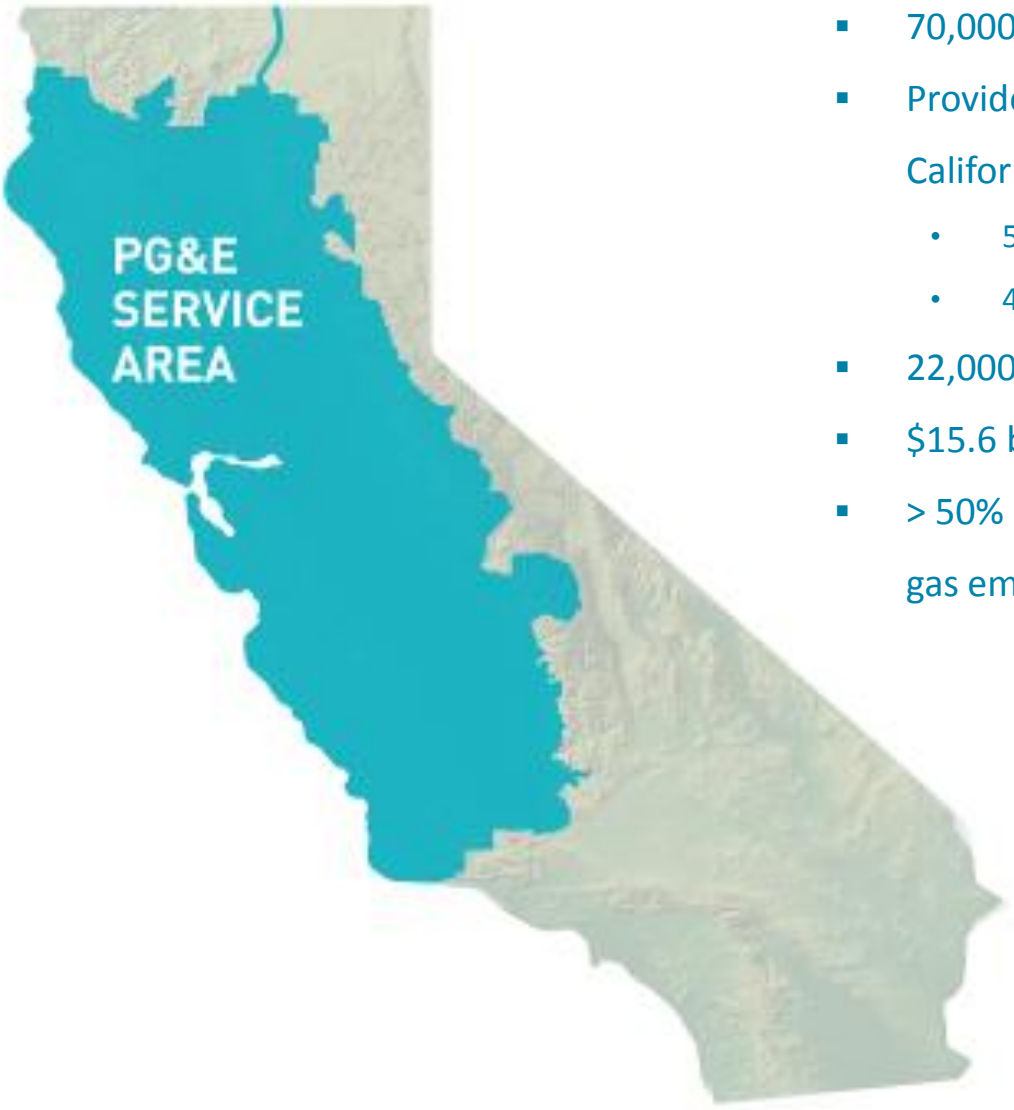
PG&E's Distribution Resource Plan

The Utility Energy Forum Spring 2016 Conference

Presentation Developed for Panel Discussion
Lake Tahoe, California
May 2016

About Pacific Gas and Electric Company (PG&E)

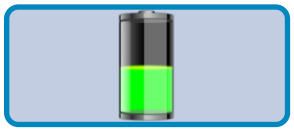


- 70,000 square-mile service area
- Provides energy services to 15 million Northern Californians
  - 5.1 million electric customer accounts
  - 4.3 million natural gas customer accounts
- 22,000 employees
- $15.6 billion in revenues
- > 50% of PG&E's electric supply comes from non-GHG gas emitting sources

AB 327 Added PUC Code Section 769

- Distributed Energy Resources (DER) means:


