INTERCONNECTION INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

Equity and Energy Justice
Distributive, Recognition, Procedural, and Restorative Justice in Interconnection | 5/17/23

An initiative spearheaded by the Solar Energy Technologies Office and the Wind Energy Technologies Office

Meeting Notes

Notes Synthesizing key points, insights, and questions from the meeting can be found here: BOX Link

Interconnection Innovation e-Xchange (i2X)

Mission: To enable a **simpler**, **faster**, and **fairer** interconnection of clean energy resources while enhancing the **reliability**, **resiliency**, and **security** of our **distribution and bulk-power electric grids**

Stakeholder Engagement

Nation-wide engagement platform and collaborative working groups

Data & Analytics

Collect and analyze interconnection data to inform solutions development

Strategic Roadmap

Create roadmap to inform interconnection process improvements

Technical Assistance

Leverage DOE laboratory expertise to support stakeholder roadmap implementation

The first half of this Teams call is being recorded and may be posted on DOE's website or used internally. If you do not wish to have your voice recorded, please do not speak during the call. If you do not wish to have your image recorded, please turn off your camera or participate by phone. If you speak during the call or use a video connection, you are presumed consent to recording and use of your voice or image.

Virtual Meetings Code of Conduct

1. *Assume good faith and respect differences*
2. *Listen actively and respectfully*
3. *Use "Yes and" to build on others' ideas*
4. *Please self-edit and encourage others to speak up*
5. *Seek to learn from others*

Mutual Respect . Collaboration . Openness

Key Outcomes from i2X e-Xchange Meetings

- Inform and formulate a ***publicly available***, strategic roadmap for interconnection
  - Topical challenges and issues
  - Practical solutions to implement and scale
  - Knowledge and data gaps and new solutions to pilot
  - Success goals and measures of success
- Summary documentation for each meeting regarding ideas discussed and opportunities for targeted stakeholder action
- Provide platform for ongoing engagement before and after meetings
- **Longer term vision** → Solution e-Xchanges to continue building a national forum for all stakeholders as a community of practice, excellence, and innovation

i2X Solution e-Xchange Topic Areas

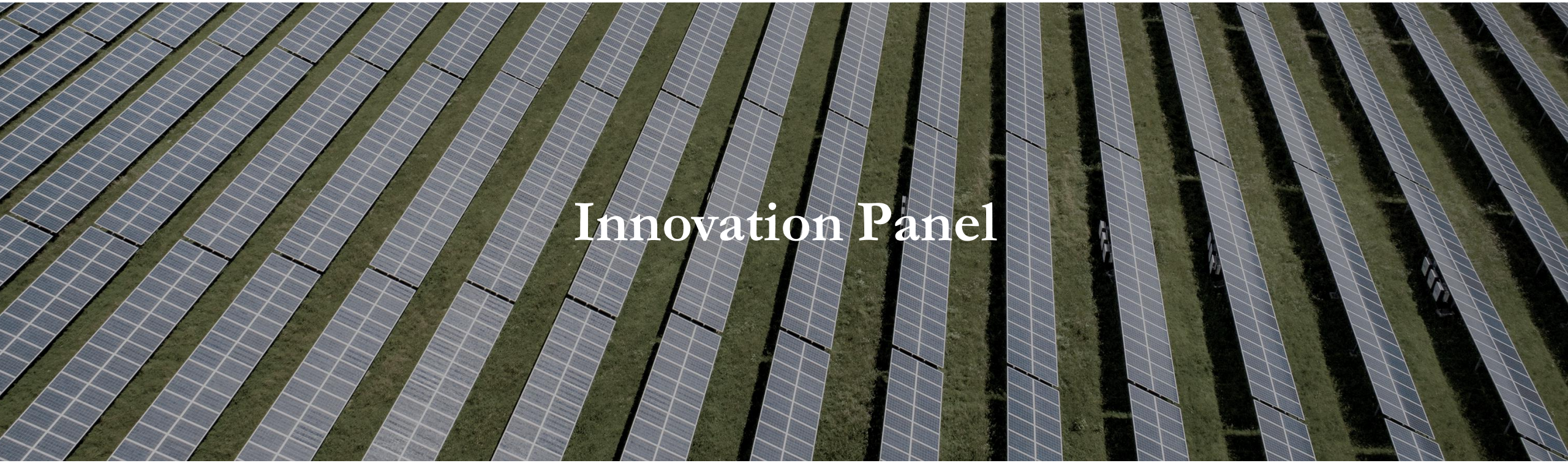
- **Queue Management and Cost Allocation**
  - Technology, regulation, administration, and organizational change focus
  - *What* innovative interconnection solutions exist?
- **Grid Engineering Practices and Standards**
  - Engineering and technology focus
  - *How* can proposed solutions be executed?
- **Equity and Energy Justice**
  - Multidisciplinary
  - *Who* is impacted by and benefits from proposed solutions?
- **Data Transparency**
  - Multidisciplinary
  - *What* transparency concerns must be addressed?
- **Interconnection Workforce and Training**
  - Multidisciplinary

Additional subjects, like capacity maps, cross these topics and will be addressed from these different perspectives. Follow the schedule of events on the i2X website.

Agenda

- **Equity and Justice Research in Interconnection (30 min)**
  - LBNL: Current State of EEJ Public Policy Trends
  - PNNL: Equity in Distribution Planning
- **Innovation Panel (30-40 min)**
  - Stephen Mariana, Hawaii PUC
  - Shiloh Costello, SMUD
  - Samantha Weaver, Community Solar Access
- **Interactive Discussion (60 min)**

Equity and Justice Research in Interconnection



Innovation Panel

Panelists

Stephen Mariani, Hawaii PUC

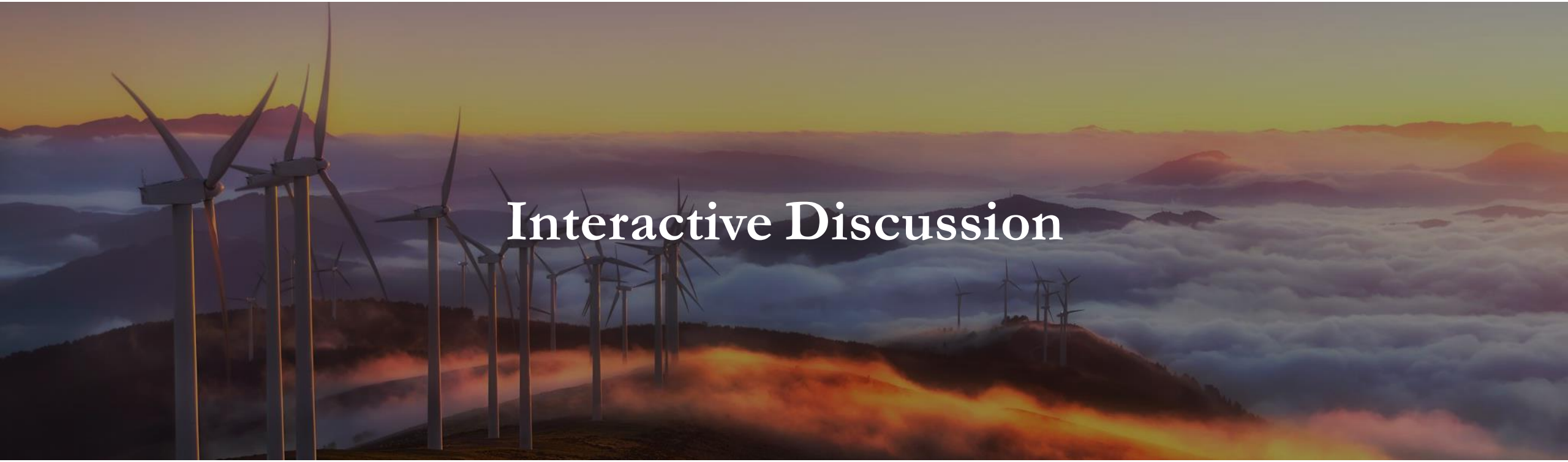
Shiloh Costello, SMUD

Sam Weaver, Coalition for Community Solar Access

Alok Kumar Bharati, PNNL

Panel Questions

- What definitions or qualifiers should be used for EEJ interconnection considerations?
- What have you learned from engaging with EEJ communities?
- What IX barriers do EEJ projects face compared to all project types?
- What pathways exist to streamline the interconnection process for EEJ projects? What has not worked? What has been most effective?
- Which grid upgrades have the most societal benefits? Which have the most EEJ benefits?



