

# Emerging Grid Technologies

## PG&E | Distribution System Operations

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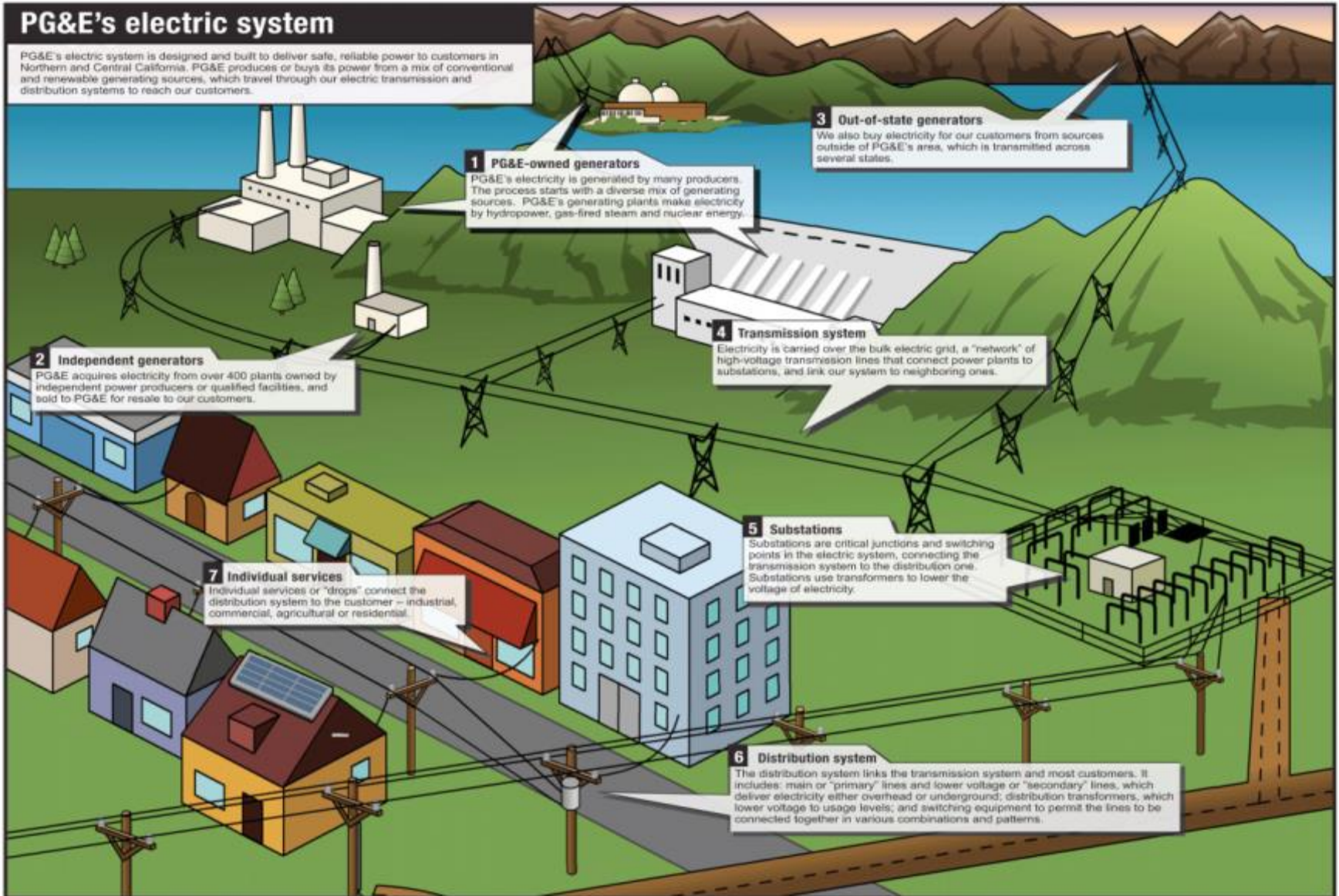
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- PG&E Overview
- Distribution System Operations
- Grid Ops Situational Intelligence
- GOSI Use Cases

## PG&E at a Glance

- Subsidiary of PG&E Corporation, based in San Francisco
- \$17B in Operating Revenues (PG&E Corporation, 2014)
- 20,000 employees providing service to approximately 16 million people
- More than 141,215 circuit miles of electric lines
- 5.4 million electric customer accounts
- Core business; transmission and delivery of energy





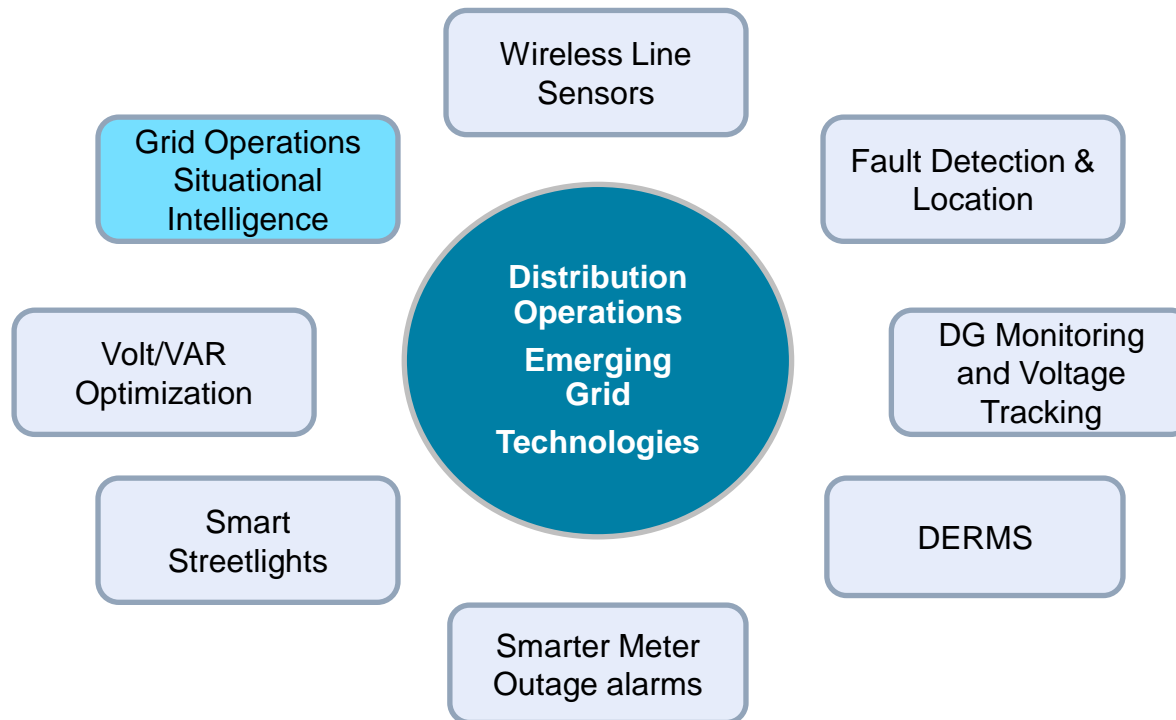
# How PG&E Differs From Most Other Businesses

