Microgrids Proceeding R.19-09-009
Track 5 Value of Resiliency

Economic and Equity Impacts of Large Disruptions:
Interruption Cost Estimate (ICE) Calculator and Power Outage Economic Tool (POET)

Grid Resiliency and Microgrids Team, Energy Division

May 10, 2022

California Public
Utilities Commission

WebEx and Call-In Information

Join by Computer:

https://cpuc.webex.com/cpuc/onstage/g.php?MTID=e4ee01db7b3a8597c8e2d17fdf5c30011

Event Password: GRMG (case sensitive)

Meeting Number: 2488 865 0074

Join by Phone:

- Please register using WebEx link to view phone number.

(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 a Staff Summary Report will be sent to the Service List summarizing the discussion.
- While one or more Commissioners and/or their staff may be present, no decisions will be made at this meeting.

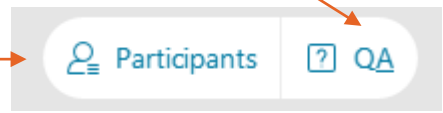
WebEx Logistics

- 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.

WebEx Tip

Access the written Q&A panel here

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



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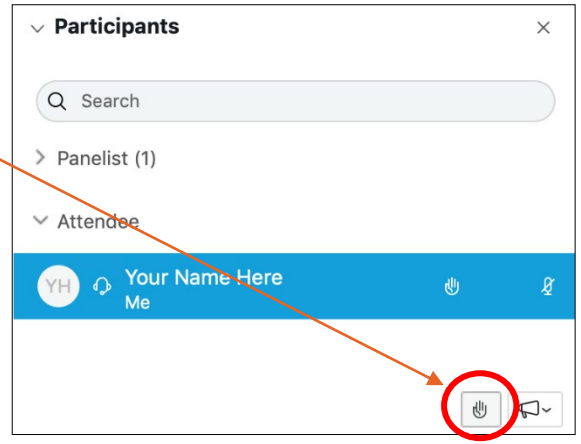

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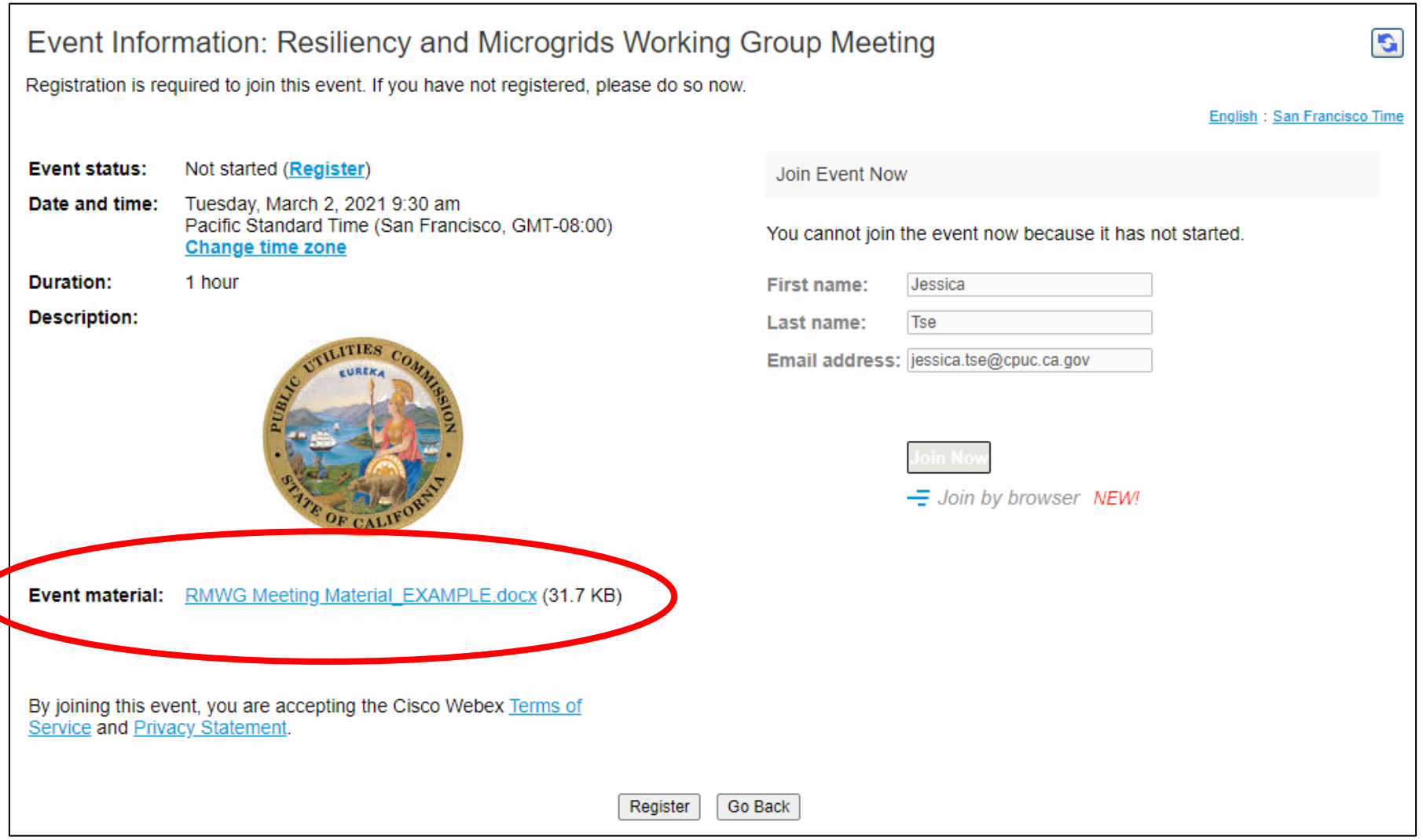
WebEx Event Materials



