Resiliency Standards: Methodologies

Improving Resilience in Integrated Resource Planning, *Lumen Energy Strategy*

Grid Resiliency and Microgrids Team, Energy Division

November 8, 2023, 9:00am – 12:00 pm

California Public Utilities Commission

WebEx and Call-In Information

Join by Computer:

https://cpuc.webex.com/cpuc/j.php?MTID=m1761e2ae5d9d9f268f6a2a587485f089

Join by Phone:

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

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

Access Code: 2485 307 8113

(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.
- 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.

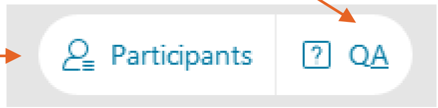
WebEx Logistics

- 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

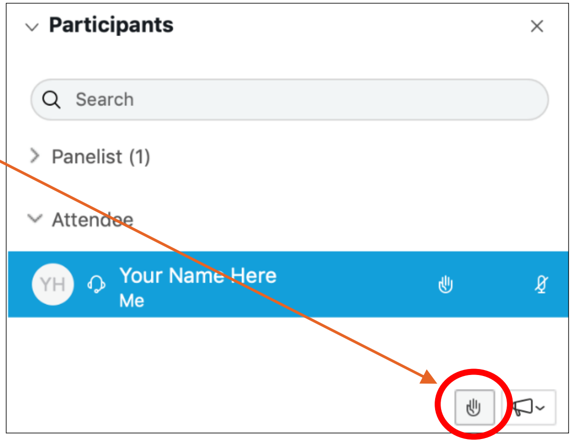
Access the written Q&A panel here

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.



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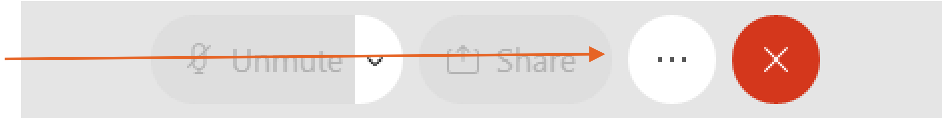


Energy Division Workshop Series on Resiliency

- ✓ **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
- ✓ **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 ← **today's event**
- ❑ **November 28, 2023** – Final Report: SCE/Sandia (DOE funded) ReNCAT Pilot Project (Phase 1)

Agenda

I.	**Introduction** *(CPUC Staff)*	**9:00a – 9:05a**
	• WebEx logistics, agenda review	
II.	**Opening Remarks, Commissioner Shiroma**	**9:05a – 9:10a**
III.	**Review of Resiliency Work To-Date**, *(CPUC staff)*	**9:10a – 9:30a**
IV.	**Overview of the Current Integrated Resource Planning Process**, *(CPUC Staff)*	**9:30a – 10:05a**
V.	**Resiliency Standards and Electric Resiliency Planning: Methodologies**, *(Lumen Energy Strategy)*	
	• Recap of Resilience Metrics and Stakeholder Feedback	**10:05a - 10:25a**
	• Methodology for Local Resilience Planning Considering Grid Benefits	**10:25a – 11:10a**
	• Q & A	
	Break	**11:10a – 11:15a**
	• Methodology for Incorporating Local Resilience Needs and Systemwide Climate Risks in IRP	**11:15a – 11:55a**
	• Q & A	
VI.	**Closing Remarks, Commissioner Shiroma**	**11:55a – 12:00p**
	• Provide information on upcoming workshops *(CPUC Staff)*	

Opening Remarks

Commissioner Shiroma

Background and Context

Review of Resiliency Work To-Date

(CPUC Staff)

The Problem to Solve: How can we optimize grid investments to integrate resiliency?

- CLIMATE CHANGE DISRUPTIONS: We are expecting **more extreme disruptions** and a **wider range of types of disruptions**. Climate change is turning Low Frequency/High Impact events into **High Frequency/High Impact events.**

- EQUITY DISPARITY: Equity disparity is revealing itself with each event; **resiliency valuation is different for those at opposite ends of the equity and wealth spectrum**.

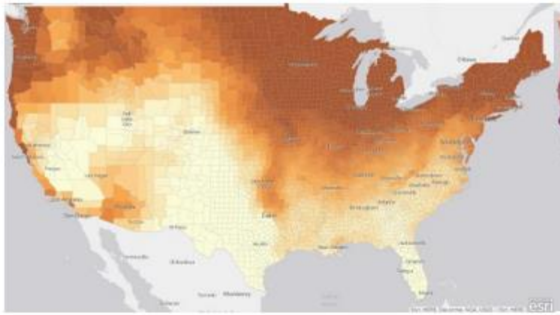
- INTERDEPENDENCIES: Disruptions highlight **interdependencies between critical infrastructure systems**.

- DECARBONIZATION/ELECTRIFICATION: To minimize climate change, it is **critical to shift to decarbonized electrification**. As this increases dependency on electrical system, it is also critical that measures are taken to **increase confidence in electrification**.

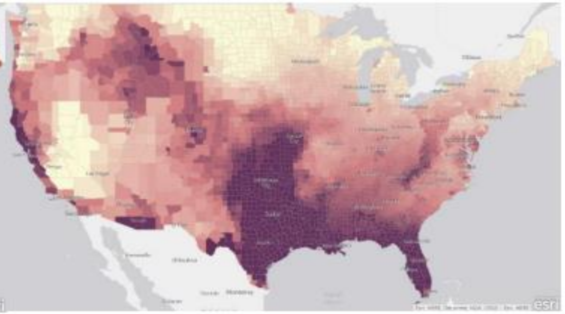
427 Four Twenty Seven Climate Solutions

March, 2017

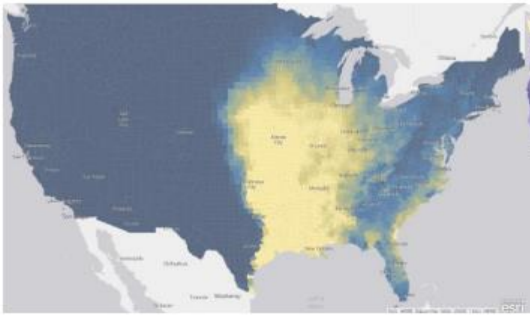
Appendix:



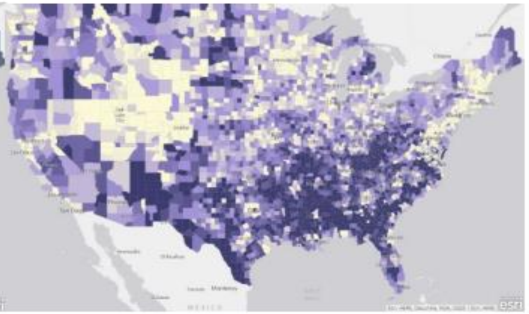
Map 2. Change in the severity of very hot days
Average change in the max wet-bulb temperature between 1981-2005 and 2045-2049



Map 3. Change in the frequency of very hot days
Average number of days over the historical 95th percentile in 2045-2049)



Map 4. Average number of days that exceed HHSI category II days in 2045-2049



Map 5. Social Vulnerability Score (2016)

System Function Relationships to Measure Improved Resiliency

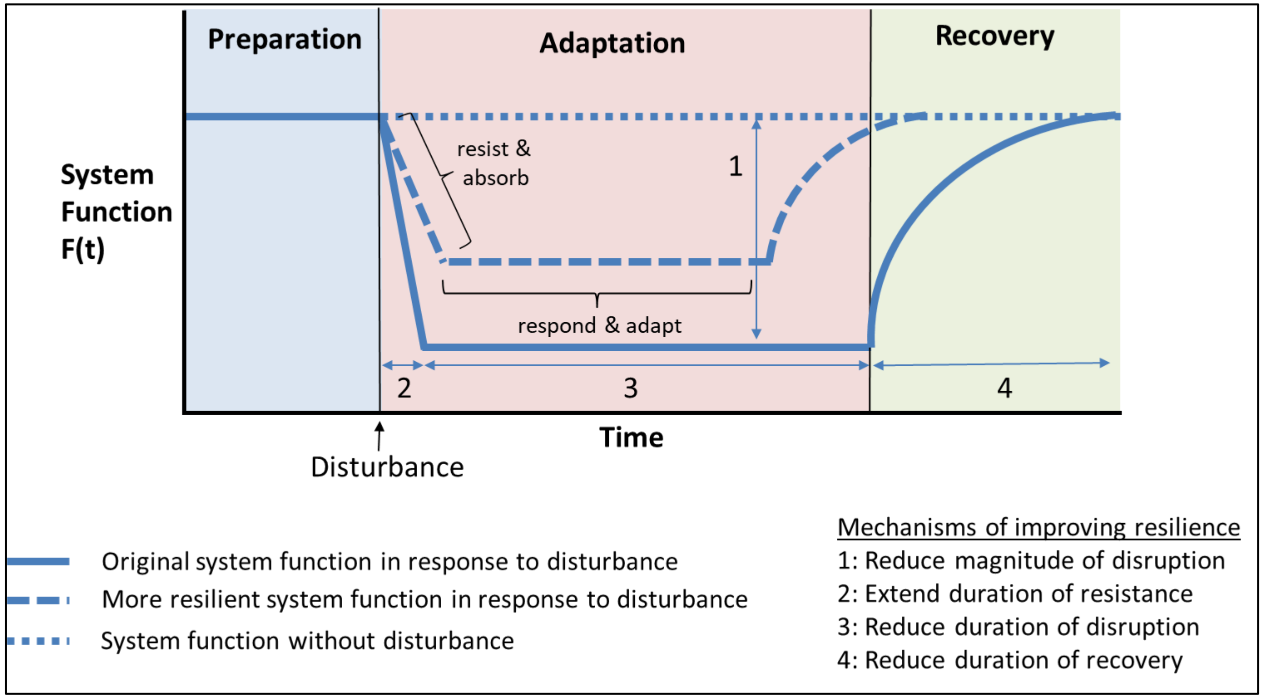
ENERGY System Function:
- operating levels – MW, MW/hrs, MW * hours
- infrastructure levels -- # lines/circuits functional, # lines/circuits tripped, # lines/circuits restored

INTERDEPENDENT System Functions:
- Water/Wastewater
- Gas
- Communications
- Transportation

ECONOMIC System Function:
- Revenue and productivity due to power disruption
- Income and perishable losses due to power disruption

SOCIAL/EQUITY System Function:
- # of vulnerable or disadvantaged population in area served
- # of Critical Facilities
- Change in Social Burden Index (ReNCAT)

ENVIRONMENTAL System function:
- GHG, Criteria Air Pollutant Emissions



Resilience Trapezoid (adapted from Panteli, et al. (2017); T. Ding, Y. Lin, G. Li, et al. (2017); T. Ding, Y. Lin, Z. Bie, et al. (2017))

4-Pillar Methodology of Equitable Resiliency Evaluation and Planning

I. Baseline Assessment

1) Define geographical area of study
2) Define load tiers or resilience categories (Critical, Priority, Discretionary)
3) Identify minimum resiliency targets within load tiers (e.g. 100% Critical, 30% Priority, 0% Discretionary)
4) Define hazards to consider (All-Hazard assessment, analysis, ranking, weighting)
5) Conduct assessment of current resiliency when disrupted from Hazard 1, Hazard 2, Hazard 3 (according to Hazard assessment)
6) Results of resilience assessment – Identify resiliency deficits and priorities and resiliency metric reporting of baseline levels

II. Mitigation Measure Assessment

1) Identify potential mitigation measure options
2) Assess ability of each mitigation option to reach resiliency targets for Hazard 1, Hazard 2, Hazard 3
3) Compare costs of each mitigation option to reach resiliency targets for Hazard 1, Hazard 2, Hazard 3

III. Resiliency "Scorecard"

1) Resiliency Scorecard is a suggested tool that provides a basic benchmark of achievement but recognizes that more can be done.
2) Scoring reflects resiliency configuration characteristics.
3) Scoring system provides for different areas of improvement (e.g. 100% resilience targets are met, but configuration uses 70% fossil fuel resources to meet those targets, improvement would be to decrease fossil fuel resources while maintaining targets. Would result in a higher "score."

IV. Resiliency Response Assessment (computer modeling or post-disruption approach)

1) Conduct Baseline Assessment (1-6).
2) After implementation of chosen mitigation measure option, conduct annual data collection of Resiliency Metrics,
3) Assess achievement of resiliency targets and any changes in community impacts

Energy Division Workshop Series on Resiliency

Dates	Workshop	Presenters	Description
05/10/2022	Interruption Cost Estimate (ICE) Calculator / Power Outage Economic Tool (POET)	Lawrence Berkeley National Labs	Top-down econometric reflection of the value of lost load
07/22/2022, 07/26/2023, 11/28/2023	Resiliency Node Cluster Analysis Tool (ReNCAT) and the Social Burden Index (SBI); Pilot Partnership Project	Sandia National Labs and Southern California Edison (SCE)	Bottom-up reflection of social burden and impacts of large-scale electrical system disruption
08/22/2023	The Value of Sharing and Consolidating Critical Community, Electricity, and Natural Hazard Information	Lawrence Berkeley National Labs	Translating hazard mitigation plans into geospatial layers to enable greater coordination of resilience planning between local authorities and utilities
10/19/2023	Use Case Demonstrations of the 4-Pillar Methodology of Resiliency Planning and Evaluation	San Diego Gas & Electric (SDG&E) and Sonoma County Junior College District	4 Pillar Methodology applied to small scale and medium scale applications of resilience planning
05/10/2023, 09/05/2023 11/08/2023	Resiliency Standards: Definitions, Metrics and Methodologies	Lumen Energy Strategy	Discussion of resiliency definitions and metrics as standards for applications using grid planning scale use case

Background

Overview of the Current Integrated Resource Planning Process

(CPUC Staff)

Statutory Basis of IRP: SB 350 (De León, 2015)

- The Commission shall…
  - PU Code Section 454.51
    - **Identify a diverse and balanced portfolio of resources… that provides optimal integration of renewable energy in a cost-effective manner**
- PU Code Section 454.52
  - **...adopt a process for each load-serving entity…to file an integrated resource plan…to ensure that load-serving entities do the following…**
    - Meet statewide GHG emission reduction targets
    - Comply with state RPS target
    - Ensure just and reasonable rates for customers of electrical corporations
    - Minimize impacts on ratepayer bills
    - Ensure system and local reliability
    - Strengthen the **diversity, sustainability, and resilience** of the bulk transmission and distribution systems, and local communities
    - Enhance distribution system and demand-side energy management
    - Minimize air pollutants with early priority on disadvantaged communities

Integrated Resource Planning (IRP) in California Today

- The objective of IRP is to reduce the cost of achieving greenhouse gas (GHG) reductions and other policy goals by looking across individual Load Serving Entity (LSE) boundaries and resource types to identify solutions to reliability, cost, or other concerns that might not otherwise be found
- Goal of the 2022-23 IRP cycle is to ensure that the electric sector is on track, between now and 2035, to support California's economy-wide GHG reduction goals and achieve the SB 100 target of 100% renewable and carbon-free electricity by 2045
- The IRP process has two parts:
  - First, it identifies an optimal portfolio for meeting state policy objectives and encourages the LSEs to procure towards that future
  - Second, it collects and aggregates the LSEs collective efforts for planned and contracted resources, compares those aggregated resources to the identified optimal system, and adopts a "Preferred System Plan" (PSP) detailing California's preferred mix of resources to achieve 100% clean electricity at least cost while maintaining reliability
    - The CPUC considers a variety of interventions to ensure LSEs are progressing towards procuring the PSP Portfolio
    - The CPUC has never ordered procurement in a PSP Decision, but retains the ability to do so

Background definitions

IRP Model types

- RESOLVE: a capacity expansion model that identifies optimal long-term electric generation and transmission investments subject to reliability, policy, and technical constraints.
- SERVM: a production cost model (PCM) that provides more detailed analysis of factors such as system reliability once a portfolio has been determined.