- PG&E makes money by making long-term investments in operating assets (rate base), and earning a return through regulated rates.
- PG&E manages costs within its regulatory constraints (authorized revenues).

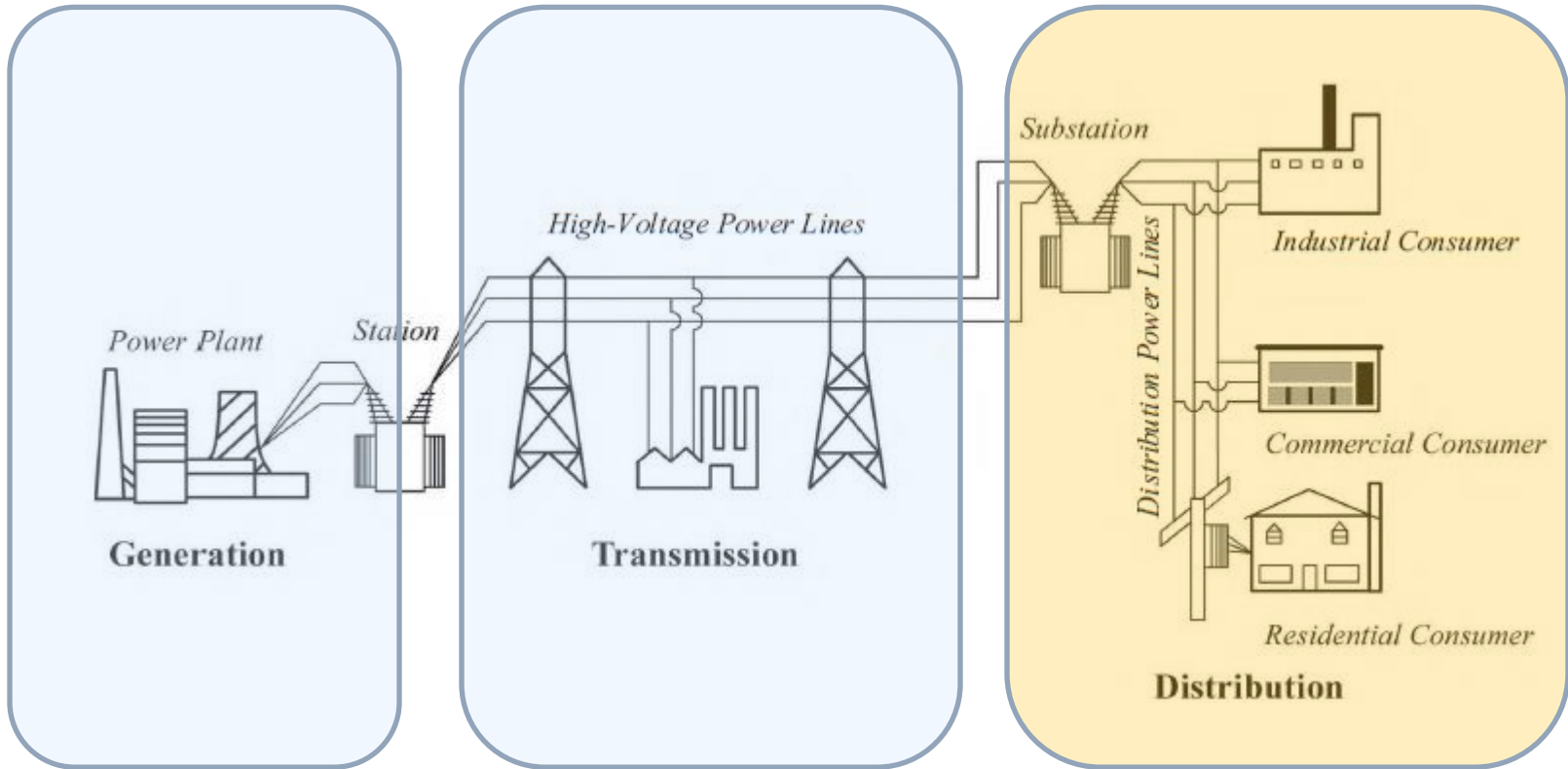
Difference	Rationale
PG&E has an <b>exclusive franchise</b> within service territory (under regulation by CPUC and FERC).	Transmission and Distribution are considered “natural monopolies”.
PG&E has an <b>obligation to serve</b> anyone who requests service within service territory.	Social objective to provide everybody with access to electricity and gas service. Often considered to be in exchange for the exclusive franchise.
Utility <b>revenues are decoupled</b> ; generally independent of actual energy sales.	Remove economic disincentive to conservation.
Customers are charged dollar-for-dollar for the cost to procure electricity and gas. <b>PG&amp;E does not profit from mark-up</b> like a traditional retail business.	Business earns a return on invested capital.

EPIC funding supports **Technology Demonstration and Deployment (TD&D)** projects that advance safety, reliability and cost-efficiency goals

- Pre-commercialization, not yet widely used in the industry.
- Proof of concept or small scale pilots; prior to full scale deployment.



