Climate Adaptation, Equity, and Resilience

An overview of work at Southern California Edison

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NARUC CPI: Resilience for Regulators Webinar
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Climate Adaptation and Vulnerability Assessment (CAVA) Overview

- Inaugural Climate Adaptation and Vulnerability Assessment (CAVA) filed on May 13th 2022
- CAVA evaluates the impacts of changing temperatures, SLR, flooding, and wildfire to our assets, operations, and services
- Near term climate adaptation measures are anticipated to be requested in the 2025-2028 GRC

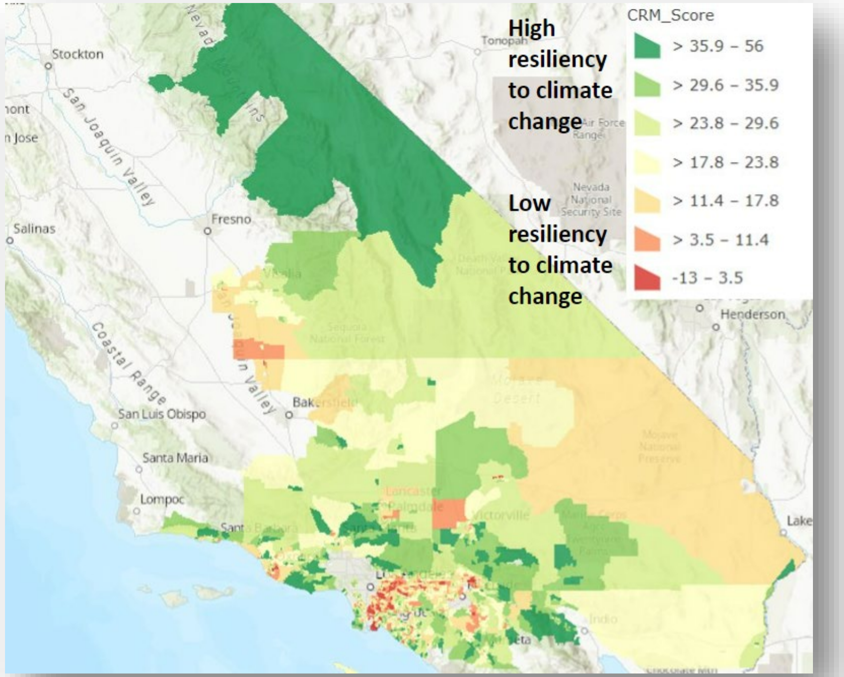
CAVA Equity Considerations Overview

1. CAVA process utilized existing Disadvantaged and Vulnerable Community (DVC) definition to guide community engagement

1) For CAVA, CPUC directed SCE to:
    1) Analyze how to promote equity
    2) Consult DVCs in determining levels of adaptive capacity
    3) Allow Community Based Organizations (CBOs) and DVC members to participate in the vulnerability assessment
2) SCE utilized opportunity to develop unique methods to best meet CAVA goals

Two equity metrics formalized to pilot prioritization and adaptation impacts for communities

Community Resilience Metric (CRM)



A set of scores measuring the sensitivity and corresponding adaptive capacity of a particular community to potential loss of utility service

Community Impact Metric (CIM)

CIM Metric	Community Burdens	DVC Cost / Benefit Ratio	Interrupted Elec. Service Resolution	Non-Reliability Public Benefit	Local Employment Impact
Adaptation Option 1	[Red]	[Green]	[Green]	[Yellow]	[Green]
Adaptation Option 2	[Yellow]	[Green]	[Yellow]	[Green]	[Green]

Set of indicators measuring the positive, negative or neutral effect of an adaptation action on the community it is deployed in

CAVA community engagement findings are integrated in CRM and CIM methodologies, which will be used to guide adaptation implementation plans

January 2021-May 2021
SCE Community Engagement Plan

October 2021-March 2022
CAVA Community Engagement

May 2022
CAVA Filed

2025 - 2028
Adaptation Implementation Plans

Outreach to community leaders to inform SCE's Community Engagement Plan filed in May 2021

Climate Resilience Leadership Group (CRLG) developed engagement plans and materials, plus administered ~800 surveys across over 70 CPUC-designated DVCs to inform CAVA.

Community feedback used to inform CRM and CIM Metrics

Climate Adaptation and Vulnerability Assessment (CAVA) released by SCE as a first-of-its kind utility look into 2030-2070 grid impacts across 50,000-square-mile service area

CRM and CIM metrics published

SCE's Adaptation Implementation Plans will incorporate equity metrics, which are informed or validated by the results of our DVC community engagement

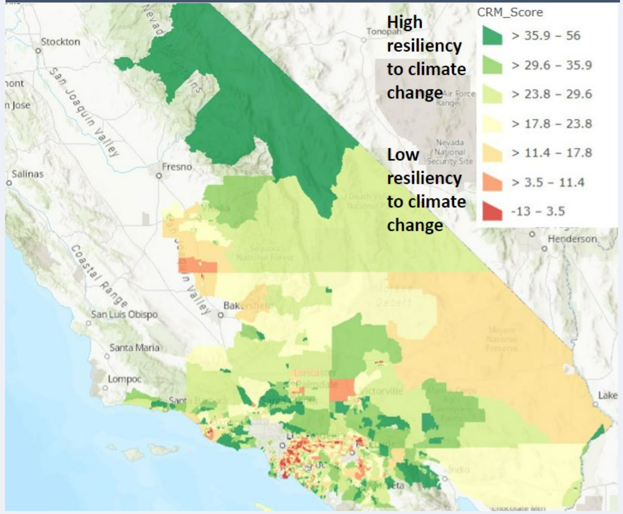
CRM and CIM metrics guiding investments

**DVC=Disadvantaged Vulnerable Community*

Next steps: piloting the use of equity metrics

1. *Guiding investments*

Community Resilience Metric (CRM)



Prioritizing investments

Community Impact Metric (CIM)

CIM Metric	Community Burdens	DVC Cost / Benefit Ratio	Interrupted Elec. Service Resolution	Non-Reliability Public Benefit	Local Employment Impact
Adaptation Option 1	Red	Green	Green	Yellow	Green
Adaptation Option 2	Yellow	Green	Yellow	Green	Green

Mitigating impacts on communities

Near-Term Adaptation Proposals

Service Transformer Proactive Replacement

Substation Transformer Replacements

Structure Brushing

New Circuit Tie Lines

Flood Resistant Switches

2. *Developing understanding of resilience needs*

Resilient Node Cluster Analysis Tool (ReNCAT)

- *Partnership with Sandia National Laboratories to consider social burden* of customers seeking to access critical non-electric services; analysis may help:*

Provide an intuitive, spatially-explicit, quantitative, and methodical insight into existing disparities in non-electric services

Understand priority facilities that are critical to keep online during outages

Consider results in prioritization of investments in electric and non-electric critical services

*Wachtel, Melander, Jeffers. Measuring Social Infrastructure Service Burden. Sandia National Laboratories, February 2022. https://energy.sandia.gov/download-sandias-resilient-node-cluster-analysis-tool-rencat/

Thank you! Questions?

