

IEc

EPIC Benefits Methodology and Quantification Workshop:

Reliability & Public Safety Benefits Calculators

Prepared for:

California Energy Commission (CEC)
Electric Program Investment Charge
(EPIC) Program

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November 19, 2020

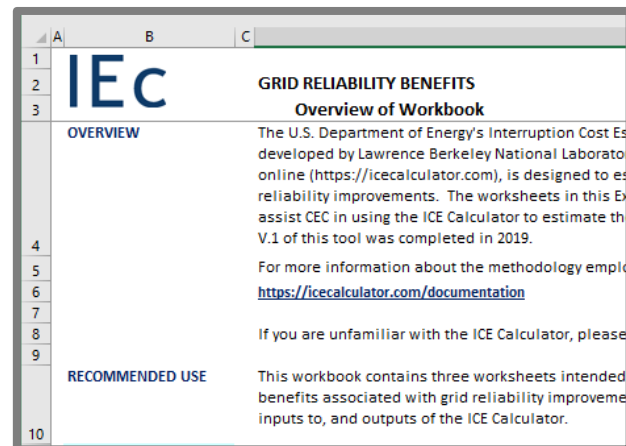
Improved Grid Reliability and Resiliency

- EPIC's investments in reliability and resiliency share a common goal: reducing the frequency or duration of interruptions in service to utility customers
- Distinction: scale and duration of outages addressed
 - Reliability - preventing disruptions that are local, brief
 - Resiliency - preventing or recovering from high-impact events with widespread, long-term consequences
- Investments in resiliency frequently focus on protecting health and safety by sustaining the capabilities of critical service providers
- Methods we have developed for EPIC differ accordingly
 - Reliability - employ existing U.S. DOE tool
 - Public safety benefits - adapt FEMA methods to value benefits of supplying power to critical service providers

Grid Reliability Benefits Calculator


- Excel-based tool created by IEc for CEC EPIC
- Relies on the U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator to estimate the benefits of grid reliability improvements
 - Developed by LBNL and Nexant, Inc.
 - <https://icecalculator.com/home>
 - Specifically designed to estimate the benefits of improved reliability

Grid Reliability Tool Readme



| IEc | | |
|---|--|--|
| GRID RELIABILITY BENEFITS | | |
| Overview of Workbook | | |
| OVERVIEW | | |
| The U.S. Department of Energy's Interruption Cost Estimate (ICE) Calculator, developed by Lawrence Berkeley National Laboratory (https://icecalculator.com), is designed to estimate the benefits of grid reliability improvements. The worksheets in this Excel workbook assist CEC in using the ICE Calculator to estimate the benefits of grid reliability improvements. V.1 of this tool was completed in 2019. | | |
| For more information about the methodology employed, please see the documentation at https://icecalculator.com/documentation | | |
| If you are unfamiliar with the ICE Calculator, please see the documentation at https://icecalculator.com/documentation | | |
| RECOMMENDED USE | | |
| This workbook contains three worksheets intended to estimate the benefits associated with grid reliability improvements. The worksheets require inputs to, and outputs of, the ICE Calculator. | | |

ICE Calculator home page



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](#) [Estimate Value of Reliability Improvement](#)

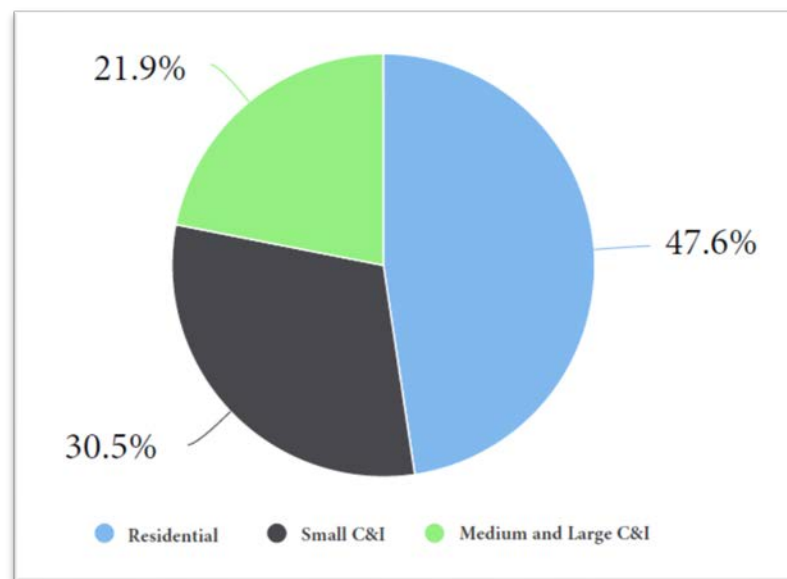
Grid Reliability Benefits Calculator (cont.)