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**Provide Safe, Reliable, and Efficient Energy**

Energy Production = Energy Consumption





- Real-time Grid Operations
- Critical Operating Environment
- Changing Technology

- Gartner, Inc. forecasts that **4.9 billion connected things will be in use in 2015**, up 30% from 2014, and will reach **25 billion by 2020**.
- **By 2020 utilities will be the top industry vertical**, largely due to smart meter investment

- Grid Complexity is Increasing
- Data Volume / Velocity is Increasing
- End-Users experiencing Information Overload

- Computing power is improving
- Visualization technology is improving
- Analytics capabilities are improving

## External Hazards and Grid Edge Devices

## Internal Sensor Data

## Integrated Situational Intelligence



- Weather
- Fire
- Earthquake
- Energy Storage
- EV's
- DG

- SCADA
- SmartMeter
- GIS
- Crew Location
- Outages

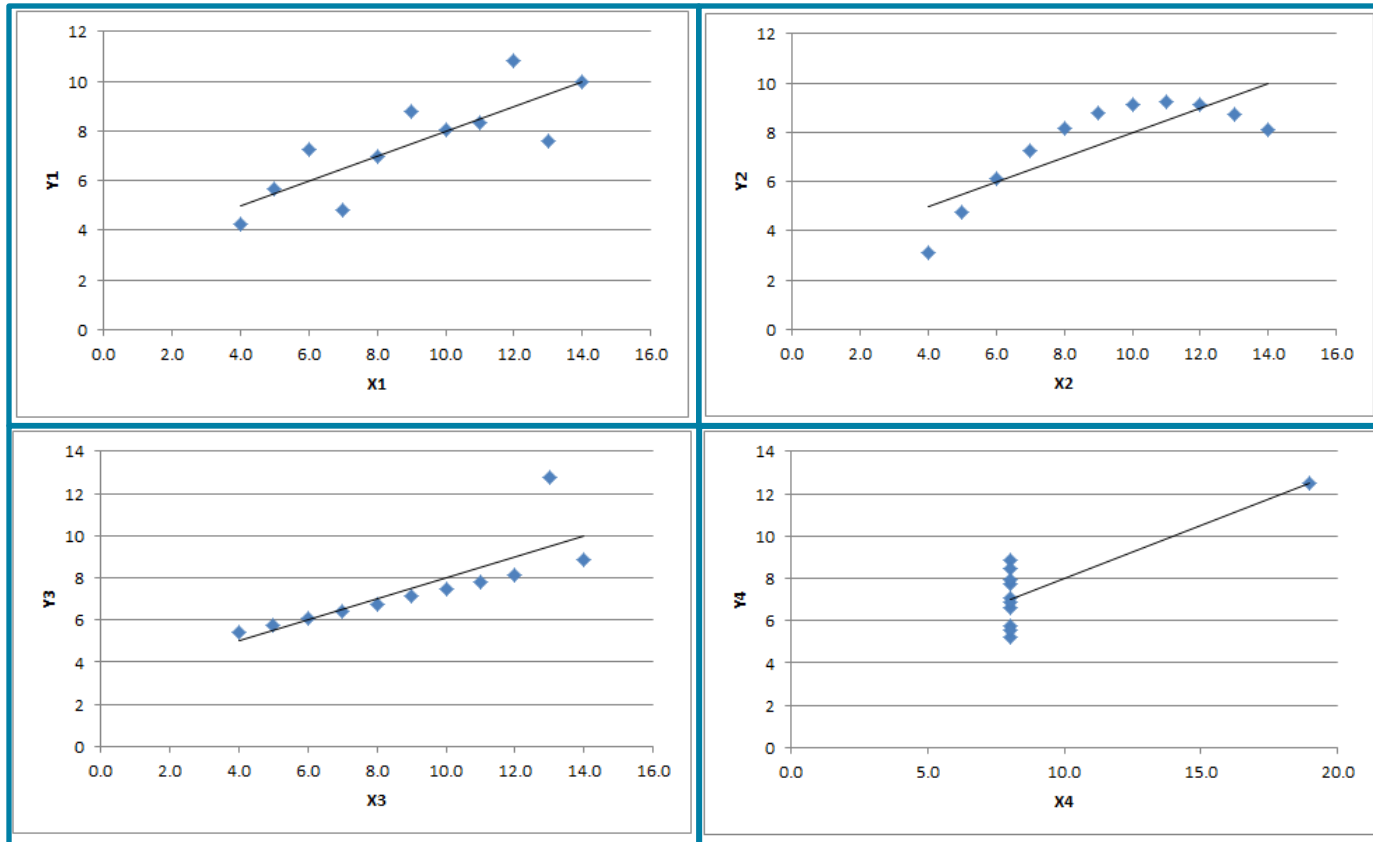
- Human Performance Improvement
- Metrics / KPI's
- Data Correlation
- Complex Event Processing
- Predictive Analytics
- Machine Learning

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I		II		III		IV		
x	y	x	y	x	y	x	y	
10.0	8.04	10.0	9.14	10.0	7.46	10.0	6.58	
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76	
13.0	7.58	13.0	8.74	13.0	12.74	13.0	7.71	
9.0	8.81	9.0	8.77	9.0	7.11	9.0	8.84	
11.0	8.33	11.0	9.26	11.0	7.81	11.0	8.47	
14.0	9.96	14.0	8.1	14.0	8.84	14.0	7.04	
6.0	7.24	6.0	6.13	6.0	6.08	6.0	5.25	
4.0	4.26	4.0	3.1	4.0	5.39	4.0	12.5	
12.0	10.84	12.0	9.13	12.0	8.15	12.0	5.56	
7.0	4.82	7.0	7.26	7.0	6.42	7.0	7.91	
5.0	5.68	5.0	4.74	5.0	5.73	5.0	6.89	
Mean	9.00	7.50	9.00	7.50	9.00	7.50	9.00	7.50
St. Dev.	3.32	2.03	3.32	2.03	3.32	2.03	3.32	2.03

## Four X-Y Data Sets

- What's the difference?