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Advancing Energy Equity in Distribution System Planning

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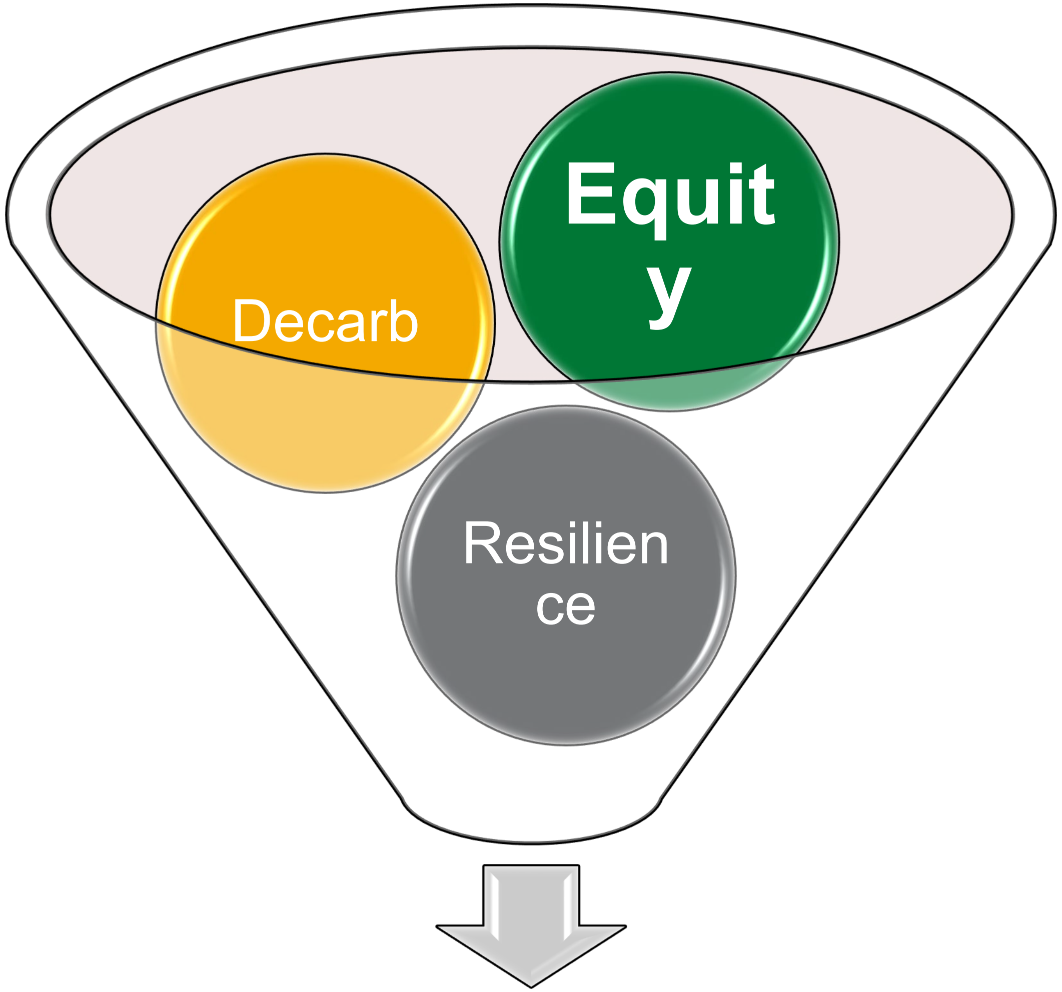
Emerging Objectives in Grid Planning

- 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.