Candidate resources

One of the types of new resource options RESOLVE can select to create an optimal portfolio. These resources are established, commercially viable resource technologies such as solar, wind, geothermal, Li-ion batteries, pumped hydro storage, shed demand response, and candidate thermal resources.

Baseline resources

Resources that are currently online or are contracted to come online within the planning horizon. Being “contracted” refers to a resource holding signed contract(s) with an LSE(s). The contracts refer to those approved by the CPUC and/or the LSE’s governing board, as applicable. These criteria indicate the resource is relatively certain to come online.

Where we are in the current IRP Cycle

1st Step of IRP Cycle

1. Set LSE Plan Filing Requirements

- Identify Optimal Portfolio" could add a bullet "CPUC conducts modeling to determine reliability, GHG, and other filing requirements
- Use CARB Scoping Plan to derive range of GHG emissions levels for electric sector
- CPUC issues Filing Requirements to encourage LSEs to procure towards that future

2nd Step of IRP Cycle

2. LSE Plan Development & Review

- LSE portfolios reflect state goals and Filing Requirements
- Stakeholders review LSE IRPs
- CPUC checks aggregated LSE plans for GHG, reliability, and cost goals

3. CPUC Creates Preferred System Plan

- CPUC validates GHG, cost, and reliability
- CPUC provides procurement and policy guidance

Preferred System Plan Decision

End of IRP cycle and beyond

4. Procurement and Policy Implementation

- LSEs conduct procurement
- CPUC monitors progress and decides if additional action is needed

Portfolio(s) transmitted to CAISO for Transmission Planning Process

What the PSP Informs

- **LSE planning:** In the 2019-21 IRP cycle, the 2021 Preferred System Plan (PSP) was used as the basis for developing LSE IRP filing requirements for the 2022-23 IRP cycle.
- **CAISO Transmission Planning Process (TPP):** The PSP is typically adopted and transmitted to CAISO for assessing transmission needs as a TPP base case. Other portfolios may also be transmitted for study as sensitivities in TPP.
- **Avoided Cost Calculator (ACC):** The PSP will likely be used as the basis for the 2024 ACC update. This update may also inform the NEM proceeding.
- **Gas forecasting:** The PSP is the basis for the gas forecasts used in other proceeding, such as the Aliso Proceeding (I.17-02-002).
- **SB 100:** The SB 100 analysis will incorporate the adopted PSP portfolio.

Analysis of LSE Filing Requirements

Filing Requirements

- LSE IRP filings are the vehicle by which the CPUC and stakeholders gain insight into individual LSEs' plans for meeting state goals
- To facilitate the filing of useful, appropriate, and complete information by LSEs, IRP staff provide LSEs with standardized tools, instructions, and templates (aka, IRP "filing requirements documents")
- The November 1, 2022 filing included LSE information on:
  - GHG reductions
  - reliability
  - imports/exports
  - impacts on disadvantaged communities
  - costs
  - other elements of long-term resource planning

Filing Requirements Documents: Purpose

- **<u>Narrative Template</u>**: To describe how LSEs approached the process of developing its plan, present the result of analytical work, and demonstrate to the Commission and the stakeholders the LSE's action plans
- **<u>Resource Data Template (RDT)</u>**: To collect planned and existing monthly LSE contracting data, including for future resources which do not exist yet. Provides a snapshot of the LSE contracted and planned monthly total energy and capacity forecast positions over a ten year look ahead period. Also used to verify that LSE portfolios achieve assigned reliability planning standard
- **<u>Clean System Power (CSP) Calculator</u>**: To use in estimating the GHG and criteria pollutant emissions of LSE portfolios and verify that LSE portfolios achieve assigned GHG planning benchmarks

Evaluation of LSE Narrative Templates

- LSEs are required to provide all requested information in all applicable Narrative Template sections
- LSEs failing to submit information in this section may be required to re-submit and could be subject to IRP's citation program if needed
- IRP staff evaluate select narrative template sections using a scorecard system that is published with the PSP Decision. LSEs receive one of the following scores:
  - <u>Exemplary</u>: response reflects surpassing requirements and potentially setting a standard for future best practices for other LSEs to emulate.
  - <u>Adequate</u>: response reflects a satisfactory fulfillment of the individual requirement; this score indicates that the LSE provided all of the required information.
  - <u>Deficient</u>: response reflects a failure to meet the requirement or answer the question included in the template or in the statutory language that underlies the filing requirement.
- An LSE receiving deficient scores will have required to formally fil supplemental Narrative Template information

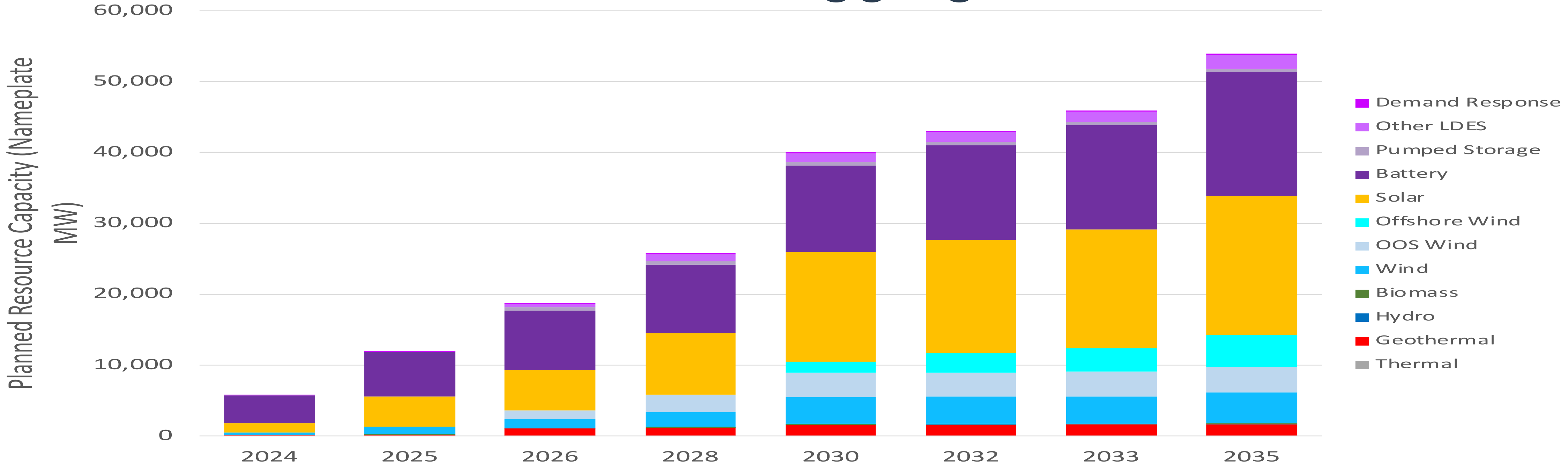
Evaluation of LSE Resource Data Templates

- Staff developed aggregated LSE plans using the data submitted in the LSEs' RDTs, which had to be evaluated for completeness and internal consistency by staff to ensure that they accurately reflected LSE planning
- Staff used the RDT Error Checking, Aggregation and Reallocation Tool (RECART) to aggregate, error check, and analyze LSE RDT filings
- RECART compiled energy and capacity under contract, contracted resources by technology type and LSE, and aggregated new resources that were in development or planned future purchases
- LSEs were contacted when errors were found in RECART and re-submitted RDT filings, where necessary

Use of Aggregated LSE plans in PSP development

- CPUC staff take individual LSE plans, aggregate them, and evaluate aggregated portfolio against overall electric system needs
- This aggregated portfolio is evaluated against reliability and GHG constraints, while seeking to meet these constraints at the lowest reasonable cost to ratepayers
- The aggregation of the individual LSE portfolios also serves to determine if there are gaps in the collective portfolio that will require action by the Commission to address

Planned Resource Additions -- Aggregated 25 MMT Plans



- CPUC Jurisdictional LSEs were required to submit plans on 11/1/2022 to collectively plan for GHG emissions targets of 18.6 MMT and 15.0 MMT in 2030 and 2035 respectively, which represents the CPUC-jurisdictional share of the statewide 30 MMT by 2030 and 25 MMT by 2035 statewide electric sector targets.
- All LSEs met their assigned GHG benchmarks, with some achieving emissions well below their assigned benchmarks:
  - LSE Emissions in 2030, per aggregated LSE CSP results: **15.1 MMT**
  - LSE Emissions in 2035, per aggregated LSE CSP results: **12.2 MMT**
- When aggregated, CPUC Jurisdictional LSEs demonstrated collective intentions to exceed their proportional GHG requirements. Their aggregated 25 MMT Portfolios reduced GHG emissions by ~3 MMT below their GHG emissions targets

LSE reported resilience projects in NTs

- Below is a sampling of some of the resilience-focused information LSEs included in their November 1, 2022, IRPs.

SCE	EBCE	MCE	PG&E
• SGIP: Beginning in April 2020, SCE customers living in low-income or DACs or in high fire risk areas are eligible for increased equity resiliency incentives to offset most of the cost to install an energy storage system. • In 2020 and 2021, SCE's parent organization, provided over $450,000 in grant funding to 16 CEAWG members or their recommended 501(c)(3) organization designees to allow local groups to plan and execute community-developed projects, including climate resiliency projects.	• EBCE and Kaluza launched a VGI program to boost grid resilience, redu ce energy costs and miti gate carbon emissions fro m EV charging. • EBCE is a partner to FreeWire Technologies, Inc., on a CEC grant awarded in 2021. Among many other facets, the project will add resilient EV charging even when grid power is unavailable and provide backup supply to power on-site loads as a microgrid.	• Through a three-year grant of $750,000 from the Buck Family Fund, this partnership is stretching MCE's contributions to secure local resilience in Marin. These funds will be used to cover the costs for select critical facilities operated by nonprofits throughout Marin County to provide backup power to vulnerable communities during planned or unplanned outages.	• Leveraging a diverse mix of resources will be necessary to meet its ambitious decarbonization goals and will help to build climate resilience within PG&E's service area. • PG&E views EVs as a source of opportunity for them to address reliability and customer resilience as part of the advanced load management programs.

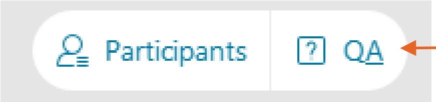
Conclusions

- All LSEs met their filing requirements, and the LSE Plan review process required fewer re-submission requests by IRP staff compared to last cycle, likely reflecting filing template improvements and greater LSE familiarity with the templates
- This was the first IRP cycle for which LSEs were assigned reliability filing requirements
  - All LSEs met their reliability filing requirements, with some LSEs planning for reliability levels in excess of their assigned requirements
- All LSEs met their assigned GHG benchmarks, with some achieving emissions results well below their assigned benchmarks
- Portfolio size and composition is broadly similar between the aggregated 30 MMT and 25 MMT (by 2035) plans, reflecting the desire of many LSEs to submit portfolios for both sets of targets achieving emissions less than or equal to their 25 MMT benchmarks
- Aggregated portfolio sizes are similar to the 2021 PSP Portfolios, although they are slightly smaller due to CPUC-jurisdictional LSE load equaling less than 100% of CAISO, near-term contracting since PSP adoption becoming part of the baseline, and a slight preference by LSEs for higher capacity factor/duration resources like geothermal and long-duration storage
- Narrative Template scorecards will be released as a part of the PD

Discussion and Q&A

WebEx Tip

Option 1:



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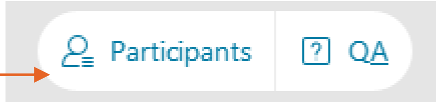

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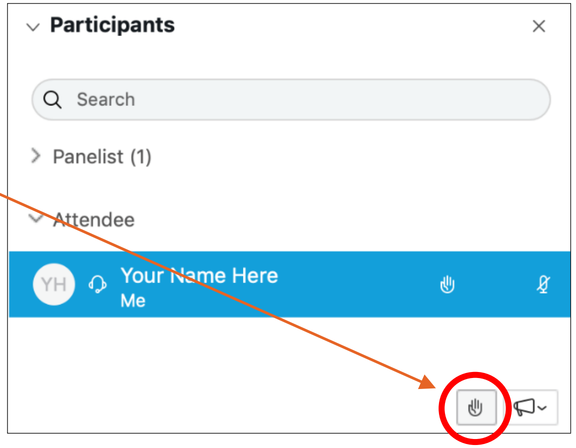


WARP to Resilience

Weather-Adapted Resource Planning

Improving Resilience through Integrated Resource Planning

Methodologies for Integrating Local Needs into Broader System Planning

Prepared for:

CPUC Resiliency and Microgrids Stakeholders

Prepared by:

Mariko Geronimo Aydin
Onur Aydin

Lumen ENERGY STRATEGY

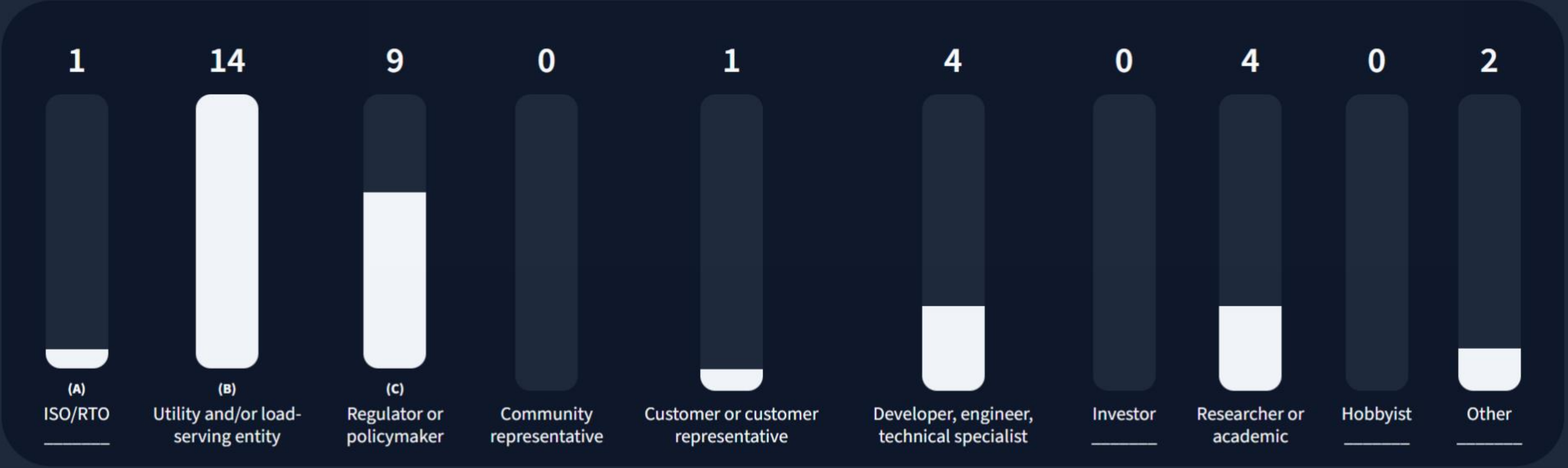
November 8, 2023

Contents

Topic
Recap of resilience metrics and stakeholder feedback
Methodology for local resilience planning including grid benefits
Methodology for incorporating local resilience needs & systemwide climate risks in IRP

What **stakeholder perspective** best describes you?