## People react to images much faster

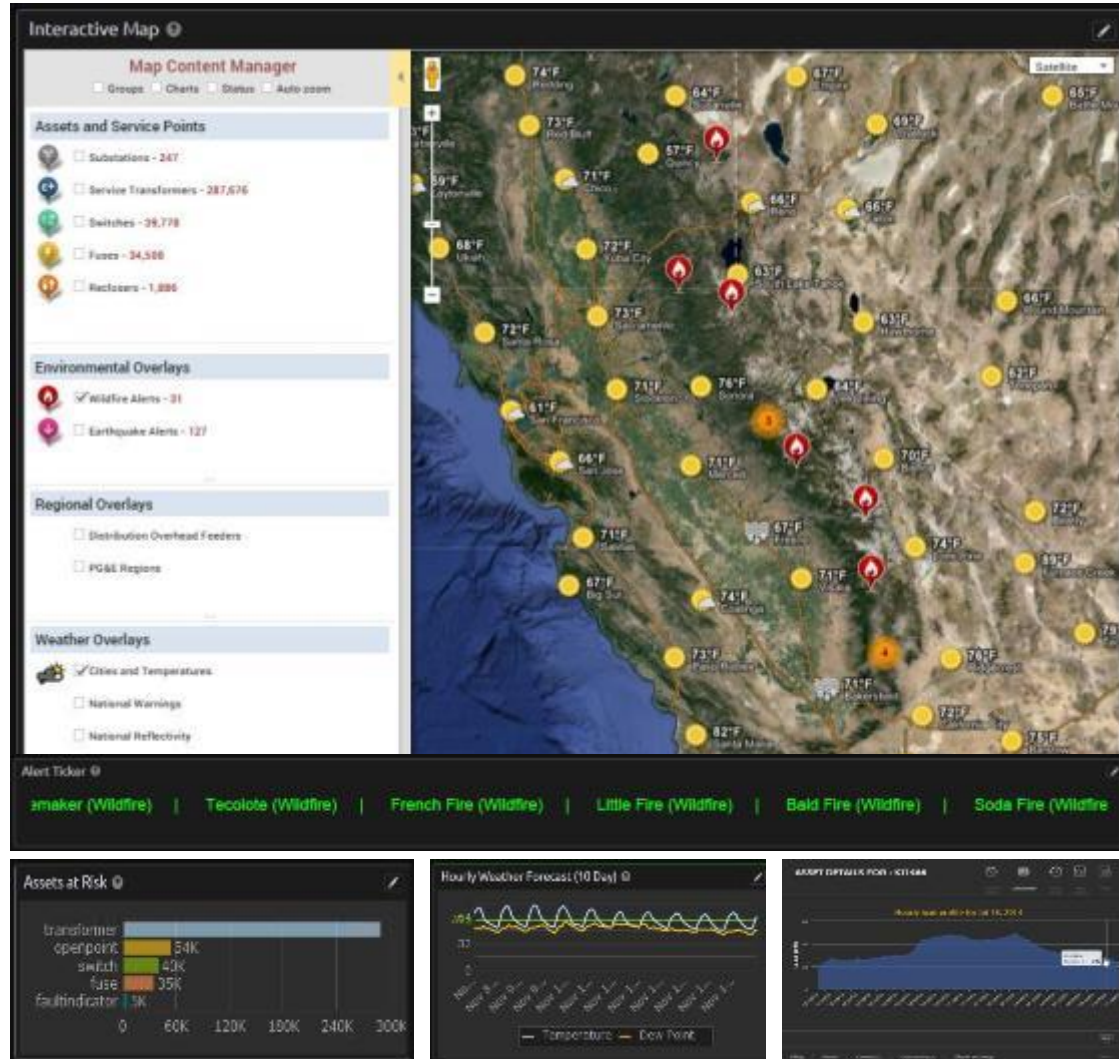
- Computers can store and process information at super-human scale
- People are still better than computers in many information processing activities: see patterns, notice oddities, etc.