Distributed Renewable Generation


Energy Storage

Energy Efficiency

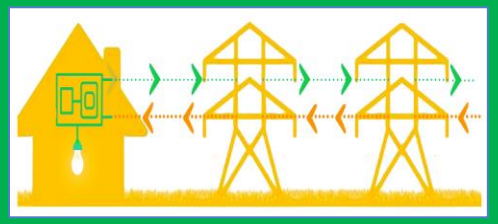

Demand Response


Electric Vehicles

- Submit a distribution resources plan proposal to the CPUC by July 1, 2015
  - Evaluate locational benefits and costs of DERs located on distribution system. This evaluation shall be based on reductions or increases in local generation capacity needs, avoided or increased investments in distribution infrastructure, safety benefits, reliability benefits, and any other savings the distributed resources provide to the electrical grid or costs to ratepayers of the electrical corporation.
  - Recommend standard tariffs, contracts, or other mechanisms for deployment of cost-effective DER
  - Propose effective coordination of existing commission-approved programs, incentives, and tariffs to maximize DER locational benefits
  - Identify additional utility spending to integrate cost effective DER into Distribution Planning to yield net benefits to ratepayers
  - Identify barriers to deployment of DER, including, but not limited to, safety standards related to technology or operation of the distribution system in a manner that ensures reliability

PUC Code Section 769

Electric Distribution Resource Plan (EDRP) OIR Objectives



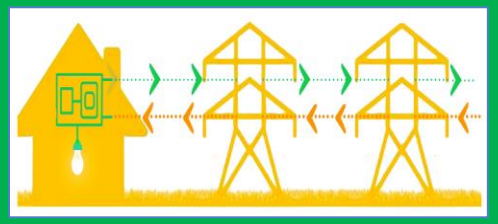
Modernize distribution system to accommodate expected DER growth through two-way power flow

Enable customer choice of new electric DER technologies and services

Identify and develop opportunities for DERs to realize grid benefits

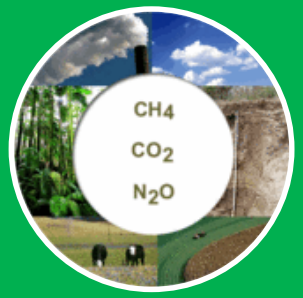
Identify Optimal Locations for deployment of DERs

Integrating DER (IDER) OIR Objectives



DRP establishes optimal locations and locational value for DERs

IDER establishes Sourcing Framework for DERs

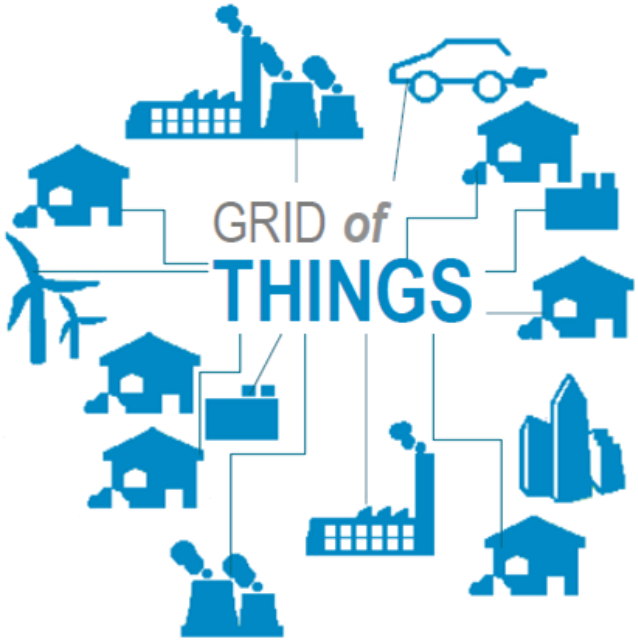


Sourcing to be done through some combination of Pricing, Programs and Procurement

Create a Sourcing Framework for Integration of DERs

PG&E's Policy and Vision

- DRP/IDER will enable significant DER integration and support California's Clean Energy Vision
- PG&E's role is essential to achieving California's goals for safe, clean, affordable, reliable and resilient energy
- PG&E's initial EDRP serves as the technical foundation for integrating DER. IDER OIR's envisioned sourcing framework serves as the commercial foundation for integrating DER
- Achieving the long term EDRP/IDER vision will require coordinated electricity pricing and tariff reform, enhanced customer program delivery mechanisms and complementary DER procurement processes.



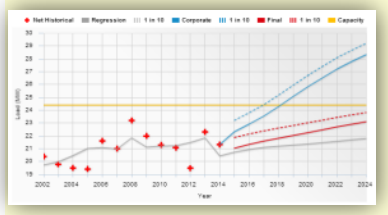
Integrated Distribution Planning Framework

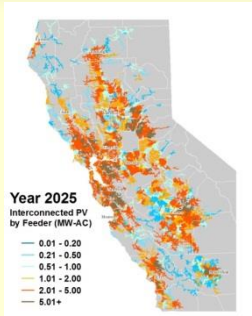
IEPR

1

Assumptions, Scenarios & Scope

Develop forecasts, assumptions and planning scenarios.