Interactive Discussion

ENERGY EQUITY & JUSTICE IN THE INTERCONNECTION PROCESS

Presentation by:

Stephen Mariani, Analyst

Public Utilities Commission of Hawaii

May 17, 2023

Outline

- Overview of Interconnection Process
- Challenges for LMI communities
- Solutions in Progress
- Remaining Issues
- Summary

Interconnection Process in Hawaii

Challenges for LMI communities

Solution - Independent Engineer & Interconnection Dispute Resolution

Status: Ongoing

Scope of Services

Solution – Shift Cost Responsibility for LMI Projects

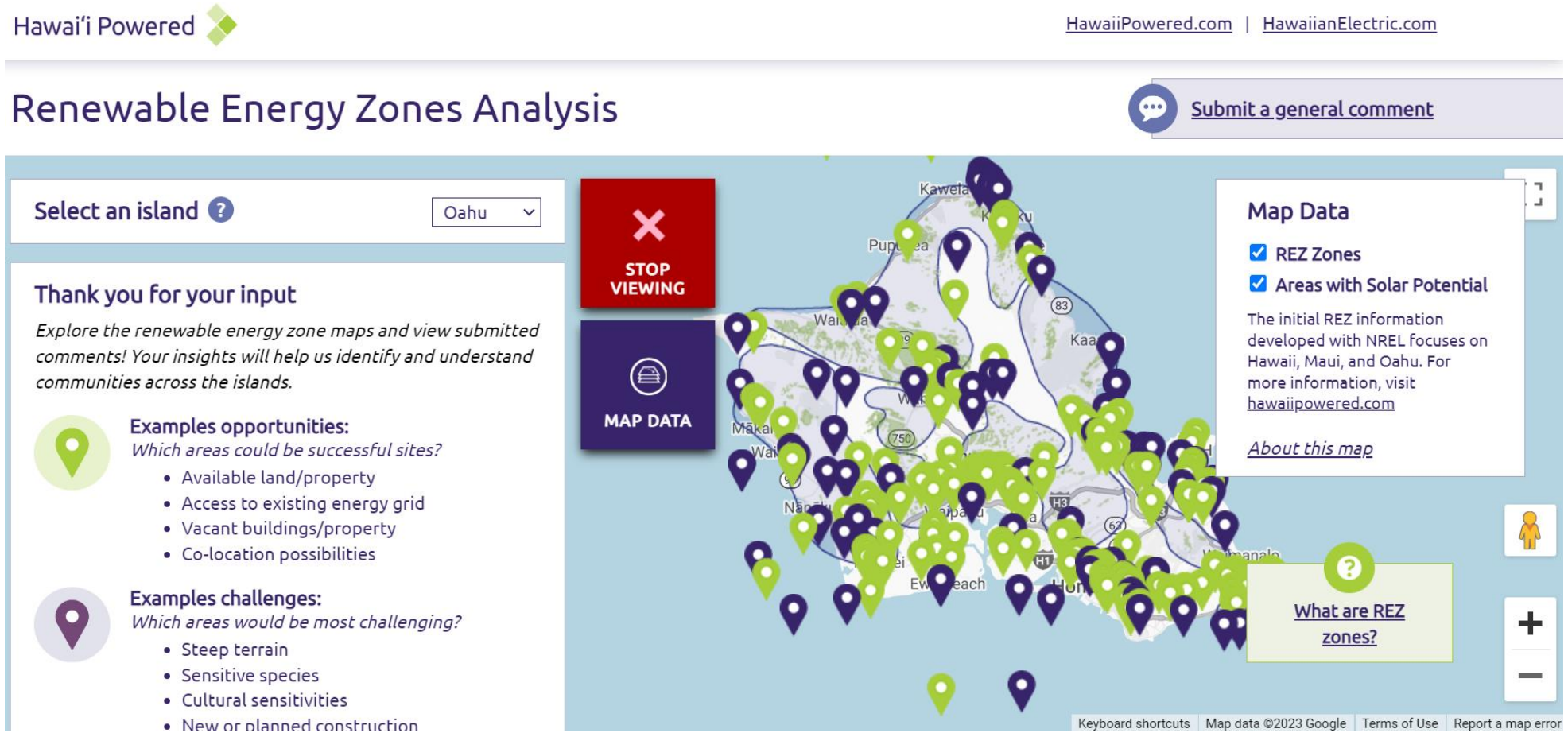
Cost Category	LMI Community Solar	Non-LMI Community Solar	Utility-Scale Projects
Facilities at proposer site	Developer and Utility	Developer†	Developer†
Station power for company switching station	Utility	Developer	Developer
Remote substation facilities	Utility	Developer (primarily) and Utility	Developer (primarily) and Utility
Line extension from grid connection point to site	Utility	Developer (primarily) and Utility	Developer (primarily) and Utility
T&D system upgrades	Utility	Utility	Utility
Company-owned fiber	Utility	Developer†	Developer†
Telecommunication facilities	Utility	Developer	Developer

†The Company will assume Betterment costs.

Ongoing Initiatives (not Interconnection-specific)

Equity Docket ("Pathways") (Link)

Example - Renewable Energy Zones



Remaining Issues

Cost Certainty

Remove risk from estimated interconnection costs

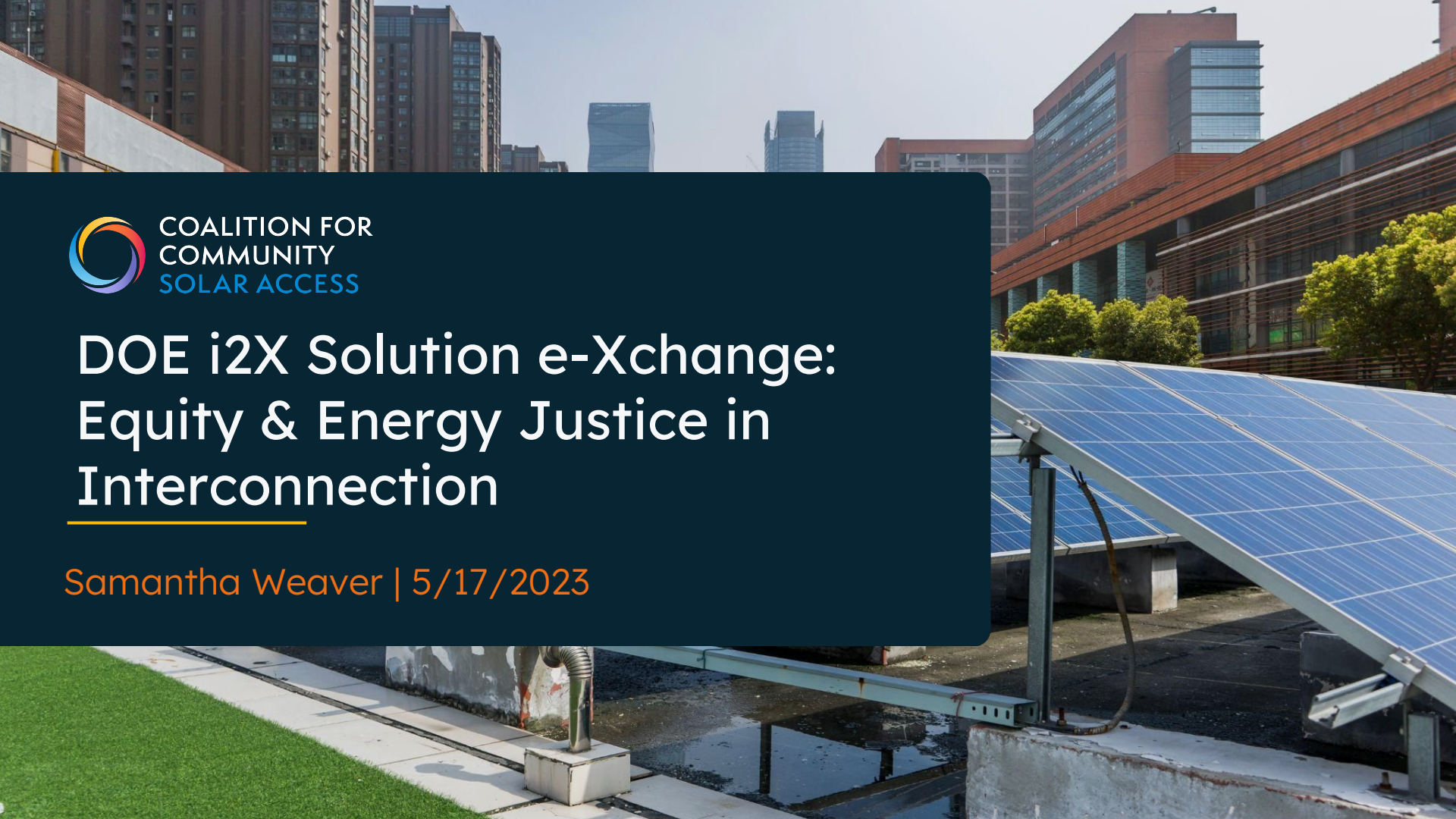
Offer studies before RFP bids

Cost Control

Summary

Solutions

THANK YOU



COALITION FOR COMMUNITY SOLAR ACCESS

DOE i2X Solution e-Xchange: Equity & Energy Justice in Interconnection

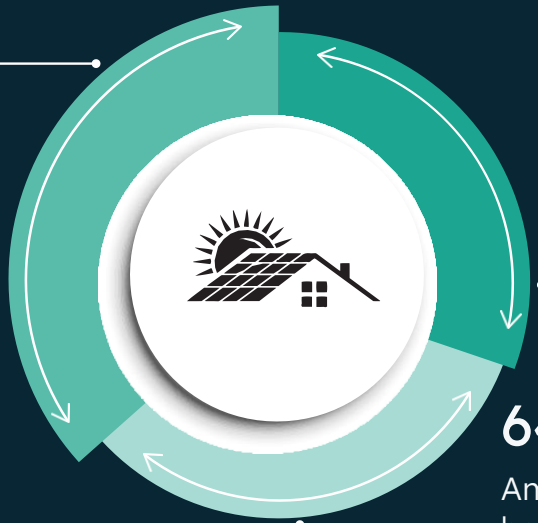
Samantha Weaver | 5/17/2023

About The Coalition for Community Solar Access

CCSA is a national trade association representing more than **100 community solar companies, businesses, and nonprofits** working to expand customer choice and access to solar for all American households and businesses through community solar. We work with customers, utilities, local stakeholders, and policymakers to develop and implement policies and best practices that ensure highly successful community solar programs that champion the energy customer.