Aggregate sources

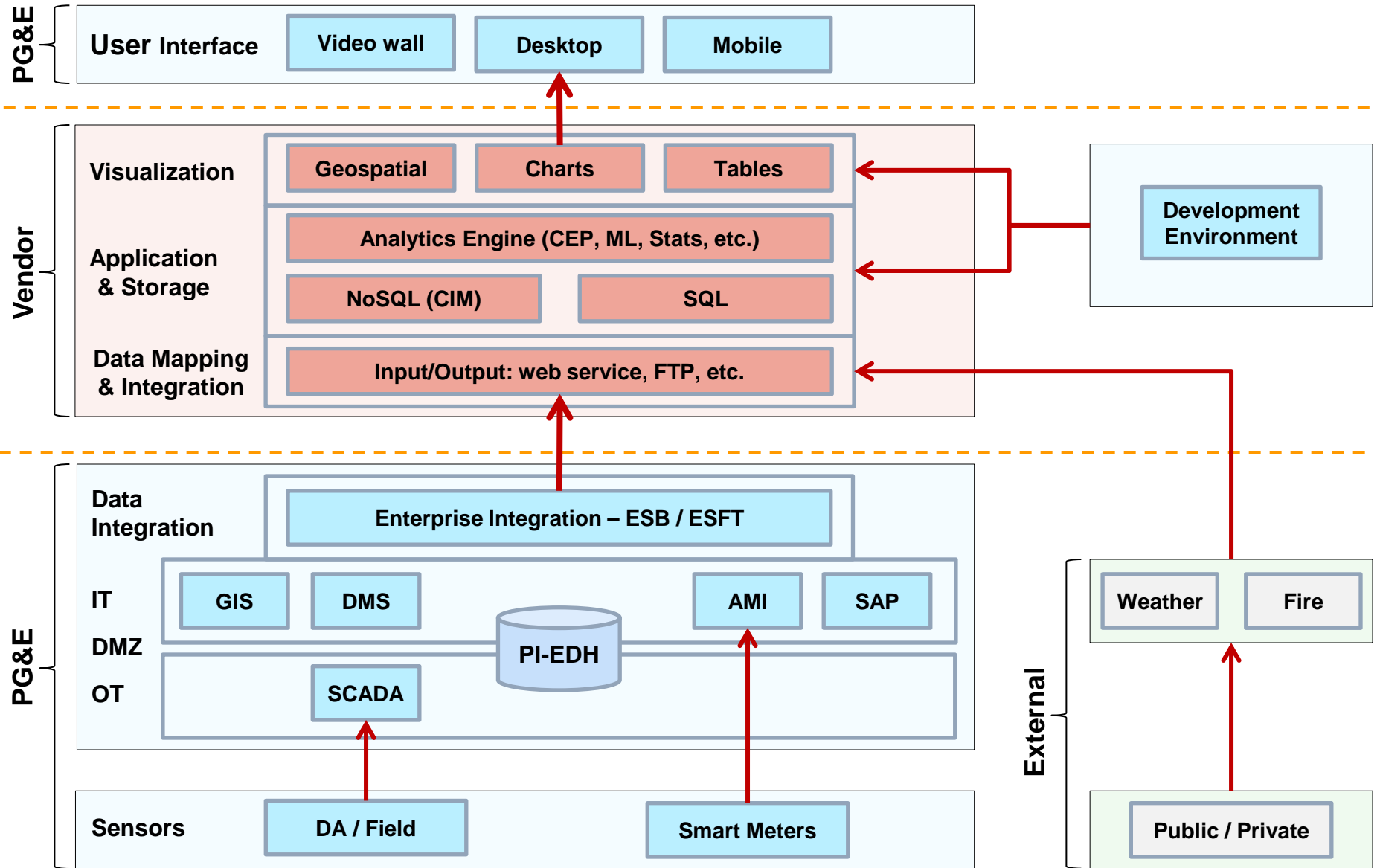
Correlate and summarize key information

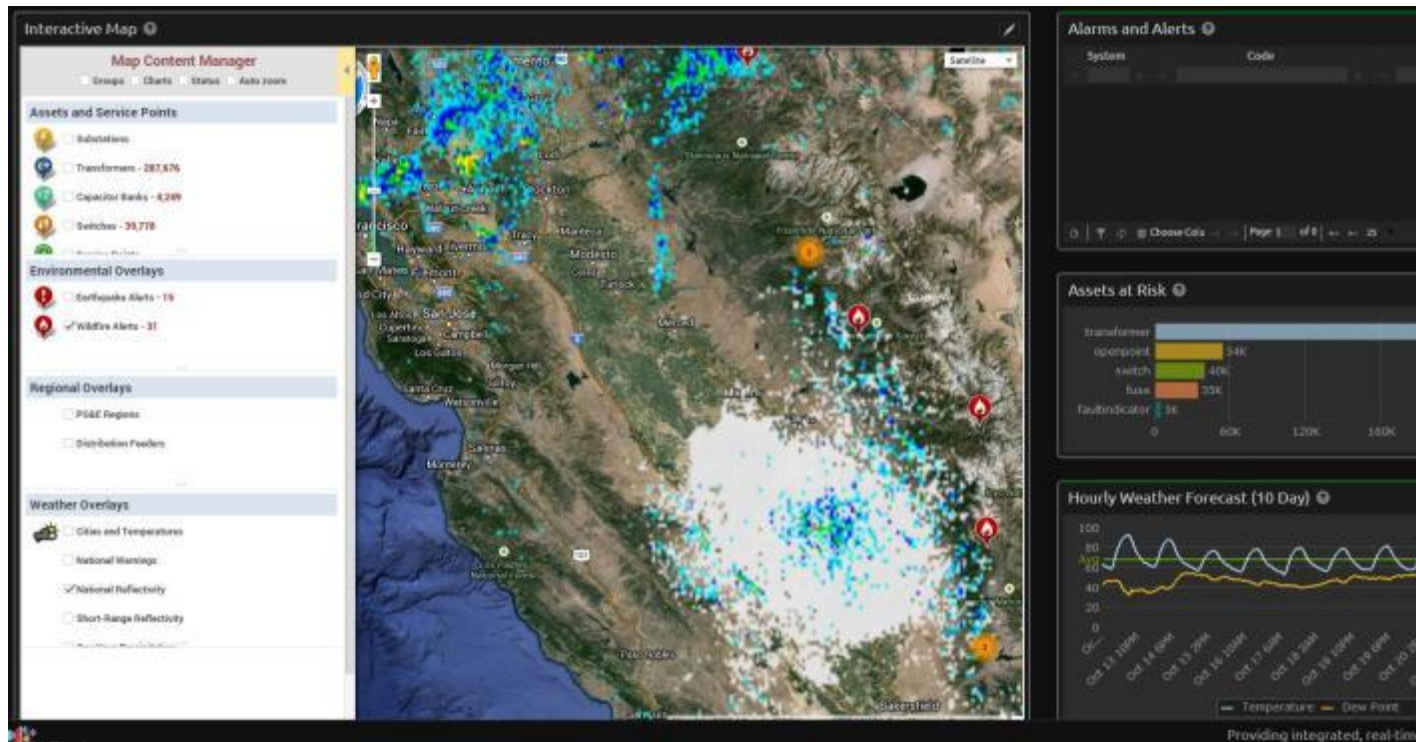
Access application

-  SCADA
-  SmartMeter
-  GIS
-  Outages
-  Crews
-  Weather
-  Fire
-  Earthquake
-  Storage
-  EV's
-  DR
-  DG









## Rapid Development:

- Quickly build prototypes and get user-feedback
- 2 week sprints with ongoing product modifications
- Transition to PG&E in-house development

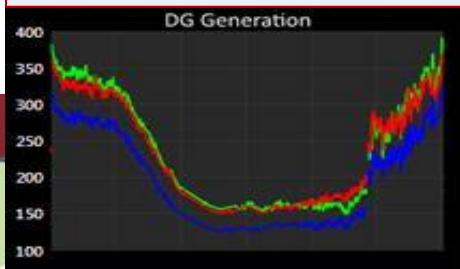
## User Configuration / Customization:

- Use cases based on end-user input
- Simple to configure new widgets and dashboards
- Enable end-users to build new use-cases in the future



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## 5. Visualize Distributed Generation



GOSI

Google Streetview



2. Anticipate Outages to Prepare Mitigation Plans

- Ex. Existing Fire with spread

## 3. Research Loading for Switch Logs for Outages



## 1. Plan and View Construction Work

CIRCUIT MAINTENANCE

Work Details:

