Resiliency Standards: Metrics

Lumen Energy Strategy – *WARP to Resilience*: Climate Resilience in Integrated Resource Planning

Grid Resiliency and Microgrids Team, Energy Division

September 5, 2023, 10:00am – 2:30 pm

California Public Utilities Commission

WebEx and Call-In Information

Join by Computer:

https://cpuc.webex.com/weblink/register/rf2777b9e25f73f3332fa67a2144c2f85

Join by Phone:

1-855-282-6330 (U.S. Toll Free)

1-415-655-0002 (U.S. Toll)

Access Code: 2481 199 6474

(Staff recommends using your computer's audio if possible.)

Notes:

- Today's presentations are available in the meeting invite (follow link above) and will be available shortly after the meeting on https://www.cpuc.ca.gov/resiliencyandmicrogrids.
- The presentation portion of this meeting will be recorded and posted on https://www.cpuc.ca.gov/resiliencyandmicrogrids.
- While one or more Commissioners and/or their staff may be present, no decisions will be made at this meeting.

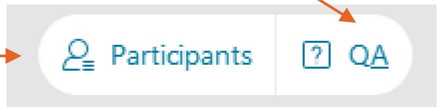
WebEx Logistics

- All attendees are muted on entry by default.
- Questions can be asked verbally during Q&A segments using the “raise hand” function.
  - The host will unmute you during Q&A portions [and you will have a maximum of 2 minutes to ask your question].
  - Please lower your hand after you’ve asked your question by clicking on the “raise hand” again.
  - If you have another question, please “re-raise your hand” by clicking on the “raise hand” button twice.
- Questions can also be written in the Q&A box and will be answered verbally during Q&A segments.
- Closed Captioning can be turned on by clicking the “cc” button the lower left of your screen.

WebEx Tip

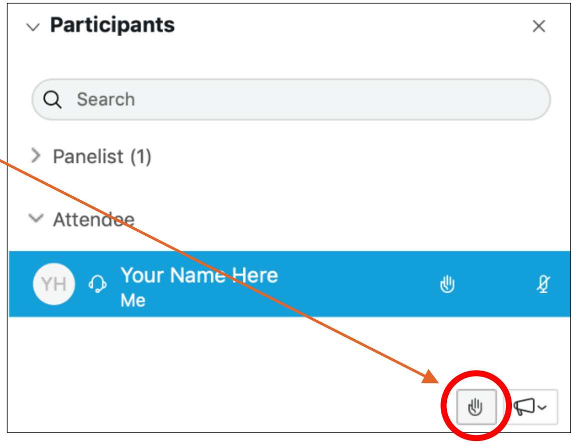
Access the written Q&A panel here

1. Click here to access the attendee list to raise and lower your hand.

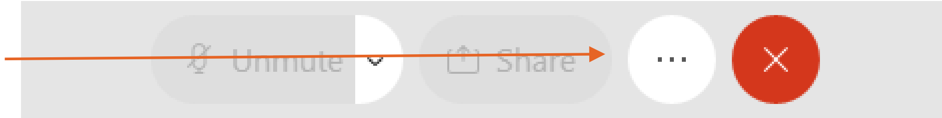


2. Raise your hand by clicking the hand icon.

3. Lower it by clicking again.



Access your meeting audio settings here



WebEx Event Materials

Event Information: Resiliency and Microgrids Working Group Meeting

Registration is required to join this event. If you have not registered, please do so now.

English : San Francisco Time

Event status: Not started (Register)

Date and time: Tuesday, March 2, 2021 9:30 am
Pacific Standard Time (San Francisco, GMT-08:00)
Change time zone

Duration: 1 hour

Description:

Event material: RMWG Meeting Material_EXAMPLE.docx (31.7 KB)

By joining this event, you are accepting the Cisco Webex Terms of Service and Privacy Statement.

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First name: Jessica

Last name: Tse

Email address: jessica.tse@cpuc.ca.gov

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Agenda

I.	**Introduction** *(CPUC Staff)*	10:00a – 10:05a
	• WebEx logistics, agenda review	
II.	**Opening Remarks, Commissioner Shiroma**	10:05a – 10:10a
	• Background and Context *(CPUC Staff)*	10:10a – 10:15a
III.	**Relevance of IRP Case Study** *(Lumen Energy Strategy)*	10:15a – 10:35a
IV.	**Review Resilience Definition and Poll Results** *(Lumen Energy Strategy)*	10:35a – 10:50a
	• Breakout Session and Results	10:50a – 11:15a
IV.	**Translating Resilience Definition into Metrics and Modeling Framework** *(Lumen Energy Strategy)*	11:15a – 11:55a
V.	**Lunch Break**	11:55a – 12:25p
VI.	**Metrics and Modeling Framework** *(Lumen Energy Strategy)*	12:25p – 12:35p
	• Breakout Session and Results	12:35p – 1:35p
VIII.	**Refine Resilience Risk Profiles and Resource Attributes** *(Lumen Energy Strategy)*	1:35p – 2:00p
IX.	**Closing Remarks, Commissioner Shiroma**	2:00p – 2:05p
	• Provide information on upcoming workshops *(CPUC Staff)*	2:05p – 2:10p

Opening Remarks

Background and Context

Energy Division Workshop Series on Resiliency

- ✓ **May 10, 2022** - Interruption Cost Estimate (ICE) Calculator/Power Outage Economic Tool (POET)
- ✓ **July 7, 2022** – Sandia National Labs – Resiliency Node Cluster Analysis Tool (ReNCAT) and the Social Burden Index
- ✓ **May 10, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 1st of 3 workshops – Resiliency Standards: Definitions
- ✓ **July 26, 2023** – SCE/Sandia (DOE funded) Kickoff ReNCAT/Social Burden Index Pilot Project (Phase 1)
- ✓ **August 22, 2023** – LBNL (DOE funded) – Final Reporting on Data Schema Pilot project
- ❑ **September 5, 2023** – Lumen Energy Strategy – 2nd of 3 workshops – Resiliency Metrics ← **today's event**
- ❑ **October 19, 2023** – SDG&E and Sonoma County Junior College District - Use Case Demonstration of 4-Pillar Methodology
- ❑ **November 8, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 3rd of 3 workshops – Resiliency Methodologies
- ❑ **November 28, 2023** – Final Report: SCE/Sandia (DOE funded) ReNCAT Pilot Project (Phase 1)

Framing the Conversation: Review of 4-Pillar Methodology

4-Pillar Methodology – Guiding Principles in Resiliency Valuation

I. **Baseline Assessment**
- What/Whom do we want to protect and where is it/are they?
- What threatens it/them?
- How well are we doing now to protect it/them?

II. **Mitigation Measure Assessment**
- What protection options do we have?
- What does the best job at protecting the most?
- What does it cost?

III. **Resiliency Scorecard** – scoring resiliency configuration characteristics including those that support State policy goals

IV. **Resiliency Response Assessment (post-disruption or modeling)** –
- How well did the investments do in reaching resiliency targets?
- Did the investments reduce impacts on the community?

WARP to Resilience

Weather-Adapted Resource Planning

Climate Resilience in Integrated Resource Planning

Resilience Definitions, Metrics, and Their Use in Grid Planning and Investment

Prepared for:

CPUC Resiliency and Microgrids Stakeholders

Prepared by:

Mariko Geronimo Aydin
Onur Aydin

September 5, 2023

Lumen ENERGY STRATEGY

Contents

Part I:
What is the relevance of the IRP case study to resiliency & microgrids?

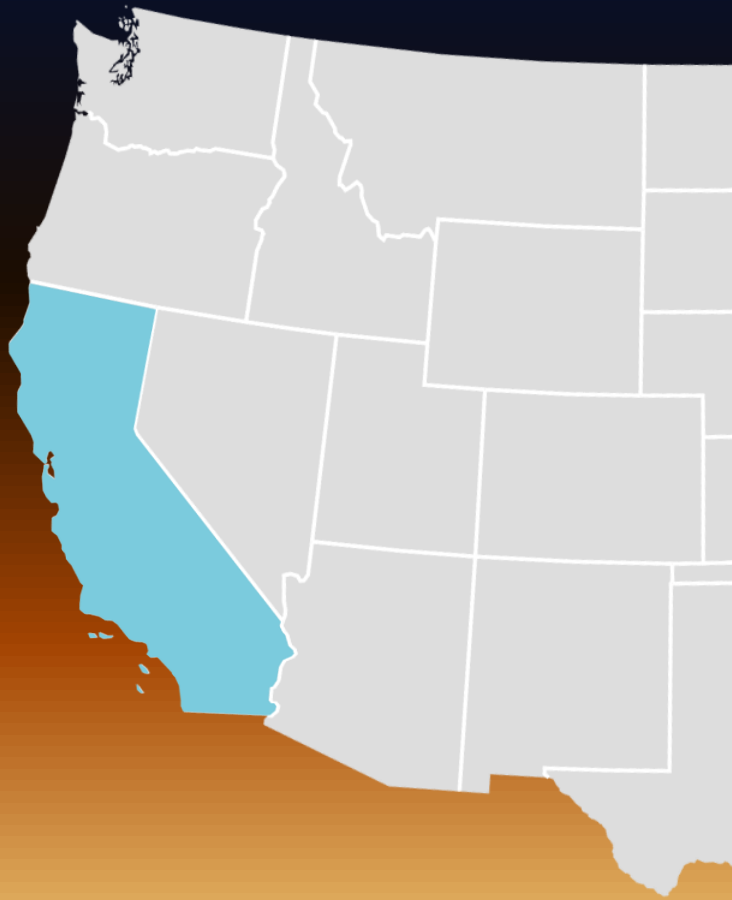
Building resilience through IRPs

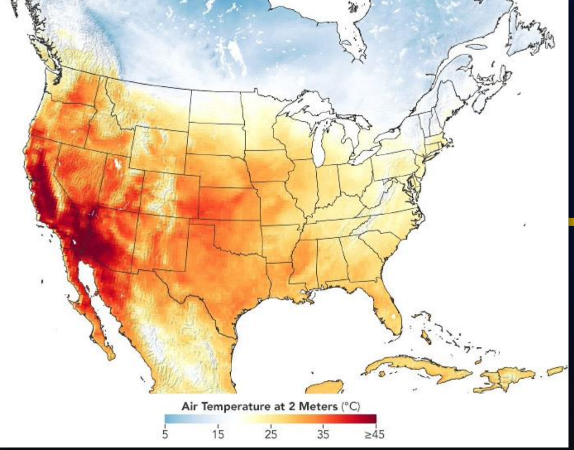
- California Public Utilities Code Section 454.52(a)(1)(G) requires IRPs to:

  "Strengthen the diversity, sustainability, and resilience of the bulk transmission and distribution systems, and local communities."