- Relies on standard metrics of grid reliability that CPUC requires IOUs to maintain:
 - SAIFI
 - CAIDI
 - SAIDI
- Estimates economic benefits of improvements in reliability based on surveys of interruption costs
 - Calculates present value of benefits over life of project
 - Also provides an estimate of undiscounted annual benefits
- Output is state-specific; i.e., estimates of benefits are tailored to California

| Sector | # of Customers | Total Benefits (2019\$) | Benefit Per Customer (2019\$) |
|----------------------|----------------|-------------------------|-------------------------------|
| Residential | 10,000 | \$3,167,443.62 | \$316.74 |
| Small C&I | 20 | \$2,025,889.69 | \$101,294.48 |
| Medium and Large C&I | 2 | \$1,457,371.33 | \$728,685.67 |
| All | 10,022 | \$6,650,704.65 | \$663.61 |

Grid Reliability Benefits Calculator (cont.)

- Data requirements for an initial benefits estimate are minimal
- User can refine estimate by providing additional data (e.g., annual electricity use by customers affected)
- Tool is not suitable for analyzing costs of long-term outages
 - Maximum CAIDI value - 960 minutes (16 hours)
 - Maximum SAIDI value - 1,920 minutes (32 hours)



Public Safety Benefits Calculator

- EPIC grants have funded microgrids and other technologies that enhance resiliency
- Some of these systems sustain delivery of critical services during an outage:
 - Water supply and wastewater treatment facilities
 - Police and fire stations
 - Hospitals and ambulance services
- Maintaining these services can mitigate at least some of the adverse consequences associated with sustained outages



The Washington Post

@washingtonpost

Follow

A Native American tribe has insulated itself from California's blackouts by creating a microgrid utility



Public Safety Benefits Calculator (cont.)

- Excel-based tool created in 2020 by Industrial Economics, Inc. for CEC to estimate public safety benefits of microgrids during an outage
- The PSB Calculator estimates the present value of public safety benefits for different outage scenarios
- Based on FEMA Benefit Cost Assessment (BCA) methods for hazard mitigation grants (e.g., microgrids)¹

IEC PUBLIC SAFETY BENEFITS CALCULATOR

Input

Clear Inputs on This Page
Clear All Inputs

OVERVIEW

Use the legend worksheet to enter the model input values into the fields in the appropriate input worksheet.

The input worksheet contains the following tables:

- Project Inputs
- Base Inputs
- Critical Services Screening Scenarios
- Alternative Scenarios for Other Services

CELL COLORS

The cells for the "Values" column on the input page are colored according to the following scheme:

- Yellow: Default input entered from the application
- Light green: Not input
- Light blue: Input entered from user

PROJECT

Enter general information on the project into the appropriate fields in the table below.

Project Name:

USER INPUTS

| ID | Header | Description | Unit | Value | Source |
|----|-------------------|---|------|-------|--------|
| 1 | Base year | The base year for dollar conversions (default = 2019) | year | | Base |
| 2 | HPV discount year | The initial year for discounting growth | year | | Base |

PROJECT INPUTS

| ID | Header | Description | Unit | Value | Source |
|----|--|--|--------------|-------|---------------------|
| 1 | Initial project year | The year in which the benefits from the project begin (default is the HPV) | year | | Applicable/optional |
| 2 | Anticipated project lifetime | The expected project lifetime in years (default = 25) | years | | Applicable/optional |
| 3 | Average number of outages annually in the service area | The average number of outages that occur annually in the service area | outages/year | | Applicable/optional |
| 4 | Average duration of an outage | The average duration of outages that occur annually in the service area | hours/outage | | Applicable/optional |
| 5 | Type of area | The general type of area benefiting from the project. Use the dropdown menu to select one of the following | area | | Applicable/optional |