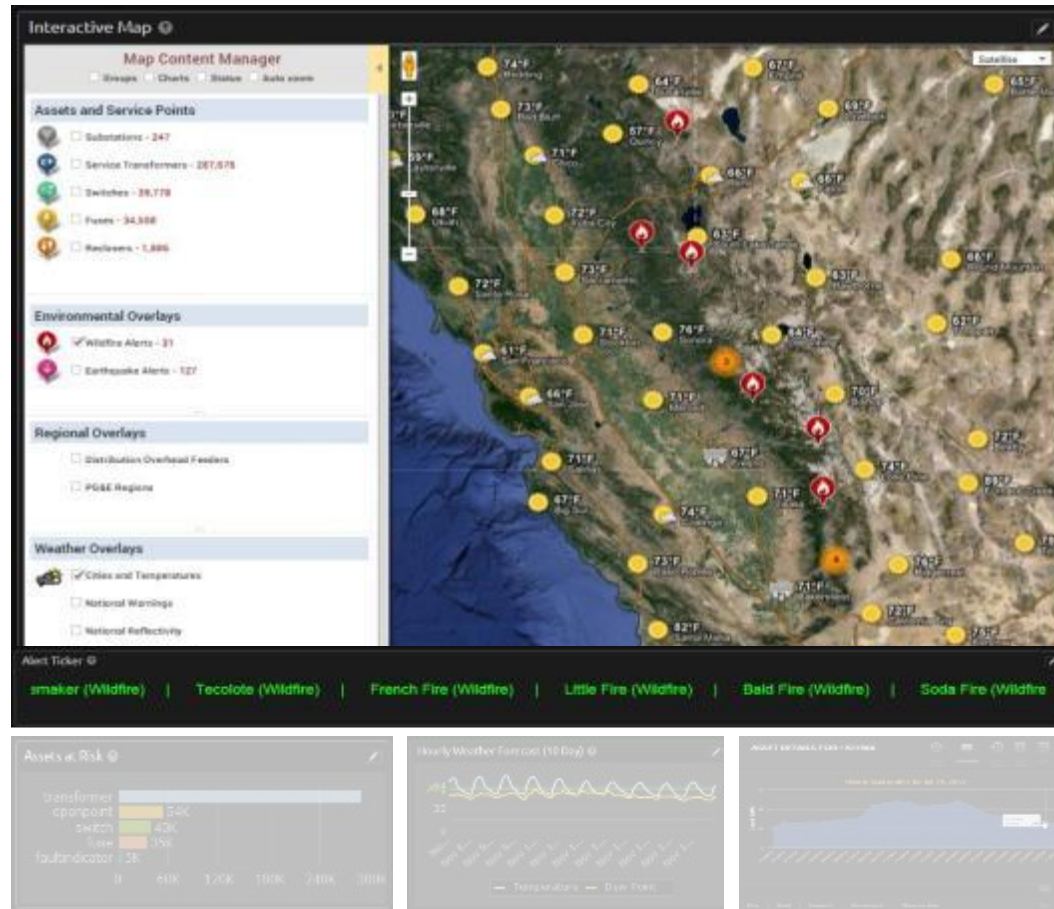
- 80271817001
- Reason/Call (Initial reason)
- Materials Required
- Total work/Complete
- Location 802218
- Project 80358
- Start Date 2014-07-30 13:00:00
- Estimated Completion 2014-07-31 13:00:00

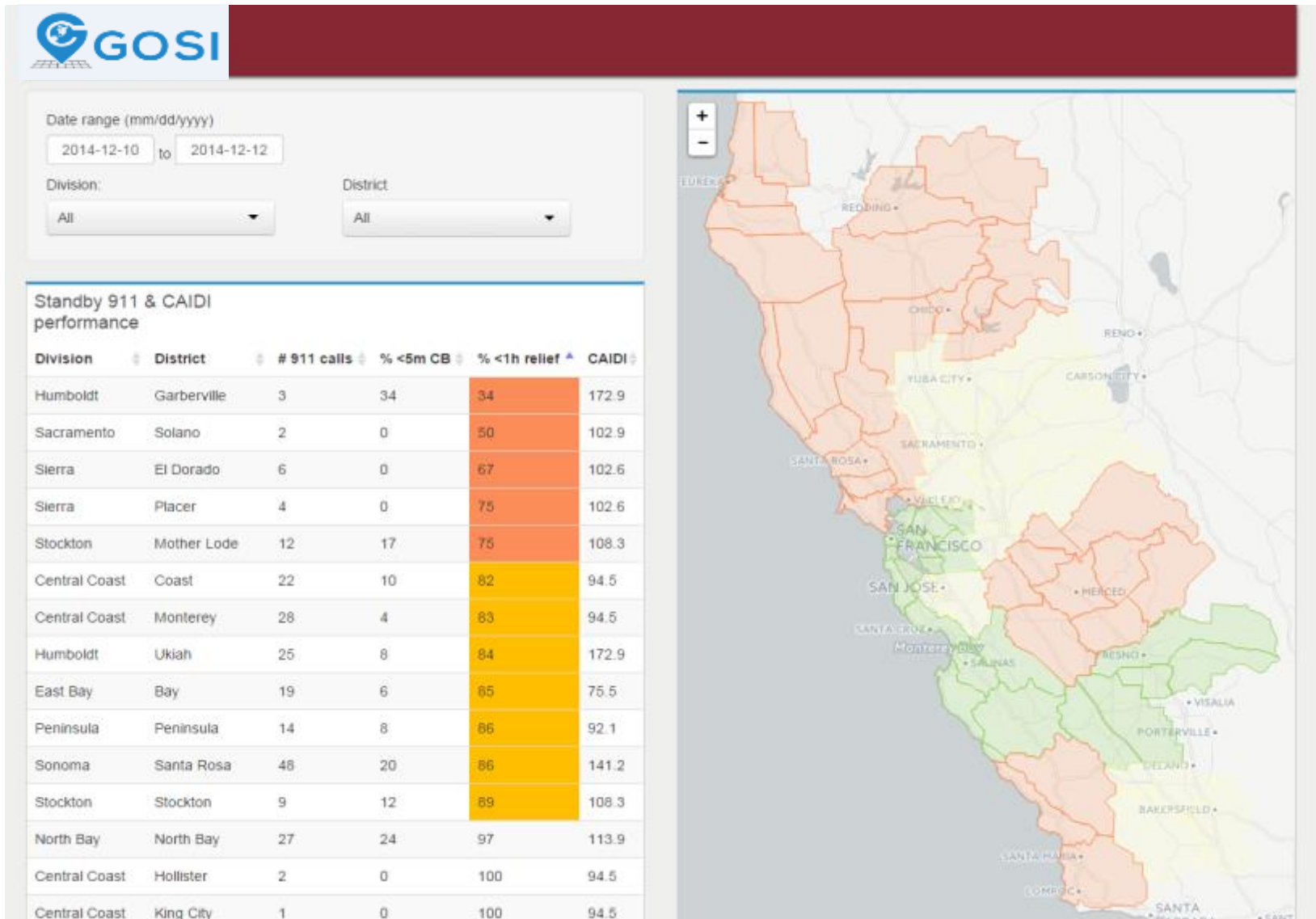
Circuit Maintenance

## 4. Operations / Emergency Dashboard

- Rapid prototype of GOSI platform
- Weather, fire, and earthquake data layered on ED-GIS network model
- Developed in ~45 days, in time for DCCC Fresno go-live