- Without a clear definition of resilience and specific metrics to evaluate resilience improvements, so far, the IRP requirement above has been open-ended, subject to interpretation, and thus, difficult to address systematically

- With a bird's eye view on system needs, IRP is uniquely positioned to incorporate resilience into the LSEs' planning processes by facilitating more dialogue with local perspectives on:
  - How to identify and model specific resilience vulnerabilities and failure points, geographies, and weather-specific situations
  - How to consider whole grid for solutions w/ more planning integration across multiple grid domains
  - How to evaluate value stacking opportunities, including upstream benefits of resilience investments and synergies to reduce net cost of resilience solutions





Western Heat Wave (2020)

Rotating blackouts in CA affecting hundreds of thousands of customers, lasting several hours

Near miss in 2022 with even higher temps in CA

Extreme Drought

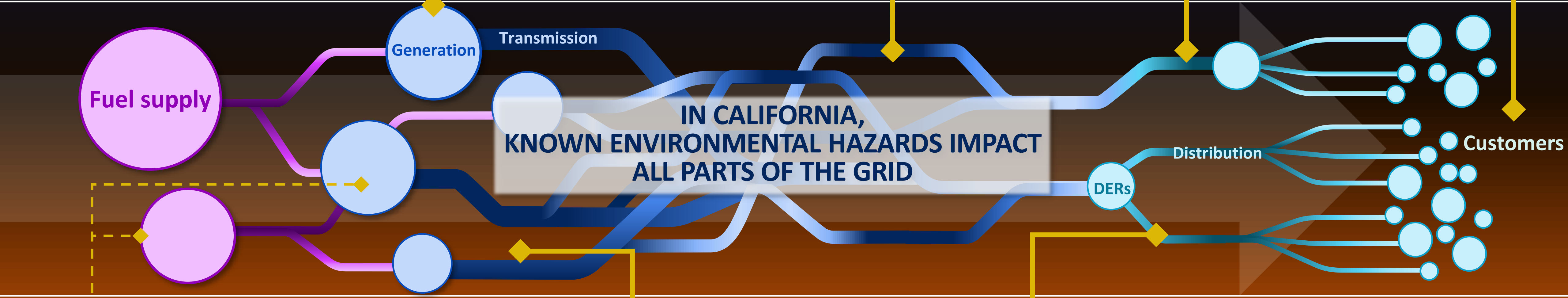
Compounding factor

Extreme Wildfires

(2007) 80k San Diego customers on outage, some for weeks, due to damage on Southwest Powerlink transmission

(2019) Multiple day outages due to PSPS, affecting millions of customers + Saddleridge fire severely impacting transmission into LADWP

IN CALIFORNIA, KNOWN ENVIRONMENTAL HAZARDS IMPACT ALL PARTS OF THE GRID



Cold Snap, TBD

Is CA's natural gas system vulnerable to cold snaps?

Extreme Smoke (2020)

Near miss when smoke tripped 4,000 MW California-Oregon Intertie, forcing 1,500 MW of de-rate on Pacific DC Intertie

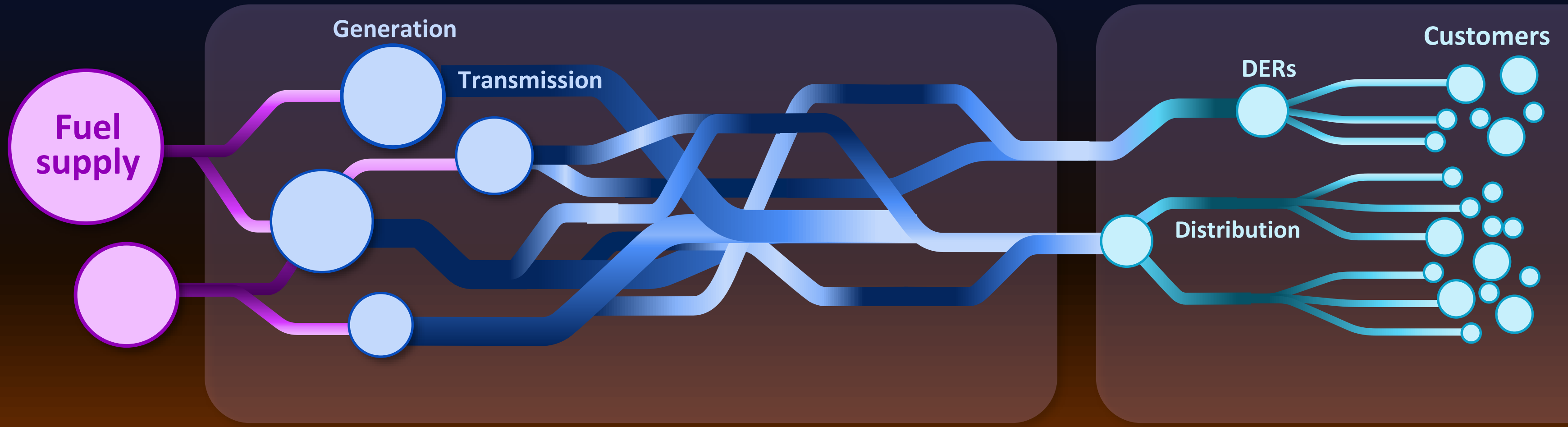
Storms, Floods (2022/23)

Rain, snow, wind, floods, mudslides

Full outage extent tbd; likely >= hundreds of thousands of people, lasting days

Image notes and credits, clockwise from top left: September 6, 2020 temperatures across California (NASA/Joshua Stevens); Lake Oroville in 2020 (AP/Ethan Swope); 2021 Caldor fire (AP/Ethan Swope); vehicle in flood water during 2022/23 winter storms in California (Robert Tong/Marin Independent Journal); downed tree from 2022/23 winter storms in California (Sara Nevis/AP); person shoveling snow from 2022/23 winter storms in California (Jae C. Hong/AP); smoke from 2020 August Complex fire (CNN/Harmeet Kaur).

Coordinated grid planning need for resilience



Today's resilience solutions include flexible resources like energy storage that can also:

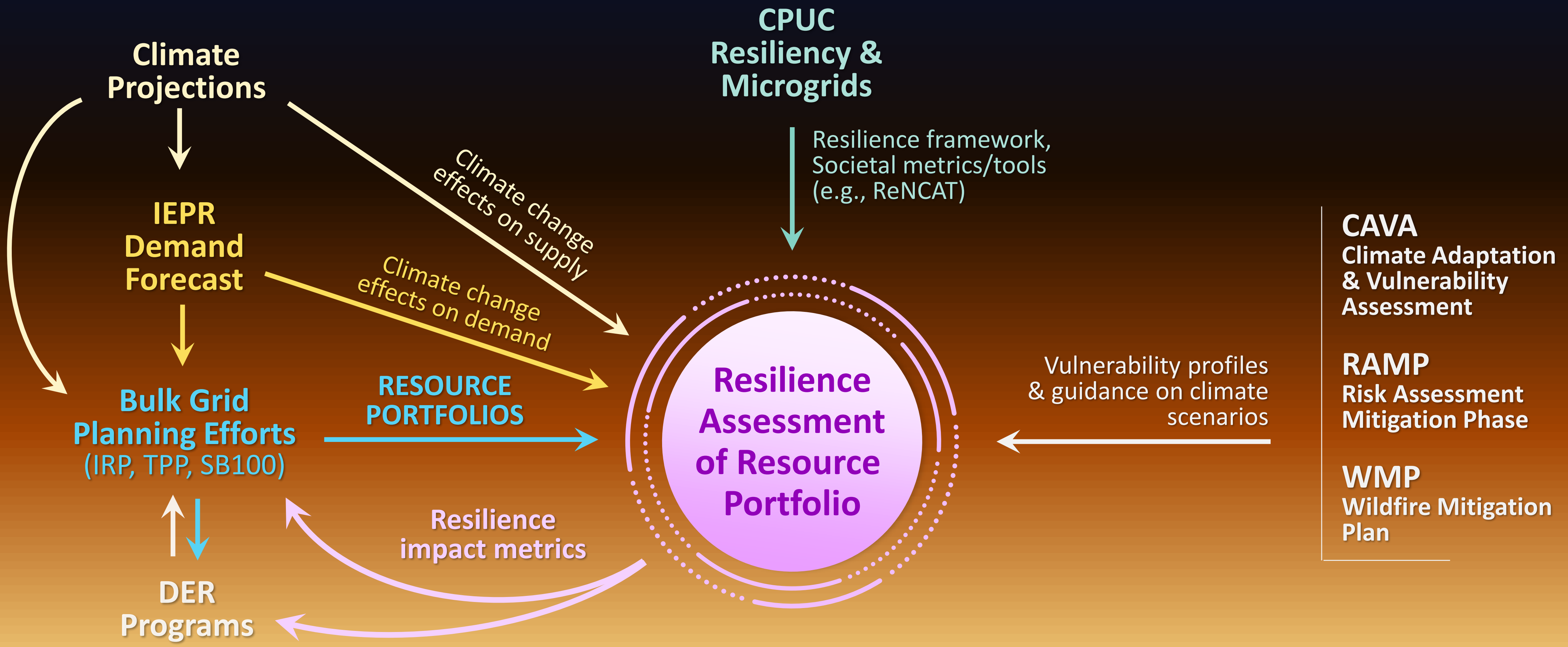
- Provide upstream benefits to bulk grid
- Support clean energy transition

Bulk grid planning needs to consider contributions (and limitations) of DERs that can provide services in multiple grid domains

Value stacking of system & local services reduces net cost to provide resilience, and can impact economic feasibility and ranking of mitigation measures needed for resilience

How to integrate "resilience" into resource planning?

Climate-resilient resource planning requires a comprehensive resilience assessment tapping into several related but currently disconnected efforts in the state



Cost effectiveness of resilience investments

- "High cost" is identified as one of the top barriers to effective resilience investments, among stakeholders in our first workshop
- Economic assessment of resilience plans and investments must consider both: (a) the degree of resilience improvement, and (b) net cost of achieving that amount of resilience improvement
- This can be addressed by metrics combining key features of net cost of new entry (CONE) and risk spend efficiency (RSE)
  - Net CONE is the amount of RA capacity revenue that a resource would need to support its initial investment. Calculated as levelized capital and O&M costs *minus* non-capacity benefits, typically shown in $ per kW-month.
  - Risk spend efficiency (RSE) is used by utilities to quantify and compare cost effectiveness of mitigation measures based on the ratio of the risk reduction to the mitigation cost.

