

# WARP to Resilience

*Weather-Adapted Resource Planning*

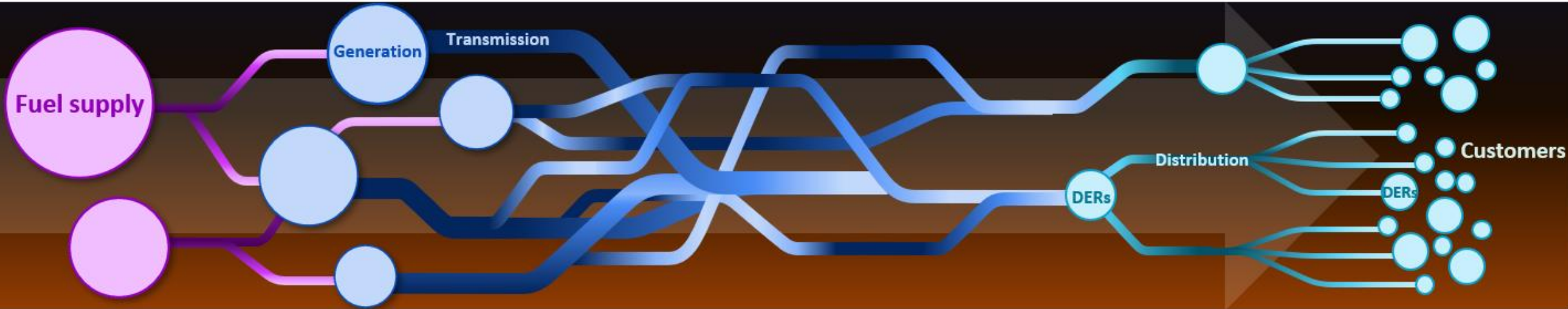
## Incorporating Resilience in Grid Planning and Decision-Making: Key Observations

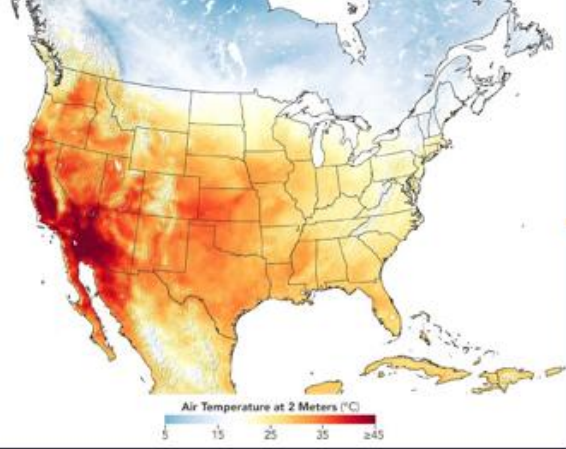
Presented by **MARIKO GERONIMO AYDIN**

Prepared for the **CALIFORNIA ENERGY COMMISSION** Scoping  
Workshop for the Informational Proceeding on Non-Energy  
Benefits and Social Costs (24-OIIP-03)