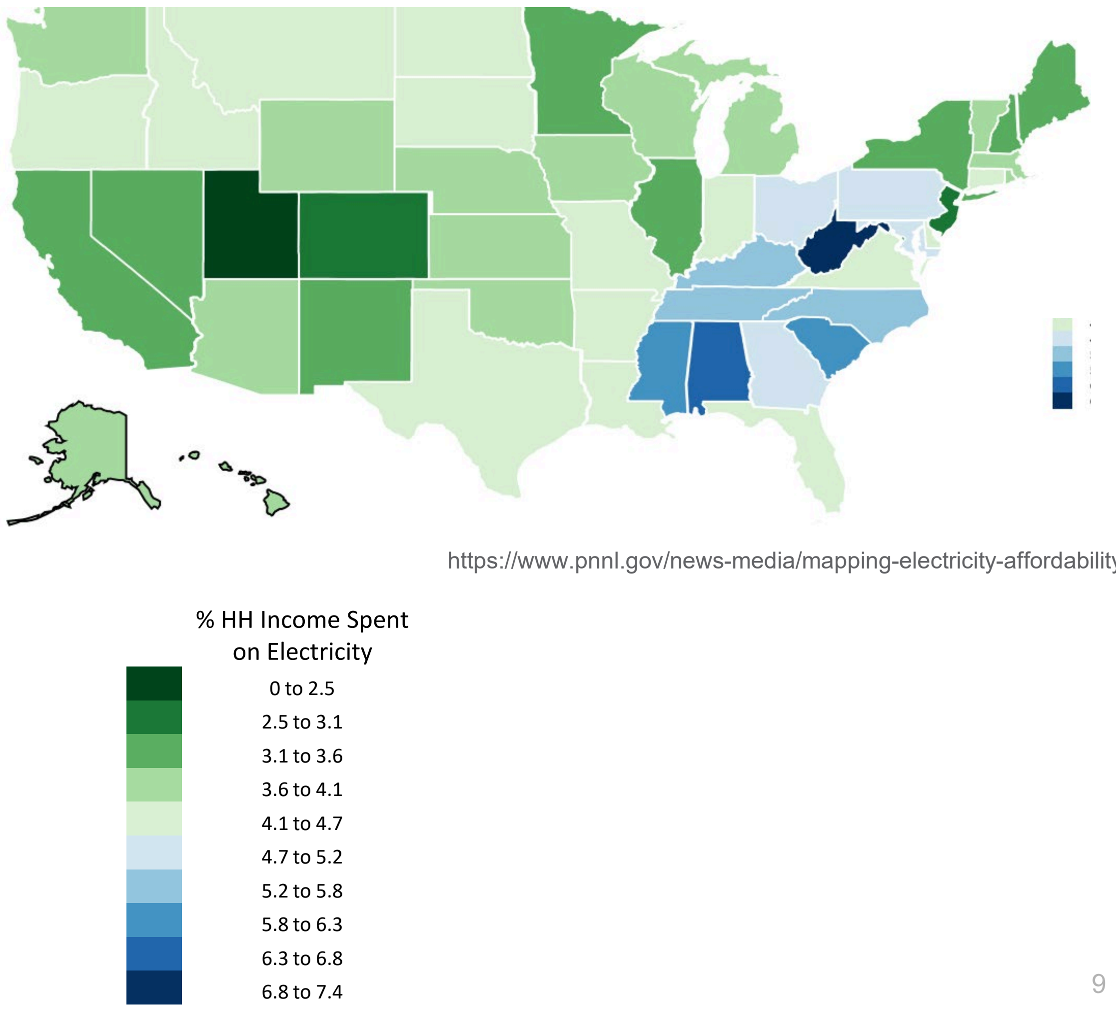
Equitable Resilient Clean Grid

Context

- Energy justice and equity examinations uncover the reality that not all customers have the same needs of the energy system. For example:
  - Elderly and disabled populations use energy in different ways and have different vulnerability profiles
  - Low-income households spend a higher percentage of their income on energy bills, relatively three times higher than affluent households (i.e., 6% of income on energy bills is a high energy burden and 10% is a severe energy burden)

- There is a clear demand for explicit work on energy equity and stakeholder engagement. More analysis can be done around:
  - Differentiating needs & interactions by demographics (age, race, health, rural, deep poverty) and compound, cumulative effects
  - Understanding the relationships between policies and grid futures and the impact on people
  - Designing technologies to be safer, to support well-being, and to include life-cycle implications
  - Recognizing the procedural limitations of energy system decision-making

Average Residential Electricity Cost Burden – Jan 2016



https://www.pnnl.gov/news-media/mapping-electricity-affordability

Environmental and Energy Justice: Definitions

- **Environmental Justice**
  "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate share of the negative human health or environmental impacts of pollution or environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies."[1]

- **Energy Justice**
  "Integrating justice principles, fairness, and social equity into energy systems and energy system transitions."[2]

- **Just Transition**
  "A transition away from the fossil-fuel economy to a new economy that provides dignified, productive, and ecologically sustainable livelihoods; democratic governance; and ecological resilience."[3]

Energy Equity
"Energy equity recognizes that disadvantaged communities have been historically marginalized and overburdened by pollution, underinvestment in clean energy infrastructure, and lack of access to energy-efficient housing and transportation. **An equitable energy system is one where the economic, health, and social benefits of participation extend to all levels of society, regardless of ability, race, or socioeconomic status. Achieving energy equity requires intentionally designing systems, technology, procedures, and policies that lead to the fair and just distribution of benefits in the energy system."**[4]

[1] https://www.epa.gov/environmentaljustice/learn-about-environmental-justice
[2] https://link.springer.com/article/10.1007/s40518-021-00184-6
[3] https://iejusa.org/glossary-and-appendix/#glossary_of_terms
[4] https://www.pnnl.gov/projects/energy-equity

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

*Energy Efficiency Equity Baseline (E3B)

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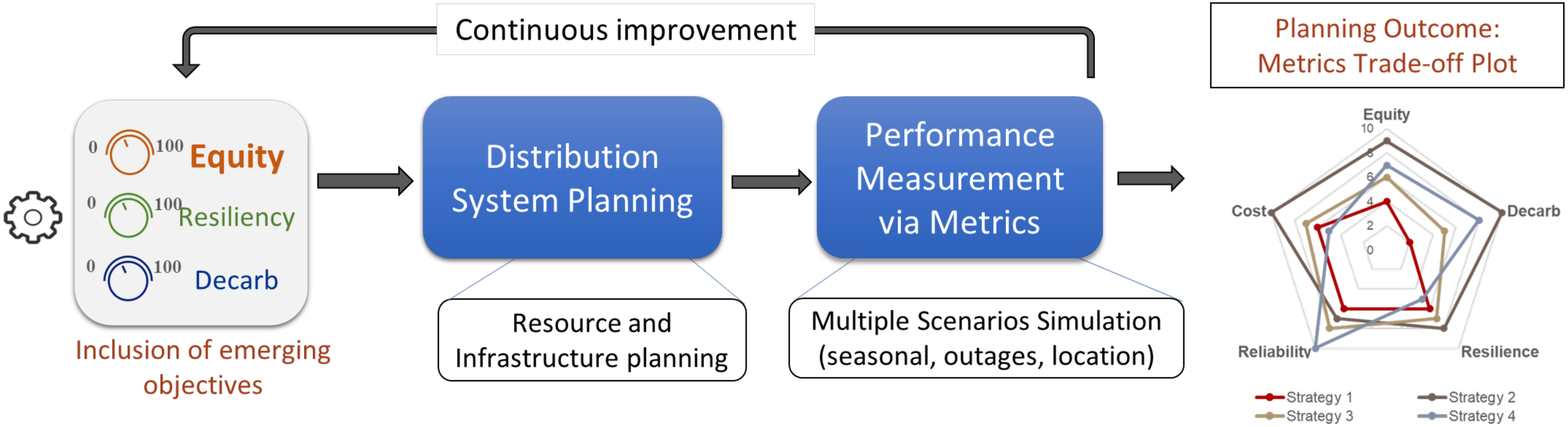
Equity-Aware Grid Analysis

Relevant Publication:

A. K. Bharati, A. Singhal, R. Jinsiwale, K. Kazimierczuk, J. Yoshimura and B. Tarekegne, "Advancing Energy Equity Considerations in Distribution Systems Planning," 2023 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference (ISGT), Washington, DC, USA, 2023, pp. 1-5, doi: 10.1109/ISGT51731.2023.10066350.