Net cost of resilience investment

Like net CONE,
net cost of resilience investment
can be calculated as levelized cost
of the mitigation measure
minus non-resilience benefits

Cost offset from non-resilience benefits can include services provided to bulk grid under blue sky conditions (e.g., energy, ancillary services, resource adequacy)

**Capturing these benefits may require changes to use case and reduce resilience improvement level*

Net cost of resilience investment = (**Levelized Capital Cost** + **Levelized O&M Cost**) − **Levelized Non-Resilience Benefits**
divided by **Resilience Improvement**

Ratio can be flipped to show resilience improvement per $ spent

- *Important to normalize by degree of resilience improvement*
- *Resilience has many dimensions related to underlying outage characteristics and types of customers impacted, for which there are no standard metrics*

Part II:

Recap of key resilience definition elements

Recap of March 21 resilience definition

In our March 21 workshop, we identified resilience in grid planning as the ability to serve electricity to end use customers, even under emergency conditions driven by a variety of weather-related hazards and failure points across all grid domains.

Key elements of a resilience definition	Application to California's grid planning
What is the **critical function or service** that must be preserved?	Electricity service to end use customers, even under emergency conditions *Recognizing that some prioritization is needed in avoiding outages, e.g., priority and critical loads*
What is the **system** providing that function/service?	Electricity grid, including all grid domains, and from fuel supply to end use customer
What are the key **hazards** that can disrupt the systems' ability to provide those functions/services?	Environmental and weather conditions that can significantly increase electricity demand, reduce electricity supply, or limit delivery of electricity to customers *Includes extreme heat/cold, drought, wildfires, storms, winds, floods, smoke*
Where are the known **failure points** on the system that would disrupt that function/service?	▪ Insufficient generation available to meet demand ▪ T&D wires outages and de-rates
What are the **most concerning sets of hazards & failure points**, reflecting risk tolerances on impact vs. probability?	▪ Temperature extremes on demand and supply ▪ Wildfire/smoke affecting distribution sections and key transmission corridors

Stakeholder feedback:
Customer & outage characteristics of most concern

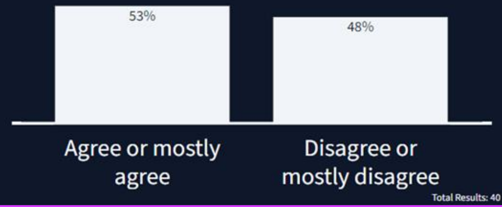
Poll participants mostly agreed that the key issue is interruption of electricity service to customers, and that not all outages are equally impactful—but some disagreed on scope of key failure points and hazards.

a) The measure of resilience for grid planning must be tied to some measure of interruption of electricity service (outage).

b) Regardless of failure point on the system, outage at the end use customer level is ultimately what we seek to avoid.

c) Not all service interruptions are equally impactful; some prioritization of loads must be considered.

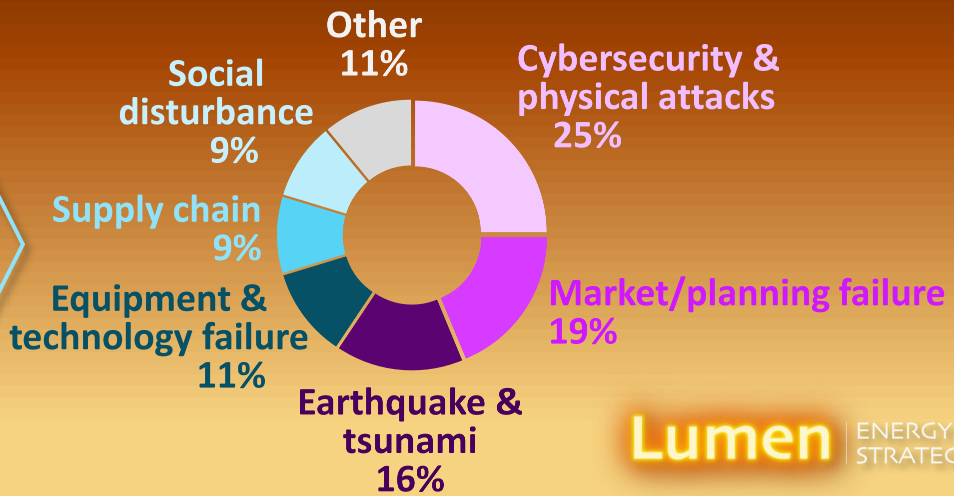
d) Failure points across all grid domains have the potential to result in high-impact outages.



We interpreted this as some disagreement on what "high-impact" means

e) The key known set of resilience hazards at the state grid planning level is weather/environmental variabilities, trends, and extremes.

f) What other resilience hazards must be considered in grid planning?



How should **physical and/or cyber security** fit into grid planning?

When poll is active respond at **PollEv.com/lumen999** Send **lumen999** to **22333**

HINT: Input complete sentences, or just strings of words. Either way, the word cloud will break up your entry into individual words. Hyphenate words you want to keep together.

Nobody has responded yet.

Hang tight! Responses are coming in.

How should **non-weather disasters** (e.g., earthquake, tsunami, societal collapse) fit into grid planning?

When poll is active respond at **PollEv.com/lumen999** Send **lumen999** to **22333**

HINT: Input complete sentences, or just strings of words. Either way, the word cloud will break up your entry into individual words. Hyphenate words you want to keep together.

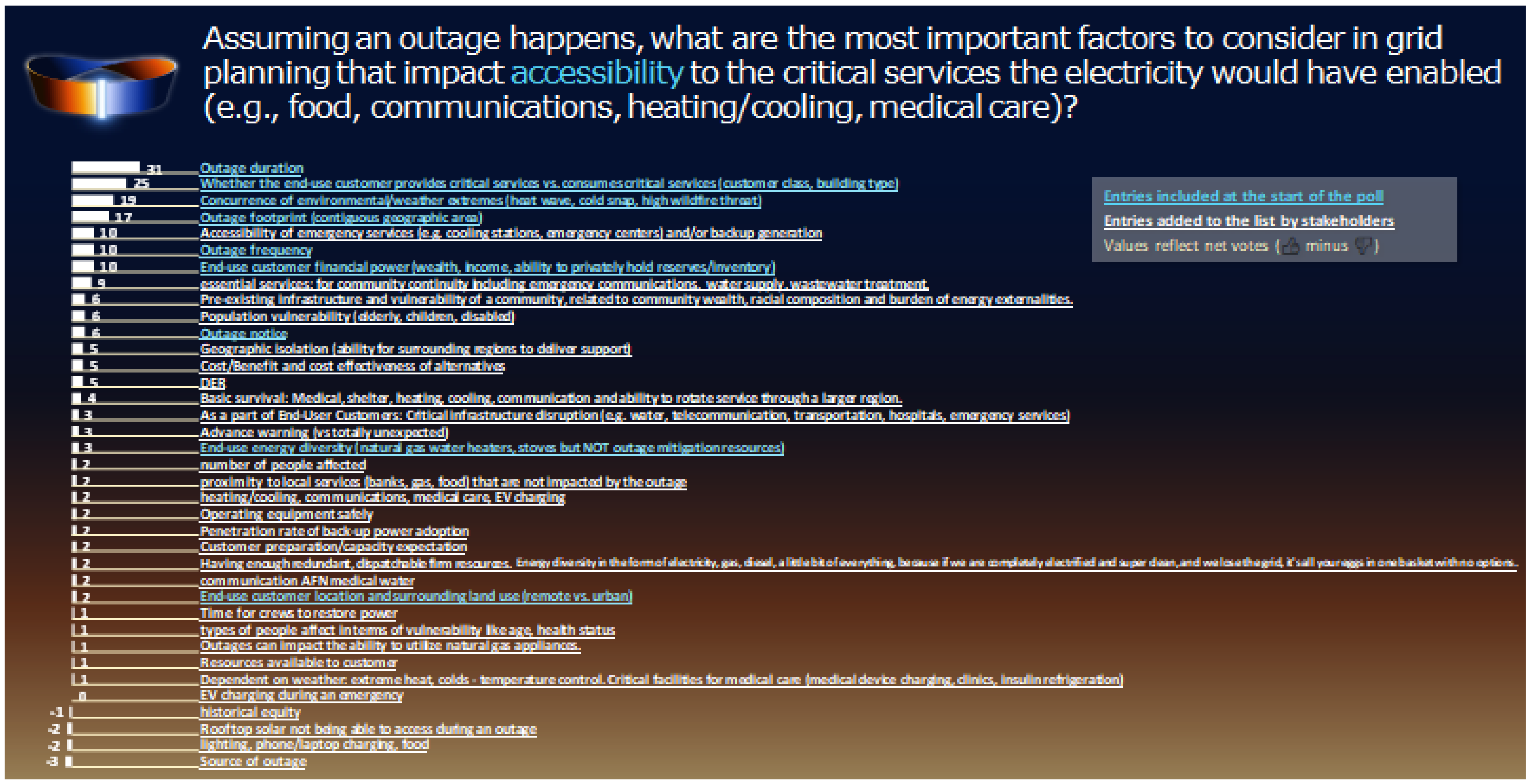
Nobody has responded yet.

Hang tight! Responses are coming in.

Stakeholder feedback (cont'd):

Customer & outage characteristics of most concern

Type of customer or service on outage, outage duration, outage footprint, and situational multipliers (e.g., heat waves) ranked relatively high in impacts to accessibility to critical services. Socioeconomic factors, outage notice & frequency, demographics, geographic isolation, and other factors are also perceived multipliers on outage impacts.



Category of outage impact drivers	Net votes	Share of total
Type of customers/services on outage	56	29%
Outage duration	32	17%
Outage footprint	21	11%
Situational multiplier	19	10%
Socioeconomic factors	15	8%
Outage notice	11	6%
Outage frequency	10	5%
Age/health demographics	7	4%
Geographic isolation	7	4%
DER adoption	7	4%
Energy diversity	5	3%
Other	2	1%

Breakout groups: mini exercise

- Our resilience definition is focused on an application that links IRP to local resilience planning, distributed resources planning, and climate adaption efforts
- What would a more broadly applicable definition look like? Would the definition need to articulate specific resilience targets or thresholds?
- Breakout groups:
  - You will be assigned a breakout group; host will move you in and out
  - First, the room moderator will give you each 1 min to react to outage prioritization question
  - Then, you'll return to main workshop and the moderator will summarize the discussion

Breakout groups: mini exercise

Exercise: REFINE THE FOLLOWING STRAW RESILIENCE DEFINITIONS.

- These definitions are for discussion purposes only.
- Identify key words or phrases that should be kept in a resilience definition.
- Identify key words or phrases that need to be modified, removed, or added.

Qualitative:

Resilience is the ability of the grid to serve customers' essential electricity needs under a variety of knowable extreme grid stressors and in the event of a system failure—by meaningfully reducing the magnitude of service disruptions, extending the duration of resistance to disruptions, reducing the duration of disruptions, and/or reducing the duration of recovery.

With specific thresholds:

Resilience is the ability to reduce division-level Average Interruption Duration Index (AIDI) on major event days (MEDs) or mitigate those service interruptions to customers.