Learn more at https://communitysolaraccess.org/

Rooftop solar doesn’t work for most people



68%
American home ownership with a 700+ credit score

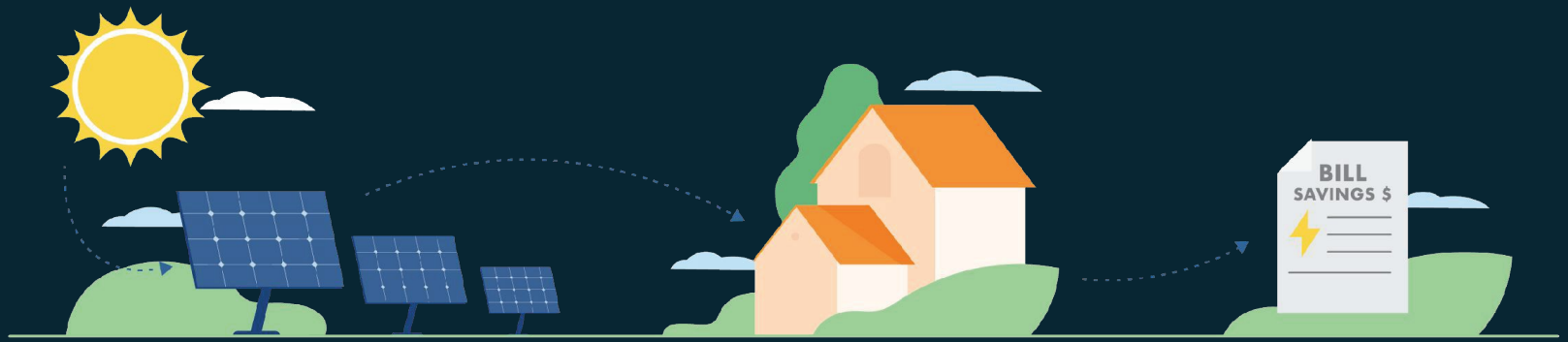
81%
American homes with a solar panel friendly roof

64.8%
American home ownership rate

34% of households qualify for rooftop solar

What is community solar?

- Projects are developed at a site in your community
- Multiple subscribers sign up for a portion of the energy produced – small businesses, churches, schools, government buildings, renters, other households
- Subscribers receive a credit on their utility bill for portion of power produced
- Projects are typically 1-5 MW (200-1,000 homes) and take up 5-25 acres of land



What do they look like?

Source: TurningPoint Energy

Source: Summit Ridge Energy, Carol County, MD

Community solar policy in 22 states

Total installed capacity, 2022:

4.5 Gigawatts
~2,500 Projects

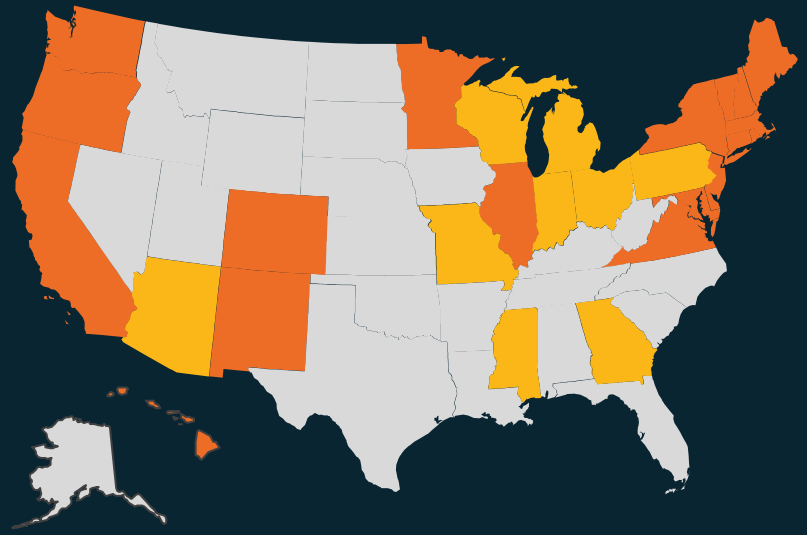
Total potential capacity, 2030:

50+ Gigawatts
15,000+ Projects

Total customers served:

2021: ~500,00 - 800,000
2030: 5 million+

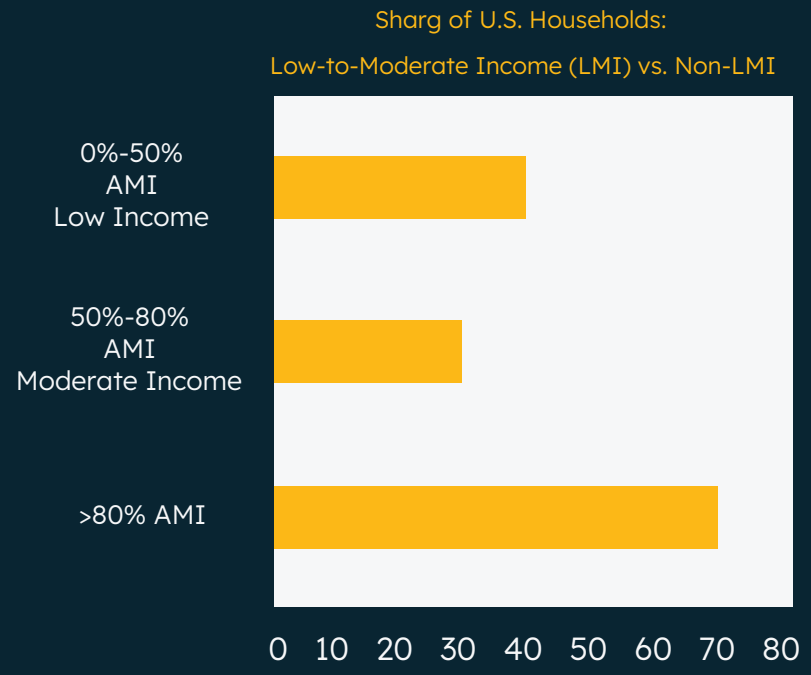
Source: *CCSA and NREL datasets; Vibrant Clean Energy "Local Solar Roadmap" 2020.*



- Established policy or program
- Republican-sponsored legislation proposed or pending

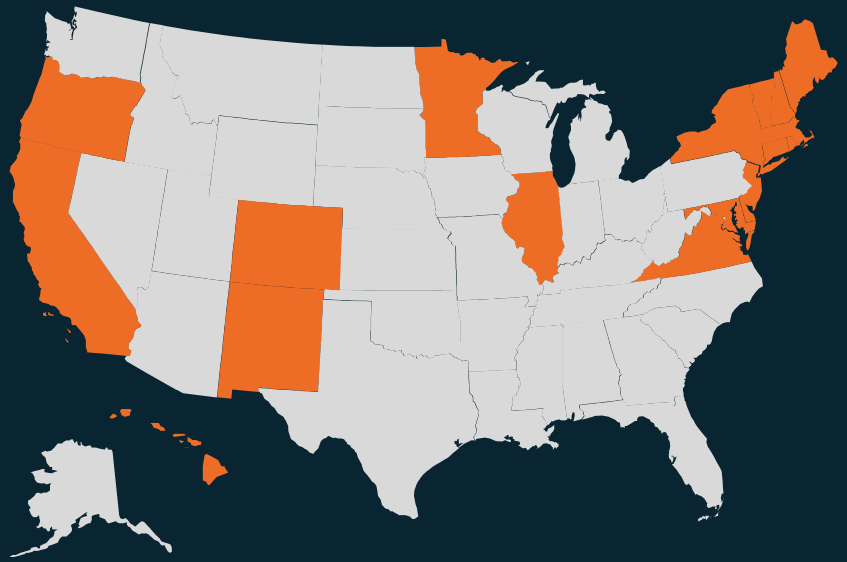
Low- to moderate-income (LMI) participation

- Community solar provides the flexibility to deliver clean energy access to all income-qualified customers, urban and rural.
- Community solar offers significant benefits to income qualified customers, including cost savings.
- Community solar provides a mechanism to bridge the gap between higher-income communities who have historically had access to rooftop solar and their income-qualified neighbors who have not.



States with LMI community solar provisions

Sources: NREL's Equitable Access to Community Solar: Program Designed and Subscriptions Considerations, NRRI's Solar Energy that pays for Low-Income Customers and Communities, Solar Power World's Community Solar Policy Gets Green Lights in Many States (solarpowerworldonline.com)



WORLD RESOURCES INSTITUTE

Interconnection as a Barrier to Solar Access

- Best estimates indicate that more **than 200 MW** of community solar projects are in interconnection queues, waiting to serve LMI customers.[1]
- Interconnection upgrades are **among the most variable and significant** project costs to community solar developers.
- Proactive **distribution system planning processes** that incorporate feedback on community needs is an important tool for:
  - Improving project viability by lowering interconnection costs.
  - Identifying tradeoffs and balancing (sometimes competing) public policy goals.