Microgrids R.19-09-009 Track 5 Workshop Schedule

Track 5 Schedule

Event	Date
Economic & Equity Impacts of Large Disruptions, public workshop(s)	Quarter 2, 2022
Definitions, Metrics, Tools, and Methods, public workshop(s)	Quarter3, 2022
Informing Grid Planning, public workshops	Quarter 4, 2022
Staff Proposal	Quarter 1, 2023
ALJ Ruling Establishing 2023 Scheduling & Activities	Quarter 1, 2023

Agenda

I. Introduction *(CPUC Staff)*	**2:00p – 2:05p**
• WebEx logistics, agenda review	
II. Opening Remarks by Commissioner Shiroma	**2:05p – 2:10p**
III. Interruption Cost Estimate (ICE), Peter Larsen, Lawrence Berkeley National Labs	**2:10p – 2:55p**
Q & A and Discussion	**2:55p – 3:10p**
IV. Power Outage Economic Tool (POET), Peter Larsen, Lawrence Berkeley National Labs	**3:10p – 3:45p**
Q & A and Discussion	**3:45p – 3:55p**
V. Closing Remarks, Adjourn	**3:55p – 4:00p**
• Provide information on the next meeting	

Microgrids Proceeding R.19-09-009 - Track 5 Value of Resiliency

- **How do we optimize grid investments while integrating resiliency?**
  - How can we ensure that the **appropriate amount of resiliency investment** is being made in the **right places** that will **benefit our most vulnerable populations?**
  - How is that resiliency level is being paid for **without causing undue burden on our most vulnerable populations?**

- We can't know the answer to this question without **quantifying** through **measuring**, **assessing** and **evaluating resiliency**, so we know where best to put enough money and effort to optimize resiliency efforts.

- Difference between Quantification and Valuation of resiliency:

  - **Quantifying resiliency** is to put numbers to the amount of risk reduction a given measure (or bundle of measures) achieves and the cost of that risk reduction, i.e. projects, events, and outcomes.
  - **Valuing resiliency** is to understand these numbers in terms of human impact – how much is the risk reduction worth relative to other solutions

ICE Calculator 2.0 and the Power Outage Economics Tool (POET)

Pete Larsen

Staff Scientist and Leader

Electricity Markets and Policy Department

Comparison of ICE Calculator and Power Outage Economics Tool (POET)

- Upgrade to Berkeley Lab's ICE Calculator will allow users to estimate the direct costs to customers from power interruptions lasting 24 hours or less—or the value of investments in power system *reliability**