Join by Web **PollEv.com/lumen999** Join by Text Send **lumen999** to **22333**



Recap of resilience metrics and stakeholder feedback

Stakeholder feedback:

Customer & outage characteristics of most concern

- Stakeholders mostly agreed that key resilience hazards at the state grid planning level are weather/environmental variabilities, trends, and extremes
- Additional feedback on non-weather disasters in grid planning:

(polls) Reactions to linkages with disaster planning

- Physical and/or cybersecurity
- Other non-weather disasters (e.g., earthquakes, tsunami, societal collapse)

Physical and/or cybersecurity

- 14 responses
- "Integral," "integrated," part of grid planning/IRP
- Utilities analyze as an enterprise risk in R.20-07-013 (Active, Risk-Based Decision-Making Framework)

Other non-weather disasters

- 20 responses
- Responses ranging from "… must plan for all types of disasters" to "impossible to plan for…"
- Several mentions of microgrids

Stakeholder feedback:

Resilience definitions

- Recap of breakout session #1; reactions to conceptual resilience definition vs. definition with a specific target threshold

need to prioritize specific customers & loads

might be too limiting

Qualitative:

might be subjective

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.

good reflection of different ways resources can help (resilience trapezoid)

does not capture dimensions like ability to recover from the event and meeting essential needs

more generalized geographic scope & granularity

specific targets needed for planning

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.

Stakeholder feedback:

Resilience planning priorities

- Recap of breakout session #2; reactions to resilience planning priorities in Sonora vs. Twain Harte example

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																		

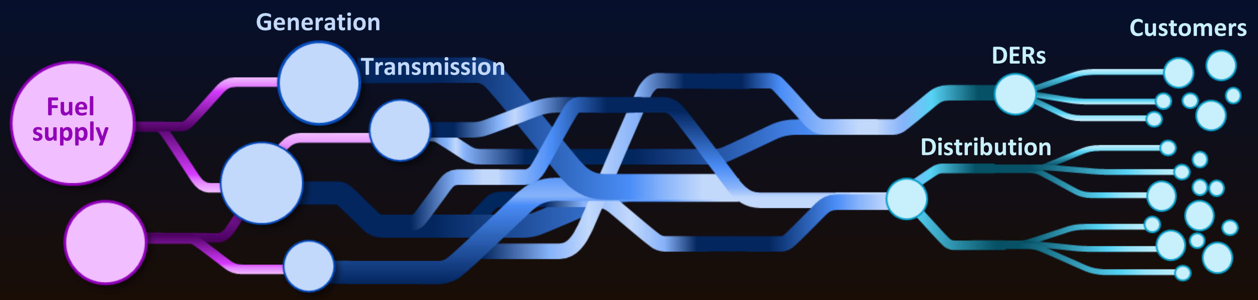
Expected kWh of outages in a planning year

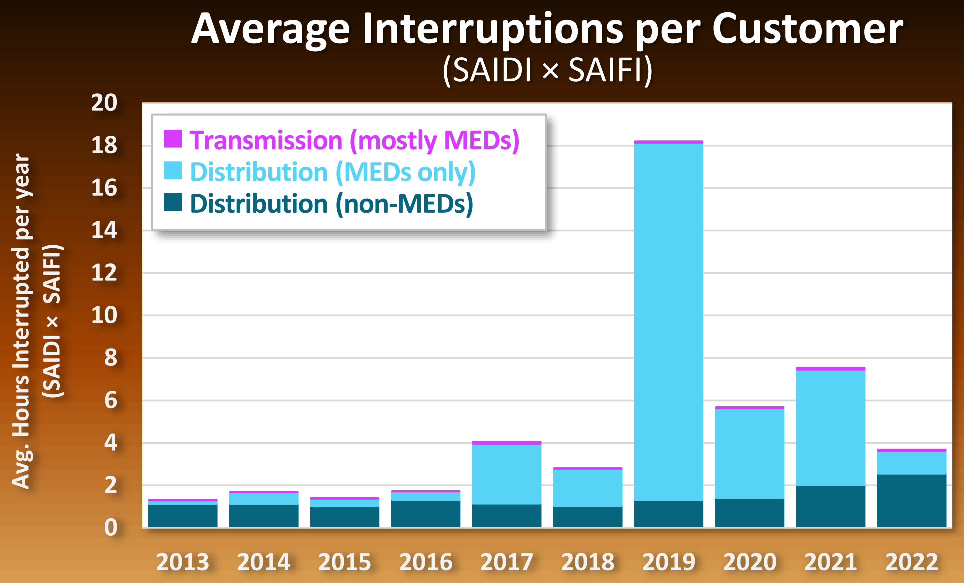
Methodology for local resilience planning including grid benefits

Key terms

- Local authorities: cities, counties, tribal entities, community-based organizations, other community leaders and decision-makers
- Load-serving entities (LSE): investor-owned utilities (IOUs), community choice aggregators (CCAs), competitive electric service providers (ESPs)
- Resources and grid domains: customer-sited, distribution-connected, vs. transmission-connected; also, bulk grid resources vs. distributed energy resources
- “Residual attributes” of a resilience resource solution
- Value-stacking, multiple use applications (MUAs)

Importance of the local perspective



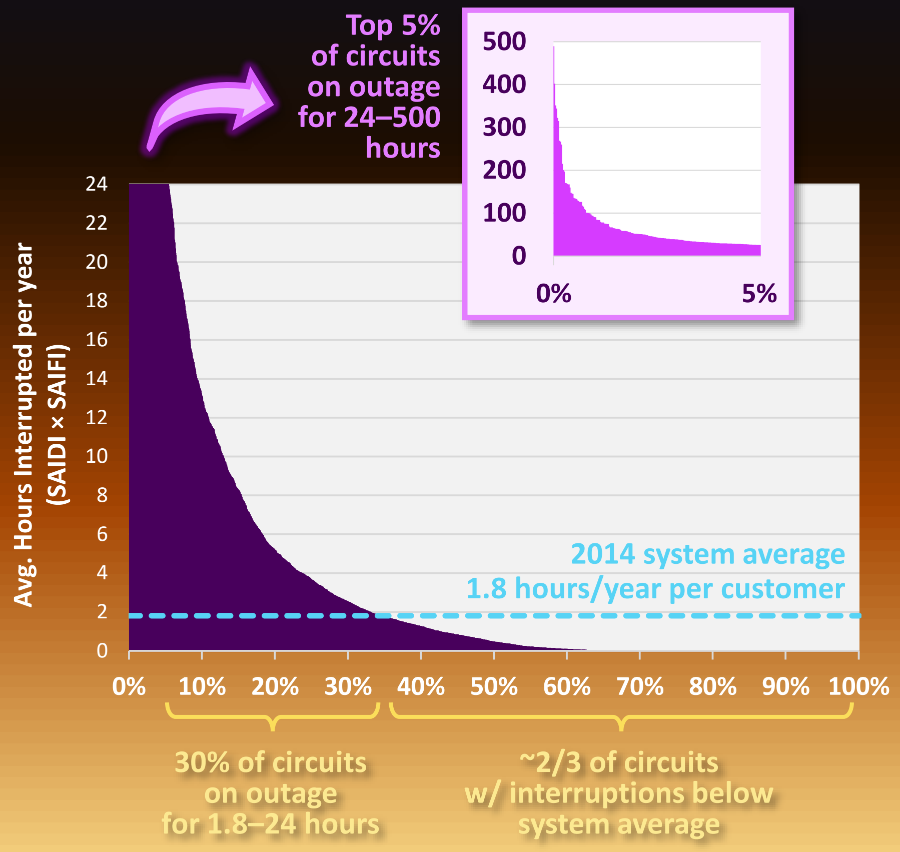


Notes: Weighted average of PG&E, SCE, and SDG&E system-wide reliability indices from their annual reports to the CPUC; MED=Major Event Days; transmission is adjusted to include 2020 rolling blackouts.

- Unlike other IRP objectives (reliability, GHG) resilience needs are highly locational
- IRP focuses on reliable delivery to the pool transmission facility (1% of customer outages) but resilience solutions must address customer-level outages and impacts
  - Transmission-connected resources won't necessarily solve distribution-level grid failures
  - See our March 21, 2023 workshop
- Resilience solutions must include investments in the distribution system and customer sites, including distributed energy resources (DERs)

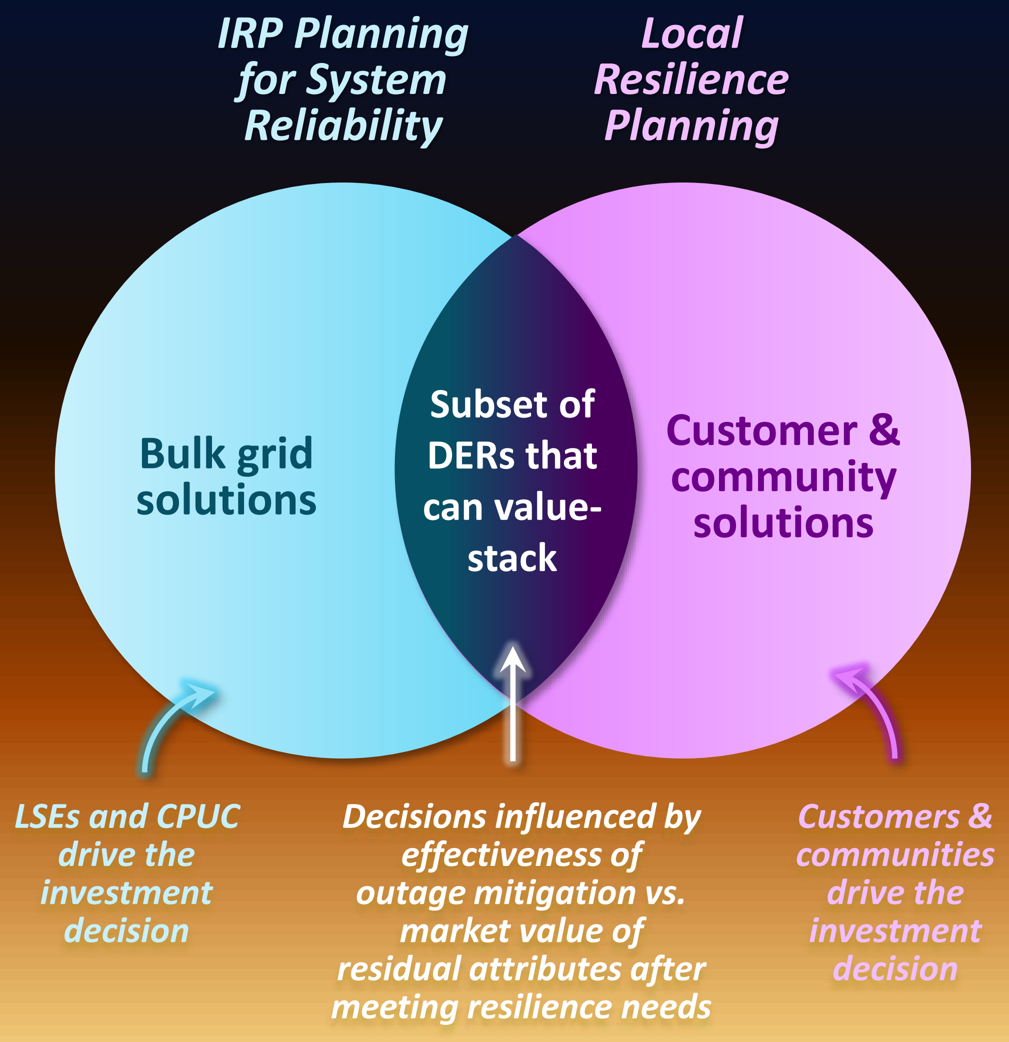
Importance of the local perspective (cont.)

SCE's 2014 Distribution Circuit-Level Average Hours Interrupted per Customer
(SAIDI × SAIFI)



- IRP analyzes reliability at the system level and has a limited view of load prioritization
- Circuit-level interruptions demonstrate the wide range of customer experiences with reliability and resilience of electricity service
- Vulnerability indicators also show a wide range of potential impacts of resilience events (e.g., SBI, CAVA)
  - Cost and economic impact of long-duration power outages could be disproportionately larger
- Resource needs and load prioritizations differ from one community to another
  - See our September 5, 2023 informational session
- Resilience solutions must include customized resources built at the customer and community level
- How can we bring this local perspective into IRP?

Need for knowledge exchange in planning



- Each party (local authority/LSE) has crucial information on the resilience risk profile and potential resource values that the other doesn't have—both perspectives are needed for effective resilience planning
- IRP has a view on broader system dynamics, including resource adequacy, major contingency events, cascading and compounding effects of climate risks
- Customers and communities understand their concerns, vulnerabilities, and load prioritization; risk preferences; where resources should be installed and what resource attributes are needed
- Coordination can address cost pressures on both sides
  - Local cost inhibiting ability to invest
  - LSEs facing ratepayer affordability crisis, need cost synergies and can't leave residual capacity on the table; also making resilience investments more cost-effective for local authorities takes pressure off of ratepayers to subsidize
  - Today, local authorities and LSEs are not really meeting in the IRP procurement marketplace

Key role of LSEs

- LSEs are uniquely positioned to bridge the local/IRP knowledge gap
- Integrate local concerns, needs, and priorities into the IRP process
- Connect local authorities with a better understanding of grid concerns, needs, priorities; opportunities for grid services
- LSEs hold established communication channels with local authorities
  - CCA leadership directly tied to communities
  - IOUs regional community liaisons and workshops

Ava Community Energy
(formerly East Bay Community Energy)

Board of Directors

The Ava Community Energy Board of Directors is made up of an elected official from each of the participating jurisdictions and one representative (non-voting) from the Community Advisory Committee (CAC). Our Board meets once a month and all meetings are open to the public. Visit the Public Meetings page for more information about the Board's meetings.

Community Advisory Committee

The Community Advisory Committee (CAC) consists of twelve members (ten appointed by the Board of Directors to represent five service area regions, and two At Large members appointed by the Alameda County Mayors' Conference) plus five Alternates. The committee acts as a liaison between key stakeholders and our Board, holding public committee meetings on a regular basis. Visit the Public Meetings page for more information about CAC meetings.

About the Community Advisory Committee

The Community Advisory Committee was formed in 2016 as part of the Ava Community Energy Joint Powers Authority and appointed by the Board of Directors to advise the Board on all subjects related to the operations of the Community Choice Aggregation program. The CAC gives the community a voice in its choice for electricity services, clean energy resource investments, and local energy projects.