DRP

2

Distribution Planning Assessment

Distribution Grid Studies

- Thermal
- Voltage
- Protection
- Safety and Reliability

3

Distribution Grid Needs

Distribution Grid Needs

- Load Serving Capacity
- DER Hosting Capacity
- DER Aggregator Requirements
- Coordination with Transmission Planning

IDER
(Sourcing Process to Satisfy DRP Needs)

4

Evaluate Options

Prioritize Grid Needs

↓

Locational Net Benefit Analysis

↓

Investment framework/technical Feasibility

Implement "Wires" alternatives for locations deemed infeasible for DERs

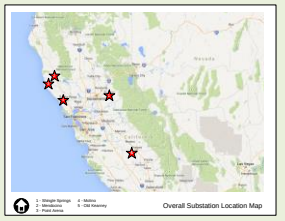
↓

Implement "Wires" Solution

5

Distribution Portfolio

Sourcing Process to satisfy needs identified in IDPP

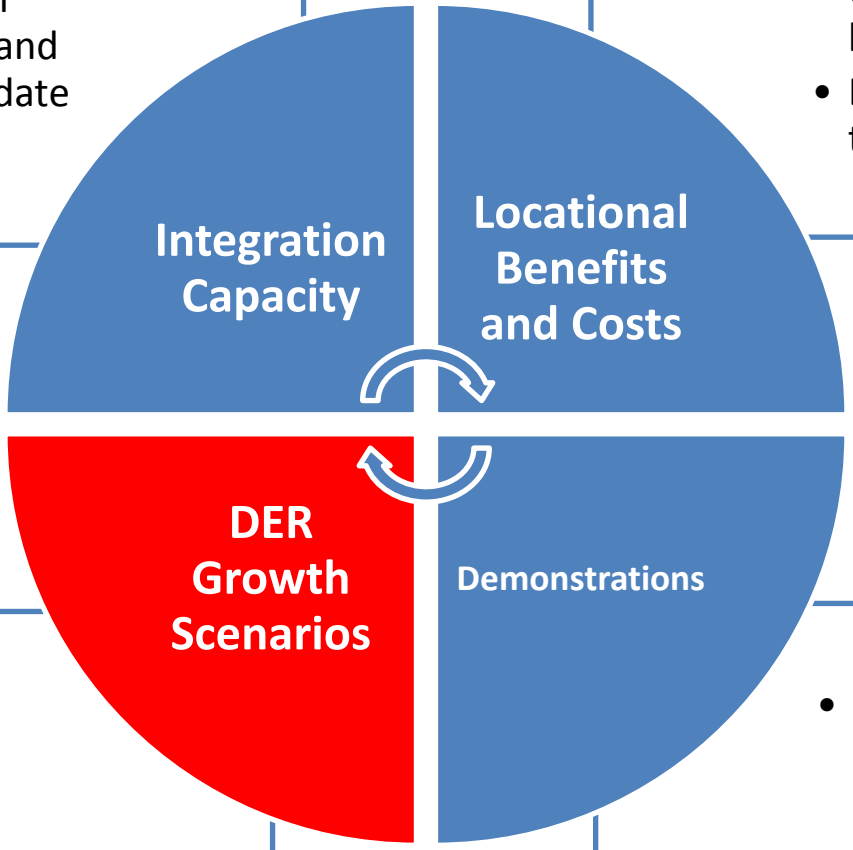


The Integrated Distribution Planning Process (IDPP) will be an annual process to identify distribution deficiencies that can be addressed with cost effective "Non-Wires" (DER) alternatives.

PG&E's Initial DRP serves as Technical Foundation for Integrating DERs into Planning and Operations

- Distribution feeder capacity to safely and reliably accommodate DER growth

- Quantification of DER locational value
- DER benefits and costs that impact rates



- Scenarios of DER portfolio growth
- Assess impacts to distribution grid

- Demonstration of DER integration into planning, operations and investment

DER Growth Scenarios

DER Growth Scenarios - Goal

- Better understand the magnitude and location of potential DER adoption to inform distribution system planning

PG&E Interpretation of DRP Guidance on DER Growth Scenarios

- **Scenario 1 - "Trajectory"**

  PG&E's best current estimate of expected DER adoption

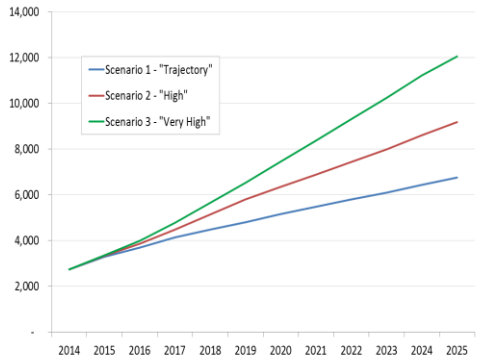
- **Scenario 2 – "High Growth"**

  Reflects ambitious levels of DER deployment that are possible with increased policy interventions and/or **technology/market innovations**

- **Scenario 3 – "Very High Growth"**

  Likely to materialize only with significant policy interventions such as: zero net energy (ZNE) requirements and deeper GHG reduction targets.