1. NREL Sharing the Sun report (December 2021).

Advancing Energy Equity in Distribution System Planning

May 18, 2023

Alok Kumar Bharati

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

Acknowledgement
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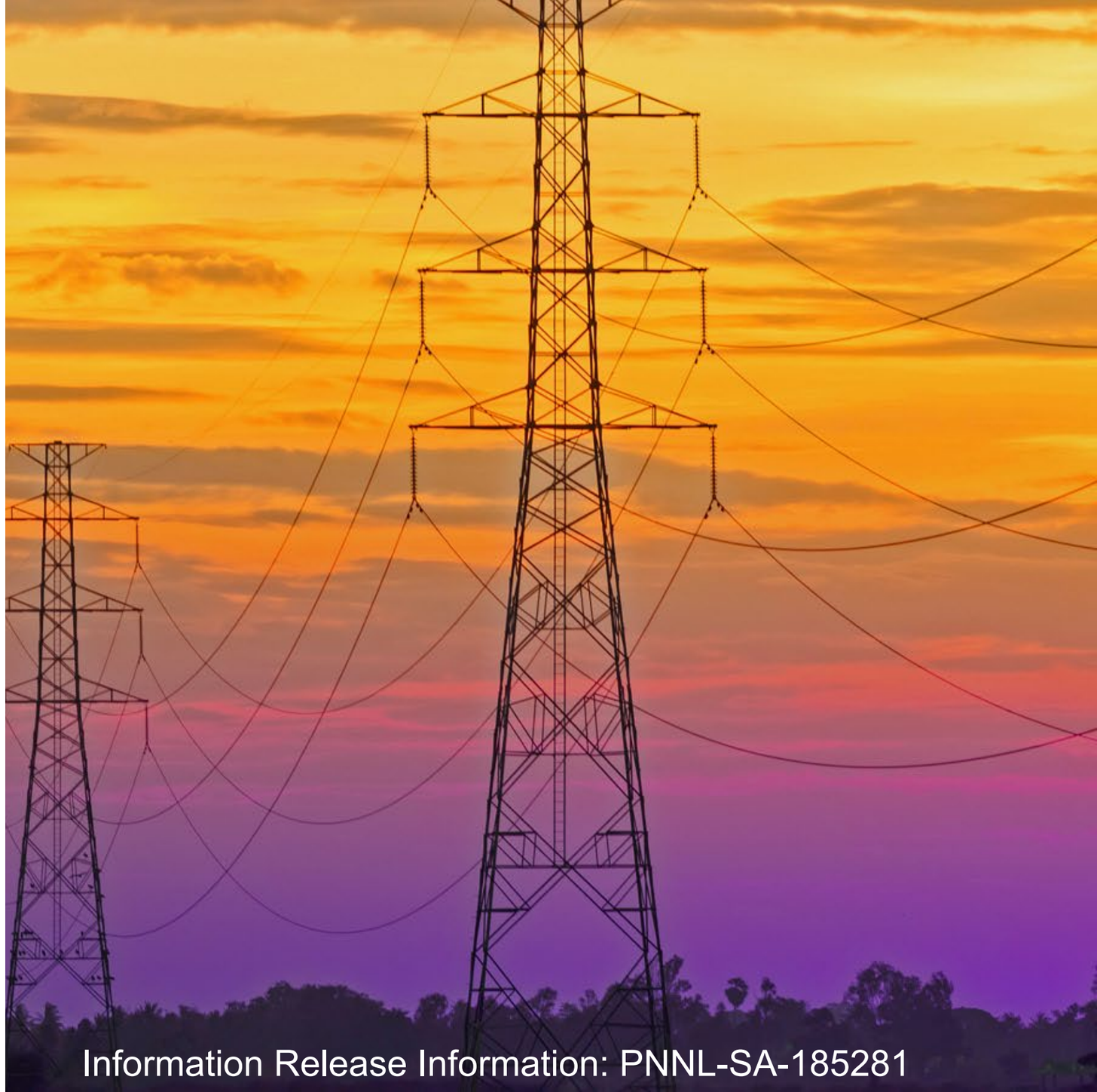
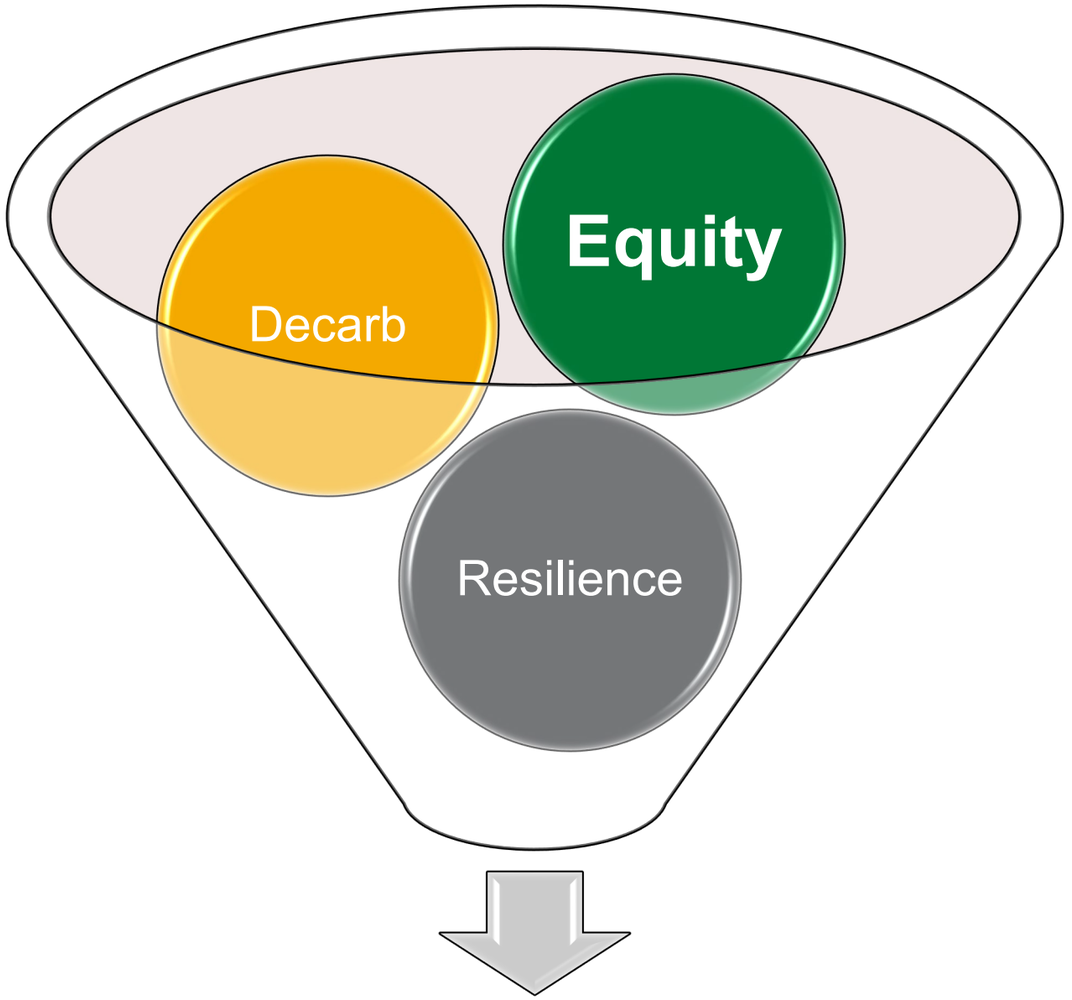


Information Release Information: PNNL-SA-185281

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.



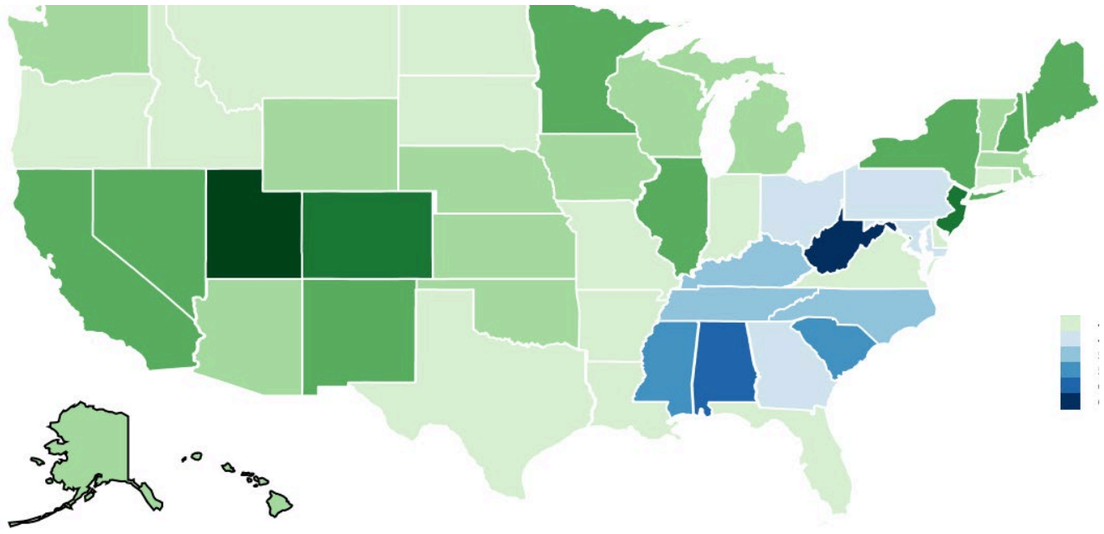
Equitable Resilient Clean Grid

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	$\frac{Annual\ utility\ bills}{Annual\ household\ income}$
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)

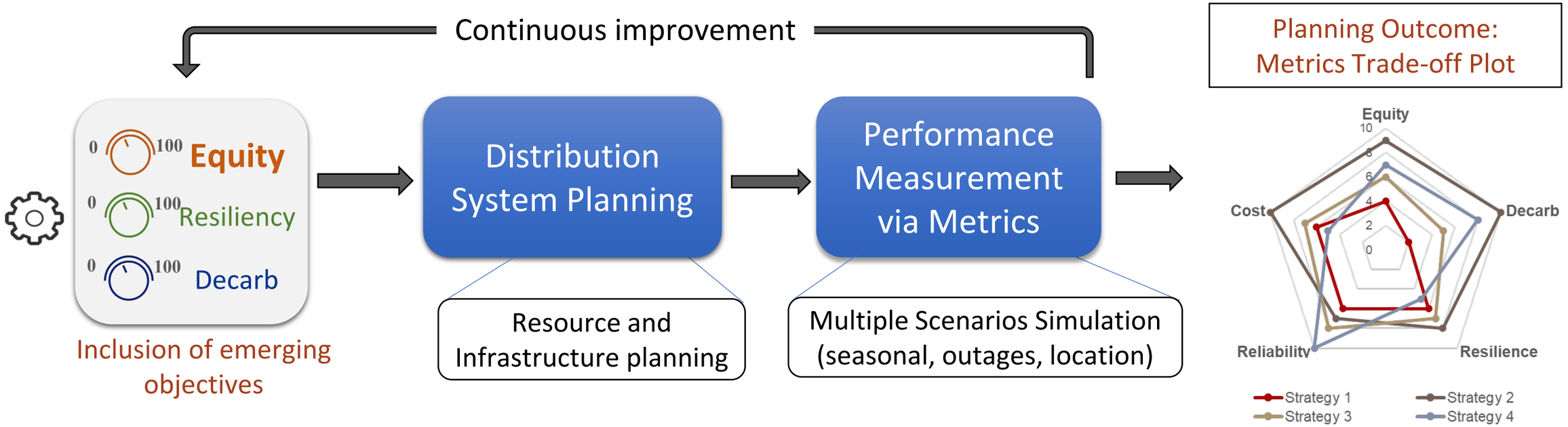
Pacific Northwest
NATIONAL LABORATORY

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.