Breakout group exercise in progress

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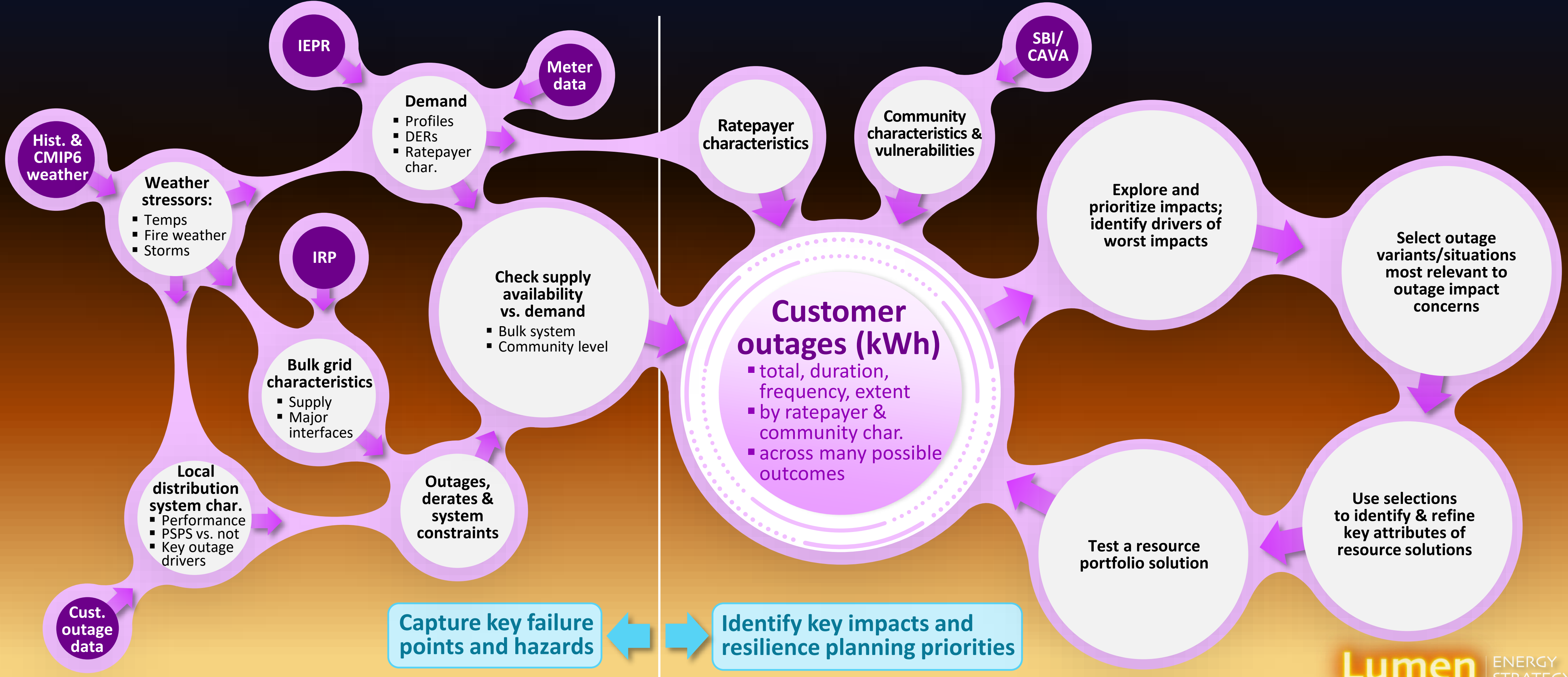
Breakout groups mini exercise: results

- What did people like about the definitions?
- What did they dislike? How would they change them?
- Pros and cons of qualitative definition vs. definition with specific thresholds?
- Other key challenges and questions?

Part III:
Translating resilience definition into metrics & a modeling framework

Key elements of a resilience evaluation model

Based on our definition of resilience for grid planning, a resilience evaluation model would need to (a) center on outage impacts to customers and (b) connect the following elements:



Data needs to capture resilience improvement

Resilience improvement is a function of changes in outage characteristics and types customers/communities most impacted by outages

- **Outage characteristics:**
  - Model output
  - Historical outage data: calibrate to known outage patterns and drivers
    - E.g., SAIDI and SAIFI with/without MED for distribution-level failures
  - Calibrate to bulk grid planning threshold (1-in-10 LOLE)
  - Historical and projected environmental stressors: consider how future outage patterns may change due to different weather patterns and as a result of climate change

- **Customer characteristics:**
  - Meter and billing data: "Ratepayer" and tariff characteristics, location, customer class, retail rate
  - Community characteristics and vulnerabilities:
    - Census-type data: demographics
    - SBI, CAVA, components of DAC, Healthy Places, etc.: socio-economic vulnerabilities and burdens
    - Land use data: density, remote vs. not, resource development constraints

Outage impact dimensions

Outage Characteristics

- **Footprint:** Isolated, local, widespread
- **Duration:** Short, multi-day, extended
- **Frequency:** Low, high

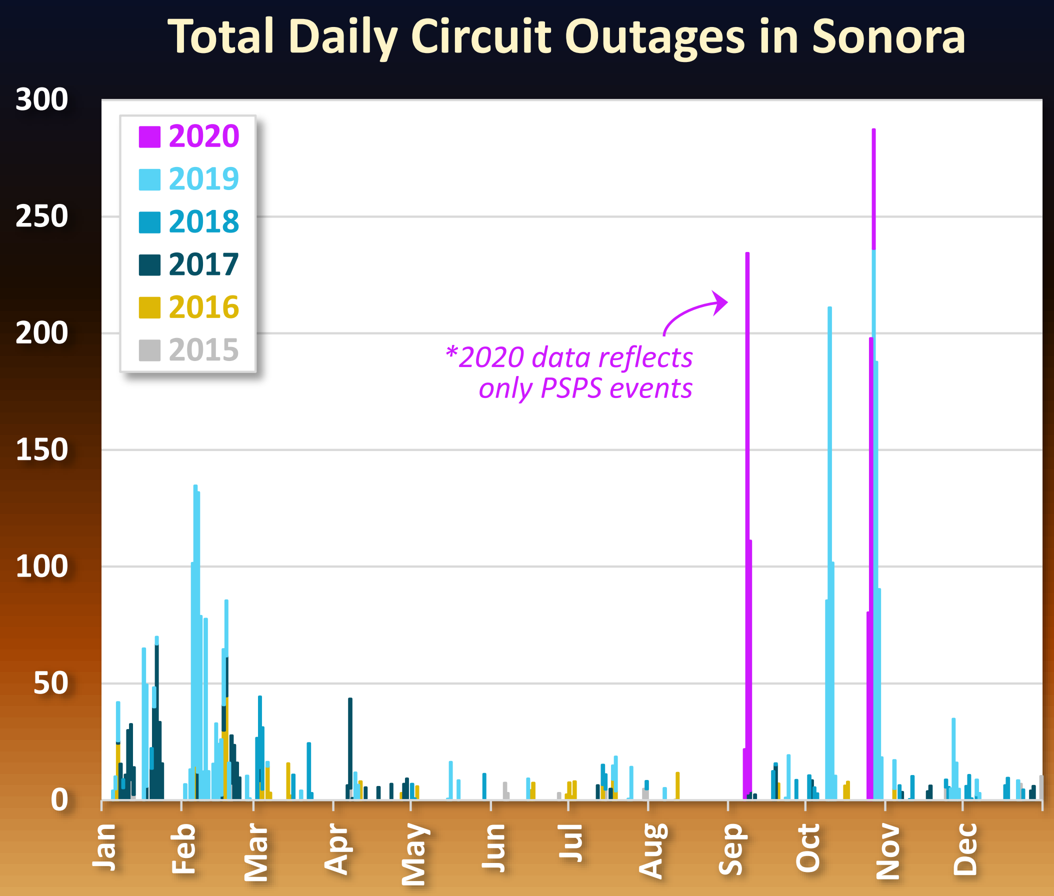
Customer Characteristics

- **Equity:** Low/high burden
- **Sector:** Res. vs. C&I
- **Load:** Critical vs. not

		Isolated						Local						Widespread					
		Short		Multi-Day		Extended		Short		Multi-Day		Extended		Short		Multi-Day		Extended	
		Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi
Low Burden	Res: non-critical																		
	Res: critical																		
	C&I: non-critical																		
	C&I: critical																		
High Burden	Res: non-critical																		
	Res: critical																		
	C&I: non-critical																		
	C&I: critical																		

Expected kWh of outages in a planning year

Circuit outages in Sonora, CA (in daily circuit-hours)



- Based on reported non-PSPS sustained distribution circuit-outages 2015–2019, including major event days
- Plus PSPS through 2020
- Key outage drivers are:
  - PSPS in the fall
  - Vegetation and equipment failures during the winter and spring

Circuit outages in Sonora, CA (in circuit-hours/yr)

Footprint	Isolated						Local						Widespread						Total circuit hrs/yr	# of circuits	Avg outage hrs/yr
Duration	Short		Multi-Day		Extended		Short		Multi-Day		Extended		Short		Multi-Day		Extended				
Frequency	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi			
Avg. circuit-hrs/yr	13	**115**	7	65					2				2	19	67	**345**			**634**	**10**	**63.4**