- The Power Outage Economics Tool—also under development—will allow users to estimate the direct and indirect economic impact of widespread, long duration power interruptions—or the value of investments that enhance power system *resilience**

* Maintain service given "reasonably expected unscheduled outages" (low-medium probability, low-medium impact)

* "Withstand and recover from deliberate attacks, accidents, and naturally occurring threats" (low probability, high impact)


ICE
CALCULATOR

Background on ICE Calculator

- Customer costs of power interruptions are of increasing importance for identifying and prioritizing cost-effective utility investments to improve reliability/resilience

- Berkeley Lab's Interruption Cost Estimate (ICE) Calculator is the leading and only publicly-available tool for estimating the customer cost impacts of power interruptions

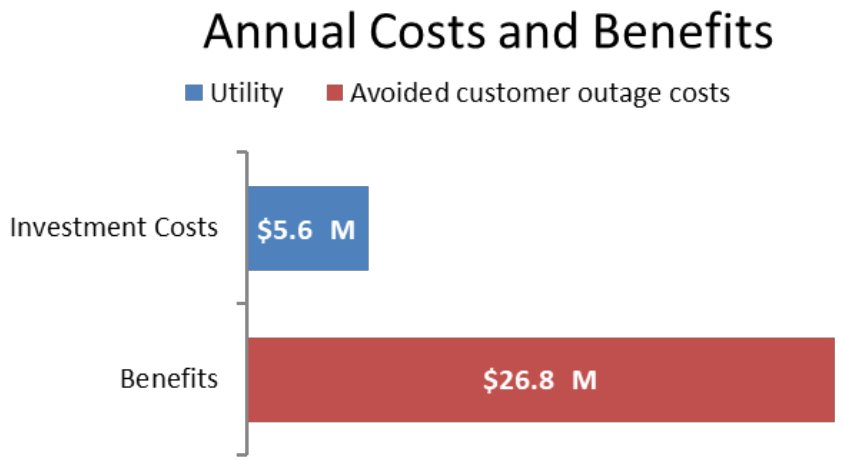
The ICE Calculator is being used to:

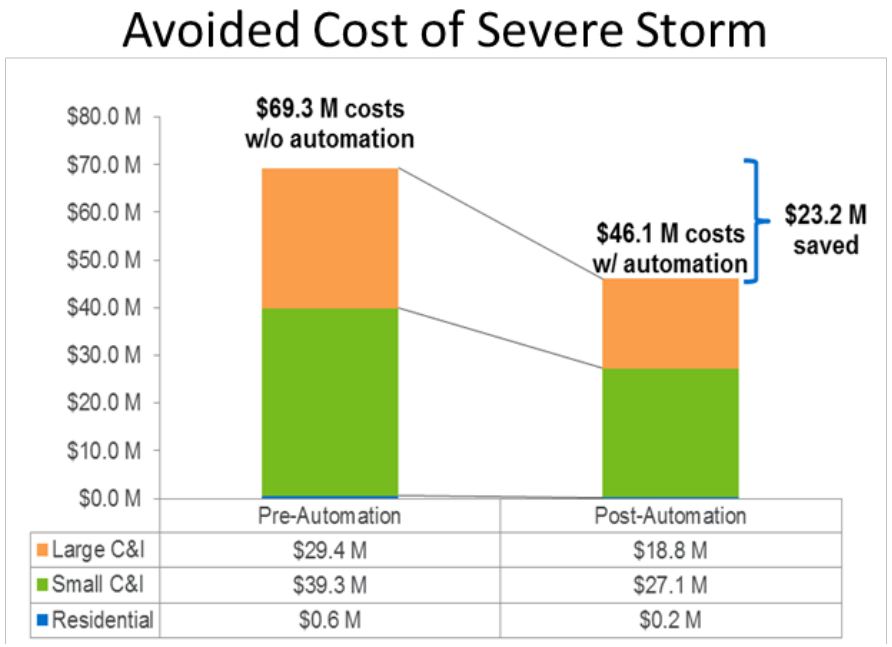
- Support internal utility reliability planning activities
- Provide a basis for discussing utility reliability investments with regulators
- Assess the economic impact of past power outages

http://www.icecalculator.com/

Reliability Value-Based Planning Example

- Utility: EPB of Chattanooga
- Customers Impacted: 174,000 customers (entire territory)
- Investment: 1,200 automated circuit switches and sensors on 171 circuits
- Reliability Improvement:
  - SAIDI ↓45% (from 112 to 61.8 minutes/year)
  - SAIFI ↓51% (from 1.42 to 0.69 interruptions/year) (between 2010 and 2015)