CRITICAL SERVICES SCREENING

Will the project improve the level of service provided during an outage for the following critical services? Default = "No."

| ID | Service | Does this project improve the level of service that can be maintained during an outage? | Source |
|----|----------------------|---|--------|
| 1 | Hospitality | Applicable/optional | |
| 2 | EMS | Applicable/optional | |
| 3 | Fire Response | Applicable/optional | |
| 4 | Police | Applicable/optional | |
| 5 | Water Supply | Applicable/optional | |
| 6 | Wastewater Treatment | Applicable/optional | |
| 7 | Community Shelters | Applicable/optional | |
| 8 | Additional Services | Applicable/optional | |

ADDITIONAL SERVICES

| ID | Default Name | Alternative Service Name | Source |
|----|----------------------|--------------------------|--------|
| 1 | Additional Service 1 | | Base |
| 2 | Additional Service 2 | | Base |
| 3 | Additional Service 3 | | Base |
| 4 | Additional Service 4 | | Base |
| 5 | Additional Service 5 | | Base |

¹ <https://www.fema.gov/benefit-cost-analysis>

Public Safety Benefits Calculator (cont.)

- Uses "avoided cost" approach to calculate the benefits of hazard mitigation (i.e., improved public safety)
- Minimizes data requirements by using standard values
 - National values (FEMA, 2016)
 - Where possible, Calculator provides California county- or state-level data
- Expands on FEMA methods to address additional types of services (e.g., community shelters)



¹ <https://www.fema.gov/benefit-cost-analysis>

Range of Services Considered

HOSPITALS



Value of avoided fatalities

Travel costs

Cost of waiting

EMS



Value of avoided fatalities

FIRE STATIONS



Value of avoided direct & indirect property losses

Value of avoided injuries and fatalities

POLICE



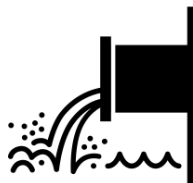
Value of avoided crimes (e.g., burglary, larceny, murder)

WATER SUPPLY



Value of service per day

WASTEWATER TREATMENT



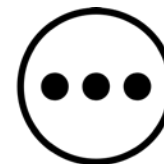
Value of service per day

COMMUNITY SHELTERS



Value of service per day

ADDITIONAL (OTHER) SERVICES



Value of service per day

Minimum Data Requirements for Analysis

- **Number of people**
Affected by/benefitting from the improvement
- **Levels of service maintained during an outage**
Before and after the improvement
- **Value of service per day**
For community shelters and other critical services

Caveats and Limitations

- Methods require specification of outage duration and other project-specific inputs (e.g., population served by critical facility)
- Some benefits affected by proximity to alternative providers who can provide backup support; therefore, must also specify geographic extent of outage
- Recommended use: to evaluate benefits associated with outages of relatively long duration (e.g., a day, a week, two weeks, or longer)
- Limitations:
 - Methods are not comprehensive
 - May understate true benefits



Appendix A: Grid Reliability Indices

Standard Indices of Grid Reliability

- SAIFI - System Average Interruption Frequency Index
 - Mean number of sustained outages each customer experienced over the course of the year (outages/customer)
 - $SAIFI = SAIDI/CAIDI$
- CAIDI - Customer Average Interruption Duration Index
 - Mean length of each outage experienced by an individual customer over the course of the year (minutes/outage/customer)
 - $CAIDI = SAIDI/SAIFI$
- SAIDI - System Average Interruption Duration Index
 - Total duration of sustained outages experienced by the average customer over the course of a year (minutes)
 - $SAIDI = SAIFI*CAIDI$

Sources of Reliability Data

- California Public Utilities Commission (CPUC) oversees the IOUs that participate in the EPIC program:
 - Pacific Gas & Electric (PG&E)
 - San Diego Gas & Electric (SDG&E)
 - SoCal Edison (SCE)
- A 1996 CPUC decision requires IOUs to:
 - Collect and maintain outage data
 - Use this data to calculate values for SAIDI, SAIFI, and CAIDI (or MAIFI)
 - Publish annual reports on system- and district-/division-level reliability
 - Provide circuit-level data upon request to any interested individual (~2,000 customers per circuit)