Source: https://avaenergy.org/who-we-are/

Join a PG&E wildfire safety webinar

PG&E hosts online webinars throughout each year for anyone who is interested in learning more about our Community Wildfire Safety Program. These virtual gatherings allow community members to learn more about wildfire safety and emergency preparedness, meet with PG&E representatives, ask questions and share feedback.

For anyone who is not able to join a live webinar, we've made our presentations and video recordings of our past webinars available below. **View past presentations**.

Source: https://www.pge.com/en_US/safety/emergency-preparedness/natural-disaster/wildfires/community-wildfire-safety-open-house-meetings.page?WT.mc_id=Vanity_firesafetywebinars

To what degree are **local resilience needs and priorities** represented in current IRP planning and procurements?

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

Need for coordination early in planning processes

- Two levels of planning are happening in parallel, at local and state levels
- To inform each others' decisions, coordination must occur early in the planning processes
  - LSEs can collect better information on the resilience problem and needs, DERs under consideration and their desired operating profiles, carve the path to meet local authorities in the procurement marketplace
  - Local authorities can learn more about the resilience risk profile, the potential grid benefits of resources, refine their resource designs
- Through this, LSEs can support meeting local-declared resilience needs
  - LSE not buying resilience at the local level, but enabling resilience investments by offering grid revenues for residual attributes of a resilience resource

Potential IRP system planning process

Pillar I | Pillar II | Pillars III & IV

Assessment of local needs and solutions

- Local authorities identify reliability and resilience concerns, needs, priorities
- Begin to identify key attributes of solutions, including approximate size, grid placement, expected contractual obligations & operating priorities

Pillar I | Pillar II | Pillars III & IV

Local resilience planning process

*This is for discussion purposes only and is not meant to reflect formal recommendations for the CPUC's IRP process.

Potential IRP system planning process

Pillar I | Pillar II | Pillars III & IV

Existing system plan (prior PSP)

LSEs add system perspective on resilience needs and solutions

- Aggregate local plans, further analyze outage impact and residual resource attributes
- Send back information on resilience risk profile, resource bulk grid value

Assessment of local needs and solutions

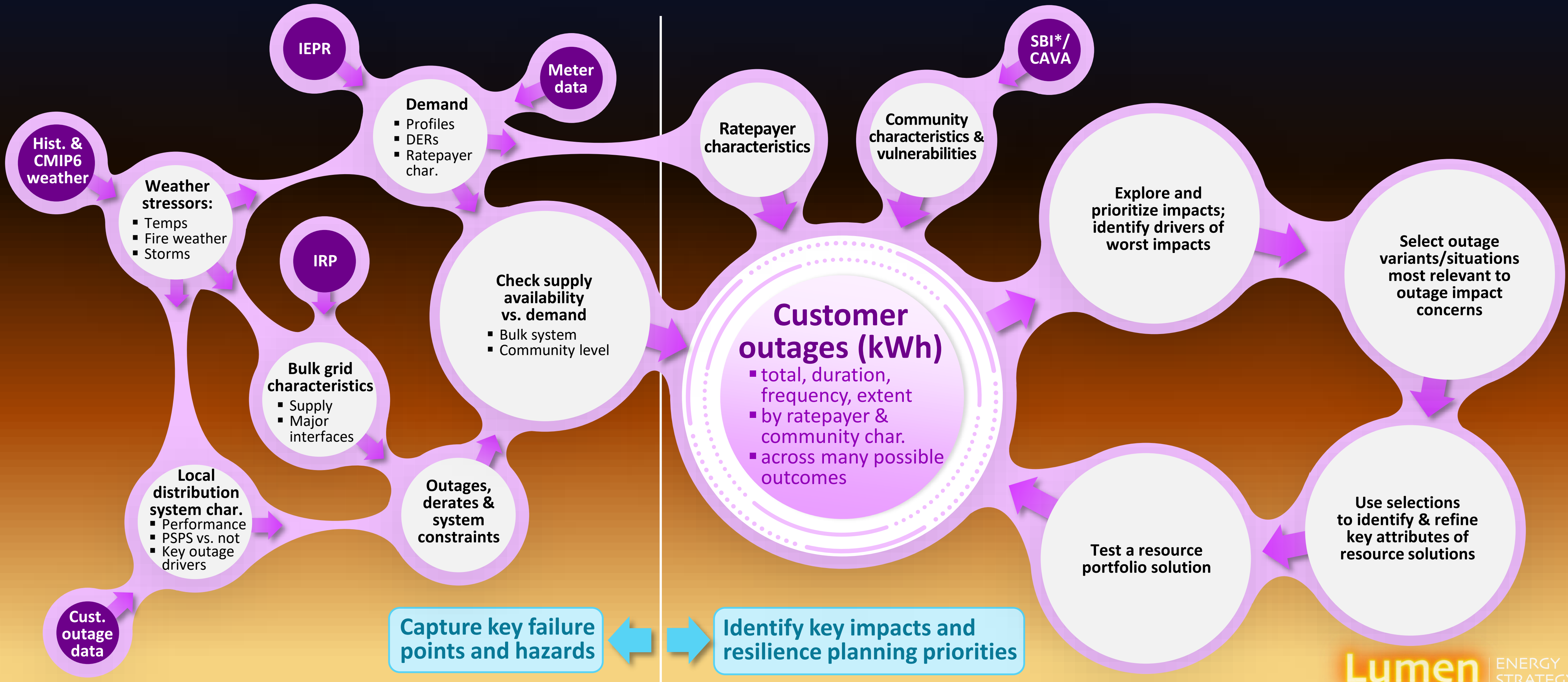
Pillar I | Pillar II | Pillars III & IV

Local resilience planning process

*This is for discussion purposes only and is not meant to reflect formal recommendations for the CPUC's IRP process.

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:

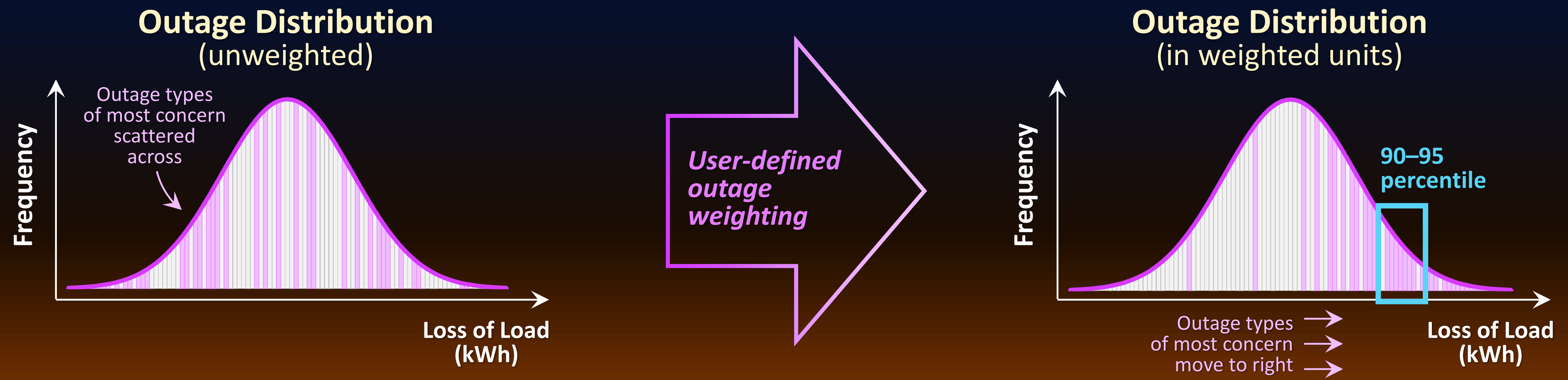


*SBI: social burden index

Refining the resilience risk profile

- How would an outage mitigation resource likely need to deliver services? 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 distribution 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 intentionally 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



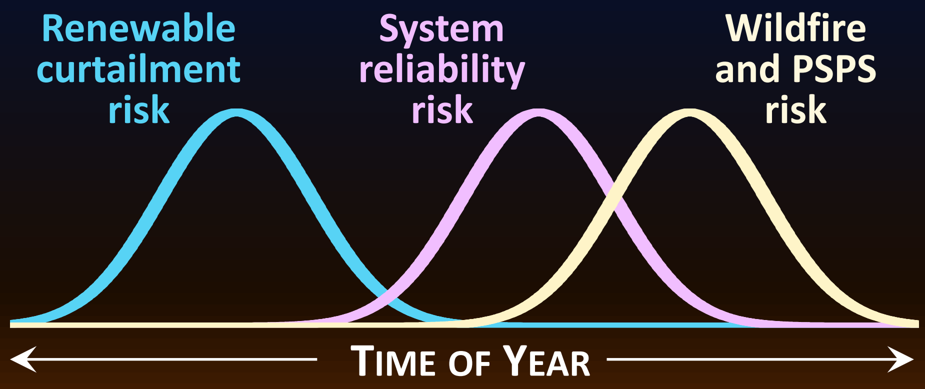
- Outages in natural units
- Can be calibrated to LOLE, SAIDI/SAIFI levels
- Outage types of most concern (e.g., short vs. long) are scattered across the distribution

- 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

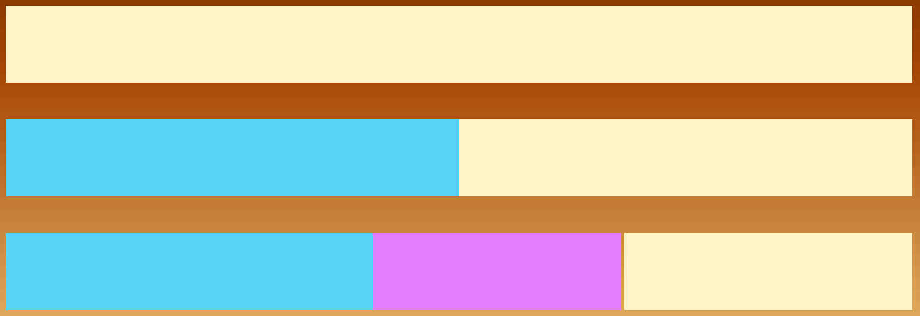
Identify hazards/failure points and test solutions

- Select top X runs based on distribution that uses weighted outages to form a subset of “extreme” runs
  - 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?

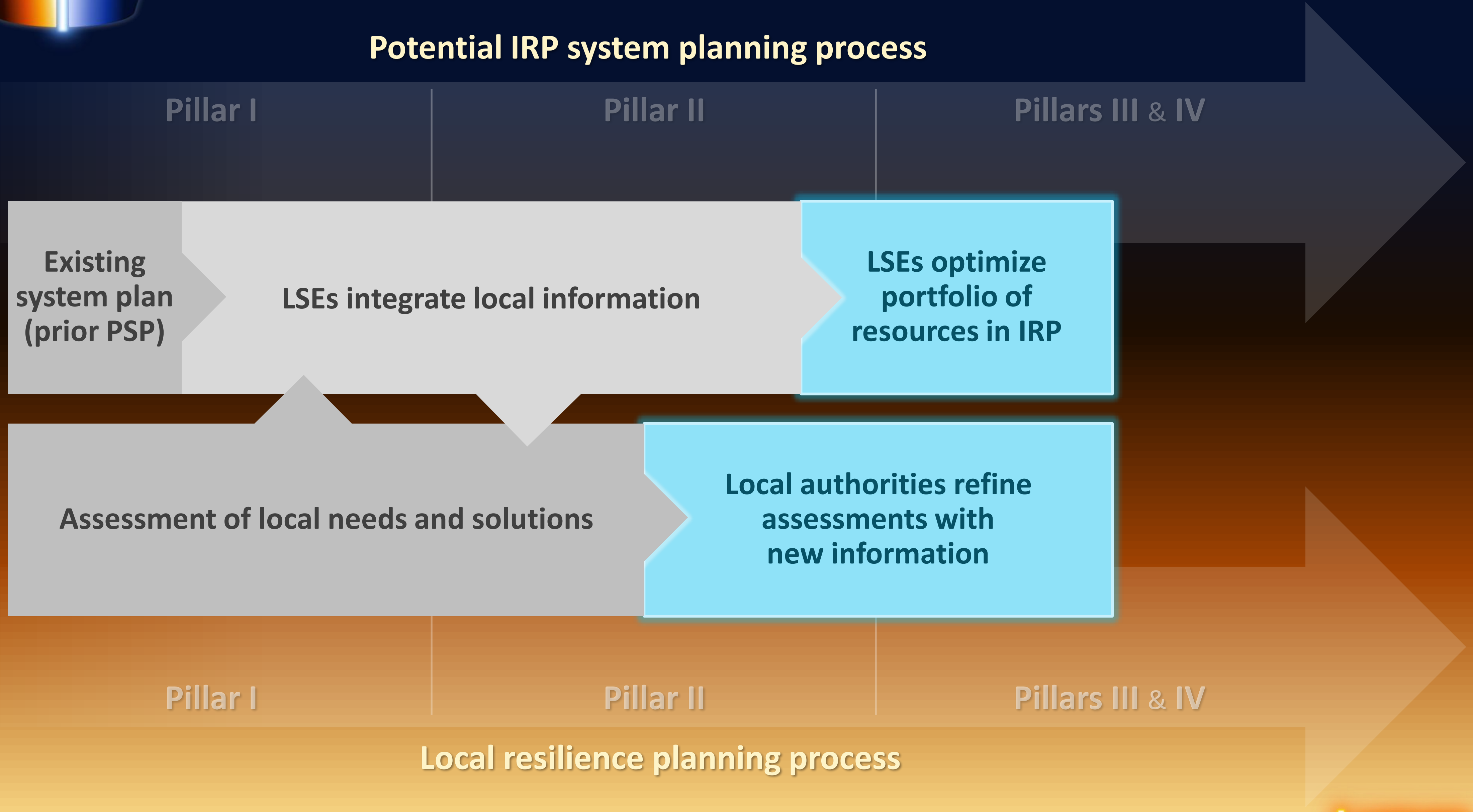
Resilience risk/market benefit tradeoff and opportunities for value-stacking



- *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
✓✓✓	✗	✗
✓✓	✗	✓✓✓
✓	✓	✓✓



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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*

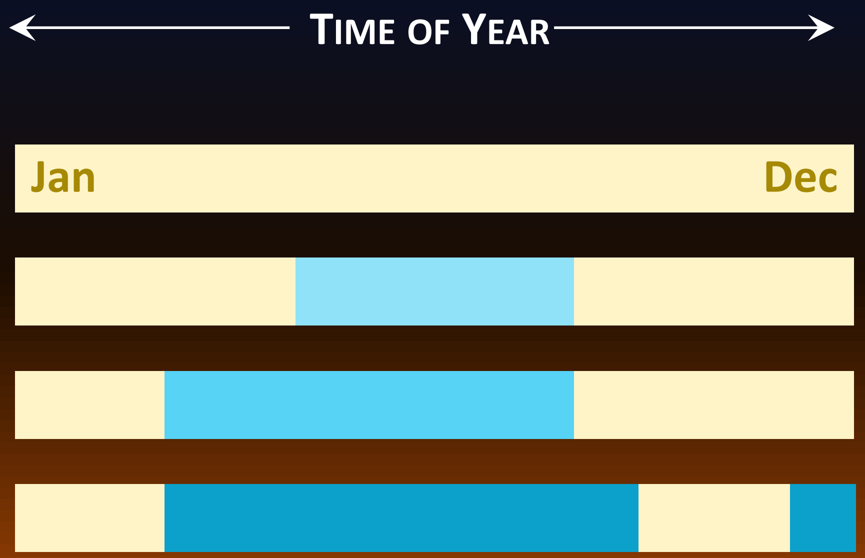
Net cost of resilience investment = (**Levelized Capital Cost** + **Levelized O&M Cost**) − **Levelized Non-Resilience Benefits** / **Resilience Improvement**

