Northwest NATIONAL LABORATORY | Sandia National Laboratories

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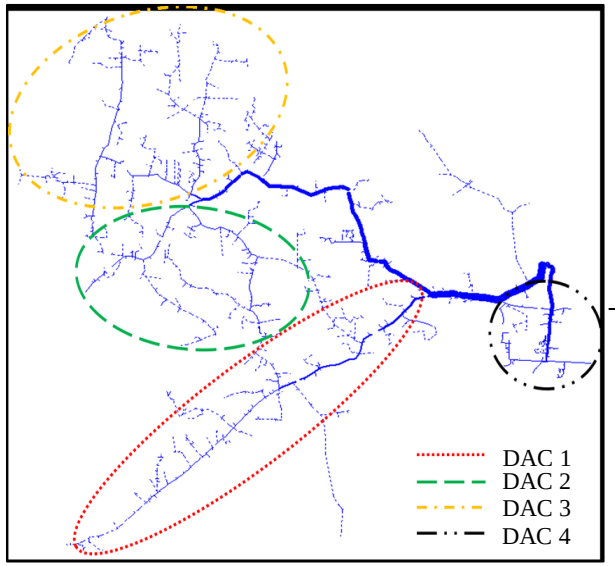

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statistical post-processing

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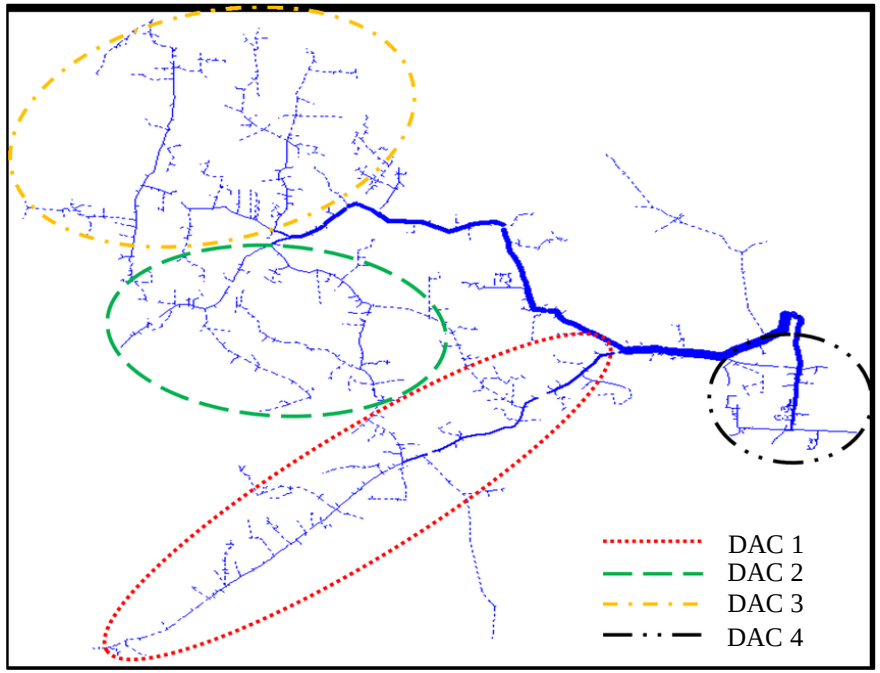
Equity input
Distribution system planning
Output metrics generation

Simulation Framework - I

Base Case Assessment

Purpose: To get system awareness of utility feeder

- Disadvantage (DAC) community identification
  - Based on income level to start with; later proximity to the critical load, medically vulnerability etc.
- Present equity status
- Critical loads and critical assets identification
- Life-cycle assessment of existing assets
- Current DER levels, EV adoption and net load



Simulation Framework - II

Load/BTM-DER Forecast

Purpose: To forecast load and customer level DER adoption subject to ***equity incentives**

