Delivering Safe and Reliable Electric Service

Steven Calvert P.E.
Senior Manager, Electric System Reliability
Agenda

• Safety and Welcome
• Overview of our electric system
• Power outages and interruptions
• System-wide and local reliability statistics
• What we’re doing in your community to improve reliability
• Questions
Energizing California for over 150 years

- Provides electric service to 16 million people
- Spans our diverse 70,000 square-mile service territory
- 20,000+ employees
- Regulated by the California Public Utilities Commission

Together, Building a Better California
Our electric system

We are committed to delivering safe, reliable, affordable and clean energy.

- operates and maintains
  of distribution lines

- of interconnected transmission lines
  focused on clean energy
Our electric system

Generation

Power Generated at
13–25 kV

Transmission

Transmission Line
60, 115, 230 or 500 kV

Distribution/Customers

Distribution Line
4, 12, 17 or 21 kV

Home or Business
120–480 Volts
Why are there outages and interruptions?

- **Weather**
- **Vegetation** (trees contacting power lines)
- **Animals**
- **Equipment failure**
- **Vehicle accidents**
- **Digging into underground electric lines**
Outage Classifications

The company classifies outages according to industry definitions specified in the Institute of Electrical and Electronic Engineers (IEEE) standards.

**Momentary Outage**
An outage of 5 minutes or less in duration.

**Sustained Outage**
An outage greater than 5 minutes in duration.

**Planned Outage**
Outages which are customer or public official-requested or where the company has provided notice to the customer.

**Major Event**
A set of outages which occurred during a specific time and location and which combined, exceeds historically expected outage duration (SAIDI) for at least one day (as defined in IEEE 1366-2012)
Reliability

What we use to measure reliability:
- SmartMeter data
- Information from customer calls
- Information from PG&E’s automated systems

How we track outages:
- Outages are logged in PG&E’s outage databases
- Some data is stored automatically
- Detailed data is gathered by PG&E’s first responders and field crews

What we do with the data:
- Data is grouped into various metrics—SAIDI, SAIFI, CAIDI, MAIFI—so we can learn more about our reliability and how best to improve
How We Manage Reliability

Immediate Response
Restoration crews make repairs and improvements to the electric system due to an outage

Daily Reviews
Previous day outages are reviewed and near-term system improvement projects are identified

Weekly and Monthly Reviews
Trends in electric reliability are reviewed and action items are developed for both near- and long-term system improvement projects

Annual Reviews
Long-term (one year or greater) system improvement projects are identified and planned
Reliability is consistently delivering power to our customers

**How we define and measure this**

**SAIDI** = \[
\frac{\text{Total minutes every customer was without power due to sustained outages}}{\text{Total number of customers}}
\]

Average cumulative minutes of sustained power interruptions during the year

**SAIFI** = \[
\frac{\text{Number of sustained customer outages experienced by all PG&E customers}}{\text{Total number of customers}}
\]

Average number of sustained power interruptions during the year

**CAIDI** = \[
\frac{\text{System Average Interruption Duration Index (SAIDI)}}{\text{System Average Interruption Frequency Index (SAIFI)}}
\]

Average duration of each sustained power interruptions during the year

**MAIFI** = \[
\frac{\text{Number of customers who experience Momentary Outages}}{\text{Total number of customers}}
\]

Average number of momentary power interruptions during the year

*\text{AIDI} – Average cumulative minutes of sustained power interruptions during the year on a specific circuit.*

*\text{AIFI} – Average number of sustained power interruptions during the year on a specific circuit.*
What is PG&E’s system-wide reliability story?

- Continued reliability improvement though recently impacted by severe storms and wildfires
- \textbf{20\% reduction} in the amount of time customers experience outages since 2009 - SAIDI
- \textbf{8\% reduction} in customer outages since 2009 - SAIFI

How will PG&E’s reliability improve?