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*

Local authorities refine assessments with new information

Example of risk and economic tradeoff



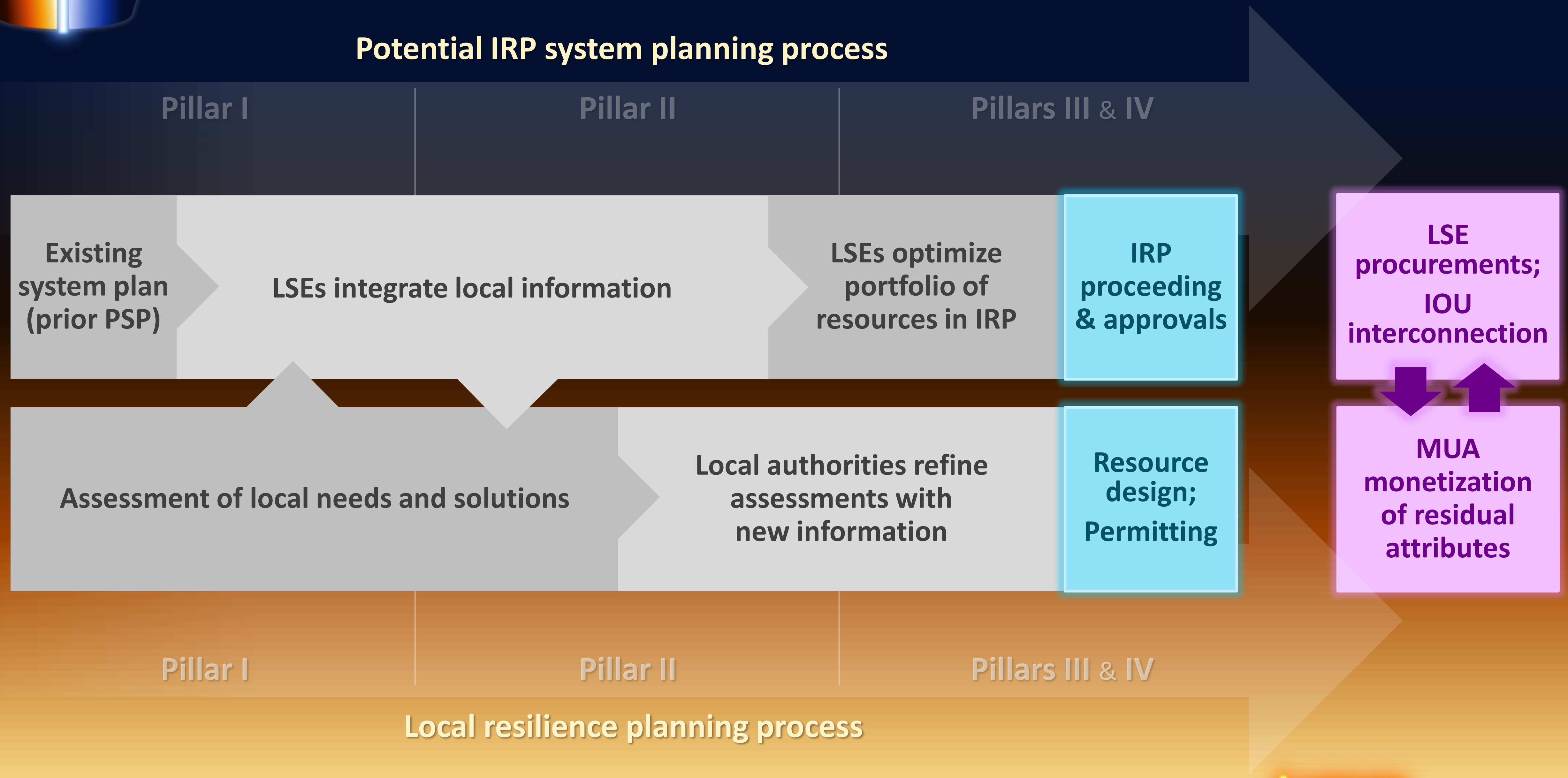
* Yellow = resilience/backup mode
Blue shades = grid services prioritized

Use Case	Outage Mitigation	Cost Offset by Grid Services	Net Cost of Resilience
A	~100%	0%	1x
B	95%	50%	0.5x
C	80%	60%	0.4x
D	50%	80%	0.2x

- 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

LSEs identify IRP resources

- What IRP resource strategies can improve the economics of resilience investments while also benefitting ratepayers?
- If the entire resource must be always on reserve for resilience (i.e., no residual attributes available to the system), still useful information for the LSE's baseline assessment of the resilience problem
- Consider/model grid-available resilience resources in two pieces:
  1. Consider the portion of capacity needed for resilience as Pillar II mitigation measure impact; i.e., as potentially IRP-supported resilience improvements
  2. Model the residual attributes as grid-available that could potentially reduce the need for transmission-connected resources
- Based on the profile of residual attributes, estimate the tradeoffs of resilience portfolio's residual attributes vs. transmission-connected resources (e.g., ELCC of the residual attributes)
  - What are the implications if more/less actual local resilience resource development than expected?
  - Avoided cost of RA capacity



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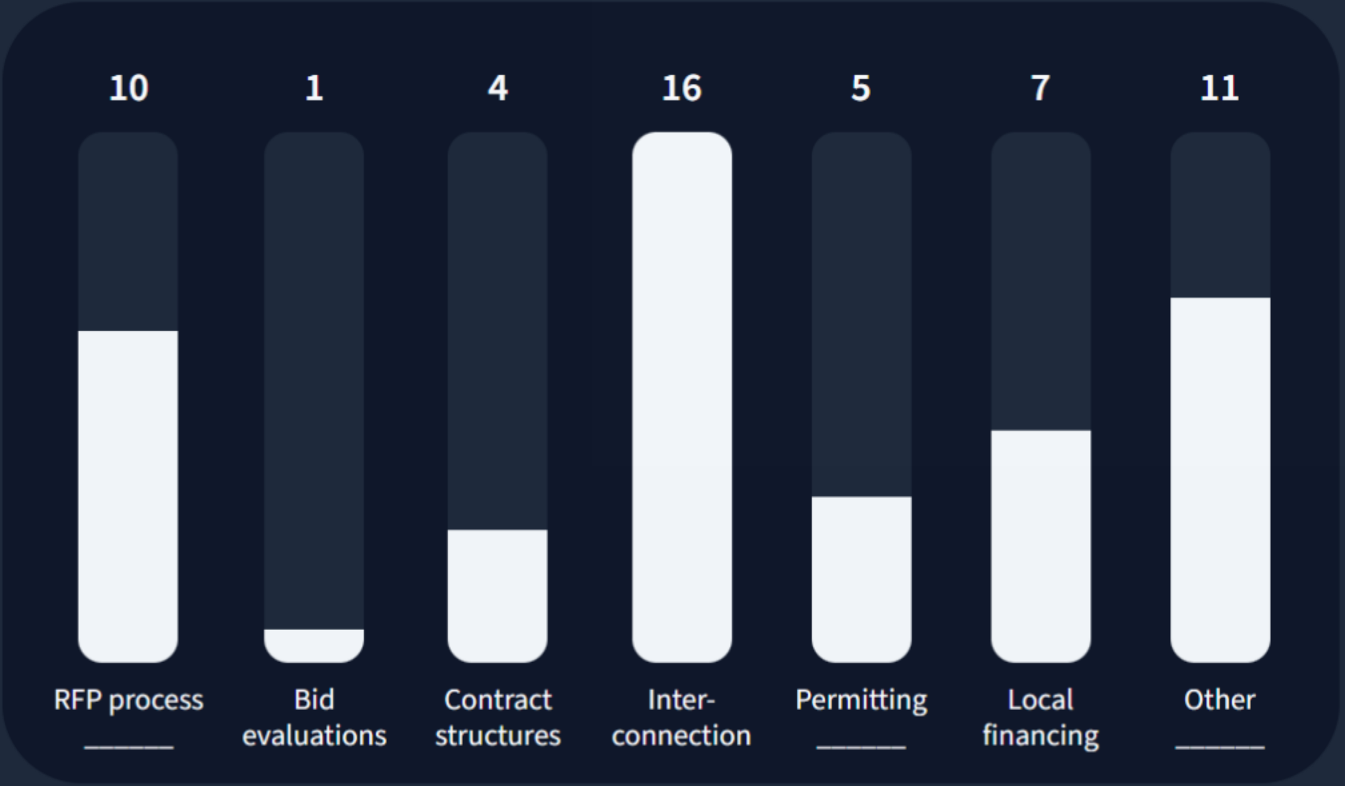
Potential benefits to LSE procurements

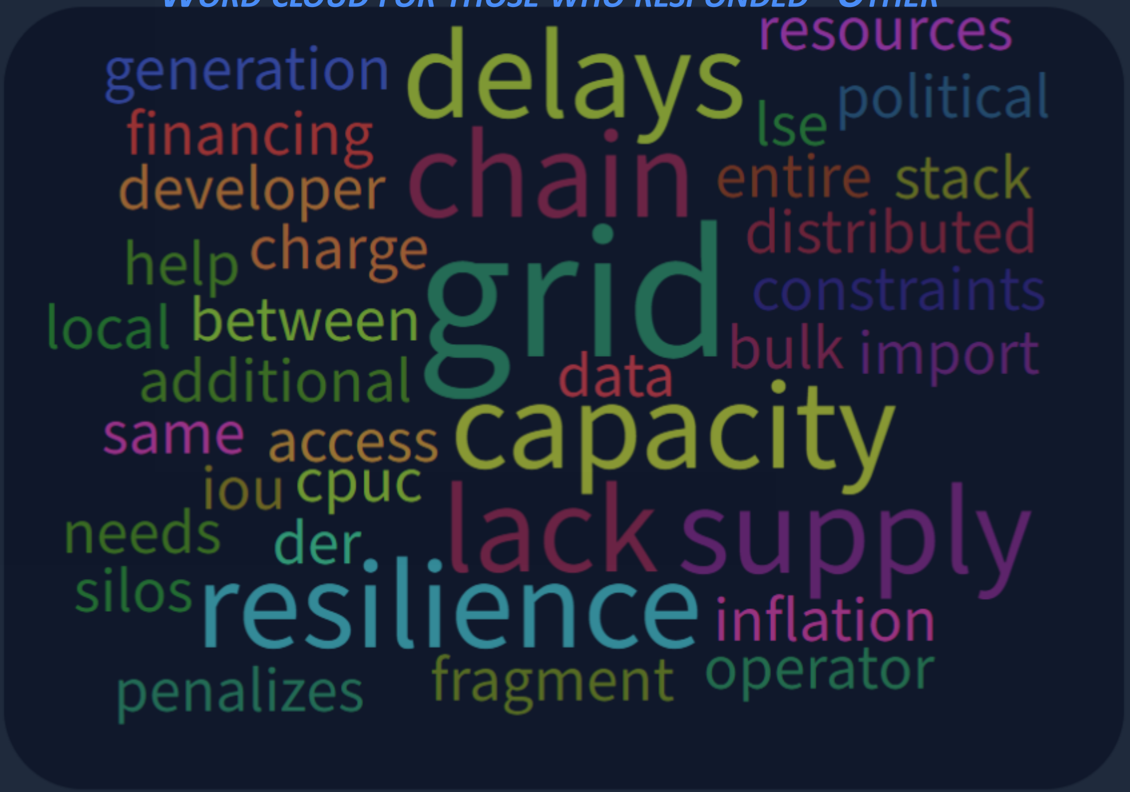
- Through contracts, incentive programs, tariffs and associated rates
  - Widen the net on desired resources to include those that stack local resilience value, potentially with a preference for these resources
  - Update standard contracts, programs, rates to incorporate these resources
- Designed per outcome of IRPs and understanding of resilience resources
- Better tailored to utilize and support (via grid revenues) local resilience investments
- What are the barriers to LSEs' procurement of local resilience resources for grid services, MUA value-stacking?
  - What else is behind the local authorities' cost barrier?
  - Interconnection/energization, timeline/costs/logistics?
  - Contract structures, ability to tailor/risk-sharing?
  - Operating agreements?

Beyond the planning process, what are the top **procurement and development barriers** to IRP procurement of resilience energy resources? (select up to 3)

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



Word cloud for those who responded "Other"

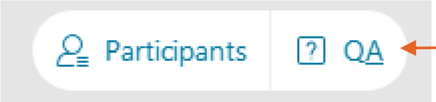


Word cloud hint: Input complete sentences, or just strings of words. Either way, the word cloud will break up your entry into individual words. Hyphenate words you want to keep together.