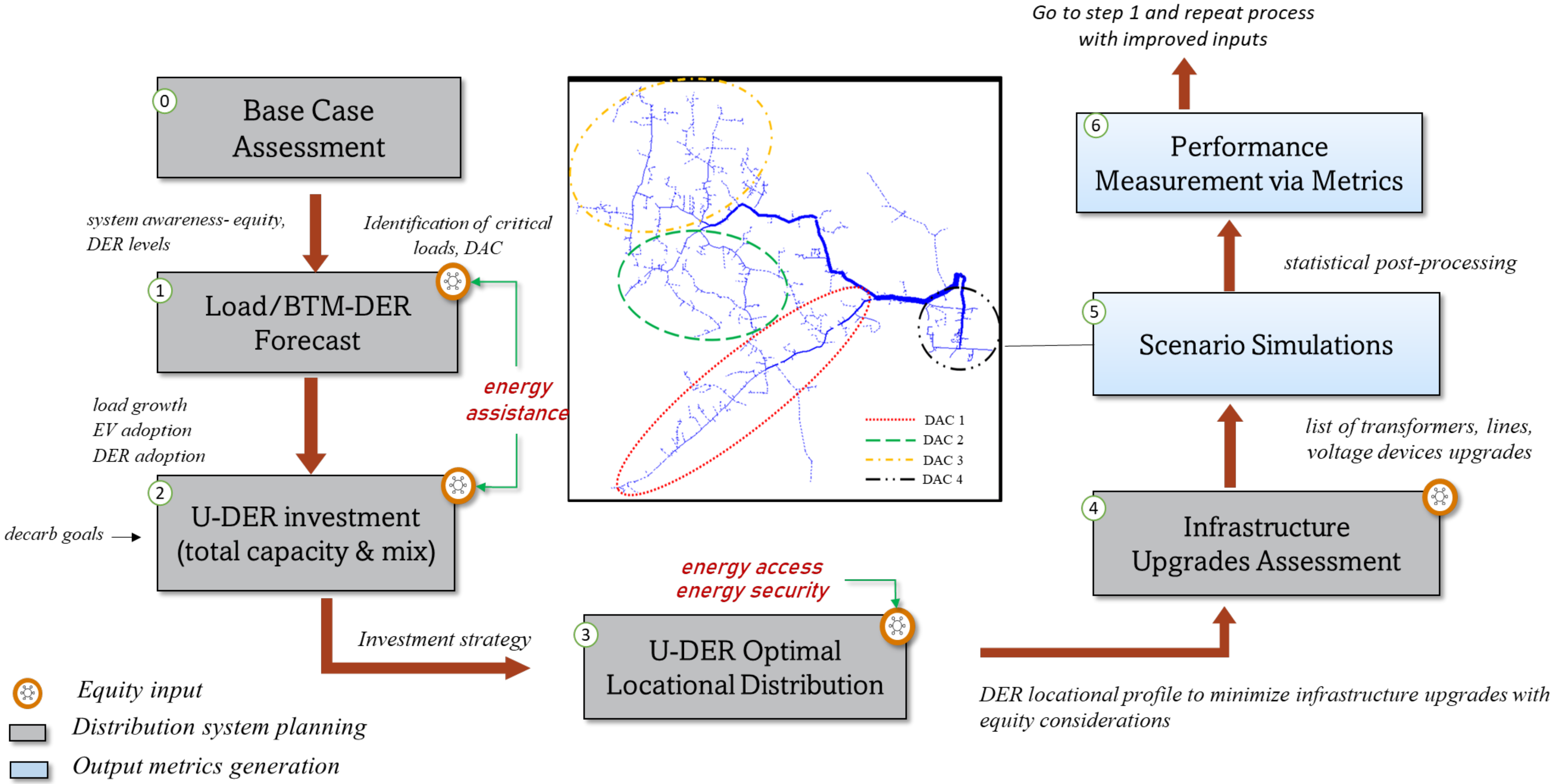
Simulation Framework



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

- ✓ Equity = 0 : Business as usual (BAU)
- ✓ Equity = 100: High equity consideration

DSP Plan and Modeling Equity



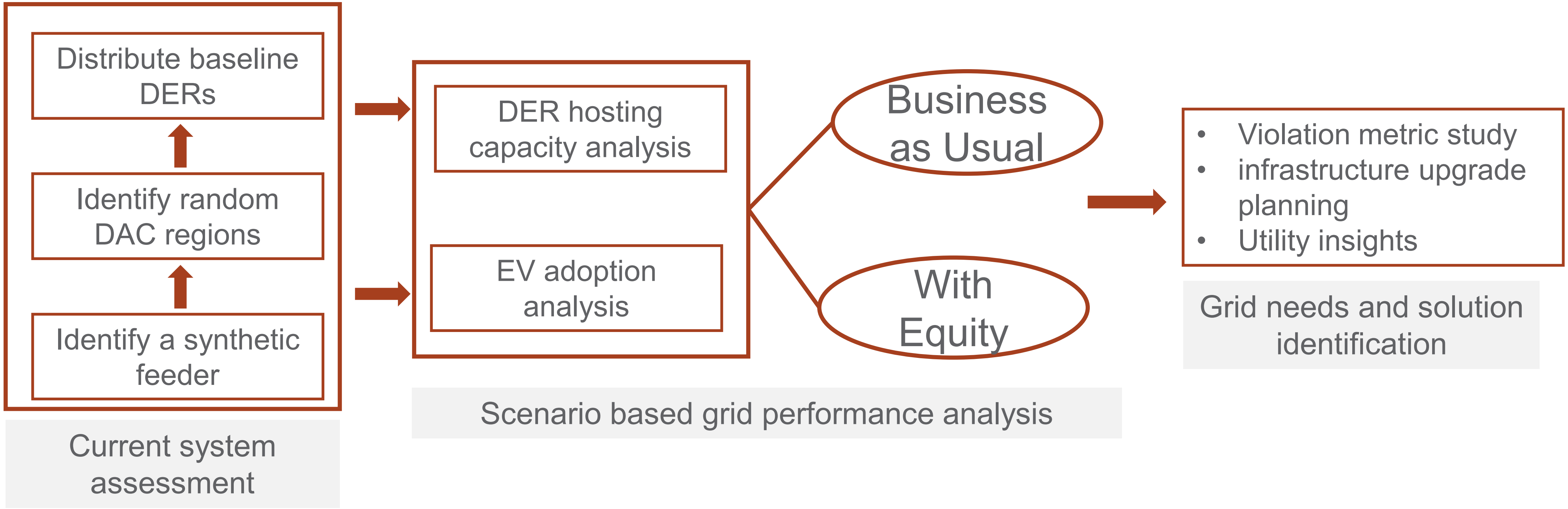
Modeling Equity in DSP Process

	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 infrastructure upgrade to host DERs in DAC regions	Infrastructure upgrade planning	Improved resiliency in DAC