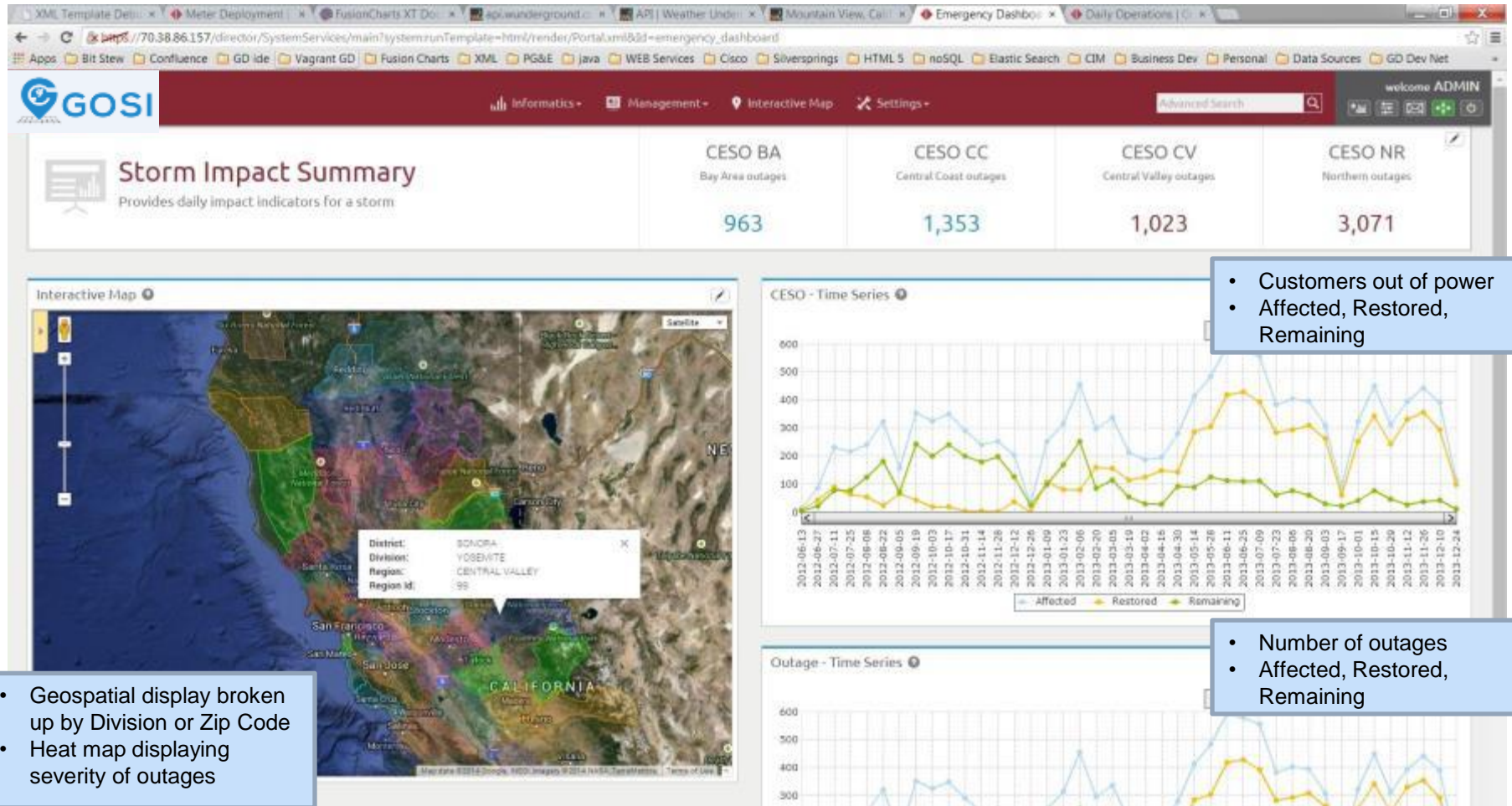
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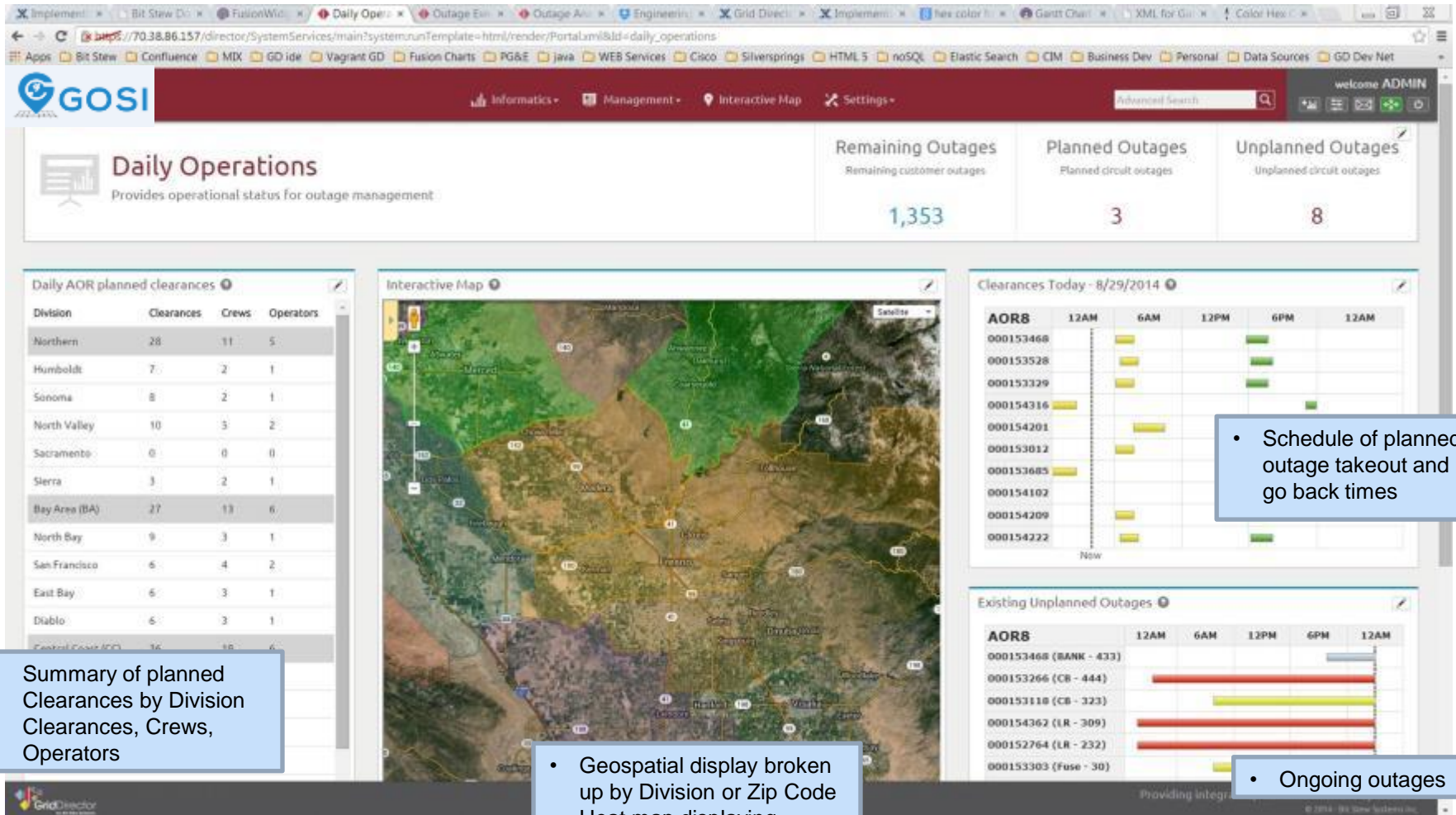
# Mockup: Emergency Operations Dashboard (UC 4)