**March 13, 2025**







### 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 + Saddle Ridge fire severely impacting transmission into LADWP

Fuel supply

Generation

Transmission

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

DERs

Distribution

Customers

### 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)

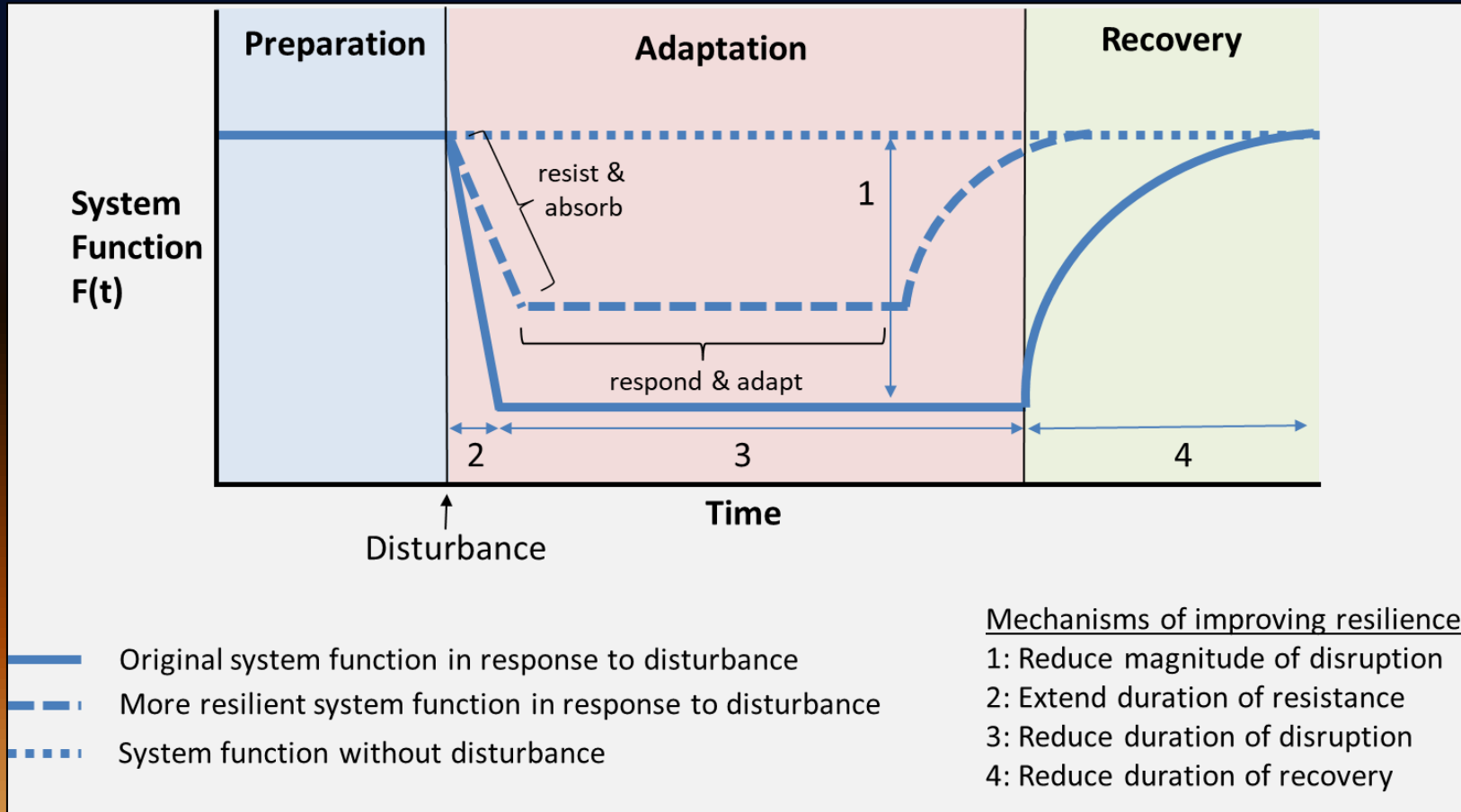
Rain, snow, wind, floods, mudslides

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).