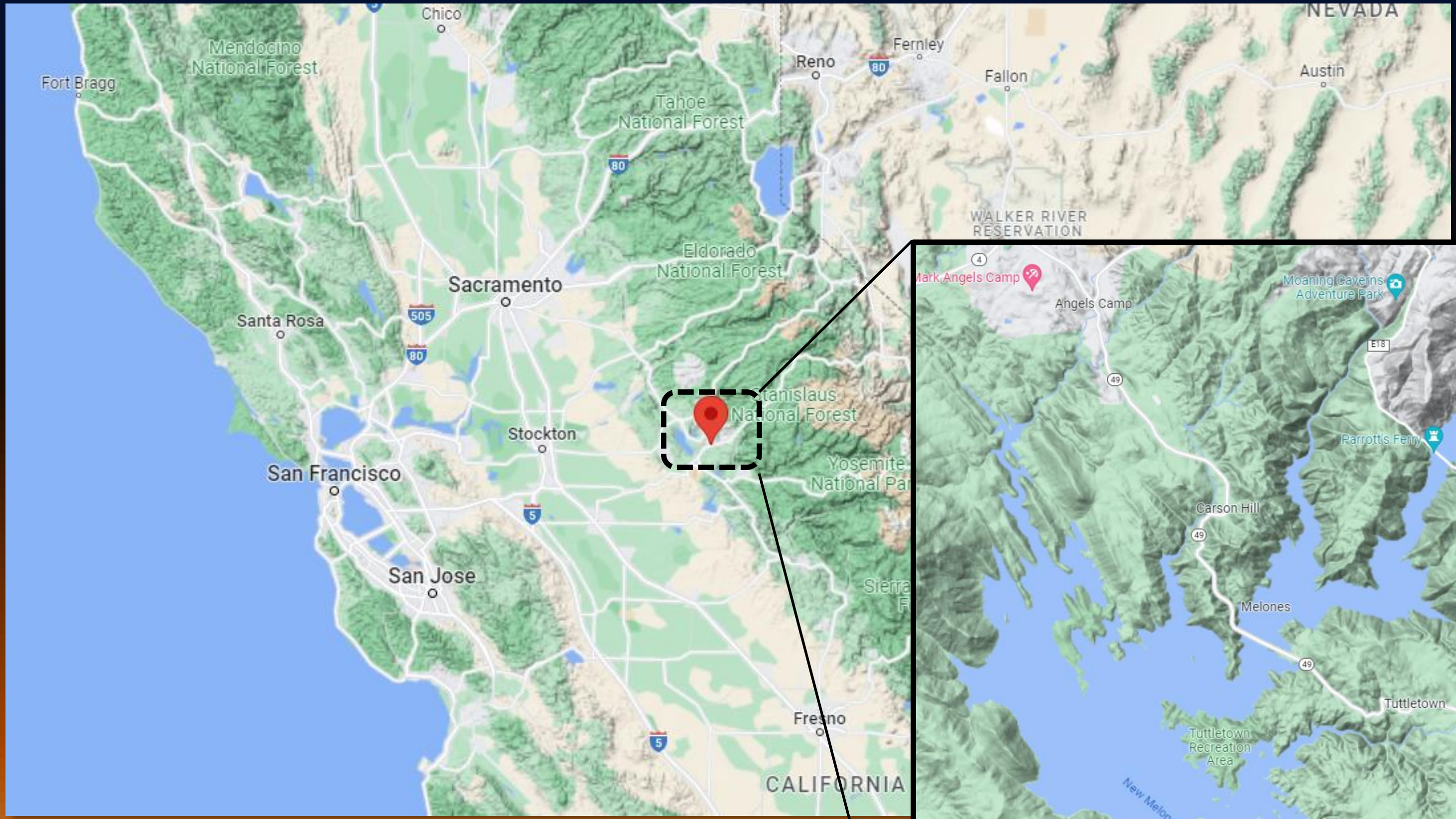
- Isolated/Local/Widespread: based on whether a zip code's outage circuit-hours in a given day is above average, plus whether or not other zip codes on the system are having above-average outage days
  - Sonora's circuit outages tend to be either isolated and relatively short (< 12 hours long), or multi-day (< week) during times when outages are widespread on the broader system
- Lo/Hi frequency: individual circuits are assigned as lo vs. hi based on their frequency of outages over a 5-year period relative to other circuits on the broader system
  - Most of Sonora's circuits have a relatively high outage frequency
  - Sonora's circuits tend to be on outage 63.4 hours per year, or about 2.5–3 days per year

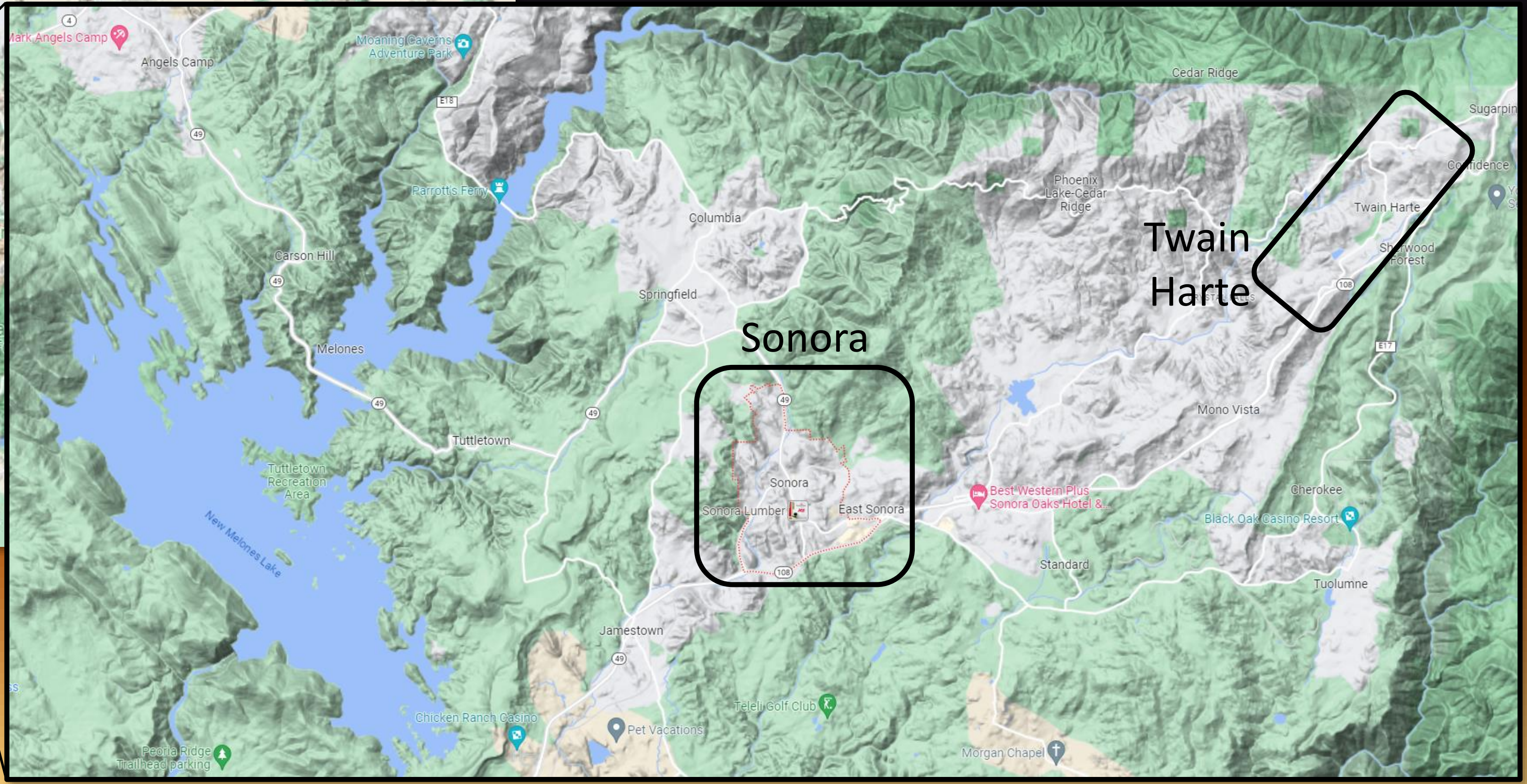
Sonora's ratepayer characteristics

Footprint	Isolated						Local						Widespread						Total circuit hrs/yr	# of circuits	Avg outage hrs/yr
Duration	Short		Multi-Day		Extended		Short		Multi-Day		Extended		Short		Multi-Day		Extended				
Frequency	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi			
Avg. circuit-hrs/yr	13	115	7	65					2				2	19	67	345			634	10	63.4
Customer hours																			cust-hrs	# cust.	
Res. medical	969	29,108	779	14,588	0	0	0	0	247	0	0	0	181	4,089	5,692	75,155	0	0	130,808	1,606	81.4
Res. non-medical	7,912	263,104	5,178	131,006	0	0	0	0	1,640	0	0	0	1,775	36,416	45,972	657,159	0	0	1,150,162	14,197	81.0
C&I	1,645	44,876	1,303	22,965	0	0	0	0	413	0	0	0	751	6,265	13,879	115,475	0	0	207,571	2,844	73.0
Other	13	1,283	13	769	0	0	0	0	4	0	0	0	10	172	157	3,839	0	0	6,262	71	88.2
TOTAL cust-hrs	**10,539**	**338,370**	**7,273**	**169,328**	0	0	0	0	**2,303**	0	0	0	**2,717**	**46,943**	**65,699**	**851,629**	0	0	1,494,803	18,718	79.9

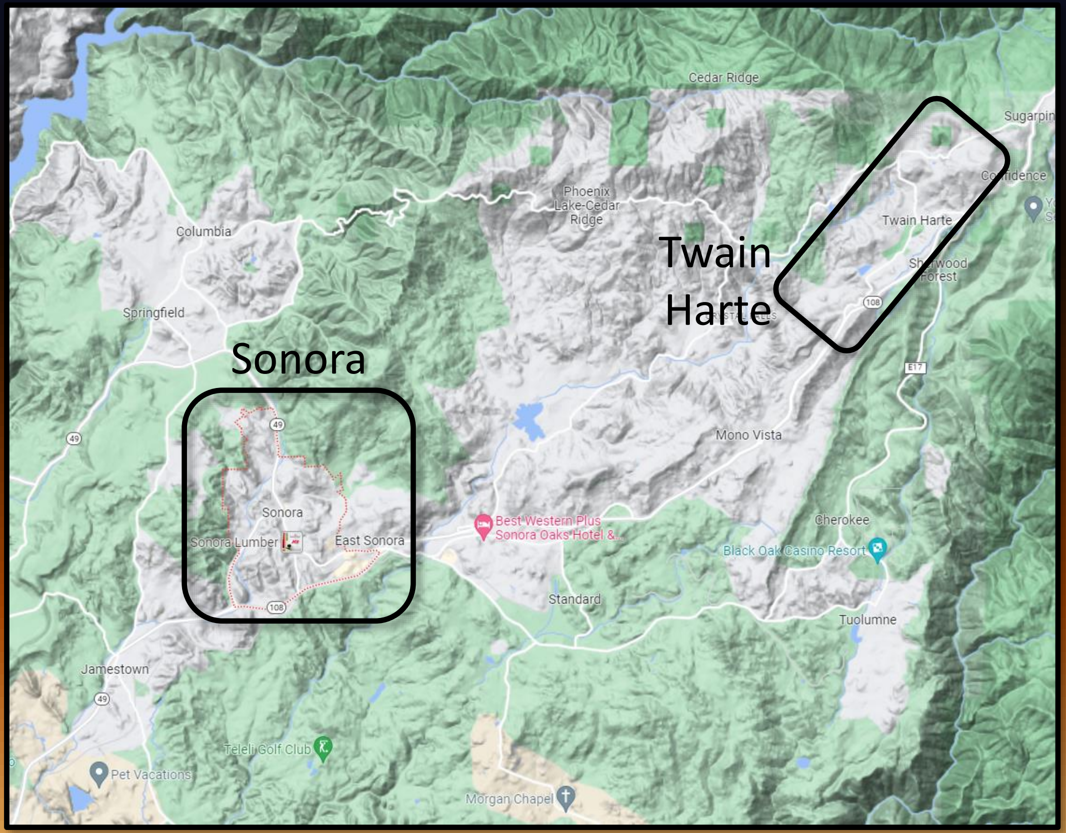
- "Ratepayer" meaning what characteristics we can observe through retail tariffs, billing, and meter data
- Demonstrated here using public information on # customers and customer mix by circuit