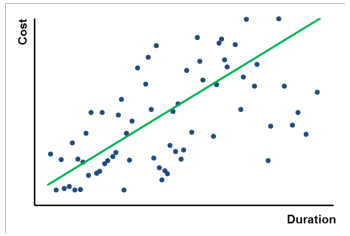
ICE Calculator Based on 100,000+ Utility-sponsored Surveys

Forecast of Reliability
- SAIFI (frequency)
- SAIDI (mins. interrupted)
- w/ and w/o investment

Customer Survey Meta-database

- 34 surveys
- 10 utilities
- 1989-2012
- N=105,000

Econometric Meta-analysis

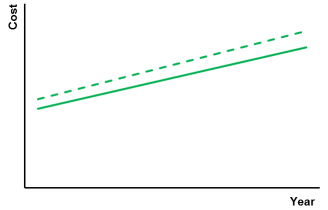


- Med/large C&I
- Small C&I
- Residential
- Other factors

ICE CALCULATOR

Customer Characteristics
- Customer class
- Usage (kWh)
- Industry

Forecast of Customer Outage Costs



- ICE Calculator output
- w/ and w/o investment

Updated analysis with new surveys and model coefficients published in 2015 https://emp.lbl.gov/publications/updated-value-service-reliability

Motivation for National Initiative to Upgrade the ICE Calculator

- Currently, the utility survey-based information relied on by the ICE Calculator is:
  - Dated—many of the surveys are 25+ years old
  - Not statistically-representative for all regions of the U.S.
  - Not appropriate for estimating costs of widespread, long-duration (> 24 hour) interruptions

Utility Company	Survey Year	Number of Observations			Min. Duration (Hours)	Max. Duration (hours)
		Medium and Large C&I	Small C&I	Residential		
Southeast-1	1997	90			0	1
Southeast-2	1993	3,926	1,559	3,107	0	4
	1997	3,055	2,787	3,608	0	12
Southeast-3	1990	2,095	765		0.5	4
	2011	7,941	2,480	3,969	1	8
Midwest-1	2002	3,171			0	8
Midwest-2	1996	1,956	206		0	4
West-1	2000	2,379	3,236	3,137	1	8
West-2	1989	2,025	5		0	4
	1993	1,790	825	2,005	0	4
	2005	3,052	3,223	4,257	0	8
	2012	5,342	4,632	4,106	0	24
Southwest	2000	3,991	2,247	3,598	0	4
Northwest-1	1989	2,210		2,126	0.25	8
Northwest-2	1999	7,091		4,299	0	12

- With encouragement and support from DOE and the Edison Electric Institute (EEI), Berkeley Lab now seeks to support upgrades to the ICE Calculator through direct funding by sponsoring U.S. utilities.

Plan to Update and Upgrade the ICE Calculator

Berkeley Lab and sponsoring utilities are collaborating to:

1. Develop a consistent set of short duration, customer interruption cost (CIC) survey questions, including supplemental questions to understand customer behavior during widespread, longer duration interruptions
2. Coordinate administration of CIC surveys to ensure survey results, collectively, will be statistically representative for all U.S. regions and customer classes
3. Update ICE Calculator with new CIC information as well as other suggested improvements to its design/performance

Organization	Roles and Responsibilities
Berkeley Lab + subcontractors	• Develop survey instrument and survey administration protocols • Conduct pre-testing and administer survey • Process CIC survey data • Upgrade ICE Calculator with new CIC information and incorporate additional feedback
Sponsoring utilities	• Provide funding • Support survey administration and sampling of customers • Provide additional feedback on ICE Calculator improvements to Berkeley Lab • Participate in *Project Steering Committee*