- Significant infrastructure and system hardening investments
- New technology implementation
- Programs targeting poorly-performing areas

(Excludes MED and Independent System Operator ISO outages, and includes planned outages)

<table>
<thead>
<tr>
<th>Year</th>
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<th>MAIFI</th>
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<td>1.527</td>
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<td>1.396</td>
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<td>0.871</td>
<td>1.594</td>
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**T&D System - SAIDI**
(Incl. Planned Outages and Excl. MEDs and ISO Outages)

(Includes Planned Outages, Excludes Major Event Days and ISO Outages)
PG&E’s poorly performing electric circuits in 2018, by the amount of time the average PG&E customer experienced a sustained outage (an outage that lasts more than five minutes).

Table 62: AIDI Worst Performing Circuit for 2018

<table>
<thead>
<tr>
<th>#</th>
<th>DIVISION</th>
<th>SUBSTATION</th>
<th>CIRCUIT NAME</th>
<th>TOTAL CUSTOMERS</th>
<th>CIRCUIT MILES</th>
<th>% OH</th>
<th>% UG</th>
<th>HFTD</th>
<th>3 YR AVG MAINLINE OUTAGES</th>
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- Highlighted circuits are poor performing on both SAIDI and SAIFI metrics. Arrow highlights Stockton area circuits.
PG&E’s poorly performing electric circuits in 2017, by the number of times the average PG&E customer experienced a sustained outage (an outage that lasts more than five minutes). Note that no Sacramento circuits met this criteria.

Table 61: AIFI Worst Performing Circuit for 2018

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</table>

- Highlighted circuits are poor performing on both SAIDI and SAIFI metrics. Arrows highlights Stockton area circuits.
PG&E’s Electric Circuit Geography

System Map

Stockton Division Area Map
PG&E plans to continue to explore and deploy smart grid technology, including:

- Fault Location, Isolation, and Service Restoration (FLISR) technology that automatically reroutes power flows to speed restoration of service to customers.
- Smart Line Sensors to improve our ability to monitor for outages
- New ways of using SmartMeter information
- Continue integrating clean and renewable energy on the grid, such as:
  - Solar
  - Electric vehicles
  - Battery storage technology
  - Energy efficiency improvement
Improved reliability over the last 10 years.

- In 2009, the average customer experienced 194.5 minutes of sustained power interruptions
- In 2018, customers experienced 121.8 minutes
- An improvement of over 37%

Fewer outage interruptions.

- In 2009, the average customer experienced 1.383 sustained power interruptions in a year
- In 2018, the average customer experienced 1.115 interruptions
- An improvement of over 19%
Stockton Division: Recently Completed Electric Projects

Stagg 1105:
Completed 2018

Identified as a poor performing circuit in 2014, significant work including the installation of new protection devices and resolving reliability issues identified through detailed circuit inspections. A 25+% improvement in reliability circuit performance was recorded in 2018.

Number of customers on the circuit: 1,794

TripSavers (various locations):
Completed 2016, 2017 & 2018

44 TripSavers (TS) were installed in Stockton Division. This new technology protection device replaced traditional fuses and had the functionality to “test” back in after an intermittent fault. This would reduce the number of sustained outages for customers beyond new TS.

Number of customers: about 10,000 per year
Pine Grove 1102:

**Planned for 2020-21**

This project will replace bare wire with insulated conductor, increase strength requirements for poles, install system automation/protection equipment, and convert overhead (OH) equipment to underground (UG) in targeted locations. This would minimize the risk of an asset failure that could result in a fire ignition.

**Number of customers on the circuit:** 2,801

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PSPS Devices (various locations):

**Planned for 2019-20**

This program will install various switching and protection devices equipped with Supervisory Control and Data Acquisition (SCADA) technology. This would minimize the customer disruption impacts of a Public Power Shut Off (PSPS) event.

**Number of customers:** about 30,000 per year
Thank you

Annual report and a copy of this presentation
pge.com/ertownhall

Contact us
800-743-5000

Questions?