Compare two nearby communities



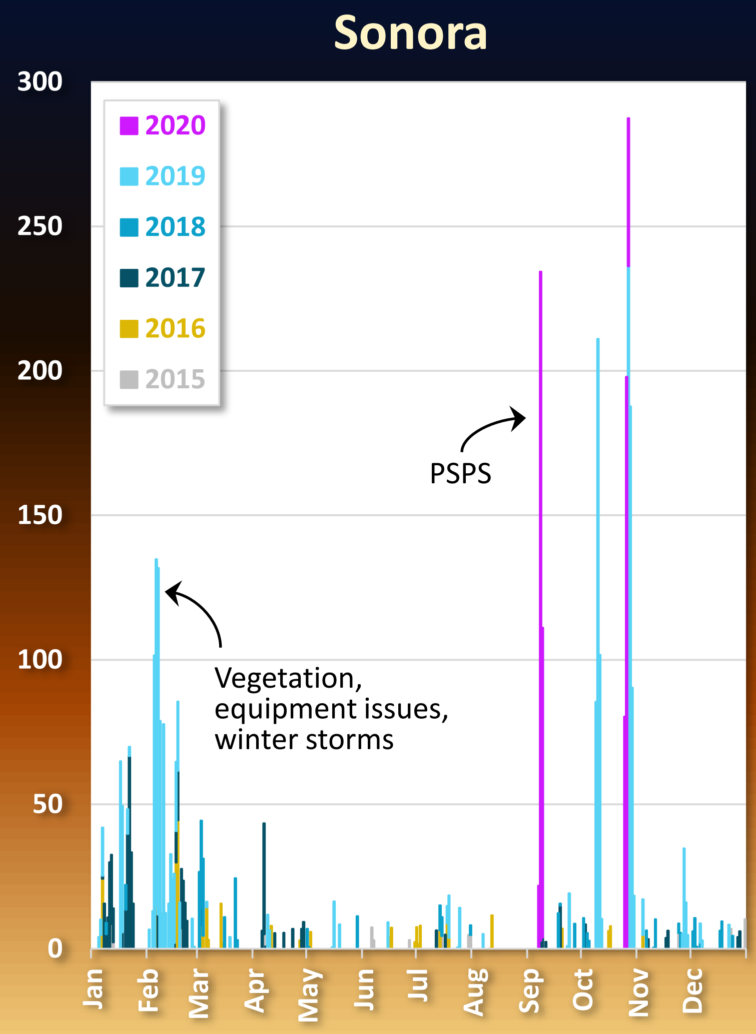


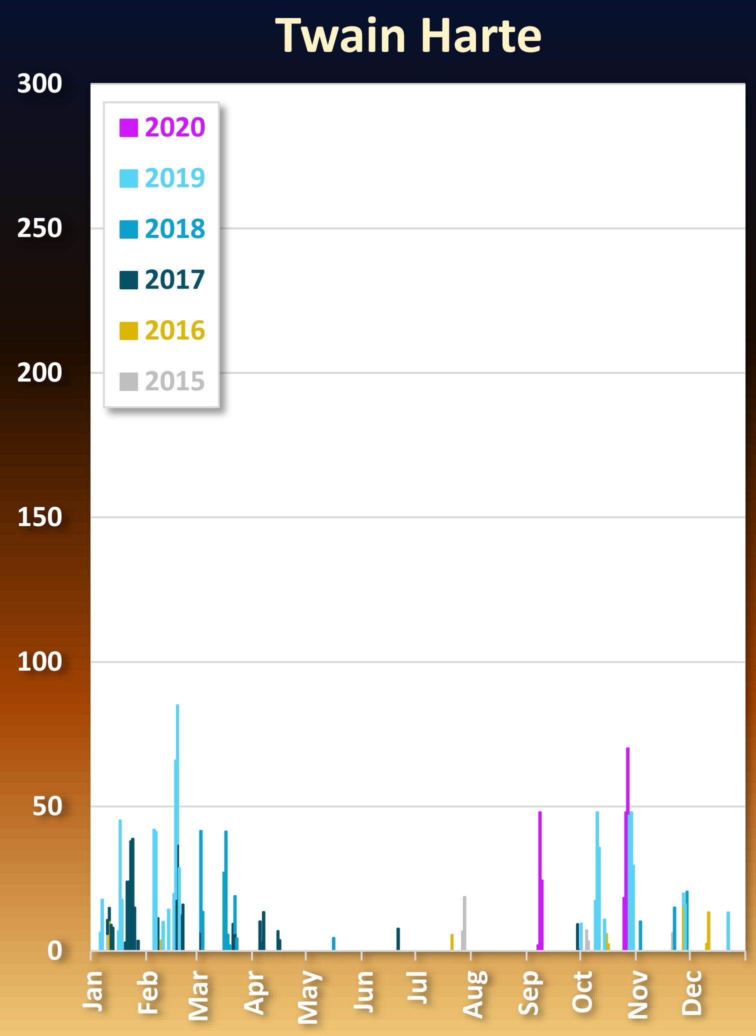
Compare two nearby communities (cont'd)



	Sonora	Twain Harte
Population	~5,000	~2,500
Age profile	15% children < 10yrs 29% elderly 60+yrs	10% children < 10yrs 36% elderly 60+yrs
Income profile	$56k median household 23% below 1.5x poverty level	$76k median household 9% below 1.5x poverty level
CalEnviroScreen 4.0 score	54 percentile overall 58% pollution burden 47% population/socioeconomic	17 percentile overall 17% pollution burden 22% population/socioeconomic
Customer mix (% of electricity use)	30% residential 70% C&I	70% residential 30% C&I
DER systems installed	1,890 installations ~16,500 kW solar (~90% residential) 700 kW storage (all residential)	137 installations ~1,000 kW solar (all residential) 100 kW storage (all residential)

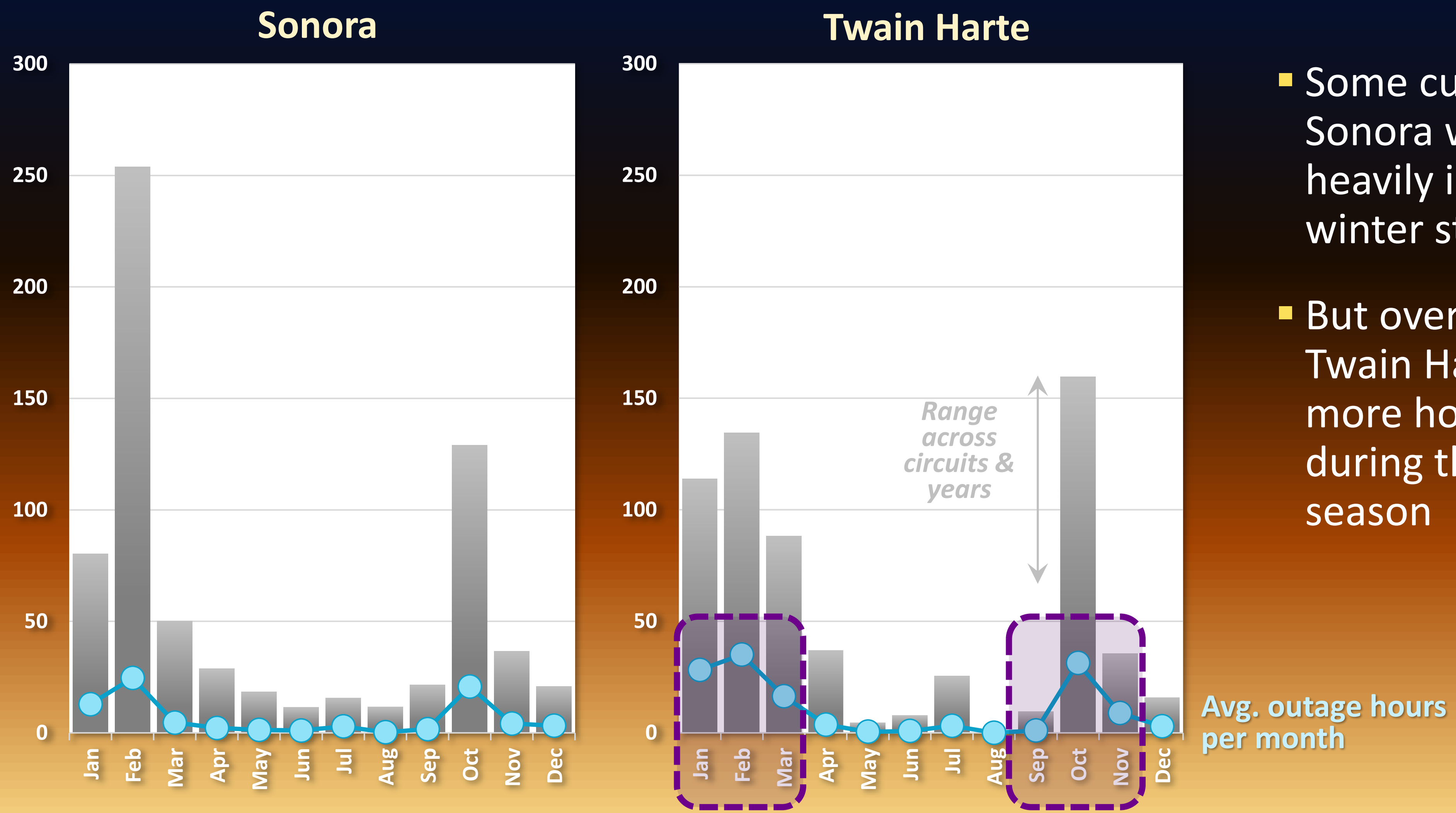
Total daily circuit-hours on outage





- Similar profiles indicating problems during the fall (fire season) and winter (storms)
- Smaller but noticeable issues in the summer in Sonora
- Higher absolute circuit-hours outages in Sonora, but when normalized by number of customers…

Monthly outage hours per customer



- Some customers in Sonora were more heavily impacted in winter storms
- But overall, customers in Twain Harte experience more hours on outage during the winter and fire season