Discussion and Q&A

WebEx Tip

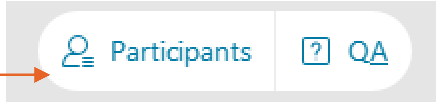
Option 1:



Access the written Q&A panel here

Option 2:

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



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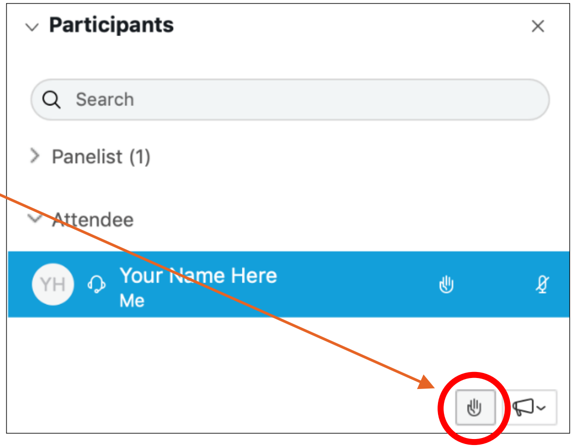


11:10 Break

Will return at 11:15

Methodology for incorporating local resilience needs & systemwide climate risks in IRP

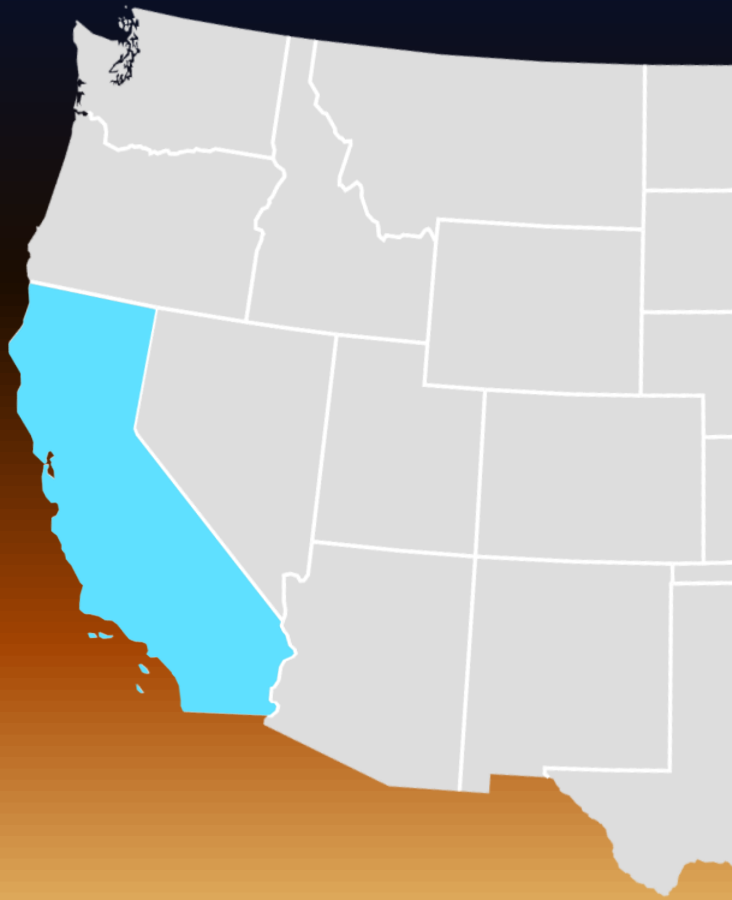
Building resilience through IRPs

- 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



Resilience vulnerabilities raise the stakes

Concurrence & compounding effects of environmental stressors on the grid and directly on customers

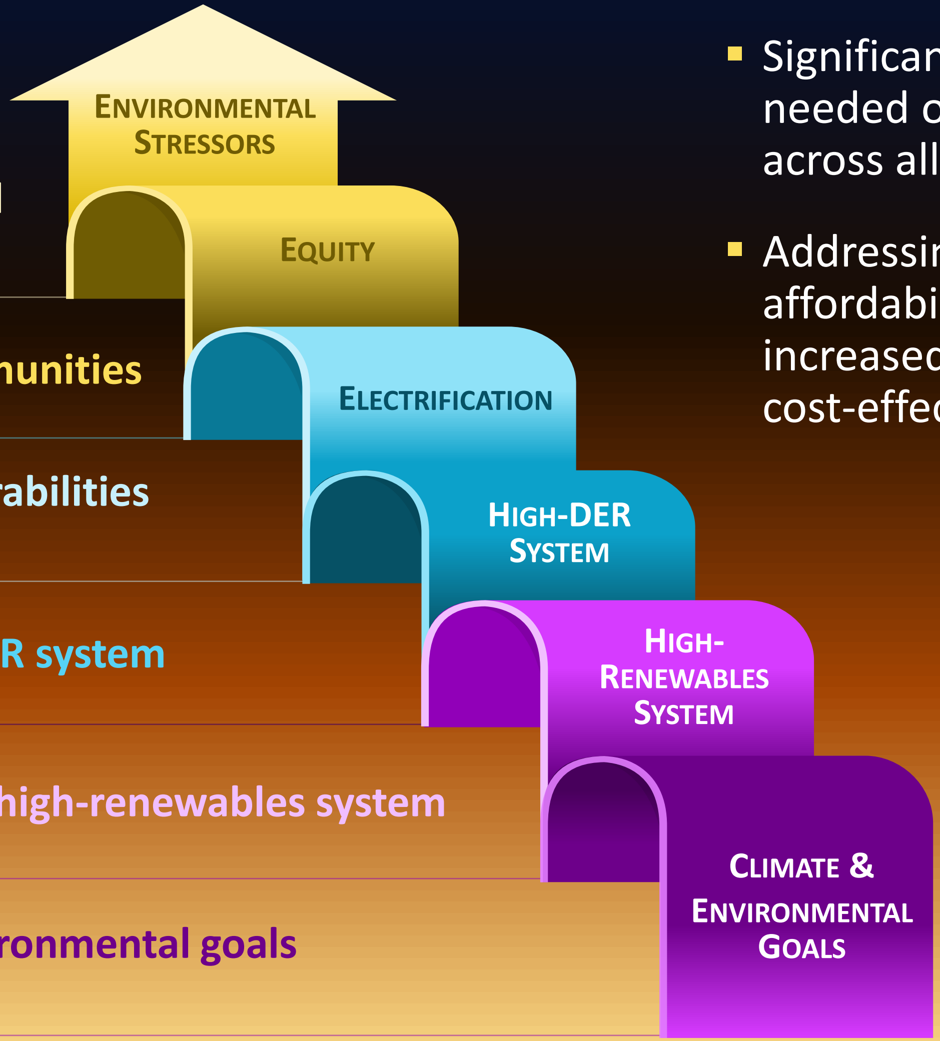
Higher burden on disadvantaged and vulnerable communities

Electrification creates new uncertainties & shift vulnerabilities
e.g., Electric heating during winter events

Institutional barriers to address resilience in a high-DER system

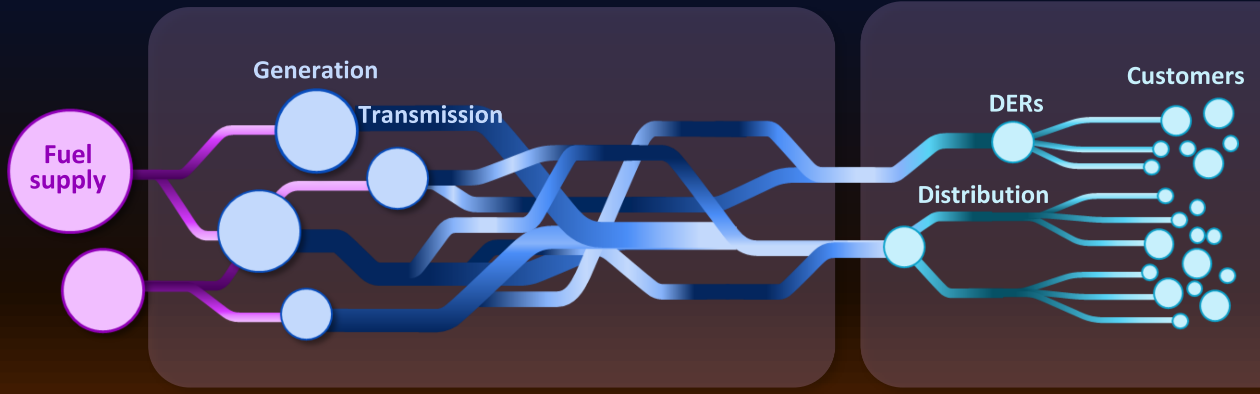
Institutional barriers to plan for reliability targets in a high-renewables system

Resilience solutions must also satisfy climate and environmental goals
e.g., Diesel backup generators not a sustainable option



- Significant grid investment needed over the next decade, across all grid domains
- Addressing potential affordability crisis will require increased emphasis on cost-effectiveness

Coordinated grid planning need



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

- Improved coordination for implementation of DERs in IRP modeling is needed to increase cost-effectiveness of DER programs, as well as the IRP portfolio
- Most DERs modeled with static profiles with little or no operational flexibility in the IRP models
- CPUC instituted rulemaking R.22-11-013 to consider DER program cost-effectiveness issues, including coordination amongst various DER proceedings, programs, and the IRP proceeding

Customer outage impacts of alternative solutions

Stakeholders are learning a lot about grid asset vulnerability through CAVA, but we still don't know enough about ultimate impacts on customer outages under different resource solutions

- CPUC D.20-08-046 directs utilities to engage with disadvantaged and vulnerable communities on climate adaptation needs and conduct vulnerability assessments (CAVA)
- CAVA analyses has primarily focused on vulnerabilities of utility assets to climate change, overlayed with community characteristics in high-risk areas identified
- SCE/Sandia pilot project combining SCE's community resilience metric and Sandia's social burden index aims to improve equity considerations in grid planning
- Ongoing efforts are helpful to characterize vulnerability profiles, but we also need ultimate impact on customer outages to compare alternative solutions and evaluate risk and economic tradeoffs

IRP integration:

Potential modeling of resilience resources in IRP

- LSE IRP filings could provide the CPUC and stakeholders findings on local resilience risks/concerns and how LSE plans mitigate these concerns
- For example:
  - Narrative template could include a section for LSEs to demonstrate how their plans will improve resilience, describing engagement with local authorities, information collected, analytical approach/assumptions, and resilience impact metrics
  - Resource data template could include a list of resources that are planned for resilience, their attributes, and availability profiles (resilience vs. grid)
- CPUC could re-optimize resource portfolio, considering capacity and grid availability of distributed resources
  - Same objective (system reliability and GHG reduction); but including resilience solutions' ability to offer grid services can reduce investment and production costs to meet reliability and GHG reduction targets, and improve overall cost-effectiveness of the portfolio selected
  - Capacity reserved for local resilience (e.g., time slice, min % of capacity) excluded from portfolio optimization but needed for resilience assessment, separately

*This is for discussion purposes only and is not meant to reflect formal recommendations for the CPUC's IRP process.

IRP integration:

Potential resilience evaluation within IRP

- As a part of the aggregation of LSE plans, IRP could also conduct a system-level resilience assessment of the aggregated resource portfolio, with a standardized set of metrics on resilience impacts by location
  - Check for consistency in treatment of climate risks and extreme weather events
  - Create summaries assuming standard prioritization across outages & customers affects
  - Demonstrate resilience improvements across LSEs with changes in CAIDI/CAIFI metrics assuming standard prioritization across outages and customers affects
  - Compare across LSEs to identify major imbalances and challenges to implementation of resilience solutions

Through this process:

IRP gets:	LSEs get:
✓ Additional connectivity to local needs, resilience concerns and risks ✓ Refined DER capacity and use cases, how much will be available for grid dispatch ✓ Checks on extreme events & grid dynamics during those events	✓ Community needs better served and represented in the planning process ✓ Clear guidelines on contracting and operating parameters for resilience services vs. grid availability ✓ Cross-LSE dialogue on resilience concerns and priorities

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Discussion and Q&A

WebEx Tip

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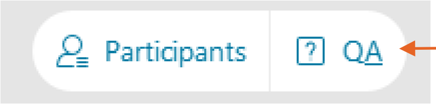

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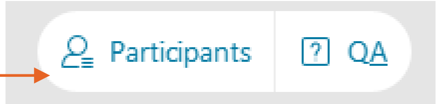

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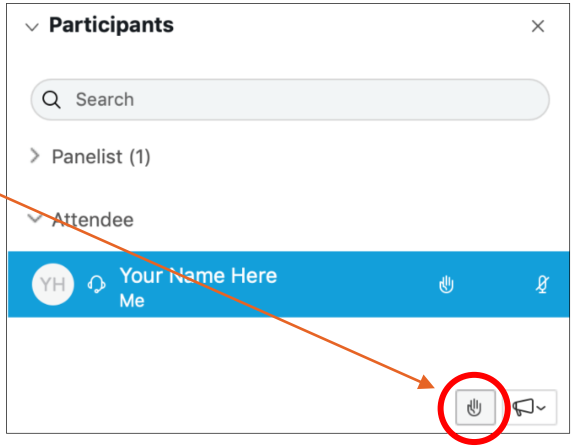
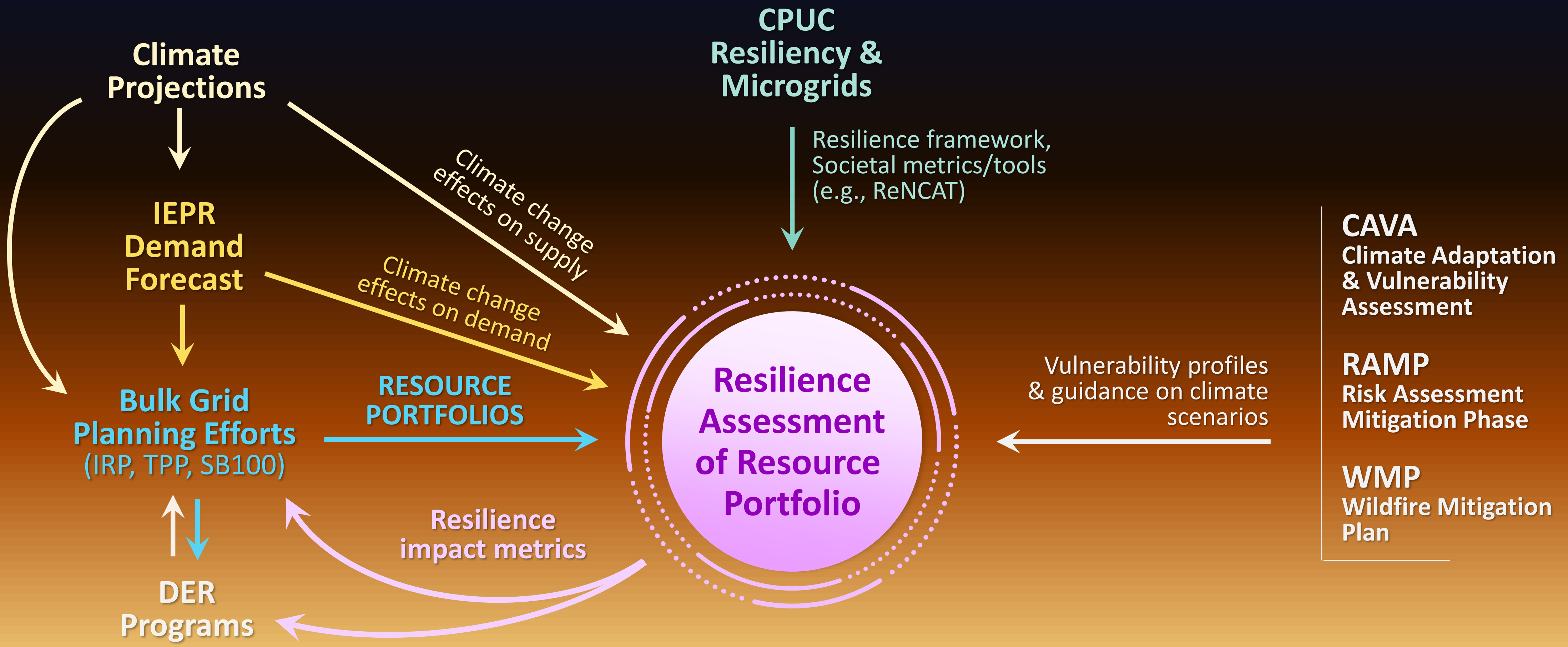
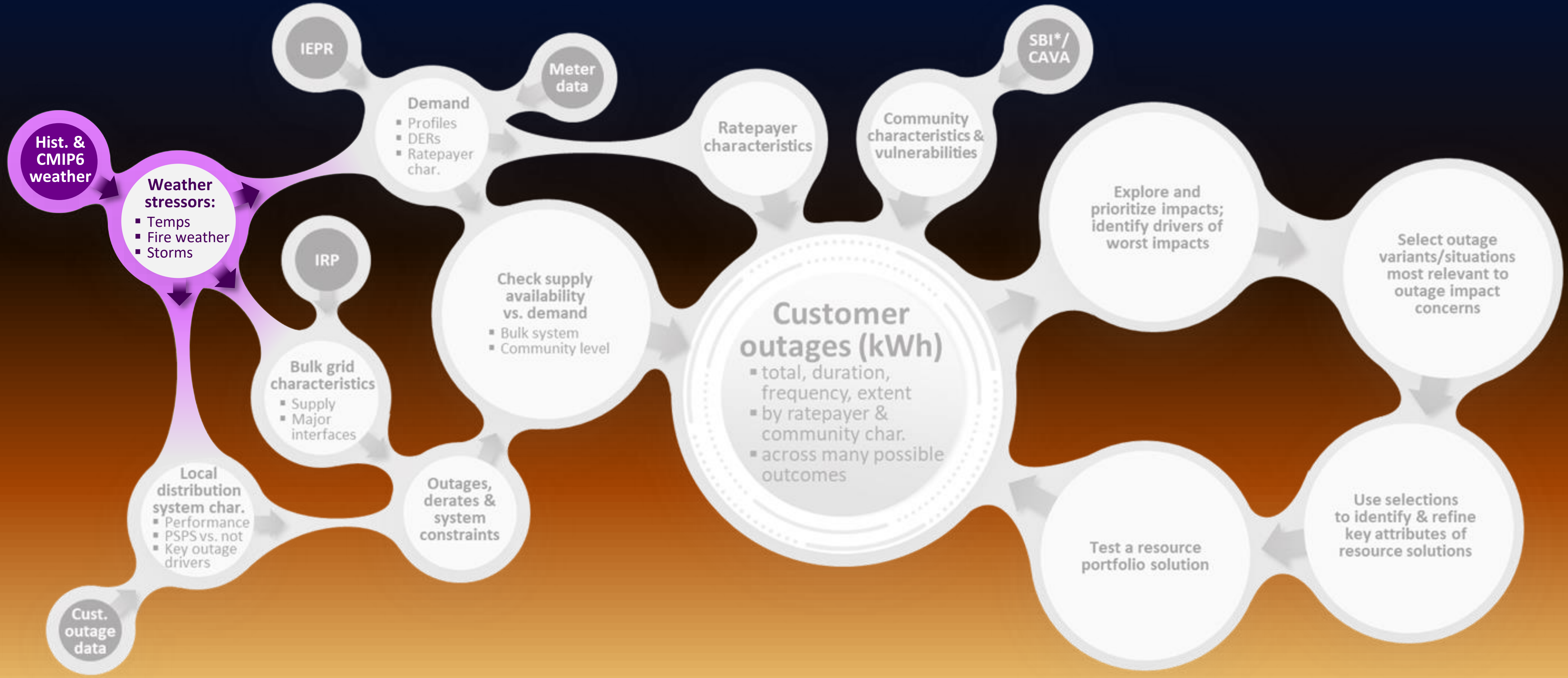