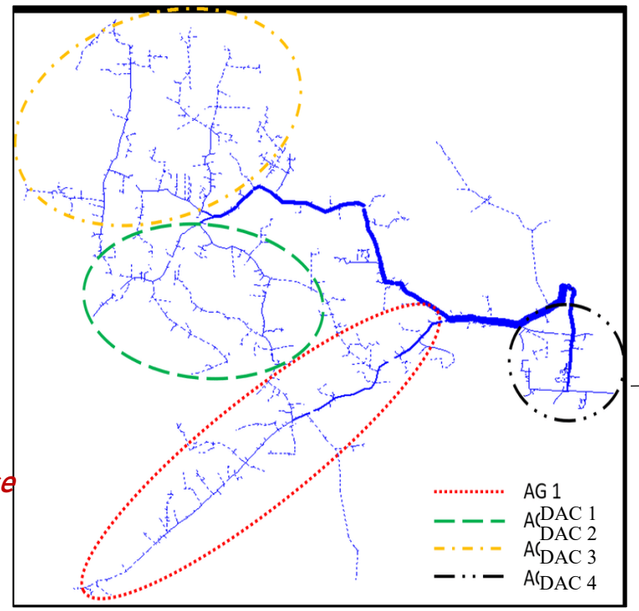
Simulation Framework



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



0 Base Case Assessment

system awareness- equity, DER levels

Identification of critical loads, DAC

1 Load/BTM-DER Forecast

load growth
EV adoption
DER adoption

energy assistance

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 infrastructure upgrades with equity considerations

4 Infrastructure Upgrades Assessment

list of transformers, lines, voltage devices upgrades

5 Monte-Carlo Simulation Analysis

statistical post-processing

6 Performance Measurement via Metrics

Go to step 1 and repeat process with improved inputs

Equity input

Distribution system planning

Output metrics generation

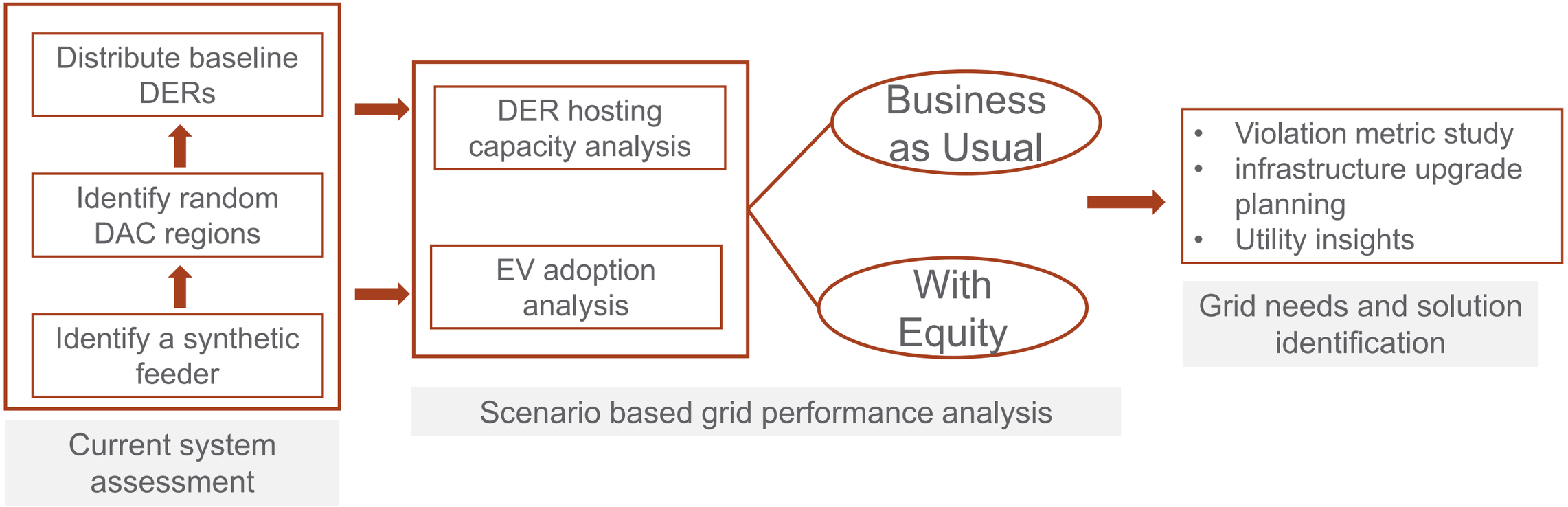
Modeling Equity in DSP Process

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

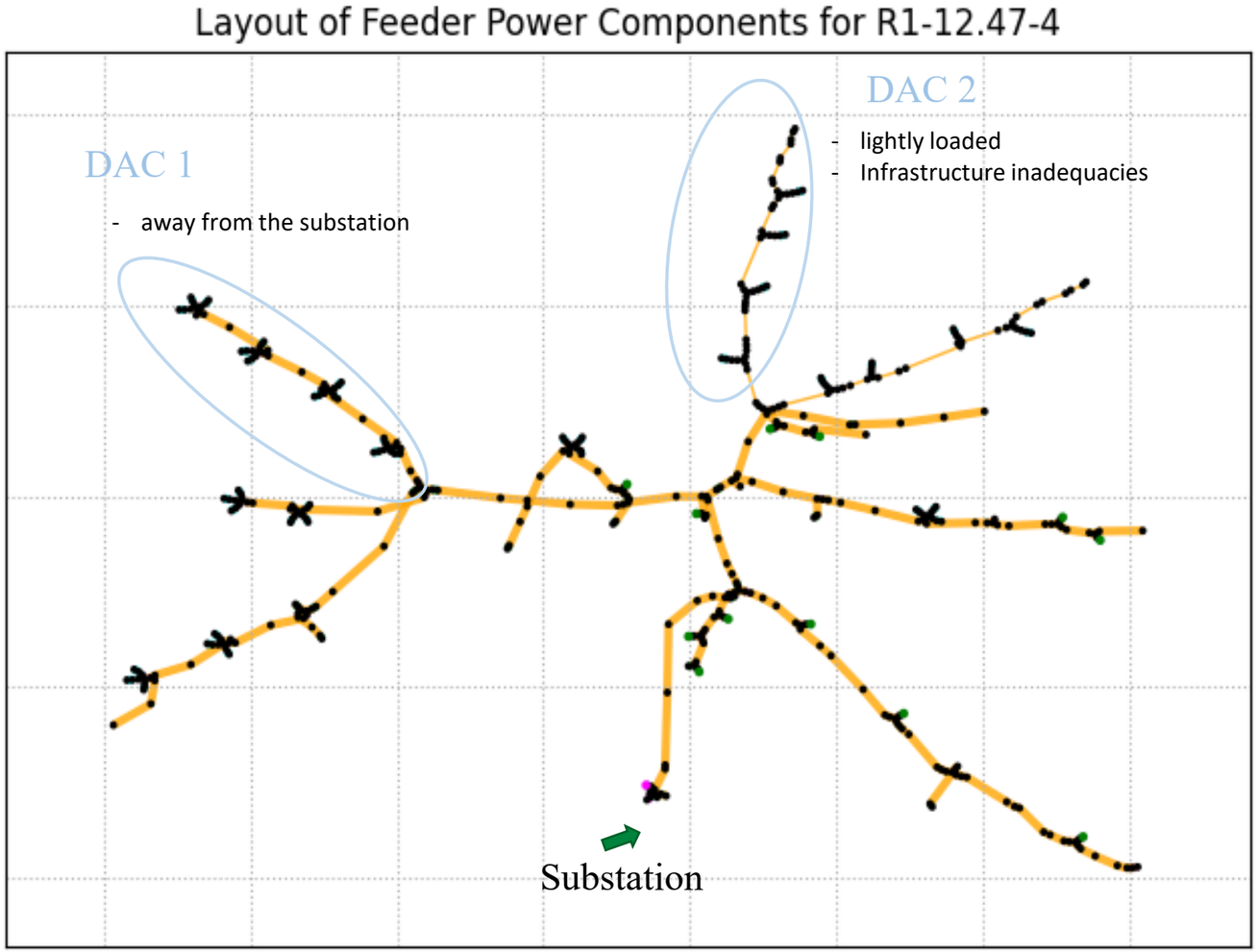
Equity Consideration: System Readiness

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



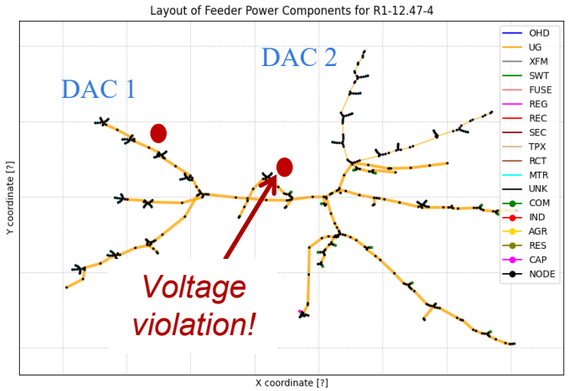
- A 300-node taxonomy feeder representing west-coast heavy sub-urban area