“Outages can be segmented by circuit and by district or division. Utilities should maintain information adequate to calculate reliability indices on these bases upon request” (CPUC Decision D 96-09-045, Appendix A, Page 3).

http://docs.cpuc.ca.gov/publishedDocs/published/FINAL_DECISION/5285.htm

Annual Reliability Reports

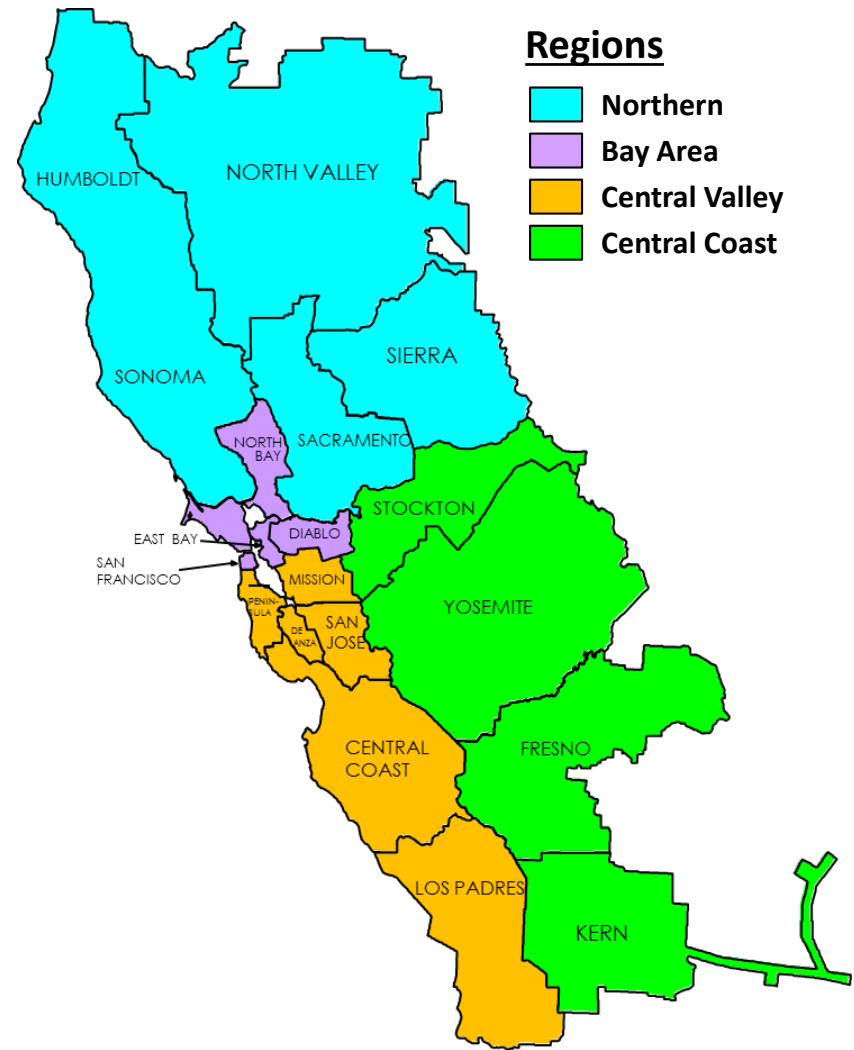
California Public Utilities Commission (CPUC) website maintains annual electric system reliability reports

- Website: <https://www.cpuc.ca.gov/General.aspx?id=4529>
- Years: 1996 to present
- Each report has past 10 years of reliability data (or to 1996)

Indices Available

- Reliability indices are provided at multiple levels of spatial resolution:
 - System-wide
 - District- or division-level
 - Transmission, distribution, or transmission & distribution combined
- Indices are calculated including or excluding certain events:
 - Planned outages only; unplanned outages only; both planned & unplanned outages
 - With and without Major Event Days (MEDs)
- The appropriate index to use in each case will vary with the scale and nature of the project

- 4 PG&E Regions
 - Northern, Bay Area, Central Valley, Central Coast
- 19 PG&E Counties/Divisions
 - Central Coast, De Anza, Diablo, East Bay, Fresno, Humboldt, Kern, Los Padres, Mission, North Bay, North Valley, Peninsula, Sacramento, San Francisco, San Jose, Sierra, Sonoma, Stockton, Yosemite
- 2018 Reliability Report ([Word Doc](#))