Approach to Developing DER Growth Scenarios



System-Level Forecasts Based On:

- Market analyst reports
- CPUC potential studies (EE)
- Existing procurement requirements
- Internal PG&E analysis

Geographic Dispersion/Allocation to Circuit Varied by DER:

- DG deployment allocated based on key adoption drivers identified through multivariate regression analysis
- Location-specific DR load reductions developed using established econometric models and experimental design techniques
- **EE location specific scenarios based on potential studies and allocations based on customer composition in local areas**
- Wholesale energy storage deployment allocated based on siting assumptions attributed to three generic project configurations

Key Findings

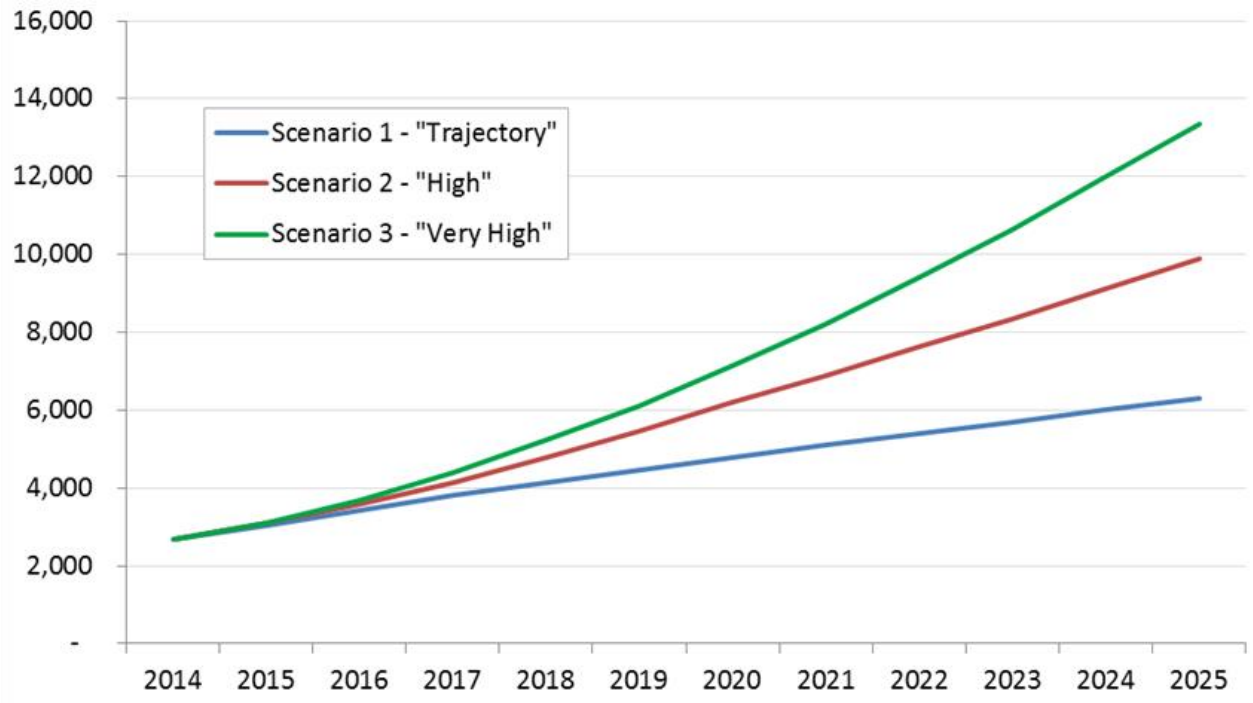
1. DER growth may result in a significant net reduction in peak load
2. **EE & Retail PV account for majority of DER capacity growth**
3. DER deployment is likely to be clustered
4. Understanding customer load and adoption patterns is important for estimating potential DER growth
5. Distribution system impacts from DER growth depend on:
    - Local load patterns
    - DER technology generation/operation profiles
    - DER communications, controls, dispatchability and services provided