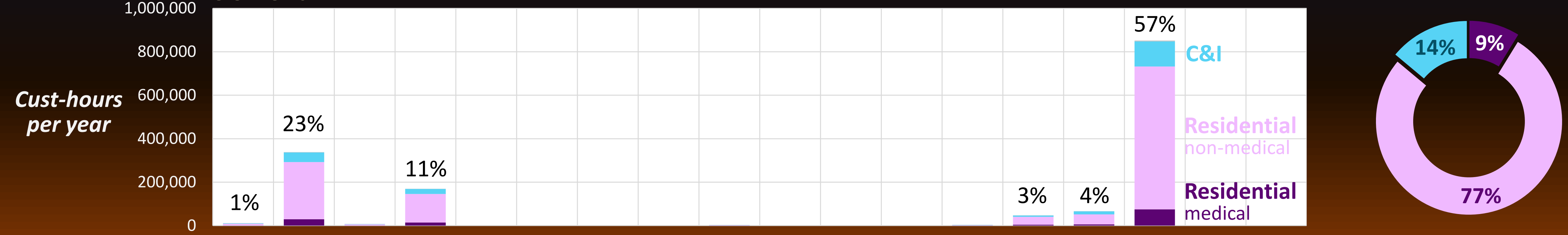
Mix of ratepayers impacted

Footprint	Isolated						Local						Widespread						Total cir. or cust. hrs/yr	# of circuits or cust.	Avg outage hrs/yr
Duration	Short		Multi-Day		Extended		Short		Multi-Day		Extended		Short		Multi-Day		Extended				
Frequency	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi			
Sonora																					
Avg. circuit-hrs/yr	13	115	7	65					2				2	19	67	345			634	10	63.4
Res. medical	969	29,108	779	14,588	0	0	0	0	247	0	0	0	181	4,089	5,692	75,155	0	0	130,808	1,606	81.4
Res. non-medical	7,912	263,104	5,178	131,006	0	0	0	0	1,640	0	0	0	1,775	36,416	45,972	657,159	0	0	1,150,162	14,197	81.0
C&I	1,645	44,876	1,303	22,965	0	0	0	0	413	0	0	0	751	6,265	13,879	115,475	0	0	207,571	2,844	73.0
Other	13	1,283	13	769	0	0	0	0	4	0	0	0	10	172	157	3,839	0	0	6,262	71	88.2
TOTAL cust-hrs	**10,539**	**338,370**	**7,273**	**169,328**	0	0	0	0	**2,303**	0	0	0	**2,717**	**46,943**	**65,699**	**851,629**	0	0	1,494,803	18,718	79.9
Twain Harte																					
Avg. circuit-hrs/yr		45		37						4						177			263	2	131.7
Res. medical	0	10,317	0	8,406	0	0	0	0	0	918	0	0	0	0	0	40,015	0	0	59,656	456	130.8
Res. non-medical	0	145,816	0	120,567	0	0	0	0	0	12,219	0	0	0	0	0	571,352	0	0	849,954	6,460	131.6
C&I	0	11,284	0	9,341	0	0	0	0	0	941	0	0	0	0	0	44,250	0	0	65,816	500	131.6
Other	0	202	0	172	0	0	0	0	0	15	0	0	0	0	0	808	0	0	1,197	9	133.0
TOTAL cust-hrs	0	**167,619**	0	**138,487**	0	0	0	0	0	**14,093**	0	0	0	0	0	**656,425**	0	0	976,624	7,425	131.5

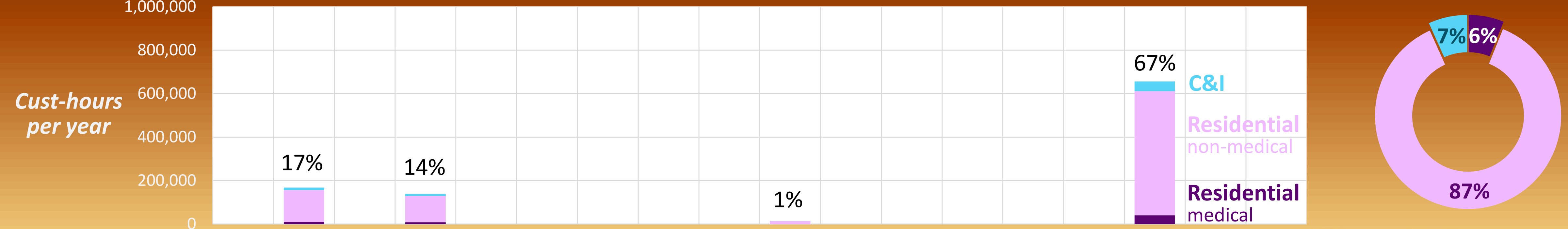
Mix of ratepayers impacted

Footprint	Isolated						Local						Widespread					
Duration	Short		Multi-Day		Extended		Short		Multi-Day		Extended		Short		Multi-Day		Extended	
Frequency	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi	Lo	Hi

Sonora



Twain Harte



Lumen ENERGY STRATEGY

11:55 Lunch Break
will return at 12:25p.m.

Questions to ponder:

- What type of outages are the most concerning? Why?
- Which community has the more severe outage problem? Why?
- Does the analytical approach so far stay true to 4 Pillars? What are its strengths; how can it be improved?

Part IV:
Using resilience metrics to identify resilience planning priorities

Audience comments on community comparison

- Sonora vs. Twain Harte example:
  - What type of outages are the most concerning? Why?
  - Which community has the more severe outage problem? Why?
  - Does the analytical approach so far stay true to 4 Pillars? What are its strengths; how can it be improved?

Breakout group exercise

- Exercise: COMPARE/CONTRAST OUTAGES; IDENTIFY PRIORITIES FOR RESILIENCE INVESTMENTS.
  - Consider outage statistics, mix of ratepayer types, community characteristics
  - Assume investment resources are limited and not all outages can be mitigated
  - Apply your own interpretation of the data and risk tolerances; no right or wrong answer

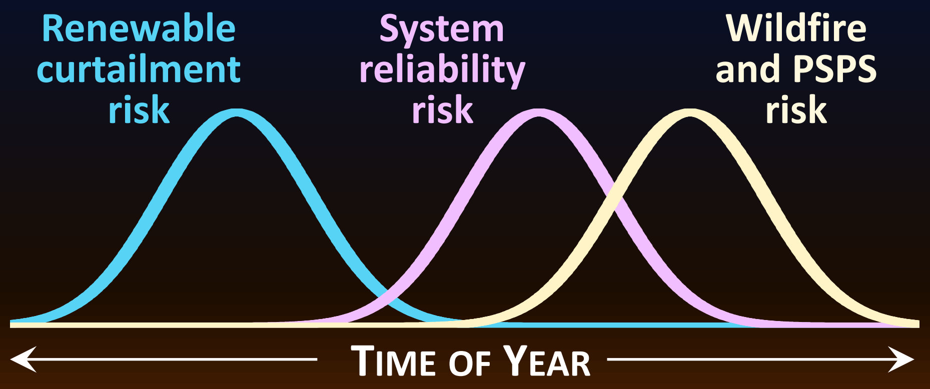
- Breakout groups:
  - You will be assigned a breakout group; host will move you in and out
  - First, the room moderator will give you each 1 min to react to outage prioritization question
  - Then, the moderator will pose additional questions to react to
  - Finally, you'll return to main workshop and the moderator will summarize the discussion

Breakout group exercise in progress

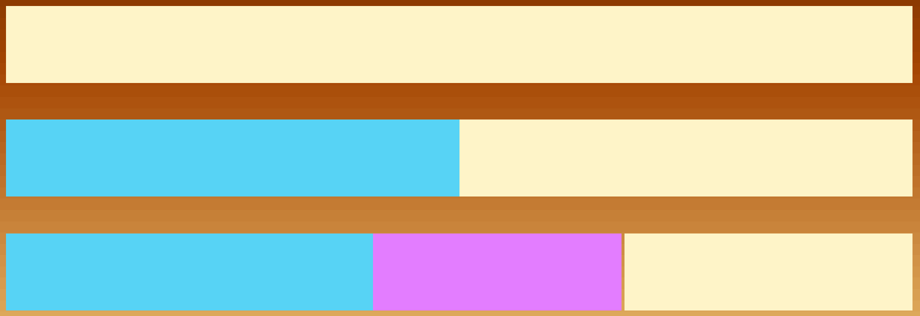
Breakout group exercise: results

- Scope of topics discussed; any of particular interest?
- Any agreement on types of outages most concerning?
- Different perspectives on how to prioritize?
- Challenges in the prioritization process?

Value stacking



- *Threats and risk profiles are not always coincident*
- *Flexible resources can adjust their use cases and priorities to enable value stacking*
- *Residual risk and economic tradeoffs need to be evaluated to determine optimal use and configuration*



Customer Resilience	System Reliability	Renewable Integration
✓✓✓	✗	✗
✓✓	✗	✓✓✓
✓	✓	✓✓

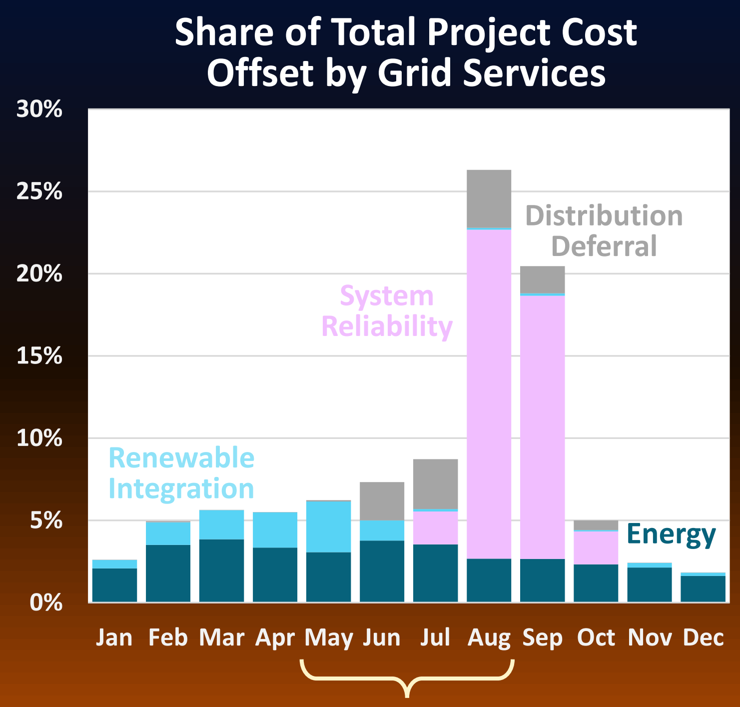
Example:

Net cost of alternative solutions

	Wires solution	Non-wires (DER)	Non-wires (DER) w/ multiple use
Sonora			
Net cost level	1x	3x	1.5x
Outage mitigation	~100%	~100%	80%
Twain Harte			
Net cost level	2x	3x	1.5x
Outage mitigation	~100%	~100%	95%

*Illustrative example. For discussion purposes only.