Planned Outcomes

- Upgraded ICE Calculator will:
  1. more accurately value reliability investments that reduce/avoid interruptions lasting up to 24 hours
  2. reflect utility recommendations that improve the tool's design and performance (e.g., incorporate API for direct connection to utility or third-party planning software)
  3. be branded as *ICE Calculator 2.0*—to communicate that this an upgrade to an existing tool that is widely cited in support of utility regulatory filings related to investments in reliability/resilience

- Berkeley Lab will use information from supplemental survey questions to continue to pioneer alternative methods for estimating the economic impacts of widespread outages lasting longer than 24 hours

- Long-term goal of incorporating economic impacts of widespread, long duration outages into the ICE Calculator as a separate module (i.e., POET)

Additional Information on Deliverables

Feature	General Public	Sponsoring Utility
Online access to ICE Calculator 2.0	✓	✓
Access to Application Programming Interface (API) • Allows for communication between ICE Calculator and software systems/planning tools internal to utility		✓
Enhanced levels of technical support		✓
Access to automatically updated, utility-specific input parameters • Allows for ICE Calculator results to be automatically customized based on sponsoring utility service territory characteristics (e.g., average annual customer electricity usage by customer class)		✓

ICE 2.0 Timeline

Aug 2020 Initiative launched –

- Target: 20+ Utility distribution service territories; 2-3 per U.S. Census Area

Oct 2020–Mar 2022* Phase I

- Project commitments and signing of contracts—continuous through March 2022

Jun 2022–Dec 2022 Phase II

- Develop survey protocol and pre-testing—identical questions will be used in all surveys

Jan 2023–Dec 2023 Phase III

- Survey administration, processing, and analysis—surveys administered in order of contracts

June 2023–Jun 2024 Phase IV

- Utility-specific reports (following completion of individual utility surveys)
- Final technical report, and ICE Calculator upgrade

*First cohort: It is expected that additional utilities will join beyond March 2022

ICE 2.0 Project Advisory Committee

- LBNL will follow an open, transparent, and peer-reviewed process to upgrade the ICE Calculator

- In addition to the Project Steering Committee, LBNL will be forming a Project Advisory Committee that will be kept apprised of the project's progress and invited to review and comment on the completion of key project milestones, such as:
  - Survey questions that will be used consistently in each utility service territory
  - Construction of customer damage functions from pooled survey results
  - Revisions to the ICE Calculator's web-based functionalities

- The Project Advisory Committee is expected to be comprised of key, national, non-sponsoring, stakeholder organizations, including NARUC, NASEO, NASUCA, EEI, APPA, NRECA, EPRI, and DOE

Discussion and Q&A

WebEx Tip

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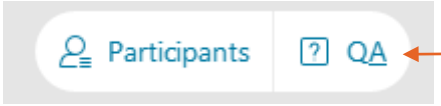

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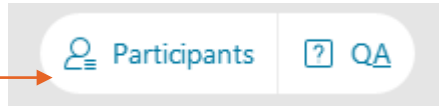

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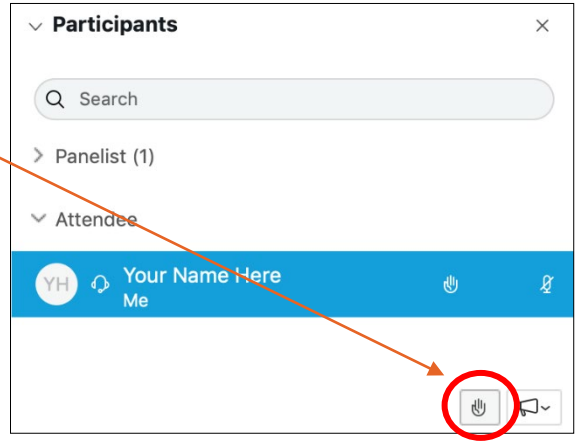


Regional Economic Models
Customer Interruption Cost Surveys
POET
GT&D Power Interruption Scenarios
Utility Resilience and Customer Mitigation Scenarios

POET Discussion Questions

- How it has been specifically applied so far (by ComEd or any other utility, agency, or government entity)?
- What the study with ComEd has entailed, and what has been learned so far from it?
- Is POET ready for distributed use? If not, what is the timing looking like for its distributed use?
- Does it need more piloting? If yes:
  - If a CA utility were to pilot its use, what would that entail (what kind of data, what kind of application, what kind of timing and what would funding needs be?)
  - If it could or would be available for use, same questions (data, application, timing and funding)

