California Public Utility Commission's SB 884 Guidelines: June 24, 2025

Interruption Cost Estimator Calculator 2.0 (ICE 2.0)



California Public Utilities Commission

Grilling Safety



- "Almost 20,000 patients go to emergency every year because of grilling related injuries." - NFPA
- Never grill near flammable materials or structures and don't leave it unattended.
- Use proper tools for grilling to prevent injury.

Agenda

Introductions	1:00 – 1:05 pm
Purpose and Expected Outcomes of TWGs	1:05 – 1:10 pm
Interruption Cost Estimator Calculator 2.0 (ICE 2.0): Lawerence Berkeley National Laboratory (LBNL) Presentation	1:10 – 1:40 pm
Q&A for LBNL	1:40 – 2:00 pm
Break	2:00 – 2:10 pm
Using the ICE 2.0 Calculator in the 2027 Test Year General Rate Case: Pacific Gas and Electric (PG&E)	2:10 – 2:40 pm
Q&A for PG&E	2:40 – 3:00 pm
Break	3:00 – 3:10 pm
General Discussion: ICE 2.0 Calculator	3:10 – 4:00 pm

Purpose and Expected Outcomes of TWGs

1:05 pm – 1:10 pm

Purpose and expected outcomes of TWGs

TWG #1 – June 3, 2025

- The purpose of TWG #1 was to introduce the draft SB 884 Project List Data Requirements Template and to gather stakeholder feedback. The data template is intended to support Phase 2 Application and progress reports of Electrical Undergrounding Plans required under Senate Bill 884.
- SPD shared and presented the Excel-based data template along with the accompanying PDF guideline, providing explanations of data structure, field names, descriptions, and input constraints.

TWG #2 – June 10, 2025

• Building on TWG #1, the TWG #2 meeting focused on discussing stakeholder feedback and addressing questions related to the Data Template. The discussion aimed to clarify specific data elements and the overall structure of the data template.

Purpose and expected outcomes of TWGs

TWG #3 – June 24, 2025

- The TWG #3 meeting will focus on the underlying methodology used to monetize reliability benefits in cost-benefit analyses, specifically the adoption of the ICE 2.0 (Interruption Cost Estimator) Calculator developed by LBNL.
- LBNL will present the major updates in ICE 2.0, which is required for utilities transitioning to the CPUC's Cost-Benefit Approach under Decision D.22-12-027.
- PG&E will share how they applied ICE 2.0 in support of their 2027 General Rate Case (GRC), providing a practical example of its application.
- The group will discuss whether the existing SB 884 data templates should be updated to reflect the new changes introduced in ICE 2.0.

Interruption Cost Estimator Calculator 2.0 (ICE 2.0)

Presenter: Lawerence Berkeley National Laboratory, 1:05 pm – 1:35 pm



ENERGY MARKETS & POLICY



Release of Updated ICE Calculator: Phase 1

Kristina LaCommare, Peter Larsen, and Joe Eto - LBNL George Jiang and Chris Ramee - Resource Innovations, Inc.

June 24, 2025



ICE 2.0 research team









Peter Larsen, Principal Investigator

Joe Eto

Kristina LaCommare

Mike Spears

Sarah Poon

Chris Ramee George Jiang Ridge Peterson Kyle Carney Michael Sullivan

Michael Hanemann

□ Motivation for updating the ICE Calculator □ ICE Calculator is being updated in 3 phases □ Surveying approach and results □ Modeling approach and results ICE Calculator website and API □ Comparison ICE 2.0 to 1.0





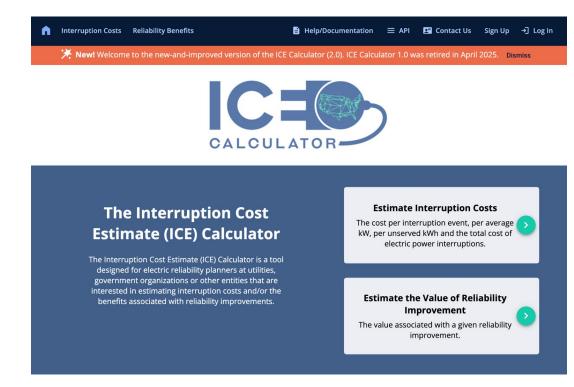
ENERGY MARKETS & POLICY

Motivation for updating the ICE Calculator



ICE Calculator estimates customer costs of shorter duration interruptions

- 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
- Development of the ICE Calculator was sponsored by the U.S. Department of Energy (DOE)
- □ 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





Motivation for updating the ICE Calculator

- The original ICE Calculator, ICE 1.0, is based on utility-sponsored customer surveys
- Reliance on ICE 1.0 has been challenged because the surveys are:
 - Dated—many of the surveys are 25+ years old
 - Not statistically representative of all regions of the U.S.
 - Limited survey data available for estimating the cost of interruptions over 12 hours

Summary of ICE 1.0 Surveys

		Num	ber of Observat	Min.	Max.		
Utility Company	Survey Year	Medium and Large C&I	I Small CVI I		Duration (Hours)	Duration (hours)	
Southeast-1	1997	9	0		0	1	
Southeast-2	1993	3,926	1,559	3,107	0	4	
Southeast-2	1997	3,055	2,787	3,608	0	12	
Southeast-3	1990	2,095	765		0.5	4	
Southeast-3	2011	7,941	7,941 2,480 3,969		1	8	
Midwest-1	2002	3,1	71		0	8	
Midwest-2	1996	1,956	206		0	4	
West-1	2000	2,379	3,236	3,137	1	8	
	1989	2,025	5		0	4	
10/a at 0	1993	1,790	825	2,005	0	4	
West-2	2005	3,052	3,223	4,257	0	8	
	2012	5,342	5,342 4,632 4		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	7,0)91	4,299	0	12	