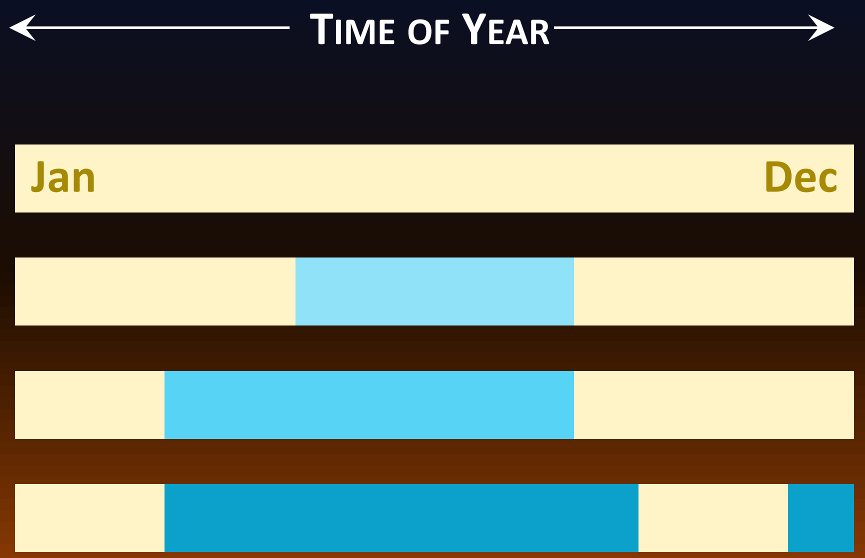
- Wires and non-wires solutions considered
- Non-wires (DER) alternative is assumed to be more expensive, but has the option to reduce net cost by offering grid services
- Multiple-use application reduces net cost, but also outage mitigation level



E.g., Value stacking of grid services during May–August reduce net cost of resilience by ~50%

Example:

Risk and economic tradeoff



* Yellow = resilience/backup mode
Blue shades = grid services prioritized

Use Case	Outage Mitigation	Cost Offset by Grid Services	Net Cost of Resilience
A	~100%	0%	3x
B	95%	50%	1.5x
C	80%	60%	1.2x
D	50%	80%	0.6x

- 4 use cases with different prioritization of resilience vs. bulk grid services
- Going from A to B, C, and D, leaves residual risk of outages, which needs to be weighed against value gained

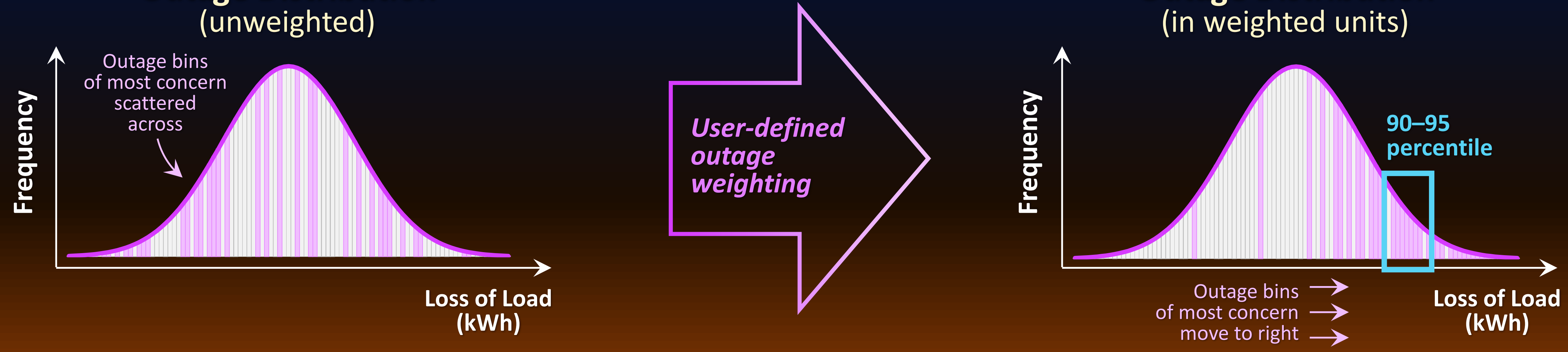
Part V:
Using stochastic analysis to refine resilience risk profile & candidate resource solutions

Refining resilience risk profile

- How would an outage mitigation resource likely need to operate? In blue sky vs. black sky conditions?
- Across many simulations of what a given year could look like, how well does this operating profile work?
  - With stochastic simulations
  - This approach also enables calibration of the model to LOLE, SAIDI/SAIFI
  - Will yield a <u>distribution</u> of possible total unserved energy outcomes for a planning year
  - We are not necessarily trying to plan for every single type of outage and situation! Stochastic outputs help us understand the range and <u>intentionally</u> narrow down to the most concerning outcomes
    - Recognizing that risk perception, tolerances, and mitigation preferences may be different in different communities
- What are the opportunities to provide grid services? What is the risk tolerance for stacking that value onto local resilience services?

Prioritize outages

Outage Distribution (unweighted) → **Outage Distribution** (in weighted units)



- Outages in natural units
- Can be calibrated to LOLE, SAIDI/SAIFI levels
- Outage bins of most concern are scattered across the distribution

- Applying weights to prioritize certain types of outages re-order simulations such that the runs with these type of outages would move to the right of the distribution
- Can subset of runs to evaluate key hazards and failure points, and compare different portfolio solutions

Identify hazards/failure points and test solutions

- Select top X runs based on distribution that uses weighted outages
  - E.g., For 1-in-20+ year events, use top 5% (500 out of 10k) of the runs
  - Need to think about reliability vs. resilience
- These subset of "extreme" runs can help identify key hazards and failure points contributing to outages that are most concerning
  - What is the time profile, probability, geography, grid topology of those hazards and failure points?
  - What resource attributes are needed to address these?
  - How does distribution of outage outcomes change with different resource portfolios?

Thank you

If you would like to submit informal feedback to the CPUC, please complete our post-workshop survey

Join us for our next workshop in late 2023!

Learn more about WARP to Resilience and join our mailing list for study updates
www.lumenenergystrategy.com/resilience

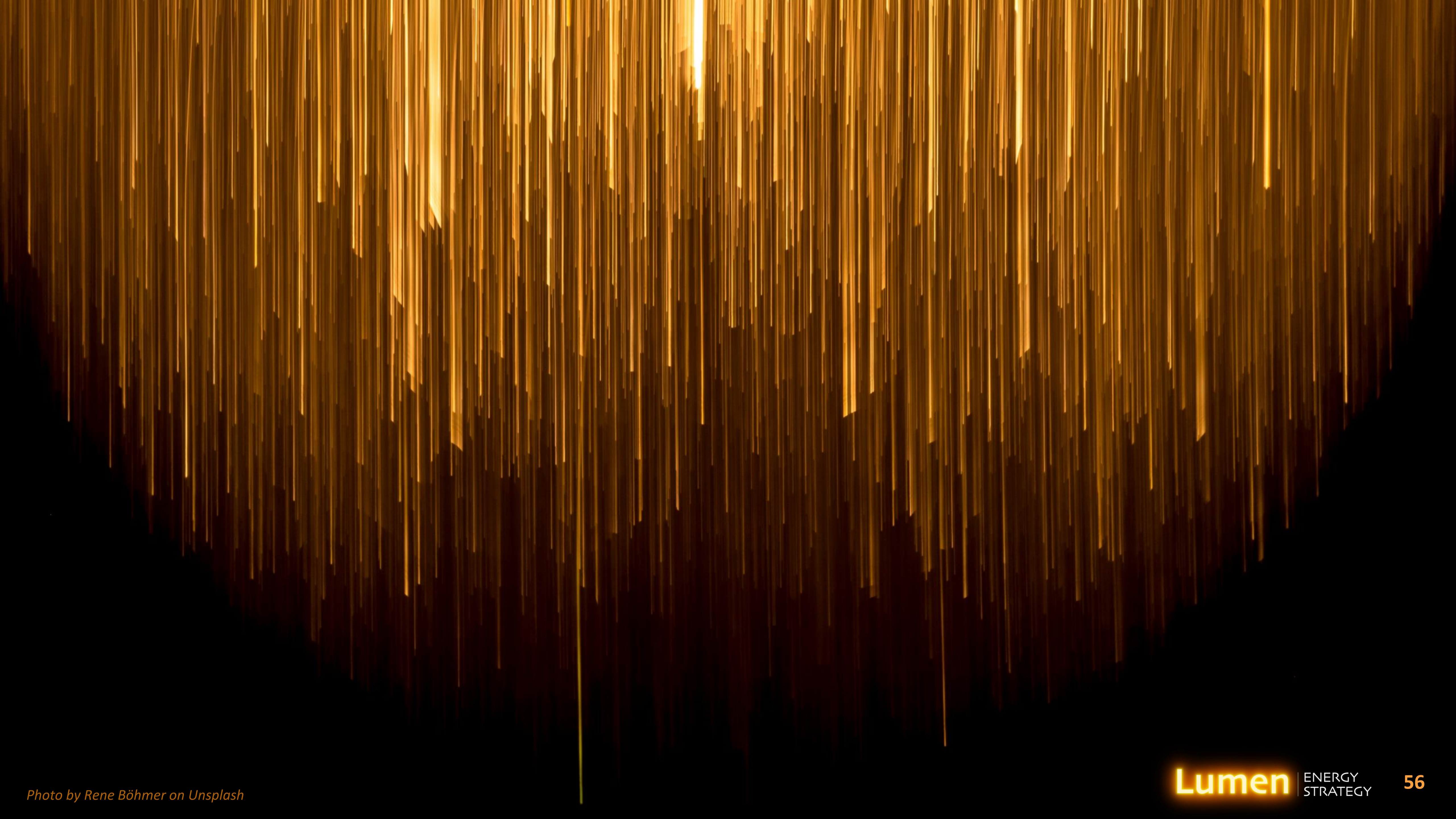


Photo by Rene Böhmer on Unsplash

Closing Remarks

Energy Division Workshop Series on Resiliency

- ✓ **May 10, 2022** - Interruption Cost Estimate (ICE) Calculator/Power Outage Economic Tool (POET)
- ✓ **July 7, 2022** – Sandia National Labs – Resiliency Node Cluster Analysis Tool (ReNCAT) and the Social Burden Index
- ✓ **May 10, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 1st of 3 workshops – Resiliency Standards: Definitions
- ✓ **July 26, 2023** – SCE/Sandia (DOE funded) Kickoff ReNCAT/Social Burden Index Pilot Project (Phase 1)
- ✓ **August 22, 2023** – LBNL (DOE funded) – Final Reporting on Data Schema Pilot project
- ❑ **September 5, 2023** – Lumen Energy Strategy – 2nd of 3 workshops – Resiliency Metrics ← **today's event**
- ❑ **October 19, 2023** – SDG&E and Sonoma County Junior College District - Use Case Demonstration of 4-Pillar Methodology
- ❑ **November 8, 2023** – Lumen Energy Strategy (CEC EPIC funded) – 3rd of 3 workshops – Resiliency Methodologies
- ❑ **November 28, 2023** – Final Report: SCE/Sandia (DOE funded) ReNCAT Pilot Project (Phase 1)

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