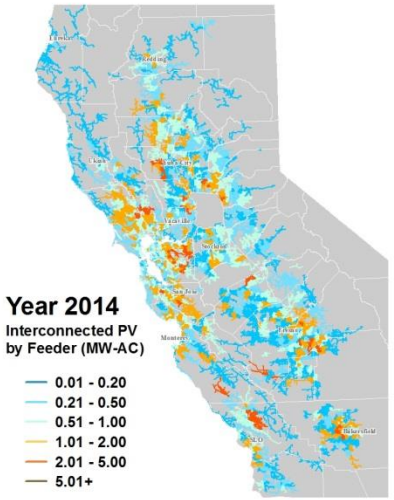
DER Growth Scenarios

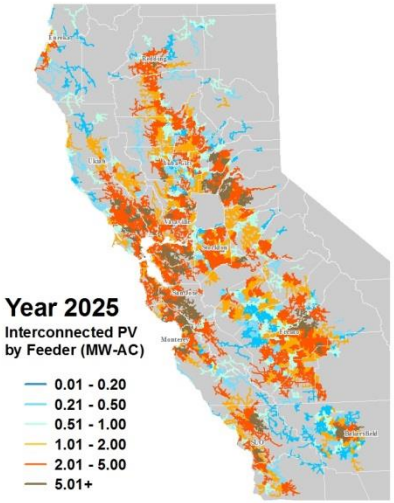
Scenario 1 – Trajectory: PG&E Expected (IEPR w/adjustment for PV and EV)
Scenario 2 – High: Significant policy interventions combined w/ tech./market innovations
Scenario 3 – Very High: Aggressive policy interventions such as:

- ZEV mandate
- ZNE
- 2030 GHG emissions reduction goals
- DR at 5% Peak

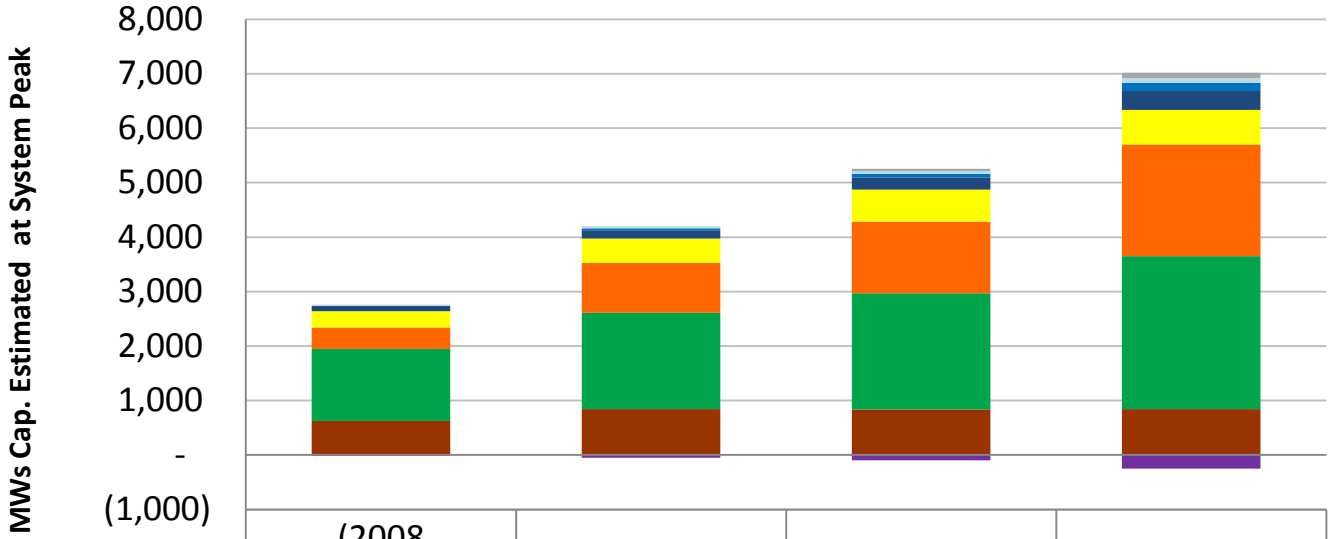
Cumulative MWs at PG&E System Peak (HE 17 Aug)







Finding 2: Estimated impact at peak greatest for energy efficiency and retail solar



	(2008 -2014)	2017	2020	2025
Distributed Wholesale Energy Storage	6	6	40	97
CHP from Feed in Tariffs	9.6	30	50	83
Retail Storage	7.4	34	68	156
Retail Non-PV DG	92	153	220	347
Wholesale DG	302	443	590	631
Retail PV	396	916	1,317	2,052
Energy Efficiency	1,318	1,770	2,134	2,809
Demand Response	627	845	834	841
Electric Vehicles	(16)	(48)	(95)	(248)