# Resilience: Withstand, Reduce Impacts, Recover

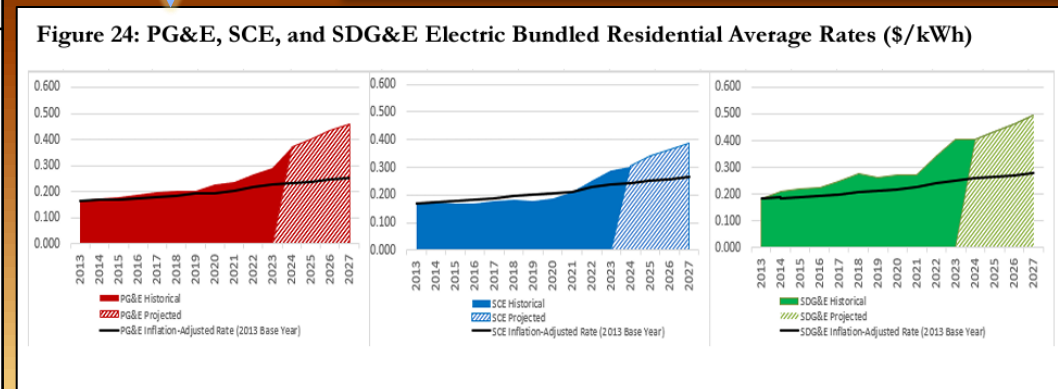
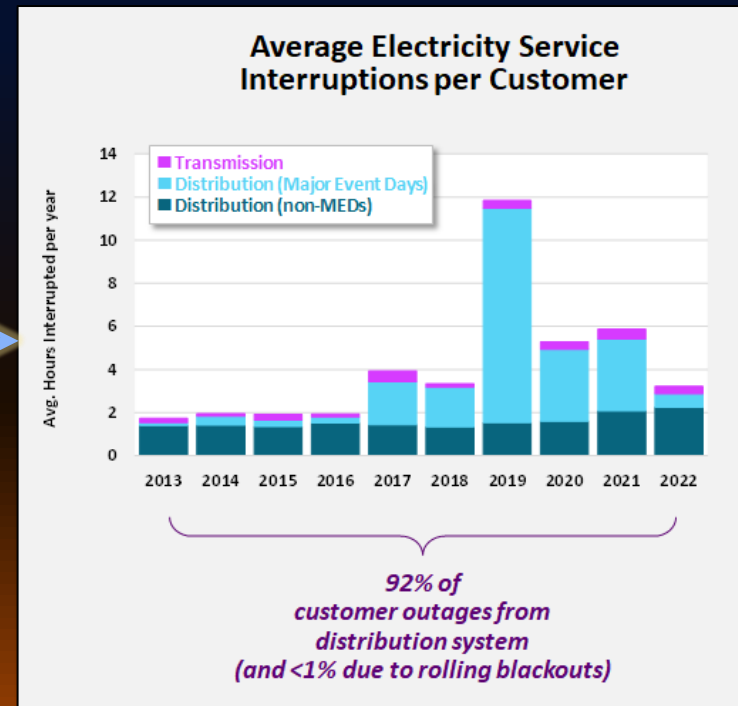


Source: Resilience trapezoid adapted from Panteli, et al. (2017); T. Ding, Y. Lin, G. Li, et al. (2017); T. Ding, Y. Lin, Z. Bie, et al. (2017); and as presented in CPUC, Information Session: Introduction to the CPUC Equitable Resiliency Study, Grid Resiliency and Microgrids Team, Energy Division, September 10, 2024.



# Observations from Resilience-Related Work

OBSERVATION	CALLS FOR:
The <b>grid's purpose</b> is an anchor	<b>Customer outages</b> as a key metric
Not all kWh served—and interrupted—are <b>equal</b>	<b>Customer and community</b> characteristics incl. equity, health, other non-energy impacts <b>Outage</b> characteristics esp. multi-day
Most <b>resilience failures</b> are on the distribution system	Solutions at or downstream of dx wire e.g., DERs and wires
Retail rate and <b>energy affordability pressures</b> are high and rising	Innovative cost-controlling solutions e.g., better utilize existing system; value-stack services from new & existing resources
Distributed resilience solutions yield privately-accrued resilience benefits; some can also provide <b>energy and capacity benefits to ratepayers</b> (value-stack)	Understanding and representing <b>DER market availability</b> in grid planning models





# Recommendations

- **Define resilience with enough specificity to analyze**
- **Use climate projections to inform future hazards and weather variants**
- **Work towards a clearer view of the distributed system & opportunities**
  - Outside of bulk system models, trends, patterns, and diversity of resilience problems & likely operating patterns of resilience solutions (informed by community guidance, see below)
  - In bulk system models, aggregate DER market availability
- **Consider how we can enable and leverage investments where most resilience failures are happening (distribution system and distributed energy resources)**
- **Decisions through the lens of how electricity service to the end-use customer is affected**
- **But lean on communities to set their own resilience priorities**
  - To guide utility investments
  - Recognizing limits to generalizing these prioritizations at the state or bulk grid level



# *THANK YOU*

LEARN MORE ABOUT *WARP TO RESILIENCE* AND JOIN OUR MAILING LIST FOR STUDY UPDATES

[www.lumenenergystrategy.com/resilience](http://www.lumenenergystrategy.com/resilience)