Berkeley Lab/Resource Innovations and sponsoring utilities have:

- □ Created a Project Executive Committee (PEC) made up of the sponsoring utilities
- Created a Project Advisory Committee (PAC) made up of well-known external stakeholders
- □ PEC and PAC provided key feedback and/or approvals throughout the Initiative
- Developed a consistent set of short duration (up to 24 hours) customer interruption cost surveys
- □ Coordinated consistent administration of surveys
- Developed new short duration customer damage function (CDF) equations with new survey information
- □ Updated the ICE Calculator website including new enhancements





ENERGY MARKETS & POLICY

ICE Calculator is being updated in 3 Phases

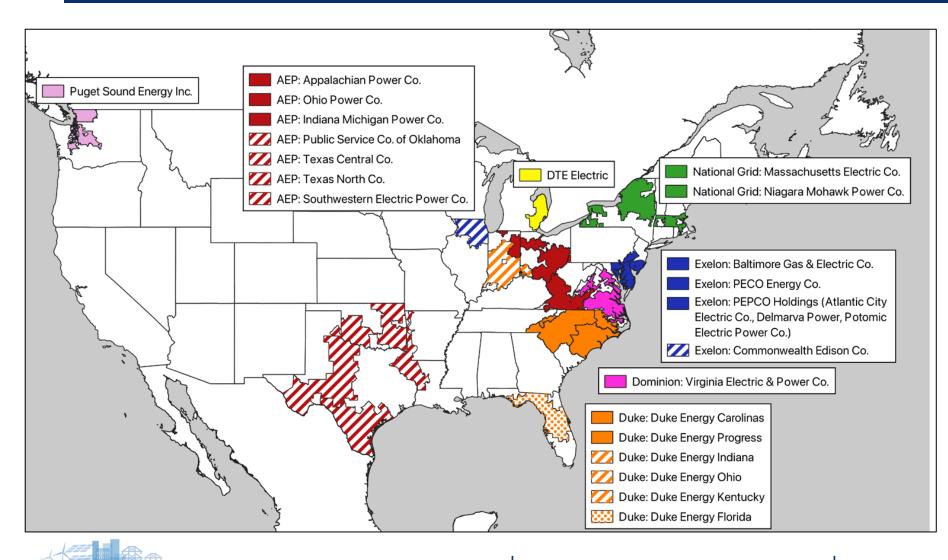


Update of ICE Calculator happening in phases

□ Phase 1 (complete)

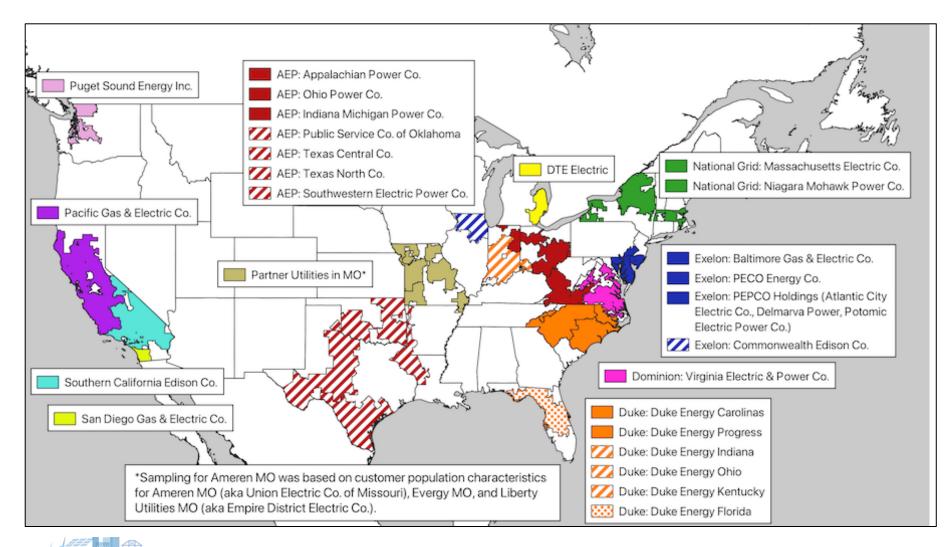
- Based on 11 surveys conducted in Eastern and Midwestern U.S., with one utility in the Pacific Northwest
- □ ICE Calculator 2.0 released April 28, 2025
- □ Newly developed customer damage functions
- □ Upgraded web interface with an API capability
- □ Phase 2 (in process)
 - □ Surveying just completed (California investor-owned utilities and Missouri utilities)
 - □ ICE Calculator update expected late 2025/early 2026
- □ Phase 3 (in process)
 - □ Surveying in process with select utility cooperatives in the U.S.
 - □ Surveying later this year with another Western utility
 - □ Recruitment still ongoing

Participating utilities: Phase 1 (Current ICE 2.0)



- → 8 sponsors
- → 11 distinct survey activities
- → 24 investor-owned utility distribution service territories represented

Participating utilities: Phase 1 and 2



- 12 sponsors \rightarrow
- \rightarrow 15 distinct survey activities
- \rightarrow 30 investor-owned utility distribution service territories represented

Phase 3

- \rightarrow We received support from DOE to partner with NRECA to survey select rural cooperatives across the U.S.
- One utility in the West \rightarrow



ENERGY MARKETS & POLICY

Surveying approach and results



Valuation approach

Residential Customers	Non-residential Customers
Willingness-to-pay for hypothetical backup service*	Direct cost = value of lost production + interruption related costs – interruption related savings
Residential costs are often related to inconvenience. However, potential tangible costs include: Relocation costs Buying supplies Going out to eat Inability to work	 Interruption-related costs: Labor costs to make up any lost production (which can be made up) Labor costs to restart the production process Material costs to restart the production process Costs resulting from damage to input feed stocks Costs of re-processing materials (if any) Cost to operate backup generation equipment
	 Interruption-related savings: Savings from unpaid wages during the interruption (if any) Savings from the cost of raw materials not used because of the interruption Savings from the cost of fuel not used Scrap value of any damaged materials