How to integrate "resilience" into resource planning?

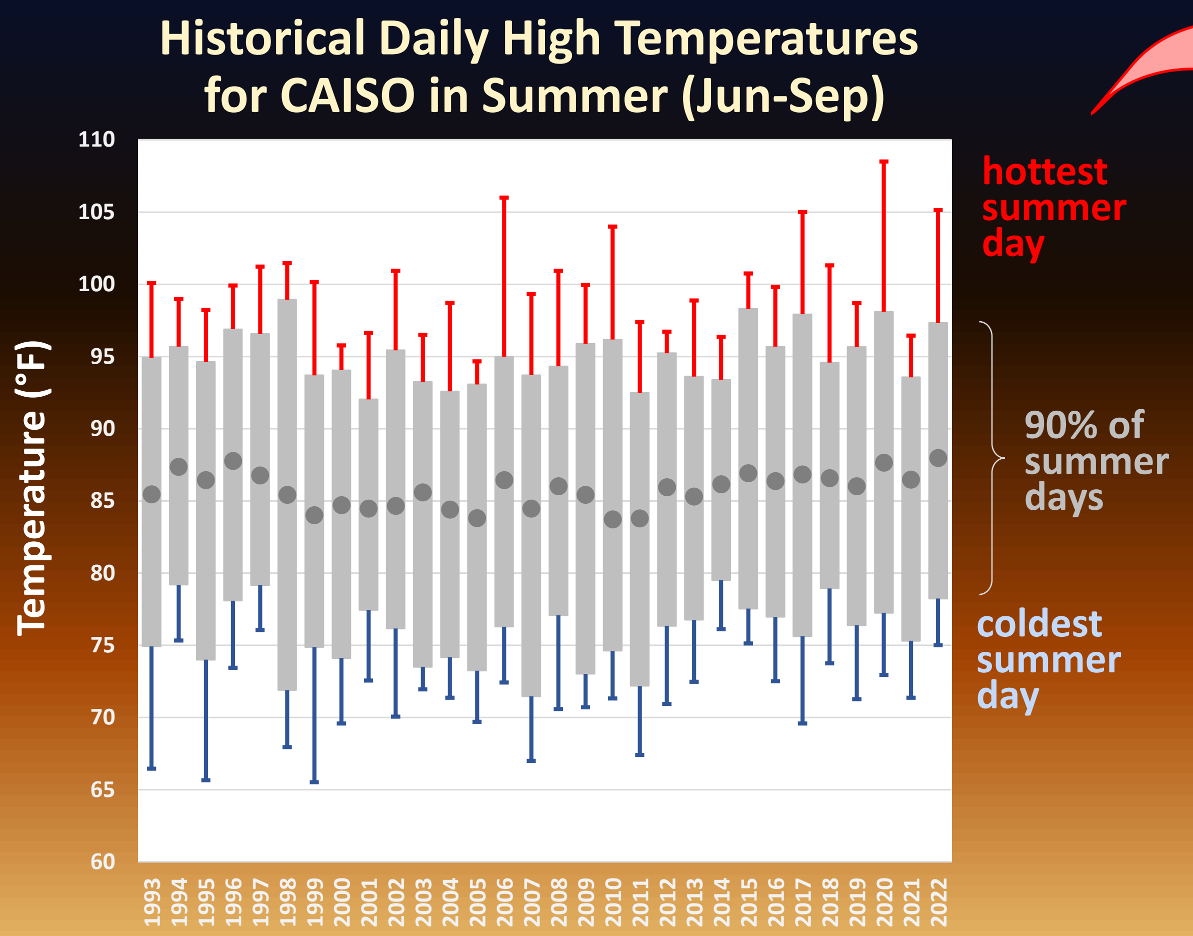
Climate-resilient resource planning requires a comprehensive resilience assessment tapping into several related but currently disconnected efforts in the state

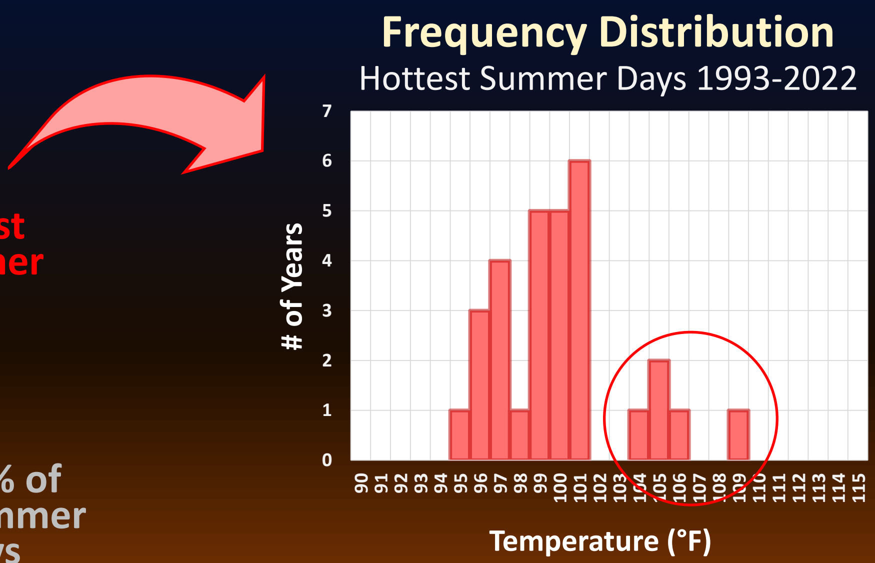


Weather is a key input to planning



Historical weather data no longer sufficient for grid planning





Recent heat waves (e.g., Aug'20, Sep'22) at the tail end of historical distribution

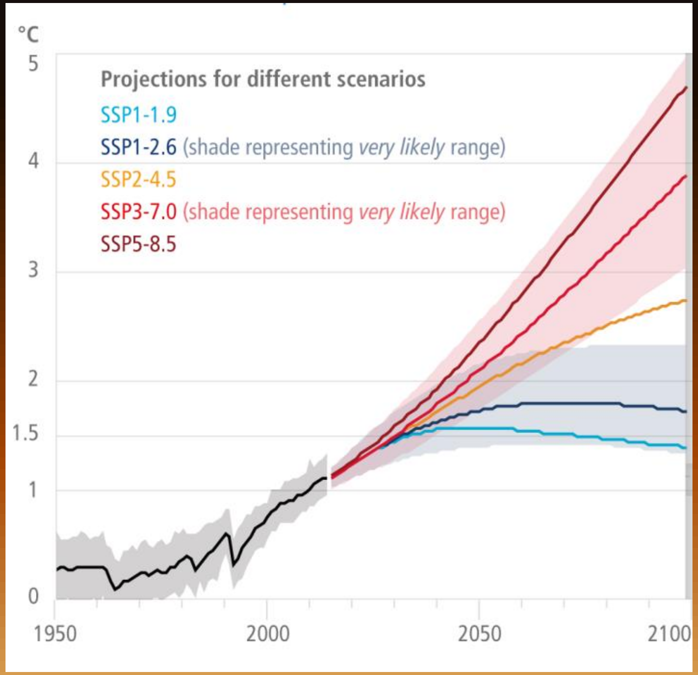
With history alone, cannot tell if such events will remain as tail events, or be the new normal

- The recent heat waves in California highlighted the importance of extreme weather events, and how they are characterized in grid planning studies
- Using a long historical record over multiple decades can increase the sample of weather conditions considered to characterize variability and extremes, but data from decades ago are less representative of today and future climate conditions

Climate projections for California

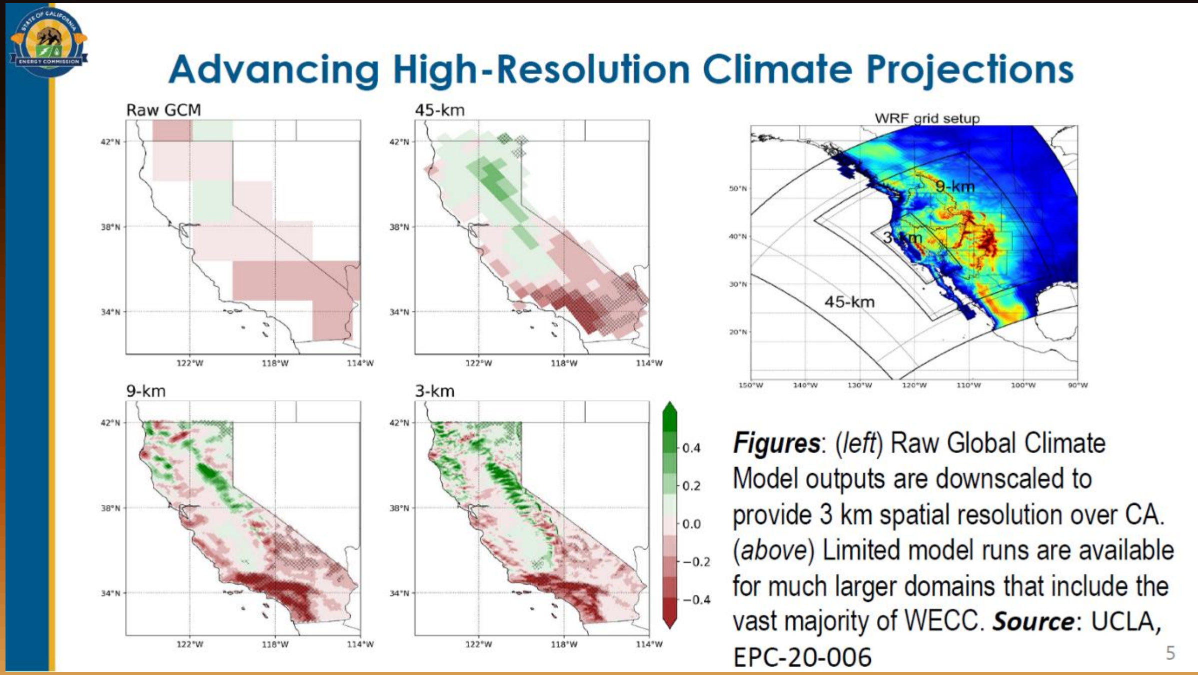
The CEC is working closely with the climate science community to produce detailed data on potential future weather outcomes and patterns to support a variety of mitigation and adaptation planning efforts in the state.

IPCC AR6: Global Surface Temperature Increase Relative to the Period 1850–1900



Source: IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926. https://www.ipcc.ch/.

EPC-20-006: Scripps Institution of Oceanography (UCSD) w/ UCLA and UC Berkeley Development of Climate Projections for California



Source: California Energy Commission, "Incorporating climate change in California's demand forecast," Presentation to the Demand Analysis Working Group, June 1, 2023, https://www.energy.ca.gov/event/workshop/2023-06/ca-energy-demand-forecast-climate-change-methodology-improvements.