Power Outage Economics Tool (POET)

- Conducting *hybrid* resilience valuation approach that integrates:
  1. Survey-based techniques to identify mitigating/adaptive behaviors that residential, commercial, industrial, and public sector customers may take to reduce risk before, during, or after a power interruption occurs
  2. Regional economic models that have been calibrated—using survey responses—to assess the full range of economic impacts from power interruptions
- Allow users to estimate direct and indirect impacts of power interruptions under a wide range of scenarios (or the economic value of enhancing resilience)

ComEd
An Exelon Company

Customer Surveys		Regional Economic Model(s)
• How much were your overall costs reduced by shifting the time or location of your production?	CALIBRATION	• ***% and $ change in sales revenue***
		• ***% change in producer (consumer) prices***
• By how much were your overall costs reduced by having backup generation?		• ***% and $ change in net economic output***
		• ***% change in labor supply (demand)***
• ***Direct costs of interruptions < 24 hours***		*Results by business sector and region for outages > 24 hours*

POET: Geographic Resolution

Region for Output	Region for Sampling	Region Name	# of Counties	ComEd Customer Count
1	1 (Urban)	Cook	1	2,347,552
2	2 (Suburban)	Dekalb and Kendall	2	92,773: Dekalb (45,391) + Kendall (47,382)
3		DuPage	1	366,421
4		Grundy and Kankakee	2	74,459: Grundy (24,044) + Kankakee (50,415)
5		Kane	1	169,405
6		Lake	1	294,518
7		McHenry	1	132,863
8		Will	1	257,291
9	3 (Rural)	Rural ComEd	15	282,303: Winnebago (125,573) + Boone (21,906) + Ford (358) + La Salle (21,836) + Lee (22,403) + Stephenson (23,279) + Jo Daviess (3,584) + Carroll (3,742) + Whiteside (23,118) + Marshall (1,607) + Ogle (18,889) + Woodford (1,622) + Bureau (1,659) + Henry (590) + Livingston (13,014)
10	N/A	Adjacent to ComEd	15	Iroquois, McLean, Tazewell, Peoria, Stark, Putnam, Rock Island, Mercer, Knox, Champaign, Porter-Indiana, Newton County-Indiana, Lake County-Indiana, Jasper County-Indiana, Kenosha-Wisconsin
11	N/A	Remainder of Illinois	67	All remaining counties in Illinois
12	N/A	Remainder of Wisconsin	71	All remaining counties in Wisconsin
13	N/A	Remainder of Indiana	89	All remaining counties in Indiana
14	N/A	Remainder of U.S.	3,103	All remaining counties or county-equivalents

POET: Sector Resolution

Sector for Output	Sector for Sampling	Description	Comments
1	1	Ag, Forestry, Fish & Hunting	
2	1	Mining	
3	2	Electric Power Generation	Electricity sector
4	2	Electric Power Transmission and Distribution	Electricity sector
5	2	Natural Gas Distribution	Sector of interest
6	2	Water, Sewage, and Other Systems	Sector of interest
7	1	Construction	
8	3	Motor and Generator Manufacturing	Sector of interest
9	3	Manufacturing	
10	4	Wholesale Trade	
11	5	Retail - Food and Beverage Stores	Electricity-intensive
12	5	Other Retail Trade	
13	4	Transportation	
14	4	Warehousing and Storage	Electricity-intensive
15	6	Internet Publishing and Broadcasting	
16	6	Telecommunications	Sector of interest
17	6	Data Processing, Hosting, and Related Services	Sector of interest

POET: Sector Resolution (cont.)