*One-and-one-half-bound dichotomous choice contingent valuation (Cooper, Hanemann, and Signorello 2002)



Survey overview

- Three different customer surveys: residential, small/medium non-residential (SMNR), and large non-residential (LNR)
- □ Four interruption durations: momentary (up to 5 min), 2 hours, 8 hours, and 24 hours
- □ Four interruption scenarios: season, day of week, time of day, and advanced warning
- □ One longer duration (3 days) scenario question (not used to updated the ICE Calculator)
- □ Target responses per survey: 250 residential, 250 SMNR, and 67 LNR
- □ Stratified sample of customers in each class based on usage

Example set of interruption scenarios for a respondent

Scenario	Season	Time of Week	Onset Time	Advance Warning	Duration	Pivot
A	Summer	Weekday	2:00 PM	No	5 minutes or less	Weekend
В	Summer	Weekday	2:00 PM	No	2 hours	Weekend
С	Summer	Weekday	2:00 PM	No	24 hours	Weekend



Phase 1 survey response

Segment	Customer Population	Customers Sampled	Response Target	Total Responses	Overall Response Rate	Validated Responses*	Validated Response Rate
Residential	22,276,695	35,743	2,750	3,316	9.3%	3,026	8.5%
Non- residential	2,141,558	90,464	3,487	4,579	5.1%	3,874	4.3%

*Initial responses were screened for invalid, illogical, or outlier responses



Validated survey responses

Utility	Validated Residential Responses	Validated Non-residential Responses
AEP East	314	342
AEP West	263	301
ComEd	259	369
Duke Energy Carolinas	270	404
Duke Energy Florida	267	367
Duke Energy Midwest	280	384
DTE Electric	271	351
Dominion Energy	281	288
Exelon	270	294
National Grid	275	350
PSE	276	424
Total	3,026	3,874



Survey status for California IOUs (Phase 2)

Utility	Survey Status	Responses completed
PG&E	Surveying - complete Utility specific report finalized in April 2025	Residential: 324 (130%) SMNR: 311 (124%) LNR: 85 (127%)
SCE	Surveying - complete Utility specific report finalized in April 2025	Residential: 320 (128%) SMNR: 299 (120%) LNR: 40 (60%)
SDG&E	Surveying - completed in June Utility specific report expected in Sept 2025	Residential: 305 (122%) SMNR: 304 (122%) LNR: 77 (115%)





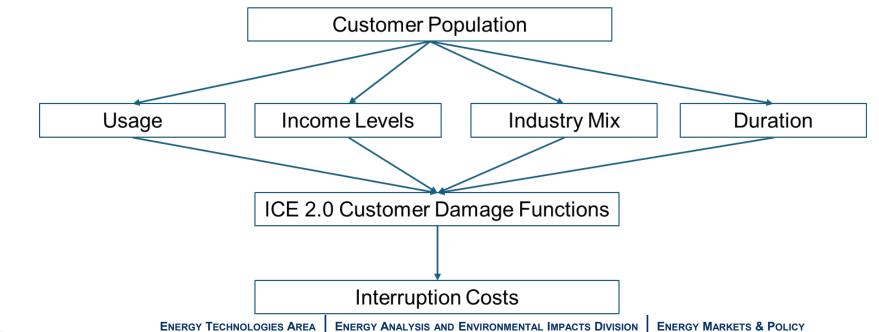
ENERGY MARKETS & POLICY

Modeling approach and results



Goal: Develop "customer damage functions" (CDFs)

- □ RI processed the survey responses and developed customer damage functions
- □ These equations correlate interruption costs to a range of explanatory variables
 - o Duration, electricity consumption, income, industry types, and more
- The customer damage functions allow users to estimate interruption costs for specific customer populations
 - For example, costs could be estimated at the circuit level if the characteristics of the customers served on that specific circuit are known





Residential model selection: Potential and selected explanatory variables

Potentia	l Model Variables	Final Model Variables
 Cont Interruption duration (in minu Annual electricity usage (in k GDP per kWh (collected at the 	Ŵĥ)	 Continuous Variables Interruption duration (in minutes) Annual electricity usage (in kWh)
Cate Interruption Onset Time Morning Midday Evening Season Summer Winter Day of Week Weekday Weekend Advance Warning Yes No Previous Interruption in Last 12 Months Yes No	gorical VariablesPersons in Household1-2 people3+ peopleOwnership of Backup GenerationYesNoWork from HomeYesNoWork from HomeYesNoAge of RespondentUnder 40 years40-70 years70+ yearsTotal Household IncomeUnder \$50,000 per year\$100,000-\$150,000 per year\$100,000-\$150,000 per yearOver \$150,000 per yearOver \$150,000 per yearApartment/CondominiumAttached Single-FamilyDetached Single-FamilyMobile HomeUnknown/Other	Model Yes No Model Selection Yes No Under \$50,000 per year \$50,000-\$100,000 per year \$100,000-\$150,000 per year Over \$150,000 per year Over \$150,000 per year Over \$150,000 per year