SCE

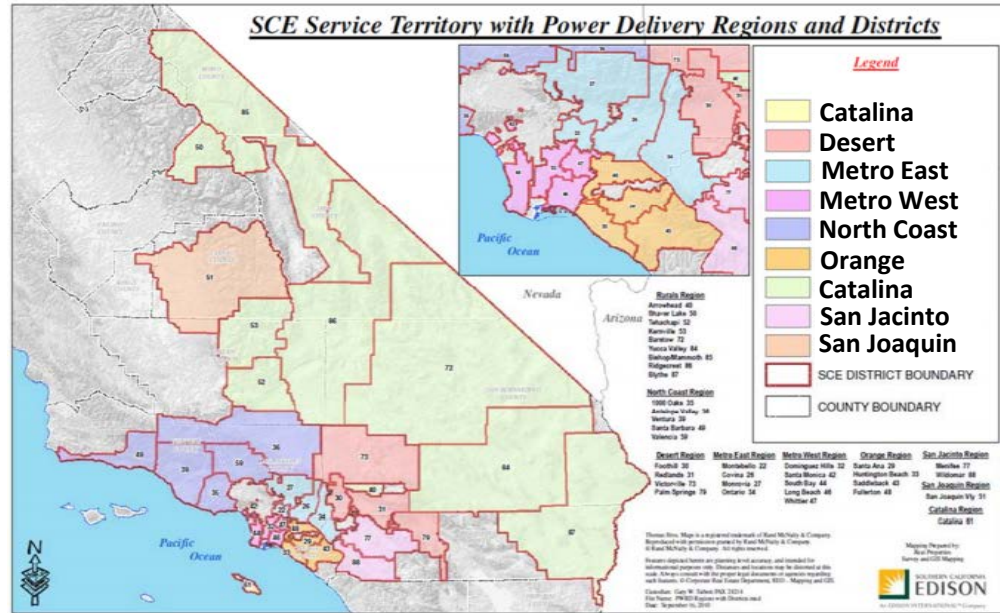
- 2018 Reliability Report ([PDF](#))

- 9 Regions

Catalina, Desert, Metro East,
Metro West, North Coast, Orange,
Catalina, San Jacinto, San Joaquin

- 35 Districts

Antelope Valley, Arrowhead,
Barstow, Bishop, Blythe, Catalina,
Compton, Covina, Foothill,
Fullerton, Huntington Beach,
Kernville, Long Beach, Menifee,
Monrovia, Montebello, Ontario,
Palm Springs, Redlands,
Ridgecrest, Saddleback, Santa
Ana, Santa Barbara, Santa Monica,
Shaver Lake, South Bay,
Tehachapi, Thousand Oaks,
Tulare, Valencia, Ventura,
Victorville, Whittier, Wildomar,
Yucca Valley



- Current-year reports for sub-districts:
 - 14 counties with total of 251 sub-districts
 - Fresno (2), Imperial (1), Inyo (6), Kern (9), Kings (5), Los Angeles (88), Mono (7), (Orange (35), Riverside (33), San Bernardino (29), Santa Barbara (7), Tulare (13), Tuolumne (1), Ventura (15)

SDG&E

- 6 SDG&E divisions
 - Orange County, North Coast, Northeast, Beach Cities, Eastern, Metro
- 2018 Reliability Report ([PDF](#))



Obtaining more Granular Data

Contact the IOUs for circuit-level reliability reports:

- PG&E
 - Online form: https://www.pge.com/en_US/residential/customer-service/help/contact-pge-landing/contact-us-form/contact-us.page
- SDG&E
 - Online form (currently requires account, circuit, and meter numbers): <http://semprasdande.prod.acquia-sites.com/reliability-request-form>
 - General service number: 1-800-411-7343
- SCE
 - Email: CircuitReliability@sce.com

Additional Links

- IOU Annual Reports (1996 to present)
 - <https://www.cpuc.ca.gov/General.aspx?id=4529>
- CPUC overview of reliability standards
 - <https://www.cpuc.ca.gov/General.aspx?id=4965>
- Reliability reporting requirements
 - CPUC Decision D 96-09-045, Appendix A
 - http://docs.cpuc.ca.gov/publishedDocs/published/FINAL_DECISION/5285.htm