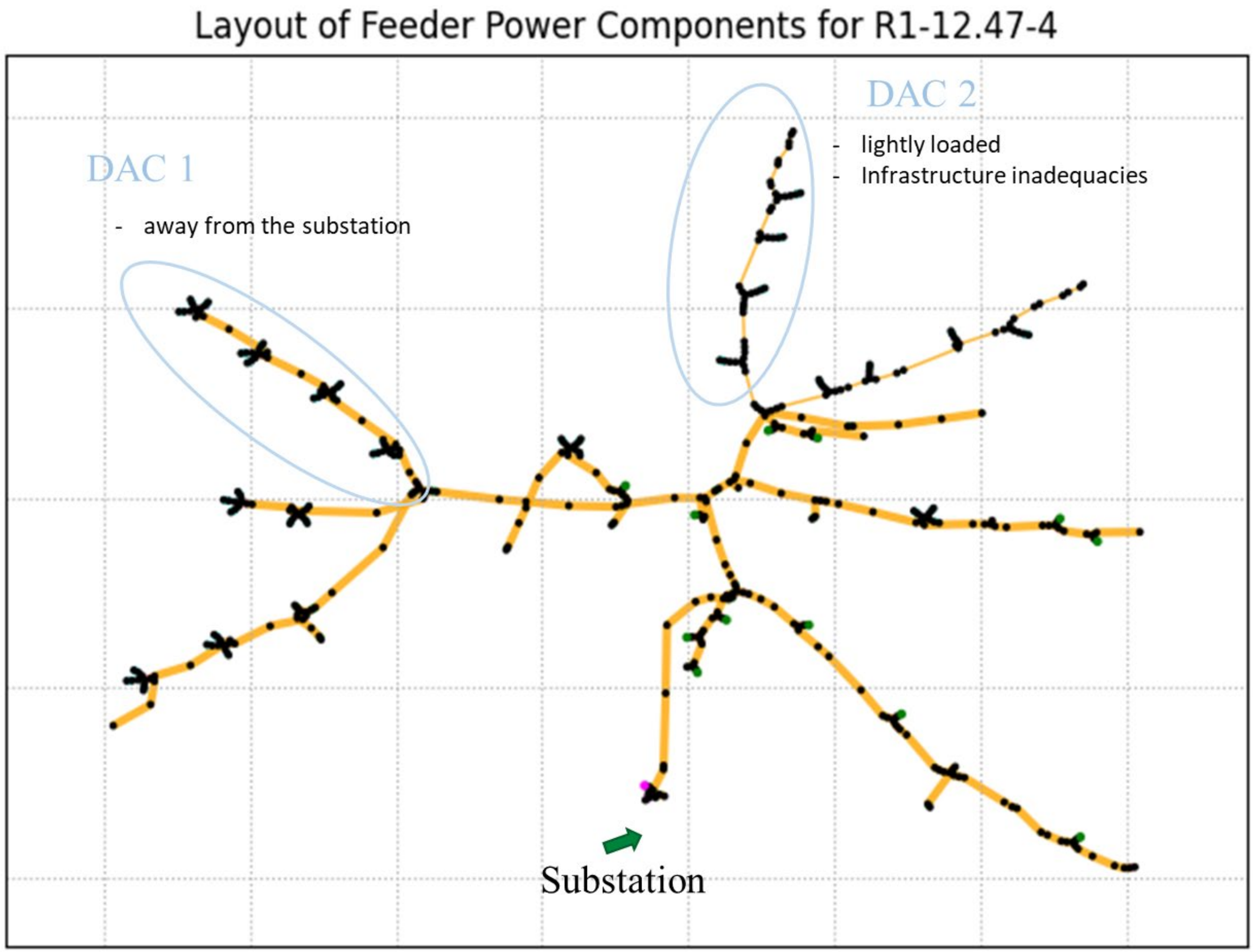
Equity Consideration: System Readiness

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



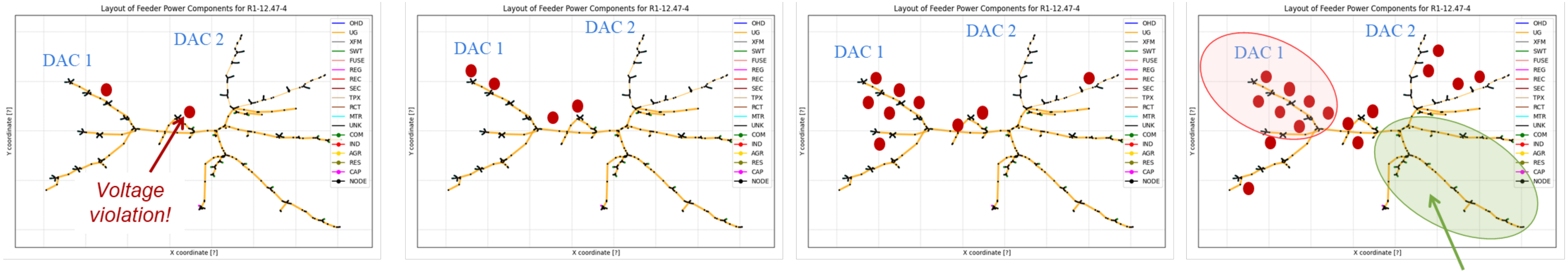
- A 300-node taxonomy feeder representing west-coast heavy sub-urban area

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)