Non-Residential model selection: Potential and selected explanatory variables

P	otential Model	Final Model
 Interruption duration (in minutes Annual electricity usage (in kWh GDP per kWh (collected at the s Cat Interruption Onset Time Morning Midday Evening Season Summer 	Initiation Variables Initiate level) Initiate level) Initiate level) Initiate level) Initiate level Initiate level) Initiate level Initiate level Initiate level Initiate level	Final Model Continuous Variables • Interruption duration (in minutes) • Annual electricity usage (in kWh) • Annual electricity usage (in kWh) • Categorical Variables Model Advance Warning • Yes • No
 Winter Day of Week Weekend Advance Warning Yes No Previous Interruption in Last 12 Months Yes No 	 Management and Remediation Service Agriculture, Forestry, Fishing and Hunting Arts, Entertainment, and Recreation Construction Educational Services Finance and Insurance Health Care and Social Assistance Information (e.g., Data Centers) Management of Companies and Enterprises Manufacturing Mining, Quarrying, and Oil and Gas Extraction Other Services Professional, Scientific, and Technical Services Public Administration Real Estate and Rental and Leasing Retail Trade Transportation and Warehousing Utilities Wholesale Trade 	 Day of Week (Probit Only) Weekday Weekend Industry (GLM Model Only) Health Care and Social Assistance Manufacturing For modeling purposes, the SMNR and LNR responses were combined into one non-res segment The single non-res model can estimate costs for customer segmentations, regardless of size Users can input usage values into the tool that align with their jurisdictions definition of "small", "medium", or "large" customers

Predicted interruption costs by duration (default values; 90% confidence)



Non-Residential





ENERGY MARKETS & POLICY

ICE Calculator website and API



ICE 2.0 website: https://icecalculator.com/

nterruption Costs Reliability Benefits

🖹 Help/Documentation 🛛 API 🔛 Contact Us Sign Up 🕂 Log In

🔰 🧩 New! Welcome to the new-and-improved version of the ICE Calculator (2.0). ICE Calculator 1.0 was retired in April 2025. 🛛 Dismiss



The Interruption Cost Estimate (ICE) Calculator

The Interruption Cost Estimate (ICE) Calculator is a tool designed for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability improvements.

Estimate Interruption Costs

The cost per interruption event, per average kW, per unserved kWh and the total cost of electric power interruptions.

Estimate the Value of Reliability Improvement The value associated with a given reliability improvement.

About the ICE Calculator 2.0

A reliability planning tool designed for electric utilities, government organizations, and other entities interested in estimating interruption costs and/or the benefits associated with reliability improvements in the United States. The tool was developed by ...

ICE Calculator API

Access the ICE Calculator's functionality programmatically through our REST API. Generate interruption cost estimates and reliability improvement valuations directly from your applications. Get started by creating an API key and exploring our comprehensive API documentation.

Get Started >

Documentation

The ICE Calculator documentation provides comprehensive guides and resources to help you understand and utilize the calculator effectively. Browse through our organized sections to find the information you need.

See All

See All >

.



Learn about the Department of Energy's Vulnerability Disclosure Program Privacy & Security Notice



Documentation page

nterruption Costs Reliability Benefits

ICE Calculator Documentation

Welcome to the ICE Calculator documentation. Here you'll find user guides, technical documentation, and additional resources organized by topic. Click on each section below to explore the available documents.

About the ICE Calculator	~
Technical Support	~
Video Tutorials	~
Interruption Cost Estimate Calculator 2.0 (Current)	~
Participating Utilities	~
Use Cases and Applications of ICE	~
Interruption Cost Estimate Calculator 1.0 (Pre 2025)	~
Value of Lost Load Survey Methods	~



Request spreadsheet model (non-commercial use only)

- Users can request spreadsheet-based version of ICE 2.0
- We are sharing these on a case-by-case basis
- Spreadsheets will be made available if not shared outside of organization and not used for commercial purposes
- ICE 1.0 spreadsheet is freely-available on new website

nterruption Costs Reliability Benefits	B Help/Documentation
ICE Calcu	lator Documentation
Velcome to the ICE Calculator documentation. Here you'll find user guides, technical document	tation, and additional resources organized by topic. Click on each section below to explore the available documents
About the ICE Calculator	
Technical Support	
Video Tutorials	
Interruption Cost Estimate Calculator 2.0 (Current)	
Final Report for Phase 1 of National Initiative to Update the Interruption Cos	st (ICE) Calculator
This is the report detailing methods, data sources, and results for the first phase of the na	ational initiative to update the ICE Calculator.
View Document	
Degweet Opreedebeet Medel	
Request Spreadsheet Model	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright o	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright or only and may require a license for use in commercial applications. Click below to submit y	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright o	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright or only and may require a license for use in commercial applications. Click below to submit y	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y Request Model Spreadsheets Comparison of ICE Calculator Versions	
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y Request Model Spreadsheets Comparison of ICE Calculator Versions	your information and request access to the spreadsheets.
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y C. Request Model Spreadsheets Comparison of ICE Calculator Versions This memorandum compares customer power interruption costs estimated using the rece	your information and request access to the spreadsheets.
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y Request Model Spreadsheets Comparison of ICE Calculator Versions This memorandum compares customer power interruption costs estimated using the recer <u>View Document</u>	your information and request access to the spreadsheets.
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y C Request Model Spreadsheets Comparison of ICE Calculator Versions This memorandum compares customer power interruption costs estimated using the rece <u>View Document</u> Survey Instruments for ICE Calculator 2.0 Initiative These survey instruments are being administered to utility customers across the country of Additional Resources	your information and request access to the spreadsheets.
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y C Request Model Spreadsheets Comparison of ICE Calculator Versions This memorandum compares customer power interruption costs estimated using the rece <u>View Document</u> Survey Instruments for ICE Calculator 2.0 Initiative These survey instruments are being administered to utility customers across the country in Additional Resources <u>Survey for Residential Customers</u>	ently updated Interruption Cost Estimate (ICE) Calculator ("ICE 2.0") to the original ICE Calculator ("ICE 1.0").
Berkeley Lab is seeking approval from the U.S. Department of Energy to assert copyright of only and may require a license for use in commercial applications. Click below to submit y Request Model Spreadsheets Comparison of ICE Calculator Versions This memorandum compares customer power interruption costs estimated using the rece <u>View Document</u> Survey Instruments for ICE Calculator 2.0 Initiative These survey instruments are being administered to utility customers across the country a Additional Resources	your information and request access to the spreadsheets.