Appendix B: Overview of FEMA Methods

Overview of FEMA Methods (cont.)

| SERVICE CATEGORY | IMPACT CALCULATED | PROJECT-SPECIFIC (USER-DEFINED) DATA NEEDED TO ESTIMATE IMPACT | STANDARD VALUES AND FORMULAS USED IN FEMA METHODOLOGY |
|---------------------------|---|---|---|
| Fire Station Service | <ol style="list-style-type: none"> Value of property losses due to fires Value of lives lost and injuries suffered due to fires | <p>Length of time without services</p> <p>Population (number of people) ordinarily served by affected station</p> <p>Distance between affected station and nearest station able to serve this population</p> | <p>National average fire incidence per capita</p> <p>National median response time for structure fires</p> <p>Relationship between distance and response time</p> <p>Relationship between response time and property losses</p> <p>Relationship between property losses and mortality/injury losses</p> <p>Value of lives lost (value of a statistical life)</p> <p>Value of injury</p> |
| Emergency Medical Service | Value of lives lost from cardiac arrest | <ol style="list-style-type: none"> Length of time without services Population (number of people) ordinarily served by affected EMS provider Distance between affected EMS provider and nearest provider able to serve this population Type of area served (urban/suburban/rural/wilderness) | <p>National average cardiac arrest incidence per capita</p> <p>National median response time for cardiac arrests by area type</p> <p>Relationship between distance and response time</p> <p>Relationship between response time and survival probability</p> <p>Value of lives lost (value of a statistical life)</p> |

Overview of FEMA Methods (cont.)

| SERVICE CATEGORY | IMPACT CALCULATED | PROJECT-SPECIFIC (USER-DEFINED) DATA NEEDED TO ESTIMATE IMPACT | STANDARD VALUES AND FORMULAS USED IN FEMA METHODOLOGY |
|------------------|--|--|--|
| Hospital Service | <p>Value of extra time spent getting to emergency department (ED) or waiting to be seen</p> <p>Value of extra distance traveled to get to ED</p> <p>Value of lives lost from acute myocardial infarction (AMI) or unintentional injuries</p> | <ol style="list-style-type: none"> 1) Length of time without ED services 2) Population (number of people) ordinarily served by affected hospital 3) Distance between affected hospital and nearest hospital able to serve this population 4) Number of people served ordinarily served by nearest hospital | <p>National average ED visit rate per capita</p> <p>National average employee compensation cost per hour</p> <p>Federal government mileage reimbursement rate</p> <p>National average deaths per capita from AMI and unintentional injuries</p> <p>Average increase in ED visits during a natural disaster</p> <p>Relationship between distance and extra travel time</p> <p>Relationship between number of ED visits and average waiting time</p> <p>Relationship between distance and survival rates for AMI and unintentional injuries</p> <p>Value of lives lost (value of a statistical life)</p> |

Overview of FEMA Methods (cont.)

| SERVICE CATEGORY | IMPACT CALCULATED | PROJECT-SPECIFIC (USER-DEFINED) DATA NEEDED TO ESTIMATE IMPACT | STANDARD VALUES AND FORMULAS USED IN FEMA METHODOLOGY |
|------------------------------|--|--|---|
| Police Service | 1) Cost of property crimes 2) Cost of violent crimes | Length of time with impaired police services Population (number of people) served by affected police station Number of police officers serving this population before and during the outage Type of area served (metropolitan/city/rural) | State average crime rates (by type of crime and area) National average cost of crimes by type National average elasticity of crime rates to police force size |
| Wastewater Treatment Service | 1) Direct economic impact of a loss of wastewater treatment service 2) Residential welfare loss from lost service | 1) Length of time without wastewater treatment 2) Number of people without wastewater treatment | 1) National GDP per capita per day by industry category 2) National GDP per capita per day for residential customers |
| Water Service | 1) Direct economic impact of a loss of water service 2) Residential welfare loss from lost service | 1) Length of time without water 2) Number of people without water | 1) National GDP per capita per day by industry category 2) National GDP per capita per day for residential customers |

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Questions?