- Load growth: **energy assistance program/ demand response program*
- BTM DER (solar and storage) adoption **equity incentives/rebate*
- EV adoption modeling (PNNL's EVAM): **equity incentives/rebate*

Utility DER investment (total capacity & mix)

Purpose: To plan optimal resource mix at utility level (DERs, DGs)

- High-level energy balance optimization with 30 years of planning horizon
- Objective is to minimize investment cost while meeting decarb goals
- Inputs: load/DER forecast, *cost associated with equity incentives, decarb goals
- Output: investment strategy with U-DER portfolio with a total capacity

Simulation Framework - III

U-DER Optimal Locational Distribution

Purpose: To optimally distribute U-DERs subject to ***equity constraints**

- Objective is to locate DERs to keep system within safe and reliable operational bounds
- Prioritized DAC infra upgrade

equity constraint

- Energy access: all DAC regions have at least x% load served from DERs
- Energy security: DAC regions have a common area (community center) in outages to access energy

Infrastructure Upgrades Assessment

Purpose: To obtain a list of assets that need upgrade to manage load growth even after utilizing DERs fully within equity constraints

With this step, we finalize the distribution system resources and infrastructure planning

Monte-Carlo Methodology

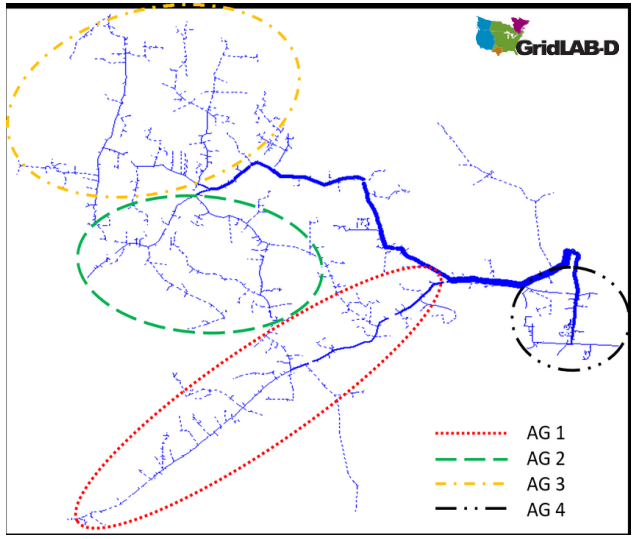
- A way to analyze a wide possibilities and scenarios to get metrics that are statistically significant

Uncertain Parameters

- House-level load growth
- House-level DER adoption
- List of possible outages/ contingencies
- Seasonal time-series

100s of scenarios

Monte Carlo simulation on feeder



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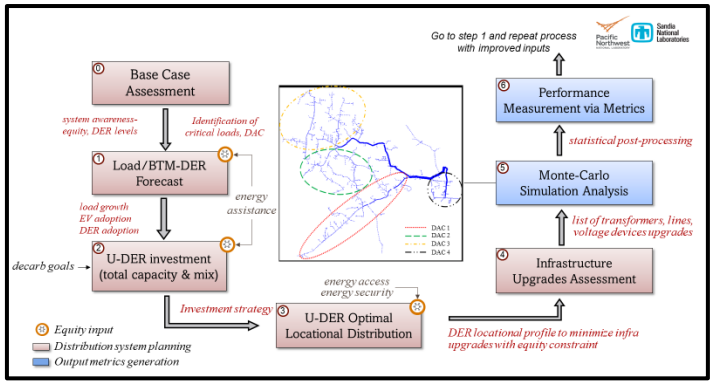
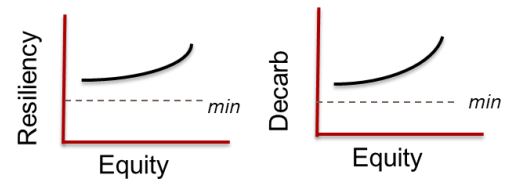
MOD Planning Process