Estimate interruption costs

	nterruption Costs Reliability Benefits							p/Documentation 🛛 🚍	E API 🗳 Contact Us Sign Up → Log In		
	Estimate Interruption Costs										
_	<u>∧</u> New Model × ⊕										
	Actions	1		-	Cost Per Customer (2023 \$) Per					Costs are	
	• * = + 11	Sector	# of Customers	Customers Event	Average kW	Unserved kWh	Minute Interrupted	Annual Cost	Total Cost (2023 \$)	expressed relative	
	Model Information	Residential	10,000	9.46	7.77	4.66	0.09	9.46	94,556.91	to daily/annual	
	Model Settings	Non-Residential	500	3,420.83	244.24	146.55	34.21	3,420.83	1,710,417.25	household income	
Customize	Keturn to full Model Settings	All Customers	10,500	171.90	19.03	11.42	1.72	171.90	1,804,974.16	and gross	
model →	🕤 States 🗸 🗸		Residential						domestic product		
inputs	🚓 Number of Customers	C	Cost/Event Relative To (%			Total Cost of Power Interruptions by Se			Sector	(GDP)	
	Reliability Settings	Daily Household	Income Annual H	lousehold Incom	ne	Resi	dential (5.2%)	lon-Residential (94.8%)	• Normalized	
	Additional Settings	3.22%		0.01%						 Normalized values may 	
	Restore Defaults		Non-Residential								
	🙃 Residential 🗸 🗸		ost/Event Relative To	(%):	_				change prioritization of		
	in Non-Residential	Daily GDP	A	nnual GDP					where reliability		
	🗐 Seasons/Days 🗸	109.57%		0.30%						investments are	
	Economic Characteristics (\$) ~									actually needed	

Estimate reliability benefits of proposed investment

0					Estima	ate Reliat	oility Benef	its						
∧New Model × ↔														
Actions ■ <u>+</u> =< ⊕ Ⅲ		Distribution of Benefits												
Model Information	~	Sector Number of		mers I	ers <u>NPV</u> of Total Benefits (\$)		Benefit Per Customer (\$)		Residential (5.2%) Non-Residential (94.8%)					
Model Settings Return to full Model Settings 		Residential	ial 60,000		3,915,807.66	66 65.26								
		Non-Residential	ential 3,000		71,839,789.35	2	23,946.60			A				
🕤 States	~	All Customers	Customers 63,000		75,755,597.01		1,202.47							
2: Number of Customers	~													
fin Investment	~							_						
E Reliability Settings	~	Forecast of Total Sustained Interruption Costs (Nominal \$)												
Additional Settings				2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	
Residential	~	Without Improver	nent 30,	368,485.76	30,975,855.48	31,595,372.59	32,227,280.04	32,871,825.64	33,529,262.15	34,199,847.39	34,883,844.3	4 35,581,521.23	3 36,293,151.65	
Non-Residential	~	With Improvem	ent 21,	416,015.44	21,844,335.75	22,281,222.46	22,726,846.91	23,181,383.85	23,645,011.53	24,117,911.76	24,600,269.9	9 25,092,275.3	9 25,594,120.90	
Seasons/Days	~	Value of Reliability Imp	rovement 8,9	952,470.32	9,131,519.73	9,314,150.12	9,500,433.13	9,690,441.79	9,884,250.62	10,081,935.64	10,283,574.3	5 10,489,245.84	4 10,699,030.75	
Economic Characteristics (~	Without Improvement With Improvement												
		38M 38M 36M 36M 36M 36M 32M 32M												



Application programming interface (API)

Interruption Costs Reliability Benefits \blacksquare Help/Documentation \equiv API E Contact Us Sign Up → Log In **ICE Calculator API API Documentation** Introduction What is an API? Getting Started An API (Application Programming Interface) is a way for different applications to communicate with each other. Think of it like a waiter in a restaurant: API Explorer You (the application) place an order (make a request) The waiter (API) takes your order to the kitchen (server) Interruption Cost • The kitchen prepares your meal (processes the request) • The waiter brings back your food (returns the data) Inputs/Outputs Examples Benefits of Using Our API **Reliability Benefits** (5 Inputs/Outputs Automation Efficiency Integration Examples Save time by accessing data Automate tasks and Easily connect our services with your existing systems integrate services directly and services Lookup Table into your workflow programmatically Inputs/Outputs C Examples

Real-time Access Get immediate access to the

latest data and functionality

Override Model Defaults

n



ENERGY MARKETS & POLICY

Comparison of ICE 2.0 to 1.0



Summary of differences between ICE 1.0 and 2.0

	ICE 1.0	ICE 2.0
Surveys Conducted (Years)	• 1989-2012	• 2022-2024
Survey Approach	 Administered independently Information on sample designs and recruitment procedures not available Different surveys with different questions 	 LBNL/Resource Innovations (RI) administered in a fully coordinated manner Consistent sample designs and recruitment procedures Identical set of survey questions One-and-one-half-bound dichotomous choice contingent valuation (residential)
Geographic Coverage	 15 distinct surveying efforts conducted across 10 utility service territories Mostly conducted in western and southeastern U.S. 	 11 distinct survey activities conducted across 24 utility service territories Eastern and midwestern U.S. as well as the pacific northwest (future phases will include more regional representation)
Interruption Durations Considered	• Varied and generally limited to 12 hrs or less	 Momentary (lasting up to 5 min), 2 hrs, 8 hrs, and 24 hrs
Customer Damage Functions	 Residential Small non-residential Medium/large non-residential 	 Residential Non-residential