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

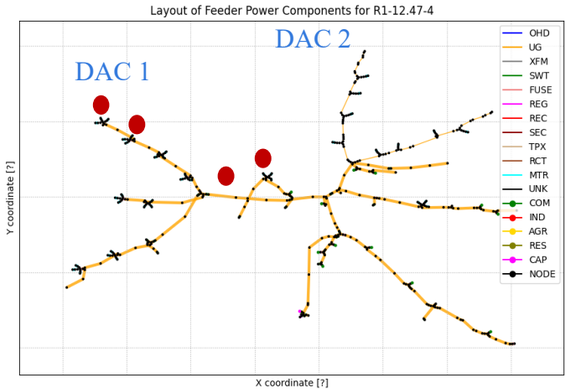
- Randomly identified 2 DAC regions
  - DAC:130 customers
  - Non-DAC: 250 customers

PV Hosting Capacity Analyis

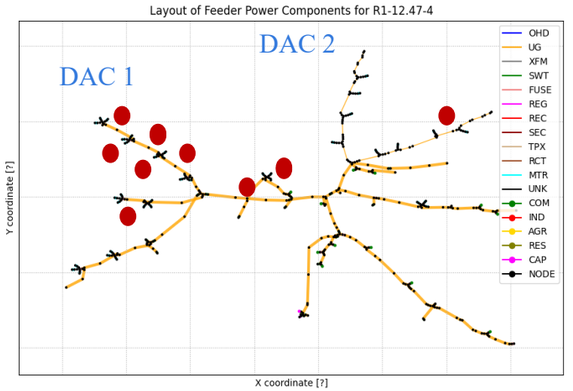
- A simplified PV hosting analysis to identify unsuitable PV locations with over-voltage violations
- Voltage violations: voltage at a node violating ANSI limits (~ 0.95-1.05 pu)



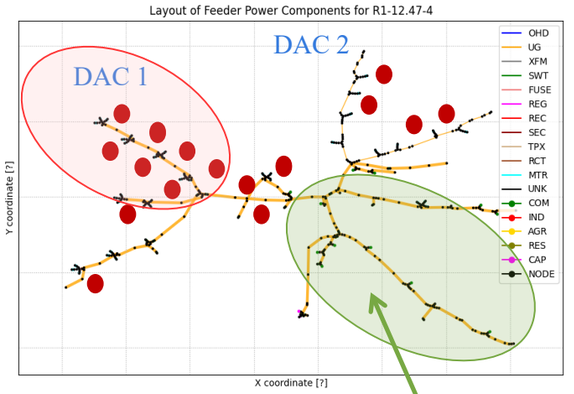
80% PV



100% PV



120% PV



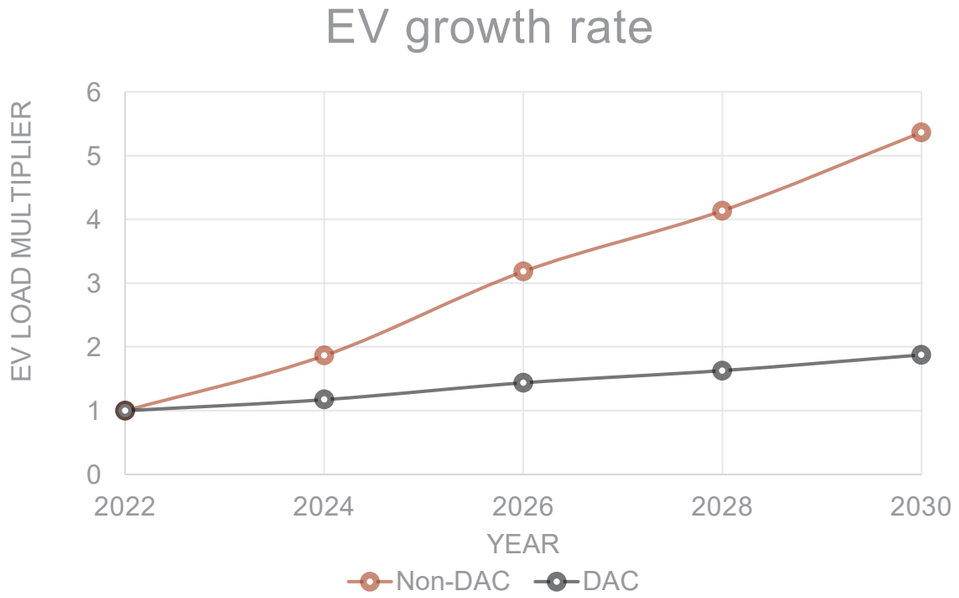
140% PV

Suitable locations for PV

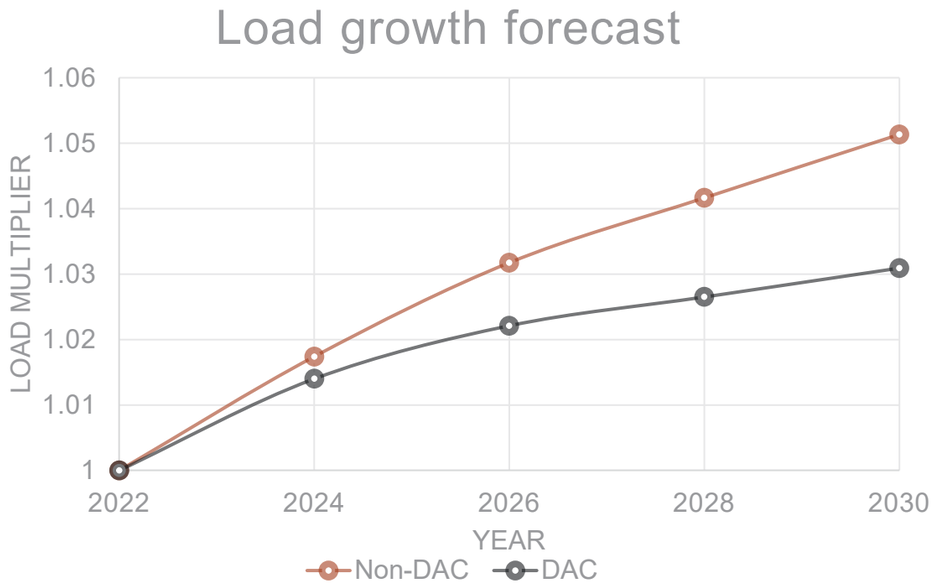
- DAC-1 turns out to be a region with high voltage violations with increasing solar PV penetration, making it unsuitable for hosting solar PV
- Bottom right region of the feeder is better location for solar PV installments

** 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

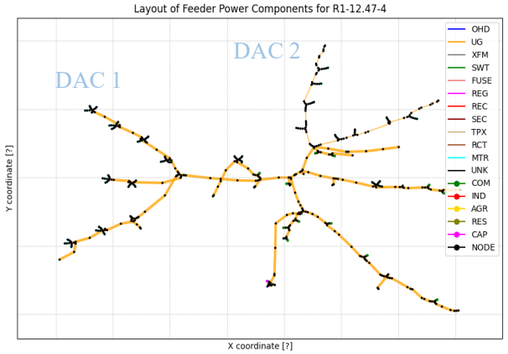
- Current (2022) EV adoption is assumed to be 25% and 5% for non-DAC and DAC regions
- DAC region growth is assumed to be 20% of non-DAC

- Base load (kW) for DAC and non-DAC are different
- DAC are assumed to have lower growth rate for loads

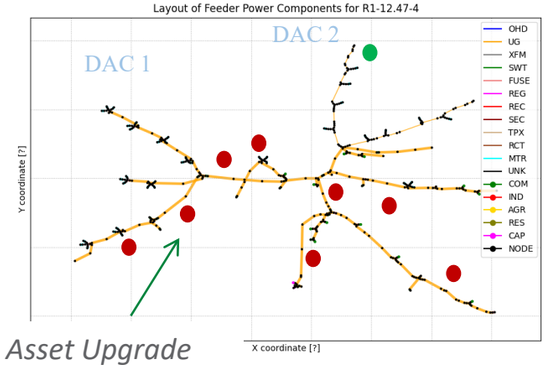
With Equity: DAC regions are assumed to have same growth as non-DAC region for EV and load