- Geospatial display broken up by Division or Zip Code
- Heat map displaying severity of outages

- Customers out of power
- Affected, Restored, Remaining

- Number of outages
- Affected, Restored, Remaining



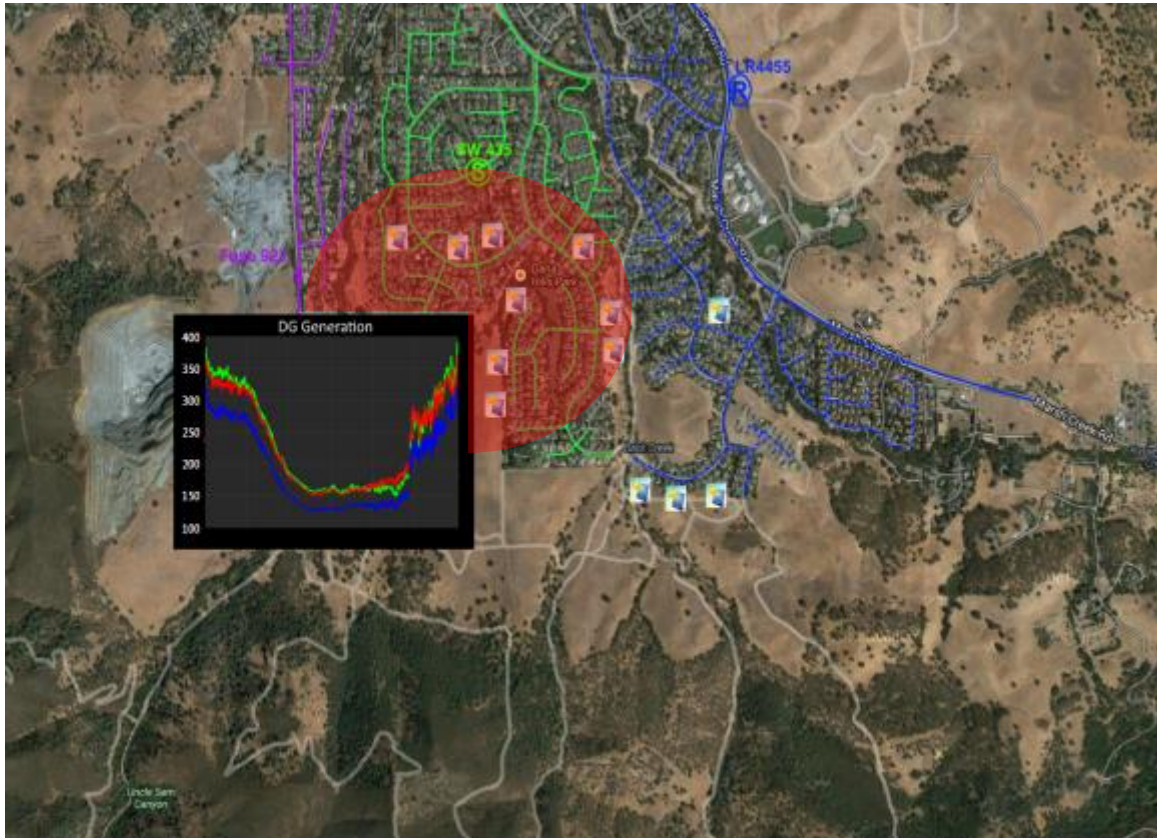
- Summary of planned Clearances by Division
- Clearances, Crews, Operators

- Geospatial display broken up by Division or Zip Code
- Heat map displaying severity of outages

- Schedule of planned outage takeout and go back times

- Ongoing outages





### DG Installations:

- Location
- Customer type
- Resource capacity

### PG&E Jurisdictions / Assets:

- Filter by Division/District
- Filter by feeder, transformer

### Identify hidden loads:

- Display DG penetration / heatmap
- Predict generation

“Obviously, Silicon Valley is all over this, but I think they are missing the point. They are **creating some gadgets, but they aren’t thinking about systems.**”

- Tim O’Reilly, Founder O’Reilly Media

"We're going to discover that **these energy technologies are tremendously more powerful and more valuable if they're wired together through the grid**, which means the grid is not only going to continue to be relevant, it's going to be just as indispensable over the next 100 years as it was in the last 100 –maybe even more so.“

- Chris Johns, President PG&E



# Questions?