ENERGY MARKETS & POLICY



Contact Information

Peter Larsen

Leader, Energy Markets and Policy Lawrence Berkeley National Lab phlarsen@lbl.gov



ICE 2.0: Technical Support (link)

ICE 2.0: National Report Documenting Phase 1 (link)

Comparison of ICE 2.0 to 1.0 (link)



Q&A for LBNL

1:35 pm – 2:00 pm

Break

2:00 pm – 2:10 pm

Using the ICE 2.0 Calculator in the 2027 Test Year General Rate Case

Presenter: Pacific Gas and Electric (PG&E) 2:10 pm – 2:40 pm

USING THE ICE 2.0 CALCULATOR IN PG&E'S 2027 TEST YEAR GENERAL RATE CASE (GRC)

CPUC Technical Working Group SB 884 Project List Data Requirements Guideline

June 24, 2025

Presentation Topics

- 1. How did PG&E disaggregate its monetized value of electric reliability for the Test Year 2027 GRC?
 - a. How did that change the inputs to the ICE 1.0 Calculator that PG&E presented in the initial 2027 GRC submission?
 - i. What new inputs did PG&E include in order to use the ICE 2.0 Calculator?
 - ii. What old inputs did PG&E remove in order to use the ICE 2.0 Calculator?
 - b. What were the results of the disaggregation (\$/CMI for each region)?
 - c. Which risks has this impacted in the 2027 GRC submission?
 - i. How has this impacted the wildfire ignition risk?
 - ii. How has this impacted the outage program risk?
 - d. Has this changed PG&E's wildfire system hardening strategy in the 2027 GRC? Explain.
- **PG&E Topic:** ICE data fields in SPD TWG tables

Q1 – Disaggregated value of electric reliability

- 1. How did PG&E disaggregate its monetized value of electric reliability for the Test Year 2027 GRC?
- In PG&E's 2024 Risk Assessment & Mitigation Phase (RAMP 2024), PG&E used Lawrence Berkeley National Laboratory's (LBNL) Interruption Cost Estimator (ICE) v1.0 calculated system-wide average value of \$3.17/Customer Minutes Interrupted (CMI).
- On 4/22, Administrative Law Judge (ALJ) Ruled that by 6/20, PG&E shall:
 - Provide parallel reliability cost calculations using the disaggregated approach recommended in the [Safety Policy Division] SPD Evaluation Report. PG&E may opt to replace its systemwide average approach with this suggested method or present both approaches in the GRC [General Rate Case].
- For the purposes of this approach, disaggregation entailed deriving two discrete \$/CMI for Residential and Non-Residential customers. The service-point level count of each customer class was added up to the tranche-level to derive a tranche-level percentage of each customer class, which then multiplied by these discrete values of \$/Residential-CMI and \$/Non-Residential-CMI to get to the tranche-level \$/CMI for modeling.

Q1 - Methodology Illustration A: Tranche Level Percentage of Residential Customers and \$/CMI Calculations

- This is an illustrative example to show how tranche level percentage of residential customers and \$/CMI are calculated based on circuit segment level data.
- Assumptions:
 - There are six circuit segments in the tranche
 - \$/CMI is 0.08 and 23.11 for residential customers and non-residential customers, respectively.

			D = B/C	$E = 0.08 \circ D + 23.11 \circ (1 - D)$
Α	В	С	D	E
Circuit Segment	Residential	Total	% Residential	
Name	Customers	Customers	Customers	\$/CMI
CS_1	5	24	20.8%	18.31
CS_2	4	5	80.0%	4.69
CS_3	369	430	85.8%	3.35
CS_4	33	34	97.1%	0.76
CS_5	70	70	100.0%	0.08
CS_6	0	1	0.0%	23.11
Aggregated	481	564	85.3%	3.47

 $E = 0.00 + D \pm 22.11 + (1 - D)$

D = P/C

Q1a – Changes to ICE 1.0 calculator inputs (1)

- a. How did that change the inputs to the ICE 1.0 Calculator that PG&E presented in the initial 2027 GRC submission?
 - i. What new inputs did PG&E include in order to use the ICE 2.0 Calculator?
 - ii. What old inputs did PG&E remove in order to use the ICE 2.0 Calculator?

PG&E does not "include" or "remove" inputs from the ICE 2.0 Calculator. LBNL's ICE 2.0 calculator has different set of inputs that are used in the model compared to ICE 1.0.

Input Type	Input Variable	ICE 1.0 GRC	Input Type	Input Variable	ICE 2.0	Source
Number of Accounts by Rate Class	Residential	4,991,827	Number of Customers by Class	Residential	4,973,630	PG&E internal data
	Small C&I	468,585		Non-Residential	641,920	PG&E internal data
	Medium and Large C&I	163,316				
Annual Usage per Customer (MWh)	Residential	5.2	Residential Usage (kWh)	Annual kWh per customer	5,156	PG&E internal data
	Small C&I	15.2	Non-Residential Usage (kWh)	Annual kWh per customer	74,612	PG&E internal data
	Medium and Large C&I	244.93				
Median HH Income	2016 USD	56,862	Residential Mean HH Income	2023 USD	134,491	ICE Calculator provided value
Number of Residents Per Household	0-6 Years Old	0.3	Percentage of Residential	Under \$50,000	26.60%	ICE Calculator provided value
of Age	7-18 Years Old	0.52	Customers by Annual Income	Above \$50,000 and Under \$1	25.40%	ICE Calculator provided value
	19-24 Years Old	0.24		Above \$100,000 and Under \$	17.80%	ICE Calculator provided value
	25-49 Years Old	1.09		Above \$150,000	30.30%	ICE Calculator provided value
	50-64 Years Old	0.41				
	65+ Years Old	0.3				
Type of Housing	Detached	58.30%	Residential BUGs	Percentage of Customers wi	17.70%	ICE 2.0 Survey of PG&E Customers
	Attached	7.00%	Residential Work from Home	Percentage of Customers w	36.94%	ICE 2.0 Survey of PG&E Customers
	Apartment / Condo	30.70%				
	Mobile homes	3.90%				
	Manufactured Housing	0.00%				
	Other or Unknown	0.10%				