Climate-informed grid planning

Several complementary efforts to incorporate climate change into the grid planning in California, including (but not limited to):

- Ongoing EPIC-funded research led by the CEC to integrate latest downscaled climate projections into the state's demand forecasting and resource planning models, and evaluate long-term reliability and resilience of planned resource portfolios
- Interim CPUC approach to adjust historical weather inputs used in IRP modeling based on estimated differences from the ensemble of raw CMIP6 data
- The CPUC and stakeholders exploring global warming level (GWL) framework in the climate adaptation efforts (CAVA) to utilize projections from various climate models at assumed warming levels
- Wildfire mitigation plans, California's Fifth Climate Change Assessment

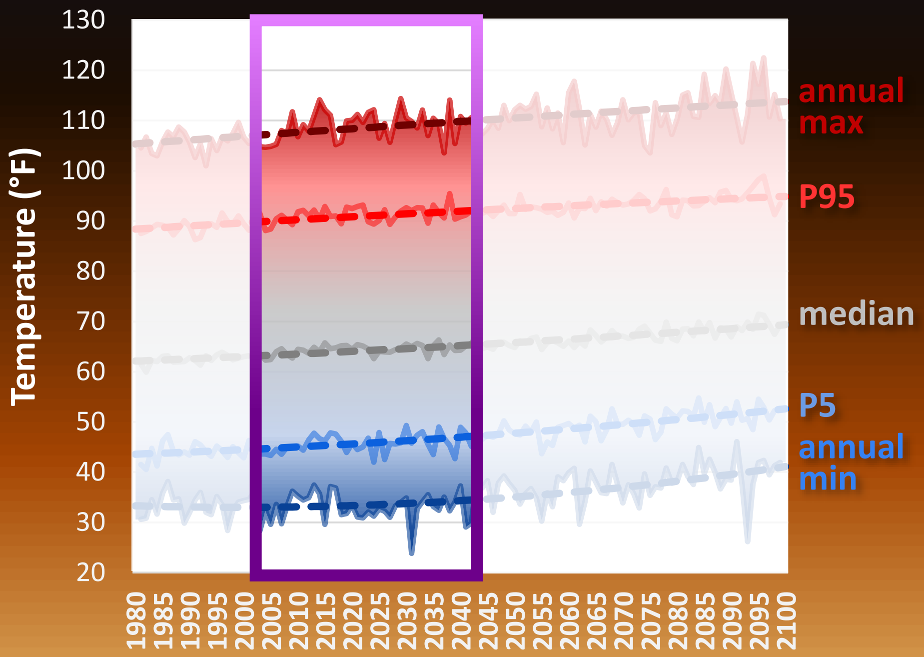
Climate change in demand forecasting

Our current work with the CEC incorporate latest high-resolution climate projections into the IEPR demand forecast, which is a key input into IRP studies in California

- Important to utilize downscaled projections, because anticipated climate change effects are not geographically uniform
- Developed a methodology to increase the size of the ensemble of weather variants, which is essential to capture the range of potential outcomes
- Draws from a window of 30–50 years centered around each forecast year; de-trended to reflect expectations for the forecast year

Historical & Projected Temperatures

Example: Riverside Station



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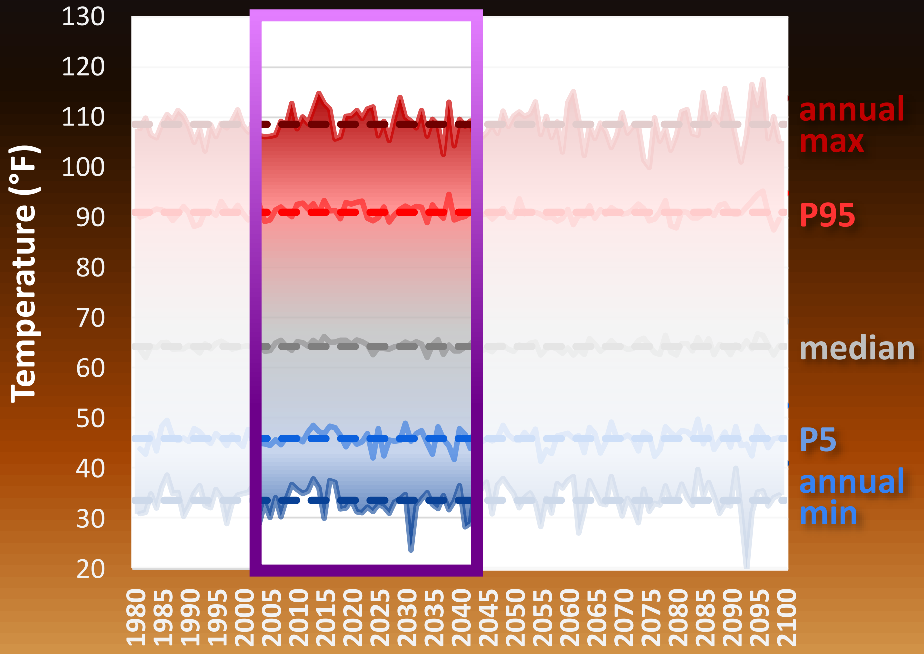
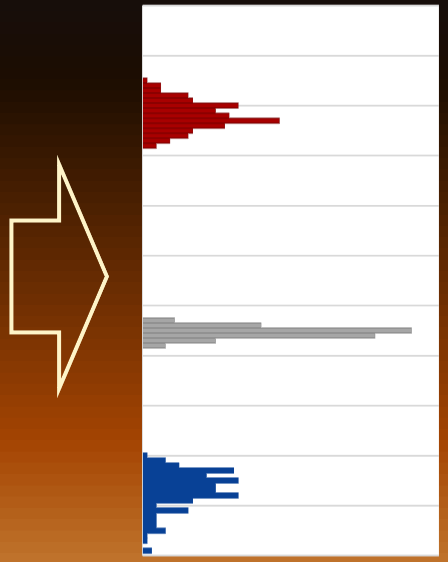
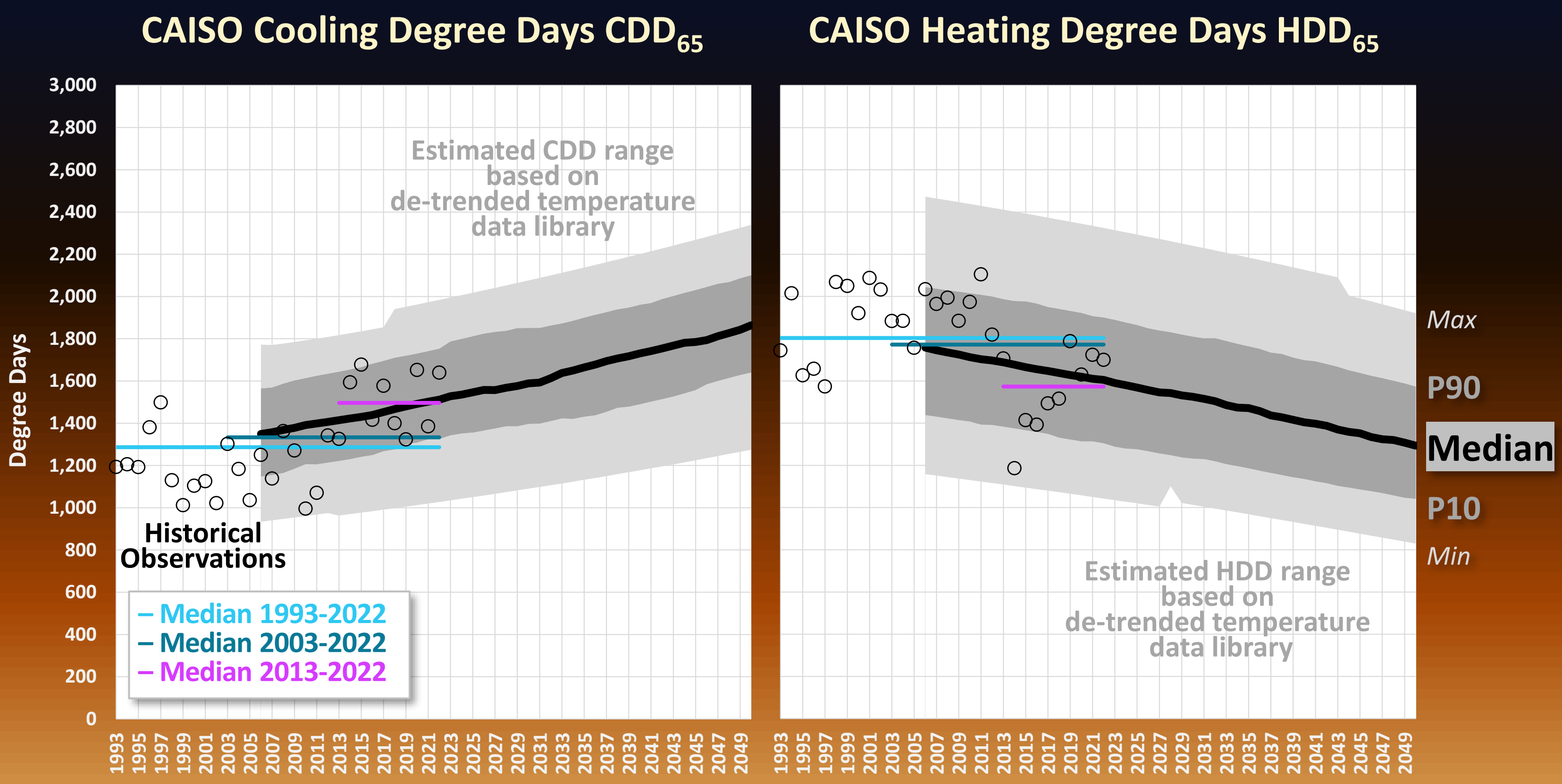


Frequency Distribution

Multiple Climate Models



Projected cooling and heating degree days

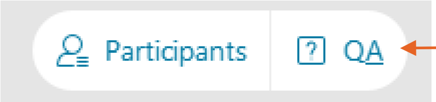


- CDDs and HDDs are key inputs to electricity consumption forecast
- Using historical data without accounting for climate change would bias cooling-related consumption low and heating-related consumption high, and may understate future clean energy needs to meet GHG targets
- De-trended temperature library developed for IEPR will provide a range of outcomes consistent with historical trends and variability, and also capture future changes anticipated based on latest climate models

Discussion and Q&A

WebEx Tip

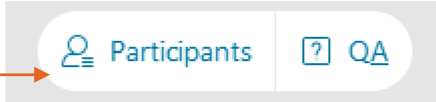
Option 1:



Access the written Q&A panel here

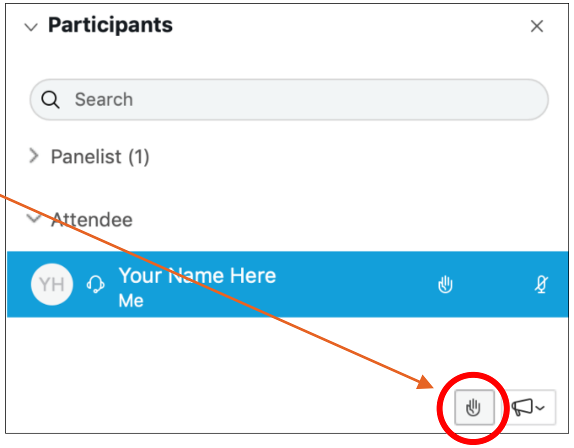
Option 2:

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.



Next steps and tentative schedule

- Continue to support CEC's efforts in 2023 IEPR to integrate localized, de-trended data library of future weather variants in peak and hourly electric demand forecast (Q4 2023)
- Re-parametrize electricity supply inputs and assumptions to characterize impacts of climate change on resource availability (Q2 2024)
- Develop a resilience evaluation model (Q1 2025; beta version mid-2024)
- Evaluate resilience of planning model resource portfolios (Q3 2025)

THANK YOU

IF YOU WOULD LIKE TO SUBMIT INFORMAL FEEDBACK TO THE CPUC, PLEASE COMPLETE OUR POST-WORKSHOP SURVEY

LEARN MORE ABOUT WARP TO RESILIENCE AND JOIN OUR MAILING LIST FOR STUDY UPDATES
www.lumenenergystrategy.com/resilience

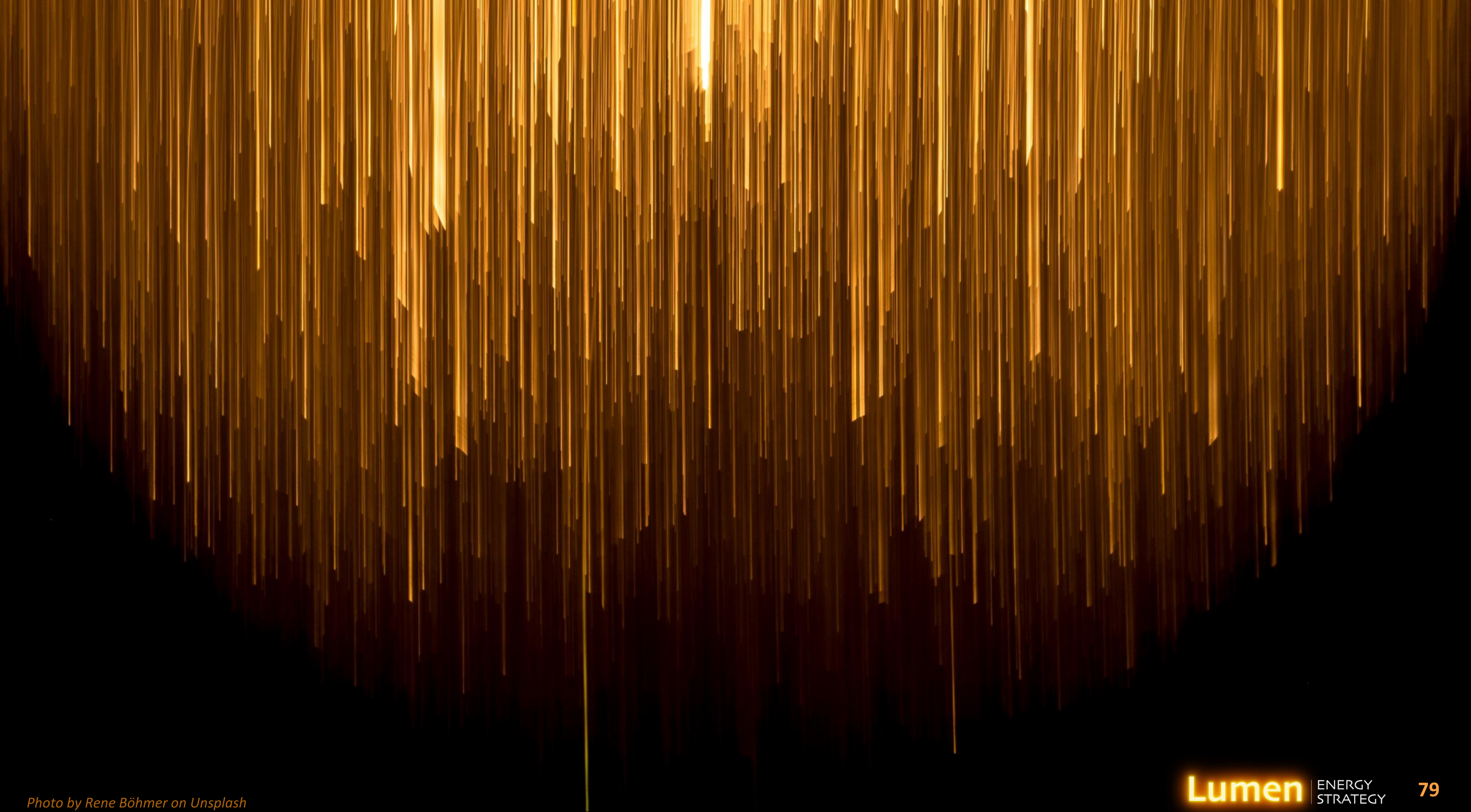


Photo by Rene Böhmer on Unsplash

Closing Remarks

Commissioner Shiroma

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
- ✓ **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) ← **Next Event**

REQUEST FOR PROPOSALS
Equitable Resiliency Evaluation and Planning Modeling

The CPUC requires the services of an expert consultant to support the CPUC with advancing equitable, resilient electrical grid modernization, and increasing community engagement in resiliency planning by applying data driven tools and developing models that contribute to an equitable resiliency evaluation and planning framework. The goal of these efforts is to:

- Enable efficient identification of equitable resiliency targets in response to all-hazard analysis and critical service identification by integrating community, local government and Tribal input about resilience priorities, needs and goals.
- Develop a geo-spatial, equitable resiliency valuation model based on resiliency targets, data and metrics including but not limited to social burden during electric disruption, affordability, direct and indirect economic impacts.
- Optimize and evaluate equitable, cost effective and affordable grid infrastructure investments that support resiliency targets by utilization of geo-spatial, equitable resiliency valuation models described above.

Responses are due Tuesday, January 16, 2024

For more information:

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https://www.cpuc.ca.gov/resiliencyandmicrogrids/