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

EV Adoption Analysis



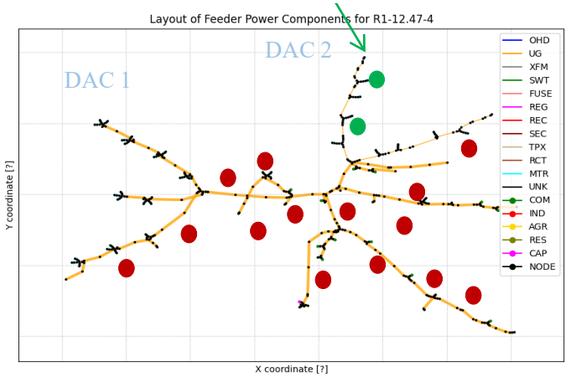
2024



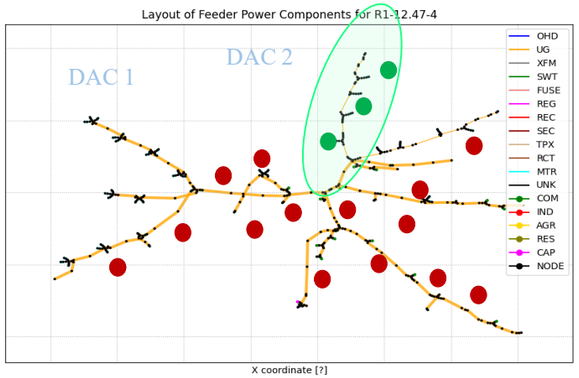
Asset Upgrade location

2026

Equity case: Asset Upgrade location



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

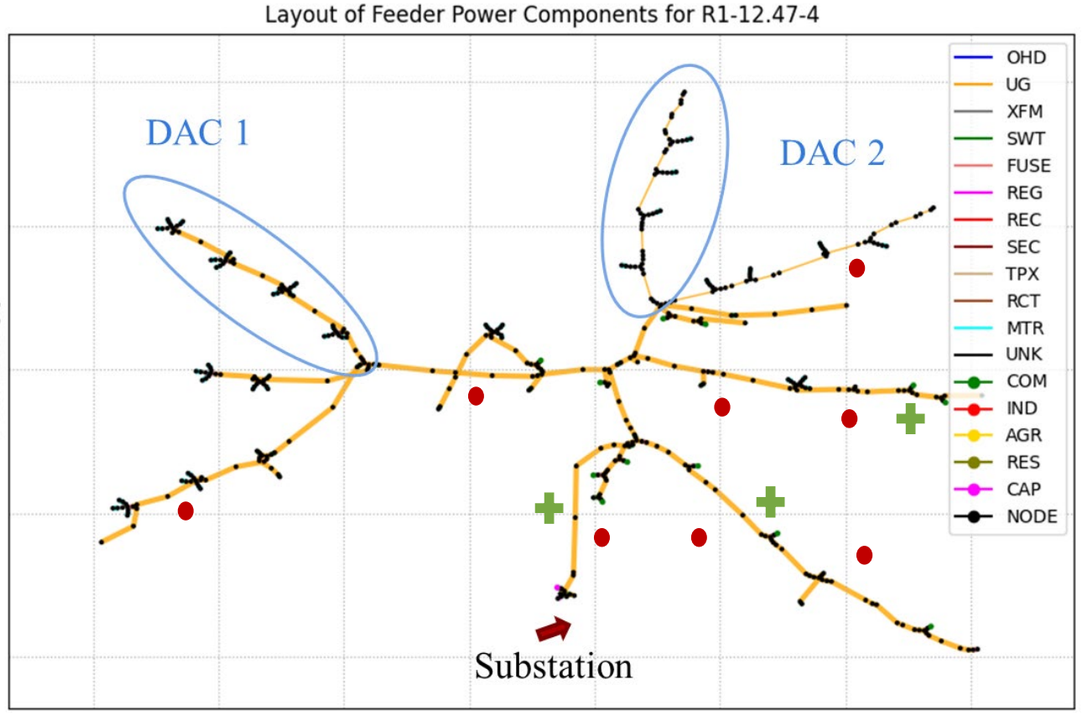
Year	Line conductors		
	Non-DAC	DAC-BAU	DAC-Equity
2022	0	0	0
2024	0	0	0
2026	2	0	0
2028	6	0	2
2030	8	0	3

- 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

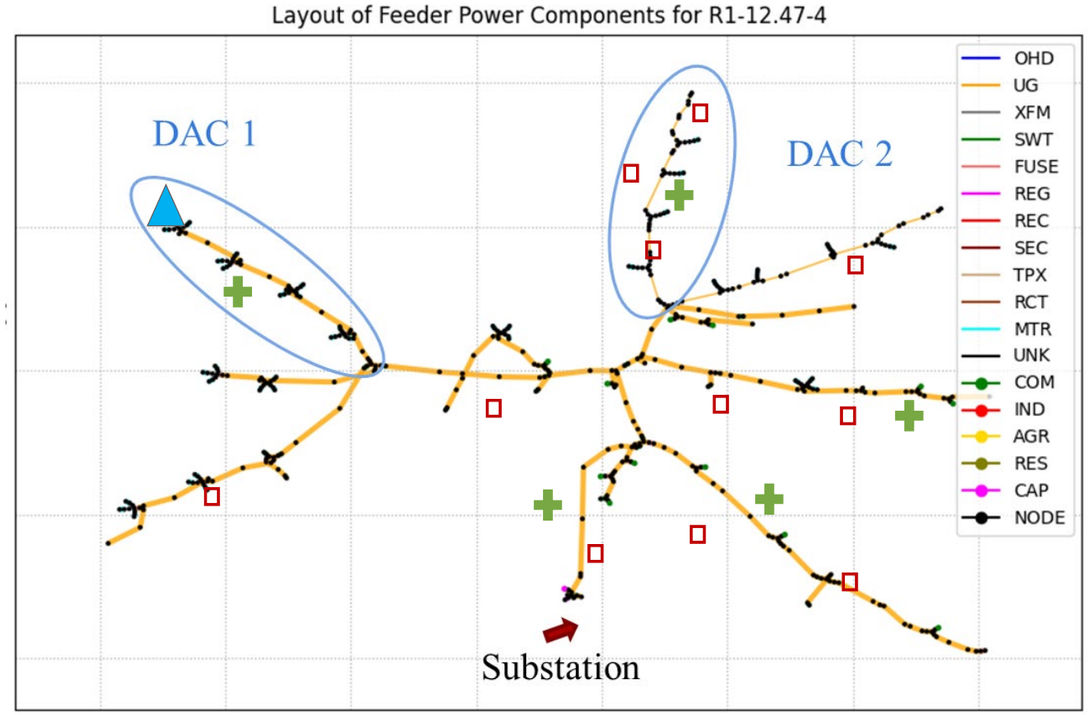


- Transformer and line upgrade
- Utility-level DER allocation

** 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



Transformer and line upgrade

Utility-level DER allocation

Voltage regulator installation

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

** 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.

Pacific Northwest
NATIONAL LABORATORY

Thank You

Acknowledgement

Support provided by Office of Electricity, US DOE

Zero Carbon by 2030: No Customer Left Behind

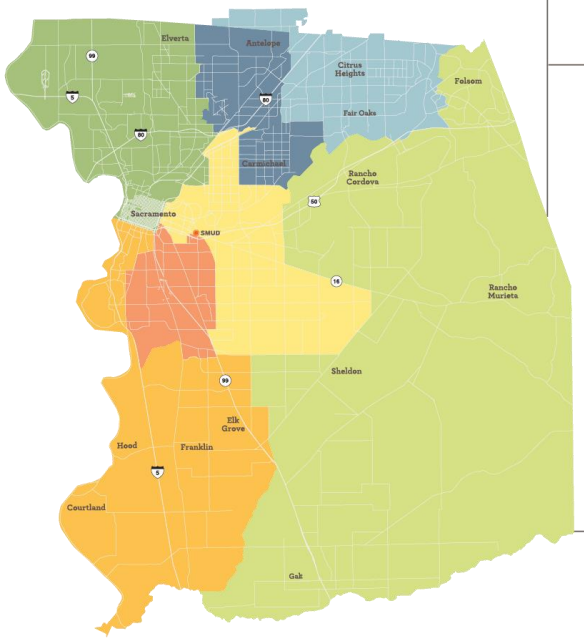
Shiloh Costello, Sustainable Communities

Powering forward.
Together.

SMUD®

About SMUD

6th largest community-owned **in the U.S.**



75+ Years

Est. 1946

Power mix that's on average about **50%** **carbon-free***

100% Zero carbon by 2030

The most ambitious goal of any large utility in the United States

~645,000 Customers

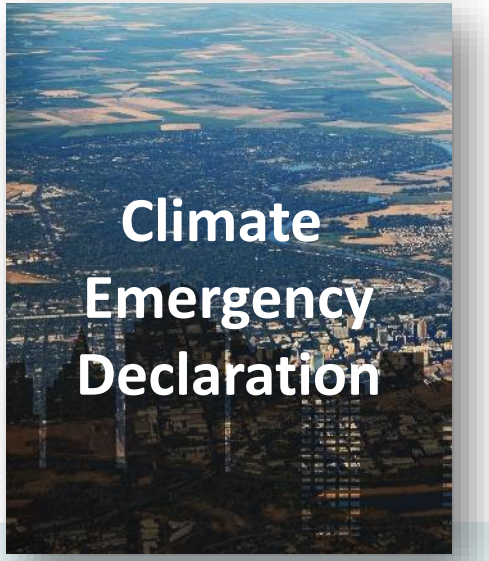
~2,300 Employees

7 member Elected Board of Directors

Rates among the lowest in CA. On average **45%** lower than PG&E

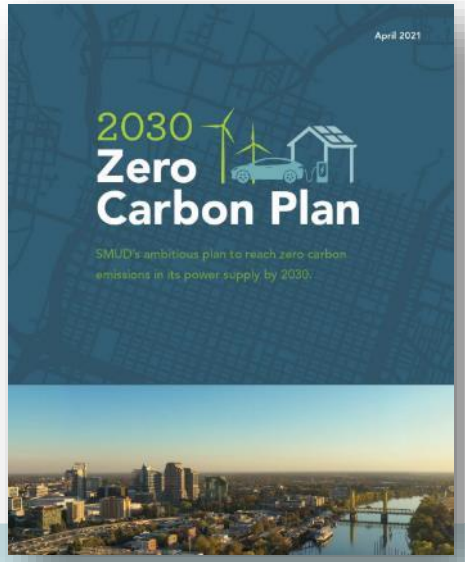
SMUD®

From declaration to plan and progress.



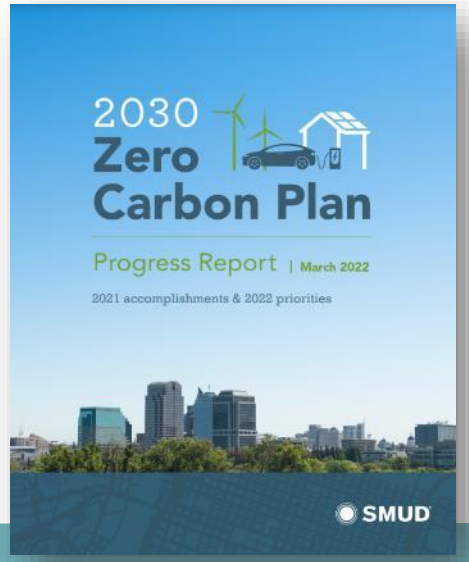
2020

Declared climate change as a pressing threat facing our region, nation and the world.



2021

Created a comprehensive plan to eliminate carbon emissions from our power supply by 2030.



2022

Made significant progress in 1 year to continue our path to a clean energy future.

2030

Improve air quality, overall health and bring more benefits to under resourced communities.