# Lumen's Resilience-Related Work

## ENERGY STORAGE STUDIES

California Public Utilities Commission  
**Energy Storage Procurement Study**  
May 31, 2023

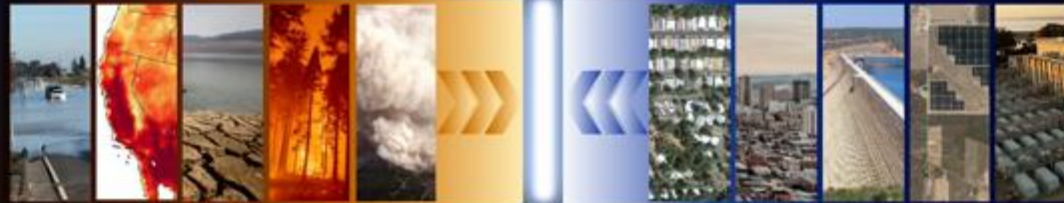
California Public Utilities Commission  
**Scaling Up and Crossing Bounds: Energy Storage in California**  
May 1, 2024

Commissioned by:  
California Public Utilities Commission



## WARP to Resilience

Weather Adapted Resource Planning



## RESILIENCE FRAMEWORK

### Microgrids Proceeding R.19-09-009 Value of Resiliency

Resiliency Standards: Definitions and Metrics  
Lumen Energy Strategy – Climate Resilience in Integrated Resource Planning

### Resiliency Standards: Metrics

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

### 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



## RESILIENCE INDEX

### Information Session: Introduction to the CPUC Equitable Resiliency Study

Grid Resiliency and Microgrids Team, Energy Division  
September 10, 2024 10:00 AM-12:00 PM Pacific



## DEMAND FORECAST

### Development of future weather variants for demand forecast

Presented by ONUR AYDIN

CEC IEP Commissioner Workshop on Load Modifier Scenario Development  
August 18, 2023

### Projected climate trends and patterns of interest to California's energy system

Presented by MARKO GERONIMO AYDIN

CEC IEP Commissioner Workshop on Load Modifier Scenario Development  
August 18, 2023

### Key findings in climate data analyses for demand forecast integration

Presented by MARKO GERONIMO AYDIN and ONUR AYDIN

CEC IEP Commissioner Workshop on the California Energy Demand Forecast Results Part II  
December 17, 2023

### Development of future weather variants for demand forecast

Presented by ONUR AYDIN and MARKO GERONIMO AYDIN

CEC IEP Commissioner Workshop  
July 30, 2024



# Selected references

Aydin, Mariko Geronimo, and Cevat Onur Aydin. 2024. *California Public Utilities Commission scaling up and crossing bounds: energy storage in California*. Lumen Energy Strategy, LLC. Prepared for the California Public Utilities Commission. May 1, 2024.

[www.lumenenergystrategy.com/energystorage](http://www.lumenenergystrategy.com/energystorage)

Brockway, Anna M., Jennifer Conde, and Duncan Callaway. 2021. "Inequitable access to distributed energy resources due to grid infrastructure limits in California." *Nature Energy*. September 13, 2021. <https://doi.org/10.1038/s41560-021-00887-6>

CPUC. 2024. *2024 Senate Bill 695 report: report to the Governor and Legislature on actions to limit utility cost and rate increases pursuant to Public Utilities Code Section 913.1*. July, 2024. <https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/office-of-governmental-affairs-division/reports/2024/2024-sb-695-report.pdf>

CPUC Staff. 2020. *Microgrids and resiliency staff concept paper*. Pursuant to Senate Bill 1339 (2018) and R.19-09-009. July 22, 2020.

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Dugan, Jesse, Dahlia Byles, and Salman Mohagheghi. 2023. "Social vulnerability to long-duration power outages." *International Journal of Disaster Risk Reduction*. 85 (2023) 103501. <https://doi.org/10.1016/j.ijdr.2022.103501>

Sparti, Chelsi, Peter Larsen, and Tyler Huntington. 2023. *The value of sharing and consolidating critical community, electricity, and natural hazard information*. Lawrence Berkeley National Laboratory Electricity Markets & Policy Energy Analysis & Environmental Impacts Division.