MOD Planning Outcome



Trade-off Analysis Plot

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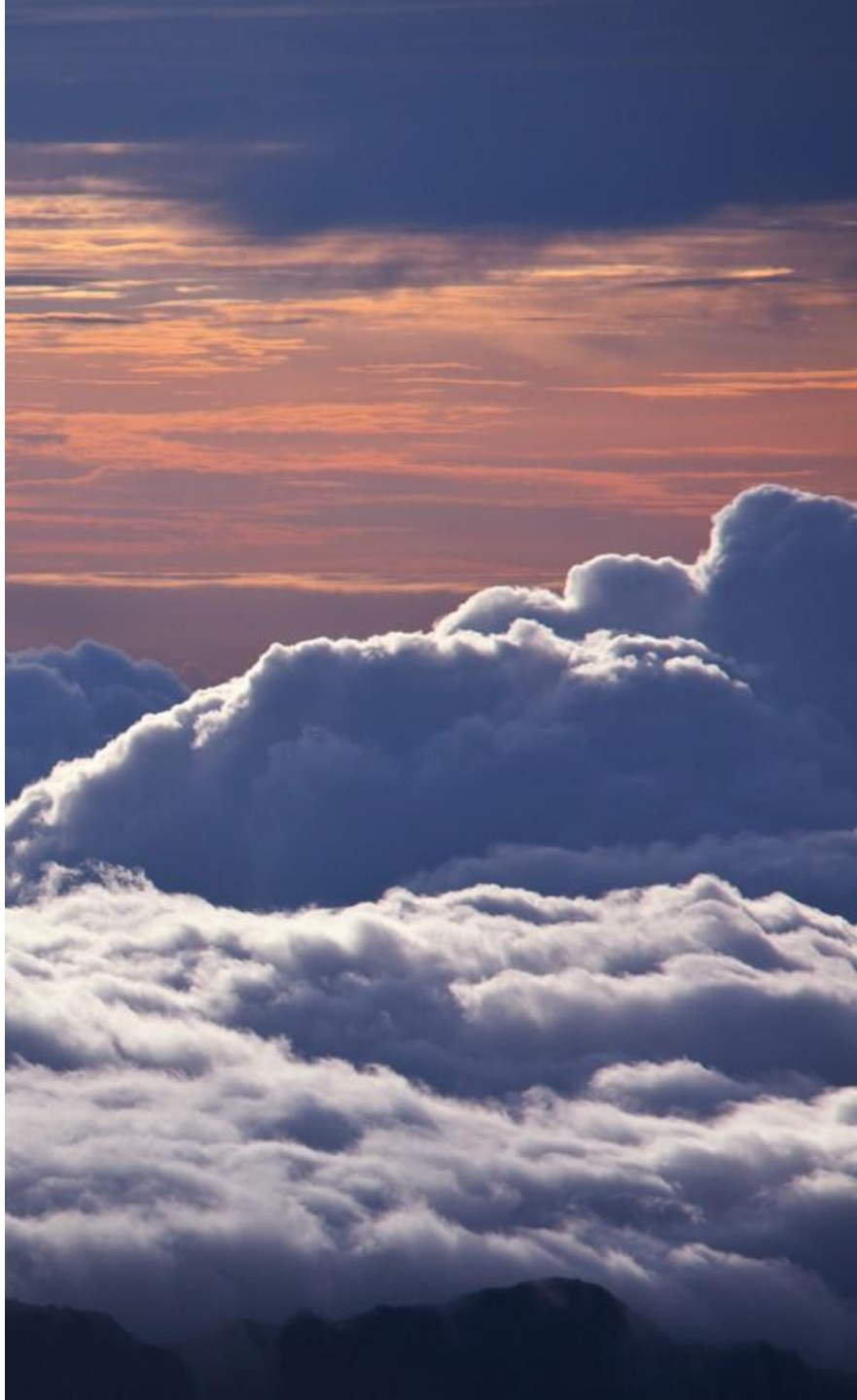
Insights on how equity inclusion changes the investment priorities



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

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