80% PV | 100% PV | 120% PV | 140% PV

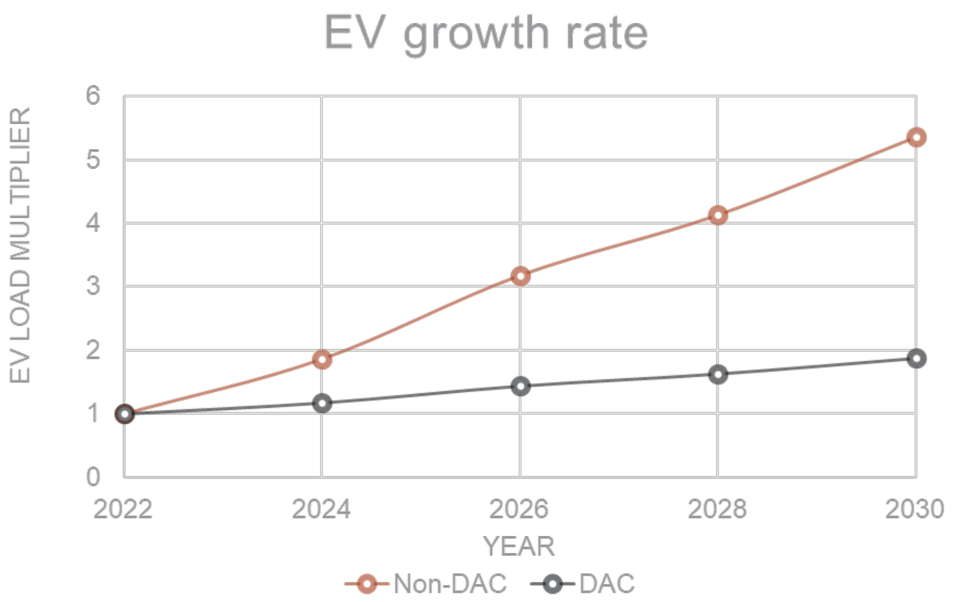
Suitable locations for PV

- DAC-1 turns out to be a region with high voltage violations with increasing solar PV penetration, making it unsuitable for hosting solar PV

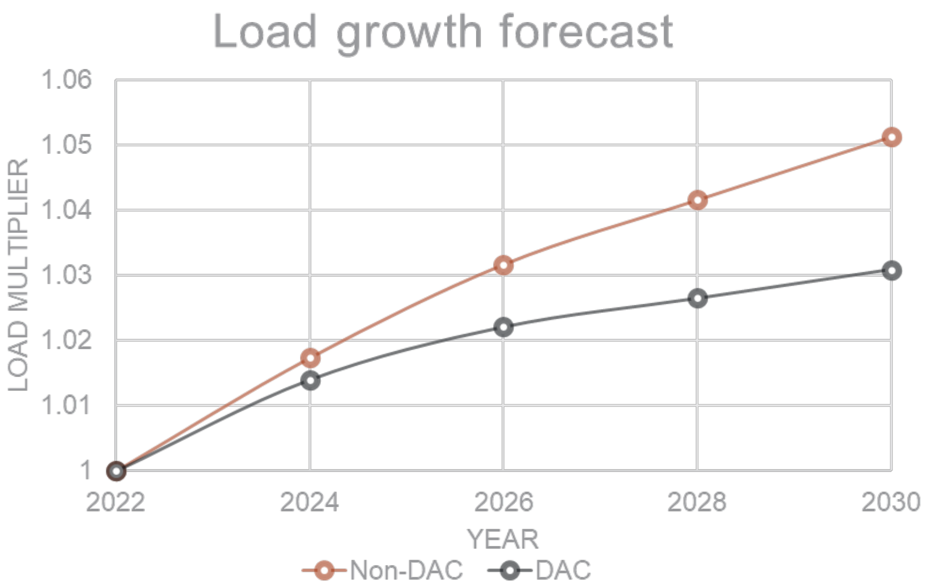
- Bottom right region of the feeder is better location for solar PV installments

** 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

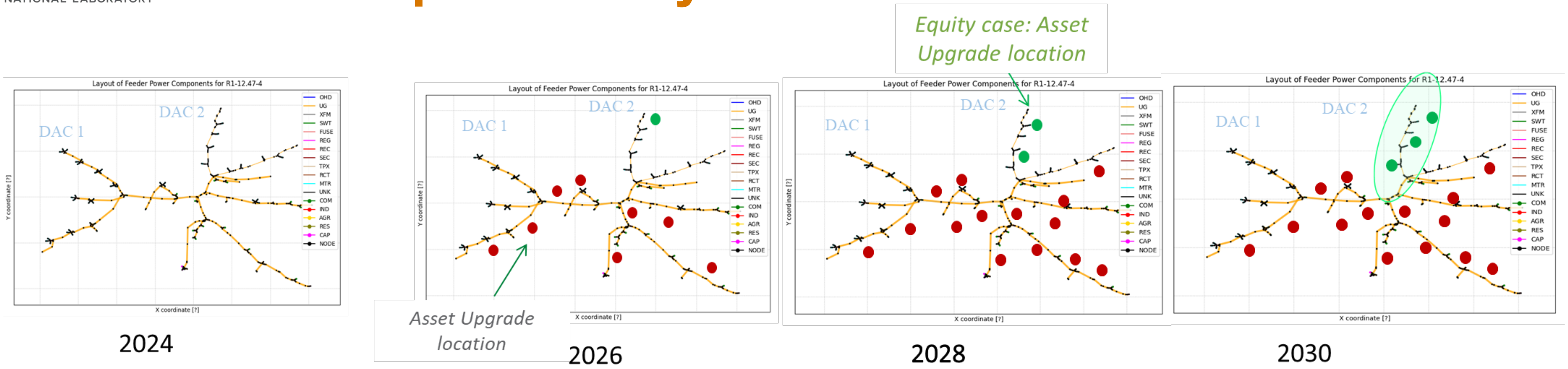
- Current (2022) EV adoption is assumed to be 25% and 5% for non-DAC and DAC regions
- DAC region growth is assumed to be 20% of non-DAC

- 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



# 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

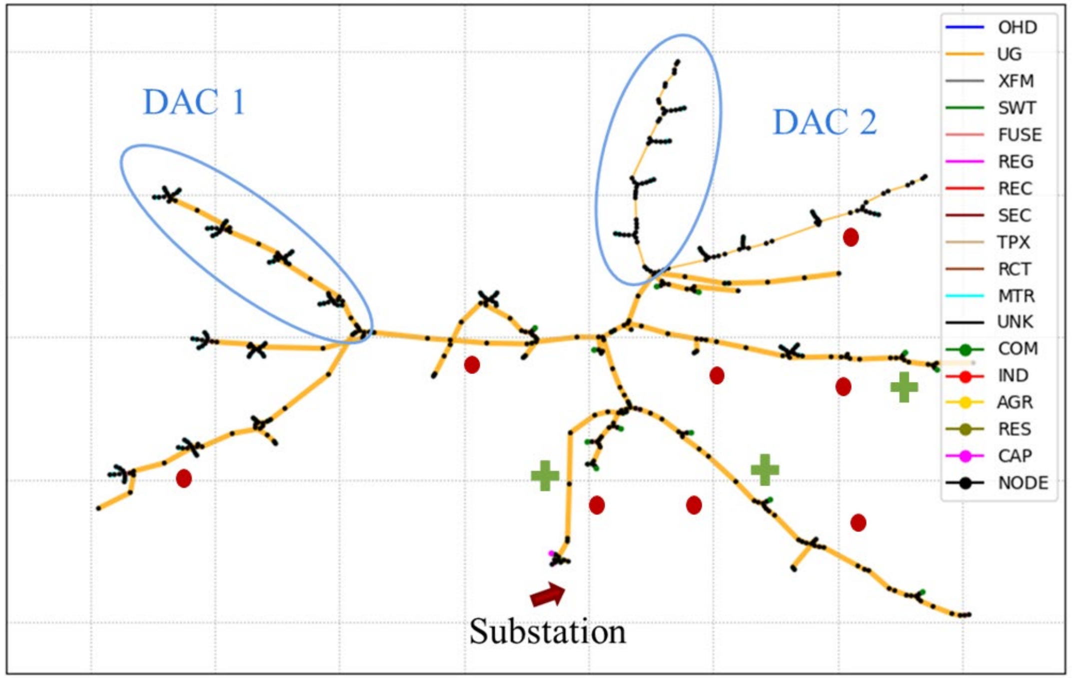
- Power-flow analysis for each year provides thermal violations of transformer and conductors due to EV adoption.
- In BAU: all upgrades are needed in non-DAC region;
- With equitable EV adoption: DAC region also need upgrade