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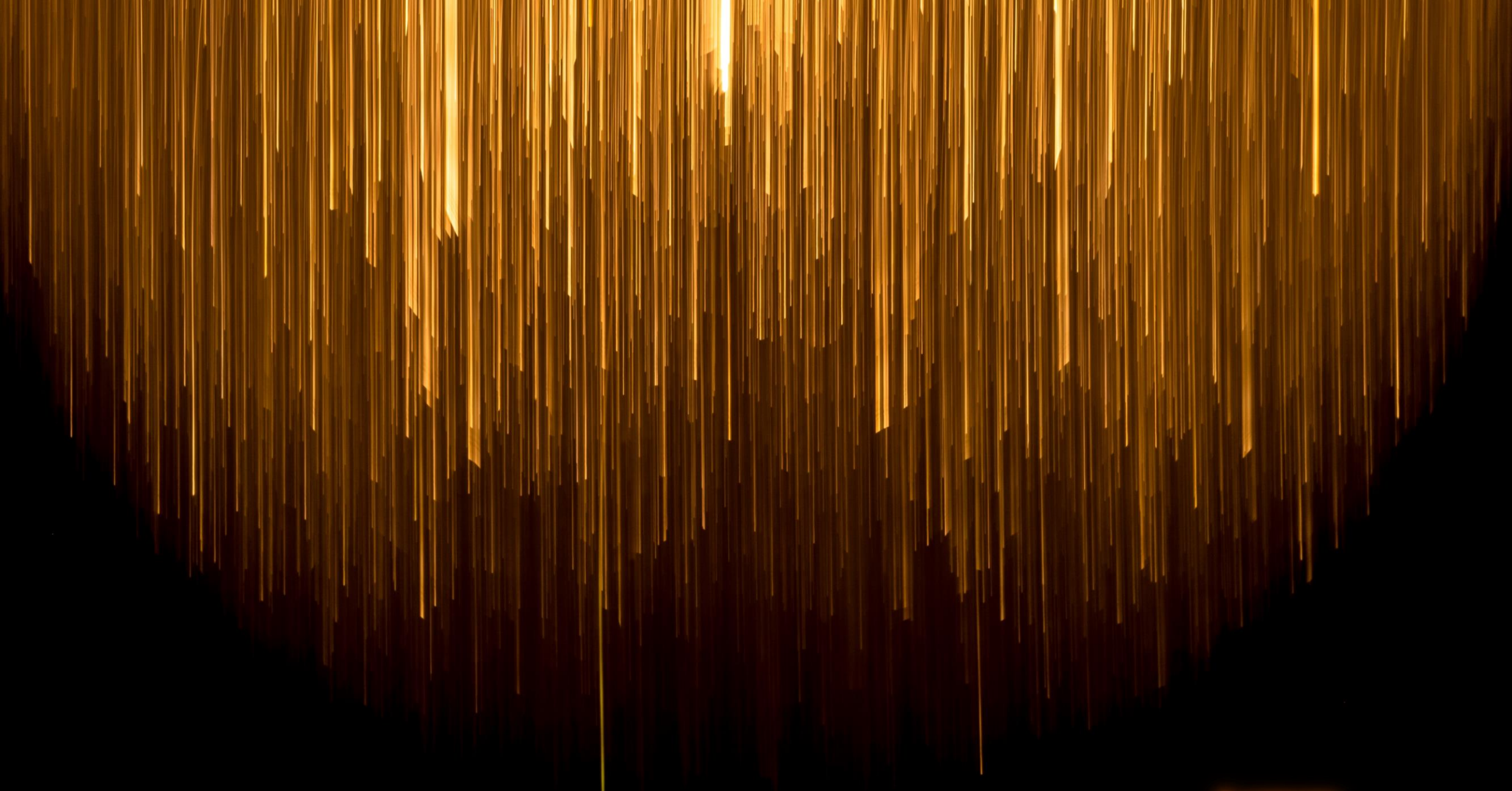
## **See Also:**

Other CPUC Resiliency and Microgrids workshops and materials, including 4 Pillars Methodology:

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

All other references to Lumen's resilience-related work available via:

[www.lumenenergystrategy.com](http://www.lumenenergystrategy.com)



*Photo by Rene Böhmer on Unsplash*

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