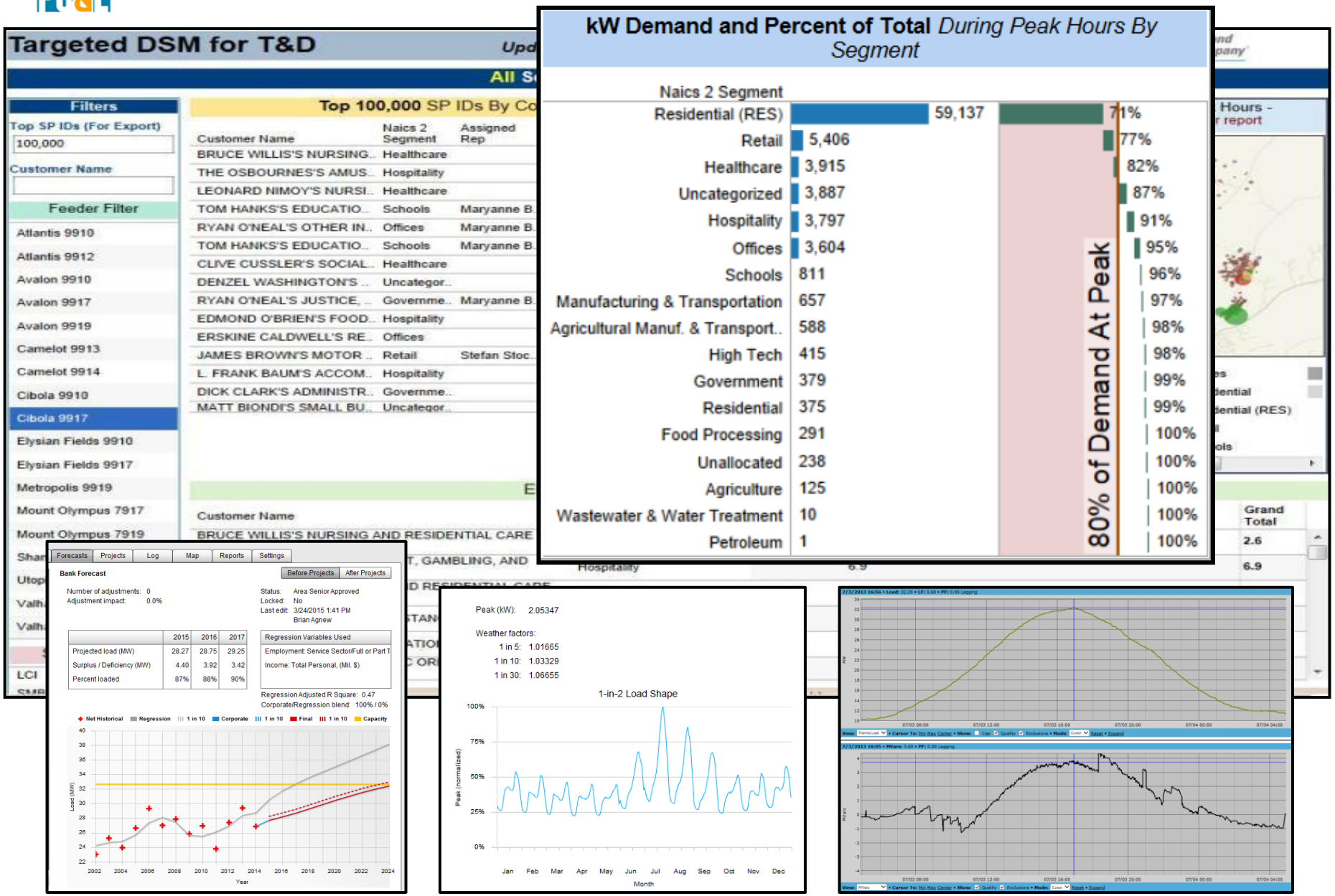
Key Uncertainties and Limitations

- Utility currently has limited visibility, operational control and ability to influence geographic location of DER assets
- Deployment is currently optimized on customer economics, not utility cost drivers
- Historical DER consumer behavior may not be indicative of future patterns
- DER adoption is heavily determined by uncertain future policy developments
- Limited sample size for some technologies constrains PG&E's ability to elicit general trends that can be applied across our service area

Enhancing the Distribution Planning Tools

EPIC 2.22 and EPIC 2.23

The Drill Down: Assessment and Tools



EPIC Project 2.23 -- Background & Overview

Project Objective

Enhance existing analytical tools (LoadSEER and CYME) to evaluate DER scenarios for integration into utility investment planning.