The Zero Carbon Plan: A Road Map

Natural gas generation repurposing

Replace 2 power plants with renewable and storage resources and retool remaining 3 to minimize emissions

Proven clean technology

Expand SMUD's renewable and battery storage resources by 3.5x

>3,000 MW of new renewable energy & storage – equivalent to energy needs of more than 600,000 homes

Support customer resources

Growing rooftop solar and batteries

90% reduction of greenhouse gas emissions

~$2.5 billion investment

~$2 billion investment

New technology & business models

Pilot & scale new projects and programs

- 2x savings from energy efficiency & building electrification
- Education & demand flexibility
- Virtual power plants & vehicle-to-grid technology
- New grid-scale technologies

Financial

- Pursue grants & partnerships
- Limit rate impacts to rate of inflation

Maximize community benefits

- Keep affordable rates & reliable power
- Improve local air quality & overall community health
- Reduce regional impacts of carbon – drought, wildfires & extreme weather
- Create regional clean tech jobs
- Strengthen all communities
- Support under-resourced communities
- Involve our customers & community in this transition

Thousands of new regional clean tech jobs

Goal:

Eliminate CO_2 from SMUD's power supply

CO_2

100%

Zero carbon by 2030

SMUD®

Leave No Community Behind – Equity Strategies

- *"34% of the Sacramento region's residents live **in struggling families**, ... and do not earn enough to cover their basic household expenses."*

Partnerships & Sponsorships

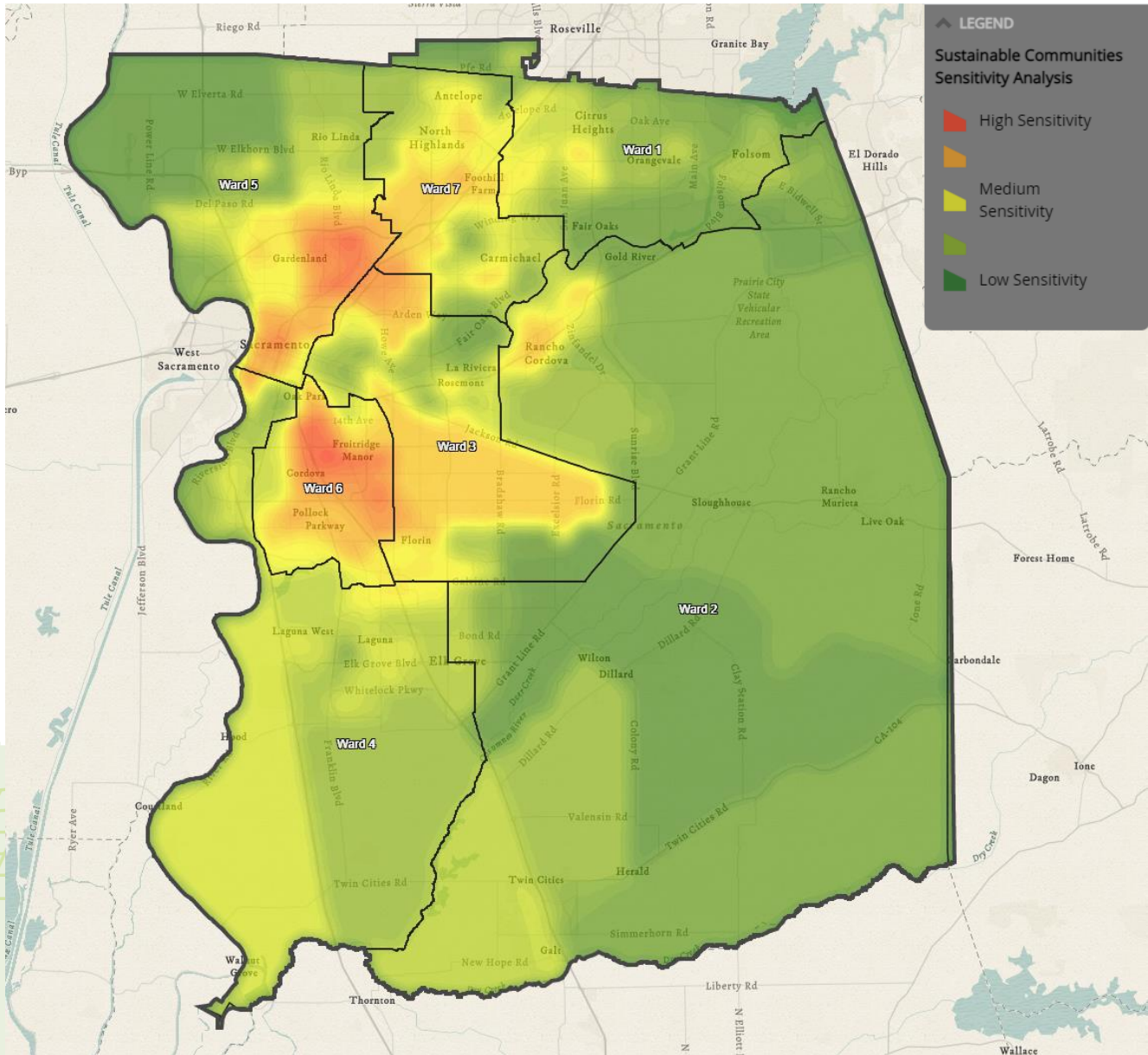
Income Eligible Programs & Services

Community Engagement & Education

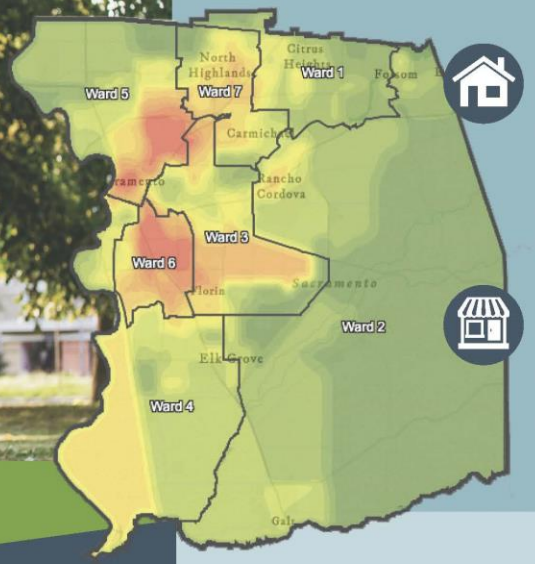
Inclusive Economic Development

Regional Workforce Development

State & Federal Grants



"Charting a Course to Sacramento Region's Future Economic Prosperity" 2018, Brookings Institute Report.



Our audience

Residential

- Low- & median-income populations who can't afford necessities
- Renter with higher energy burdens
- Under-served populations with cultural or language barriers

Commercial

- Small businesses
- Nonprofits

Our focus

Affordability

Equitable access

Community engagement

We're doubling the current investment towards under-resourced communities!

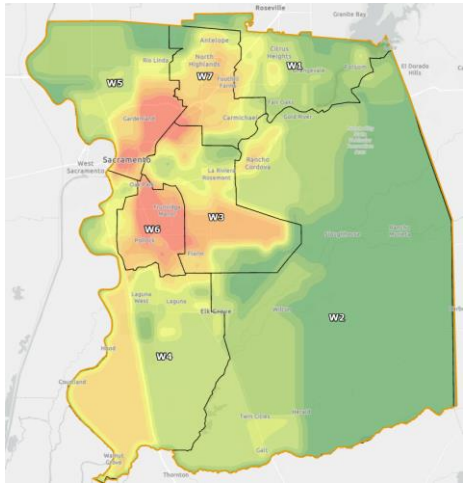
Our approach

- **Diversifying** clean energy programs to make them accessible to more residential customers.
- **Leading** inclusive economic development with new job trainings and job placement programs for clean energy jobs.
- **Focusing** on investing in the business community through meaningful and impactful partnerships.
- **Creating** capacity building opportunities for nonprofits to support our 2030 zero carbon plan engagement.
- **Showing up** in culturally relevant ways with community education and outreach through our community ambassador teams.

Low-& Median Income Equity Programs

- Mass Market Solar Shares
- Transportation Electrification Equity Investments
- Community Partner Rooftop Solar
- Zero Carbon Loan Program
- Community Impact Plan

Neighborhood Approach

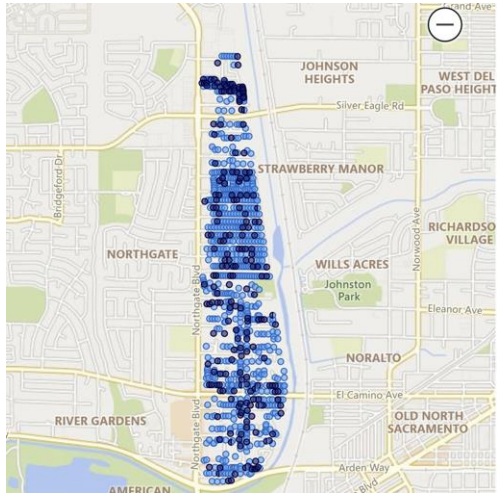


Priority neighborhoods:

- Avondale
- Parkway
- Meadowview
- Fruitridge Manor
- Lawrence Park
- North Highlands
- Gardenland

Select a group of homes in a red zone:

- Age of home
- % Energy Assistance Program Rate
- % inefficient cooling



Gardenland Natomas: <100 homes

- Engage community to create support and recruit homeowners and property owners
- Conduct energy assessment of each home/business
- Assign contractors to perform direct installation of equipment; Measures may include 1 or more:
  - Heat Pump Space Heating
  - Heat Pump Water Heater
  - Induction Stove/ commercial cooking equipment
  - EV ready
  - Solar (<10% of customers)
- Address urban heat through tree planting
- Educate community on climate change impacts, monitoring energy usage, the benefits of electrification;
- In-language and translation support provided as applicable