** 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

Layout of Feeder Power Components for R1-12.47-4



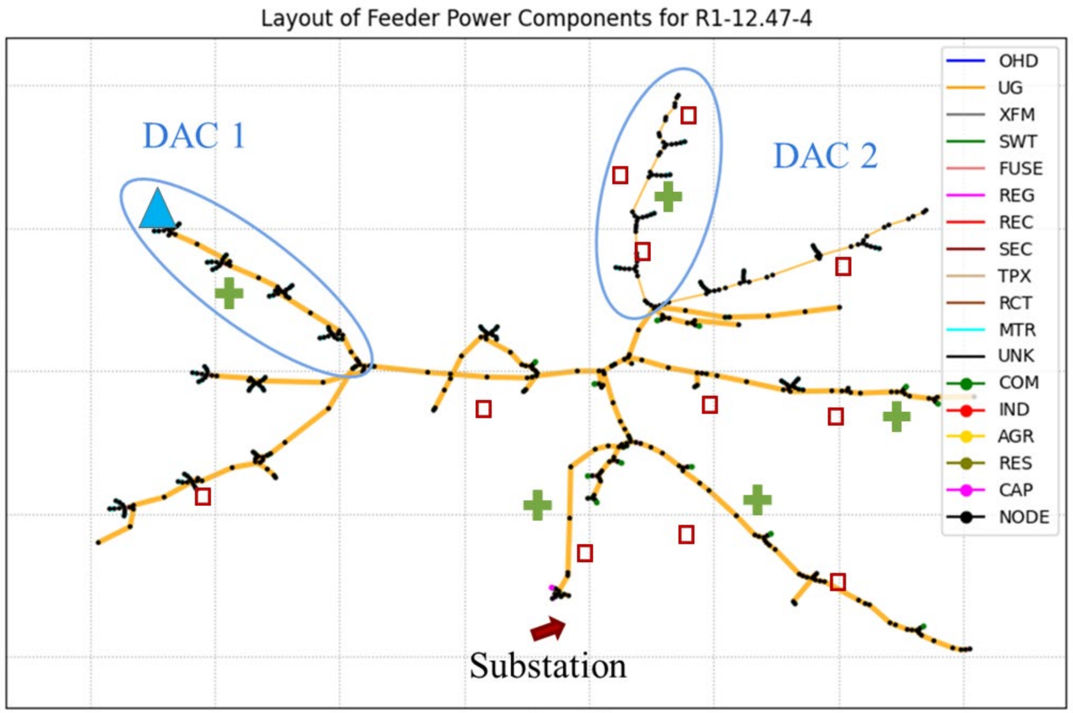
- Transformer and line upgrade
- Utility-level DER allocation

** 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:
  - Equitable DER access
  - Hosting capacity of DAC regions likely to make system more equitable and resilient
  - Improved Ancillary services from DER inverters such as volt/var, freq/watt, etc.

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

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Thank You

Acknowledgement

Support provided by Office of Electricity, US DOE

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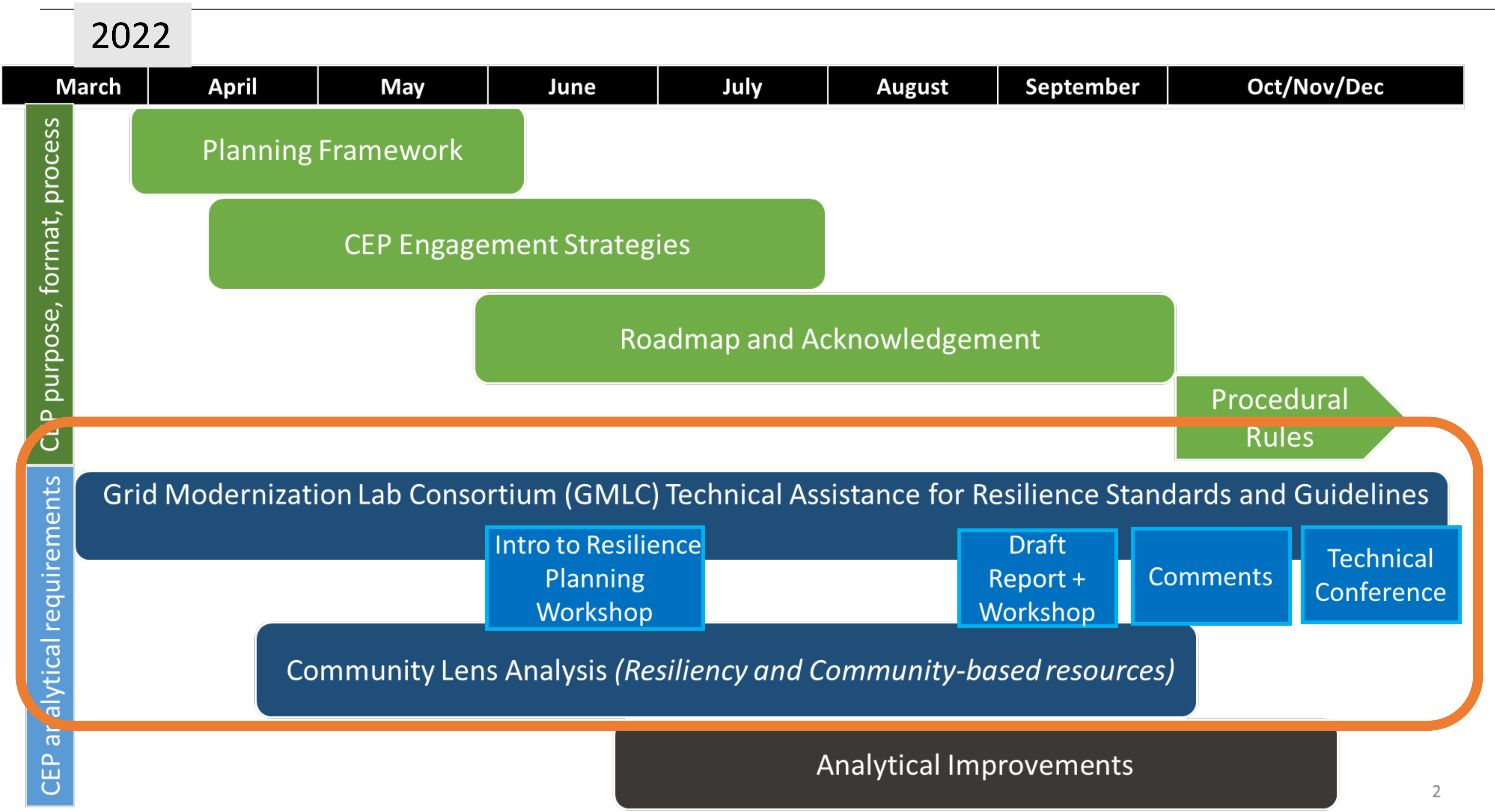
Advancing Equitable Community Resilience Through Stakeholder Engagement Strategies