Concern, Problem, or Gap to be Addressed

1. Need to develop standardized and transparent distribution planning tools that incorporate DERs.
2. Need for significant engineer staff resources to perform “Ad Hoc” analysis for DER integration planning.

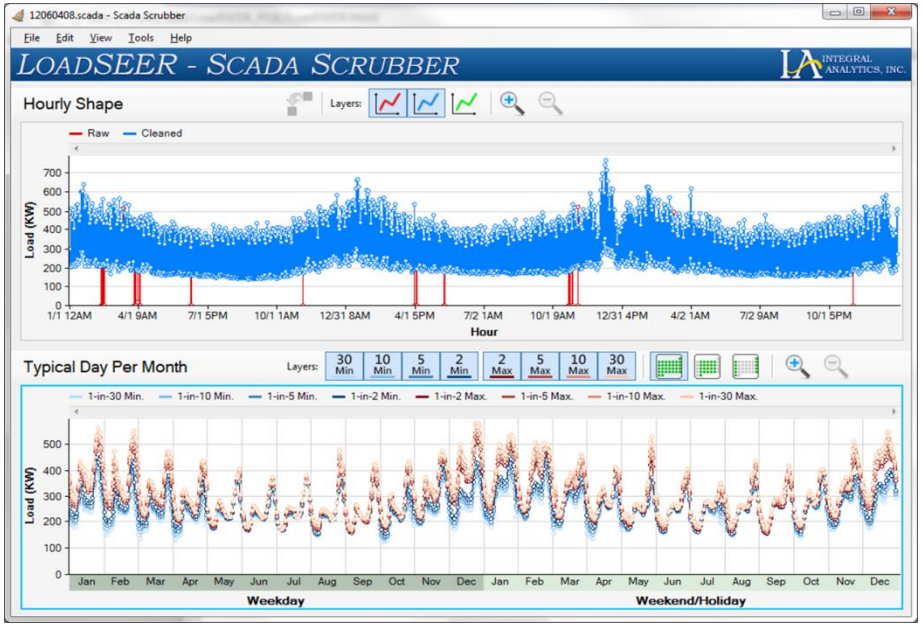
Key Deliverables

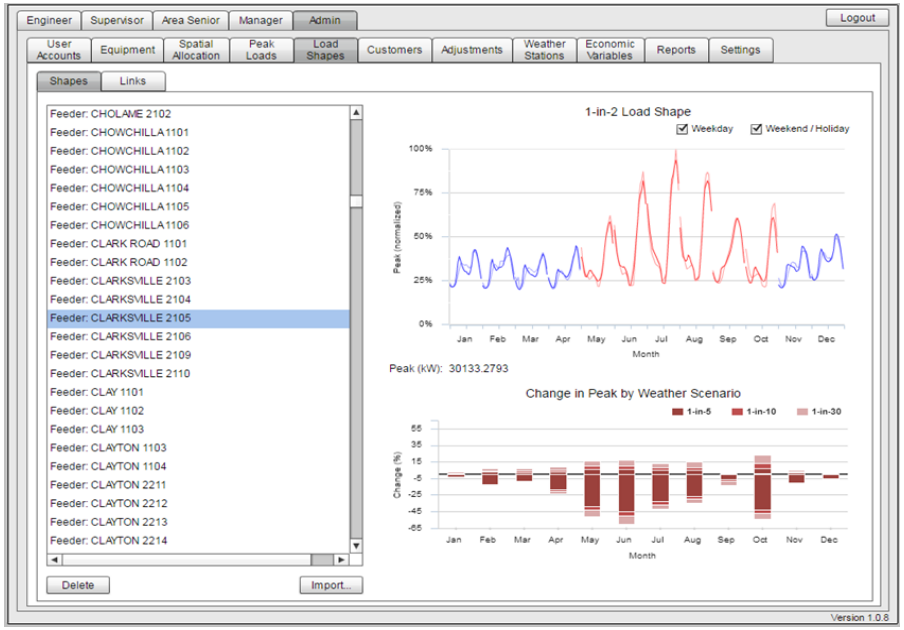
1. Enhanced catalog of customer load and DER shapes in LoadSEER to improve local area load growth forecasting.
2. Incorporation of multiple DER projection scenarios into LoadSEER to allow potential impacts of DERs to be studied in the planning process.
3. Build capability to incorporate a streamlined Integration Capacity Analysis (ICA) into LoadSEER and CYME.
4. Enhanced CYME circuit modeling to facilitate analysis of DERs and forecasted loads to greater spatial and hourly level.
5. Enhanced data transfer capabilities between LoadSEER and CYME and other data bases used for planning studies such as PI and TeraData (AMI data).