Sector for Output	Sector for Sampling	Description	Comments
18	6	Other Information Services	
19	6	Finance & Insurance	
20	6	Real Estate	Electricity-intensive
21	6	Rental & Leasing Services	
22	6	Professional, Scientific, & Tech Services	
23	6	Management of Companies	Electricity-intensive
24	6	Administrative & Waste Services	
25	7	Educational Services	
26	8	Hospitals	Electricity-intensive
27	6	Other Health & Social Services	
28	9	Arts, Entertainment & Recreation	
29	9	Hotels and Motels (including Casino Hotels)	Electricity-intensive
30	9	Restaurants	Electricity-intensive
31	9	Other Accommodation & Food Services	
32	9	Other Services	
33	9	Non NAICS	
34	10	Governments	

POET Timeline

Aug 2020	Project launched
2020-2021	Survey instrument design, sampling strategy, modeling dry-runs
Winter 2022-Spring 2022	Pre-testing survey and full survey administration
Spring-Fall 2022	Processing survey results, model calibration, and model runs
Fall 2022-Winter 2023	Project report and release of simple online tool for ComEd use

Adapting POET Framework for California

Step	Phase	Description	Approx. Timeline
1	Pre-survey	Develop sampling strategy, including geographic and sectoral resolution; Define interruption scenarios; Utility/CPUC review of survey instruments*	3-6 months from kick-off
2	Survey	Pre-testing survey instruments (if necessary); Full survey administration	9-12 months
3	Analysis	Process survey responses; Calibrate regional economic model	12-18 months
4	Results	Run calibrated model and update online tool to display results for California utility (or utilities)	18-24 months from kick-off

** It is also possible to develop and deploy a survey instrument to estimate the direct costs to residential customers from widespread, long duration interruptions*

Deliverables:

- Simple online tool for use by utilities, regulators, and other stakeholders
- Report detailing method, survey responses, and economic impacts of widespread, long duration power interruptions

Contact Info

Peter Larsen, Department Head/Staff Scientist

Peter conducts research and analysis on electricity reliability and resiliency, energy efficiency, and regional electric system planning including: Energy Services Company Industry and Market Trends; Utility Resource Planning Practices and Trends; Western Electricity and Natural Gas Markets; Societal Impacts from Abnormal Weather; and the Reliability of the U.S. Power System. Peter holds a Ph.D. in Management Science and Engineering from Stanford University; M.S. degrees from Stanford University (Management Science and Engineering) and Cornell University (Natural Resource Economics); and a B.A. in Economics from the University of Montana at Missoula.

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Joe Eto, Staff Scientist

Joe is a Senior Advisor to the Electricity Markets and Policy Department and the Strategic Advisor for the Energy Storage and Demand Resources Department. Joe also leads the program office for the Consortium for Electric Reliability Technology Solutions, which is a national laboratory-university-industry R&D consortium founded by LBNL, ORNL, PNNL, SNL, PSERC, and the Electric Power Group that conducts research and analysis on electricity reliability and transmission. Joe received an A.B. in philosophy of science and an M.S. in energy and resources from the University of California, Berkeley. He is a registered professional Mechanical Engineer in the State of California.

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Discussion and Q&A

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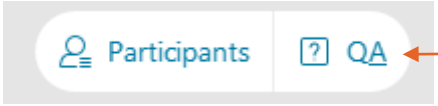

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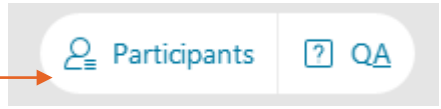

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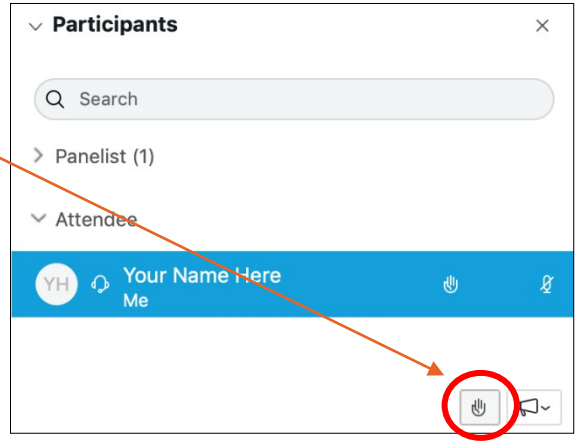

Upcoming Meetings

- **Friday, July 15, 2022**
  Economic and Equity Impacts of Large Disruptions:
  Sandia Labs presentation of Resiliency Node Cluster Analysis Tool and the Social Burden Index

For more information:

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