Purple: Used to convert ICE Calculator outputs to weighted average \$/CMI Yellow: Used in ICE Calculator Model

Q1a – Changes to ICE 1.0 calculator inputs (2)

Input Type	Input Variable	ICE 1.0 GRC	Input Type	Input Variable	ICE 2.0	Source	
Industry Percentages - Small C&I	Agriculture, Forestry and Fishing	0.20%					
	Mining	0.10%		Purple: Used to convert ICE (outputs to weighted average	ge \$/CMI
	Construction	9.50%		Yellow: Used in ICE Calculat	or Model	<u> </u>	
	Manufacturing	6.70%					
	Transportation, Communication & Utilities	4.70%					
	Wholesale & Retail Trade	18.80%					
	Finance, Insurance & Real Estate	10.80%					
	Services	50.80%					
	Public Administration	0.00%					
	Unknown Industry	0.20%					
	Backup generation or Power Conditioning	26.20%					
	Backup generation and Power Conditioning	3.40%					
Industry Percentages - Medium and	Agriculture, Forestry and Fishing	0.10%					
Large C&I	Mining	0.30%					
	Construction	2.00%					
	Manufacturing	12.40%	Industry Percentages	Manufacturing	12.40%	PG&E internal data	
	Transportation, Communication & Utilities	8.20%		Health Care and Social Assistance	5.40%	PG&E internal data	
	Wholesale & Retail Trade	20.00%					
	Finance, Insurance & Real Estate	7.60%					
	Services	44.60%					
	Public Administration	0.00%					
	Unknown Industry	0.20%					
Regional Characteristics - Medium	2016 GDP (\$ Millions)	2,622,731	GDP Per Non-Res Account	2023 USD	1,985,036	ICE Calculator provided value	
and Large C&I	2016 Non-residential Usage (MWh)	168,535,566					
Power Interruption Timing	Morning	34.40%					
	Afternoon	26.70%					
	Evening	20.90%					
	Night	18.00%					
	Summer	29.00%	Event Details	Summer	28.60%	PG&E internal data	
	Weekday	71.40%		Weekend	28.57%	ICE Calculator provided value	
	Advanced Warning	0.00%	Non-Residential Advanced Warning	Percentage of Customers with Warning	0.00%	ICE Calculator provided value	1
Reliability Inputs	SAIFI	1	Reliability Inputs	SAIFI	1	PG&E internal data	1
- •	SAIDI	132		SAIDI	132	PG&E internal data	1
	CAIDI	132		CAIDI	132	PG&E internal data	1
CPI for All Urban Consumers (CPI-U)	CPI Multiplier (2016 to 2023 \$)	1.306999379	CPI for All Urban Consumers (CPI-U)	CPI Multiplier (2023 to 2024 \$)	1.02949	PG&E internal data	1

Q1b – Results of disaggregation

b. What were the results of the disaggregation (\$/CMI for each region)?

Table 1: \$/CMI by residential and non-residential customers

	\$/Residential CMI	\$/Non-Residential CMI	\$/CMI
ICE 1.0	0.05	29.17	3.33
ICE 2.0	0.08	23.11	2.72

Table 2: \$/CMI by HFRA/HFTD and non-HFRA/HFTD for all customers

HFTD/HFRA Assignment	Non-Res Customers	Res Customers	Total Customers	Res Customers Percent	\$/CMI (ICE 1.0)	\$/CMI (ICE 2.0)
Non-HFTD/HFRA	595,484	4,506,326	5,101,810	88%	3.45	2.77
HFTD/HFRA	46,436	467,304	513,740	91%	2.68	2.16
All	641,920	4,973,630	5,615,550	89%	3.38*	2.71

*Aggregated 3.38 \$/CMI is slightly different than \$3.33/CMI used as ICE1.0 aggregated used for the GRC because the former is estimated using the latest SPIDs data for total customer count whereas the latter was developed using total customer count from Rates at the time.

Table 3: Weighted \$/CMI by HFRA Tier & Division for Distribution 'Overhead' Customers

	ICE 2.0 Weighted Value of Service									
				HFTD						
	HFTD	HFTD	HFTD	Overall		Non-				
	Zone 1 -	Tier 2 -	Tier 3 -	No Zone	HFTD	HFTD				
Division	HHZ	Elevated	Extreme	1	Overall	Overall	Overall			
MISSION		\$1.93	\$5.00	\$2.63	\$2.63	\$1.49	\$1.53			
DIABLO		\$1.35	\$1.66	\$1.42	\$1.42	\$1.83	\$1.79			
YOSEMITE		\$2.07	\$1.51	\$1.88	\$1.88	\$5.98	\$4.69			
EAST BAY		\$1.06	\$0.96	\$1.03	\$1.03	\$1.56	\$1.52			
SACRAMENTO		\$2.51	\$3.23	\$2.57	\$2.57	\$5.05	\$4.96			
HUMBOLDT	\$11.60	\$2.44	\$2.16	\$2.41	\$2.41	\$3.12	\$2.88			
SIERRA	\$1.89	\$1.59	\$1.25	\$1.47	\$1.47	\$3.00	\$1.97			
DE ANZA		\$1.67	\$2.05	\$1.84	\$1.84	\$1.33	\$1.37			
SONOMA		\$2.53	\$1.70	\$2.04	\$2.04	\$2.59	\$2.45			
CENTRAL COAST		\$3.11	\$1.61	\$2.26	\$2.26	\$2.89	\$2.78			
LOS PADRES		\$3.90	\$4.36	\$3.95	\$3.95	\$3.23	\$3.35			
PENINSULA		\$1.83	\$2.58	\$1.93	\$1.93	\$1.74	\$1.75			
STOCKTON	\$1.52	\$2.74	\$1.27	\$2.11	\$2.11	\$3.96	\$3.58			
NORTH BAY		\$5.30	\$4.68	\$4.94	\$4.94	\$2.92	\$3.06			
FRESNO		\$2.21	\$3.54	\$2.24	\$2.24	\$4.88	\$4.77			
NORTH VALLEY		\$1.97	\$1.56	\$1.85	\$1.85	\$4.23	\$3.50			
KERN		\$8.95		\$8.95	\$8.95	\$4.07	\$4.09			
SAN FRANCISCO		\$23.11		\$23.11	\$23.11	\$1.42	\$1.42			
SAN JOSE		\$3.10	\$3.27	\$3.12	\$3.12	\$1.79	\$1.82			
Overall	\$2.11	\$2.24	\$1.69	\$2.05	\$2.05	\$2.80	\$2.69			