NARUC
June 23, 2023

Clean Energy Plan (CEP) Investigation



§4(4)(c) Include a risk-based examination of resiliency opportunities that includes costs, consequences, outcomes and benefits based on reasonable and prudent industry resiliency standards and guidelines established by the Public Utility Commission

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Investigation Outcomes – Big Learnings

Define resilience goals

Develop system and resilience metrics

Characterize threats and their probabilities and consequences

Evaluate effectiveness and cost of alternative resilience measures for avoiding or mitigating threats

- Standards are still emerging
- Resource planning (IRP/CEP) is just a slice of resiliency
- Resilience value of a resource is dependent on design and operations
- Analysis is both *procedural* and *quantitative*
- Resilience is a priority Community Benefit Indicator (CBIs)

Resilience opportunities are priority Community Based Renewable Energy Projects (CBRE)

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Investigation Outcomes – Analytical Expectations

Evaluating risks

- Consider *community* resilience
- Take a broad look at outage types, causes, and customer impacts – incl. demographics
- Leverage risk analysis from other efforts e.g., wildfire, DSP

Identifying Opportunities

- Establish annual acquisition targets for CBREs using CBIs and community input
- Evaluate all actions on CBIs
- Focus on actions with emissions reduction value

Transparency and accountability

- Thoroughly describe analysis and engagement
- Consider opportunities to work with local planning
- Describe feasibility of any specific actions

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Looking Forward

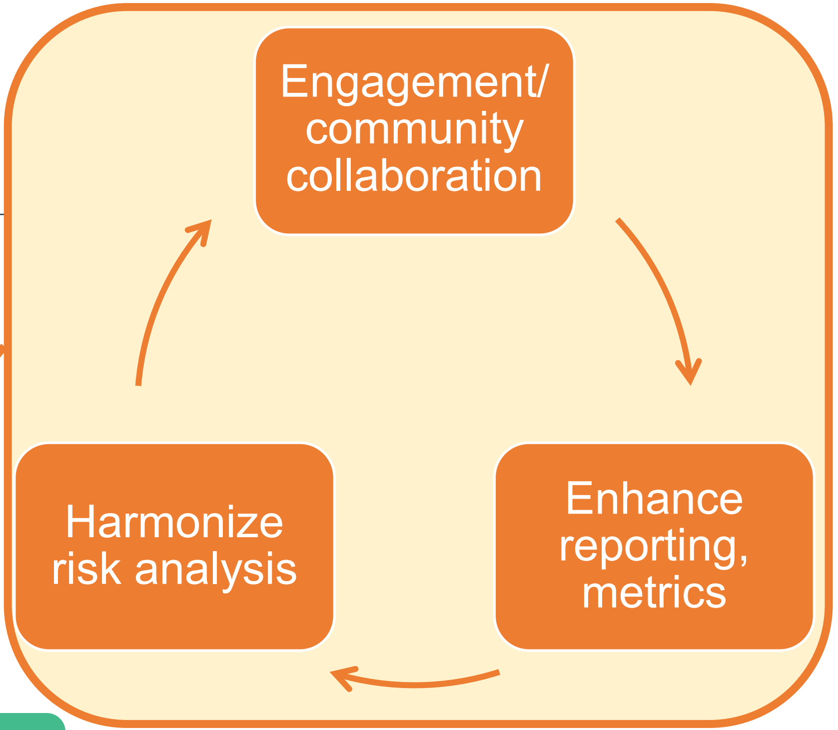
Review CEP/IRP and resulting programs

Incorporate resilience best practices into other planning and activities e.g. DSP, wildfire, UCBIAG, reliability reports

Focus existing frameworks e.g., interconnection, compensation, community tariff

Look to integrate planning and evolve investment decision frameworks

Continue to collaborate



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Utility Community Benefits and Impacts Advisory Groups

Centering Environmental Justice

- Representative of impacted communities
- Provide community lens across utility processes
- Consult on biennial report filed with Public Utility Commission that describes:
  - Energy burden and disconnections
  - Contracting practices
  - Resilience
  - Grid investments

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Environmental Justice Advocate Perspectives

Priorities and Best Practices

- Prioritize transparency around feedback, how it is collected, and how it is used
- Partner with organizations and individuals who have experience engaging community members in shared learning, education, and level-setting
- Develop comprehensive engagement plans that center direct community feedback with UCBIAG discussions
- Work collaboratively with UCBIAG members on operating guidelines and level-setting
- Clearly articulate to UCBIAG members what the utilities see as the role of the UCBIAG to help inform participation
- Partner with EJ advocates to develop content and input brought before UCBIAGs

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Opportunities and Observations

Reflecting on challenges in engagement

- Accountability and feedback loops
- Moving toward meaningful engagement and substantive topics
- Avoiding “framing bias”
- Ensuring UCBIAGs are additive to rather than substituted for existing environmental justice advocacy

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Questions?

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