Large disparities in \$/CMI values between Residential and non-residential customers can lead to vastly different results depending on the granularity of the analysis and thus can result in unintended consequences.

Q1c – Impacted risks in 2027 GRC

- c. Which risks has this impacted in the 2027 GRC submission?
 - i. How has this impacted the wildfire ignition risk?
 - ii. How has this impacted the outage program risk?
- All electric reliability risks in 2027 GRC submission have been impacted.
- Note these results are based on the risk models and associated data at the time of the GRC filing.
- The results were produced in a relatively short timeframe to comply with the requirements of the ruling.
- PG&E expects the risk models and approaches taken will continue to evolve.

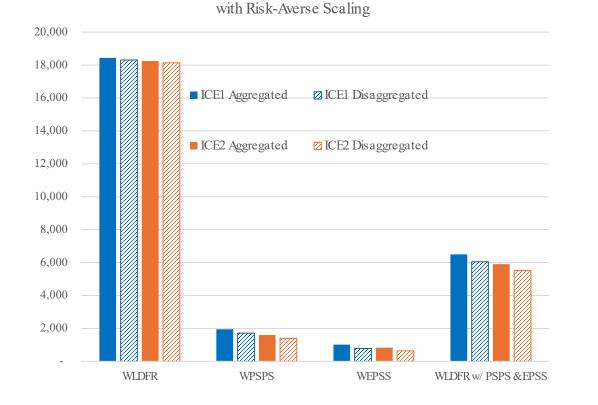
2027 TY Baseline	Risk-Averse Scaling						Risk-Neutral Scaling					
Risk Score	ICE1			ICE2			ICE1			ICE2		
Risk ID	Aggregated	Disaggregated	% Change	Aggregated	Disaggregated	% Change	Aggregated	Disaggregated	% Change	Aggregated	Disaggregated	% Change
Wildfire pre-PSPS/EPSS	18,436	18,309	-1%	18,246	18,132	-1%	3,894	3,822	-2%	3,768	3,701	-2%
PSPS	1,944	1,715	-12%	1,600	1,393	-13%	1,355	1,196	-12%	1,116	972	-13%
EPSS	1,013	781	-23%	831	634	-24%	1,013	781	-23%	831	634	-24%
Wildfire with PSPS and EPSS	6,496	6,051	-7%	5,907	5,511	-7%	3,242	2,865	-12%	2,772	2,438	-12%

Note: PG&E stands by using risk-averse scaling and a system-wide aggregated electric reliability values for the TY 2027 GRC CBR values.

Q1c – Impacted risks in 2027 GRC

- c. Which risks has this impacted in the 2027 GRC submission?
 - i. How has this impacted the wildfire ignition risk?
 - ii. How has this impacted the outage program risk?

2027 TYBaseline Risk Scores (\$M)



4,500 4,000 4,000 a ICEI Aggregated ICEI Disaggregated 3,500 a ICE2 Aggregated ICE2 Disaggregated 2,500 1,500 500

WPSPS

2027 TYBaseline Risk Scores (\$M) with Risk-Neutral Scaling

WLDFR

WLDFR w/ PSPS & EPSS

WEPSS

Q1d – Impact to SH strategy in 2027 GRC

d. Has this changed PG&E's wildfire system hardening strategy in the 2027 GRC? Explain.

- The overarching System Hardening strategy in the GRC will not change given the GRC has already been filed.
- PG&E's selection of System Hardening projects in the GRC was based on WDRM v4 wildfire risk rank; therefore, the reevaluation of reliability using ICE 2.0 will not impact the selection of these projects.

The SPD agenda indicated that at the June 24 TWG workshop attendees will discuss whether the SPD should consider adjusting Tables in the SB 884 Project List Data Requirements Guideline to reflect changes in ICE 2.0

• PG&E recommends that utilities be given the choice to report the reliability risk information that corresponds to the version of the ICE calculator they are using in their risk analysis.

For utilities using the ICE 2.0 calculator

- PG&E recommends reporting information in Table 6 only at the system level and not at the operational division or HFTD tier level.
 - Running the ICE 2.0 calculator at the operational division or tier level introduces bias into the modeling results because higher cost per minute (CMI) outage values would be assigned to residential customers in certain divisions or tiers based on income level.
 - Running the ICE 2.0 calculator at the system level, without distinguishing by operational division or HFTD tier, does not exacerbate inequity.

Q&A for PG&E

2:40 pm – 3:00 pm

Break

3:00 pm – 3:10 pm

General Discussion: ICE 2.0 Calculator

3:10 pm – 4:00 pm

Thank you!

Amin Emrani Amin.emrani@cpuc.ca.gov