EPIC Project 2.23 -- Enhanced Load Shapes Catalogue

Transferred historical interval data to vendor with typical monthly/daily load shapes for each feeder

Incorporated circuit load shape and customer class load shapes into LoadSEER



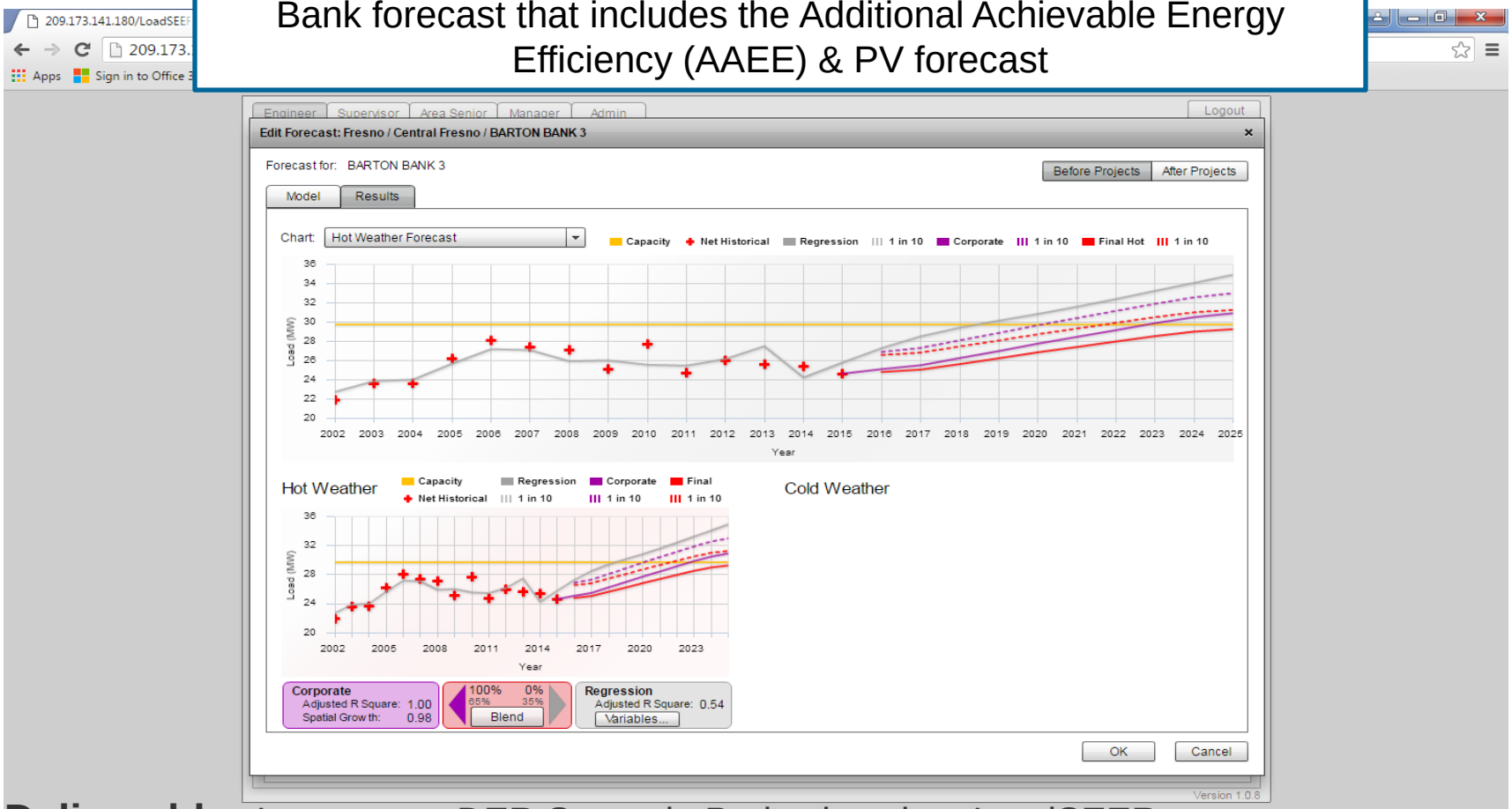


Deliverable: Develop enhanced Customer and DER Load Shapes Catalog in LoadSEER Planning Tool.

- *Significance:*
  - Successfully combined available SCADA load information data with 3 years of historical interval meter data for ***all 5 million PG&E electric customers.***
    - Currently only have 4 customer load shapes for each of the 255 Distribution Planning Areas (DPAs).
  - With 3,200+ feeders, this deliverable will **create a catalog of ~320,000+ load shapes** that creates a granular load shape, specific to each feeder. In future iterations, ability to create custom load shapes.

EPIC Project 2.23-- Incorporation of DER Growth Scenarios

Bank forecast that includes the Additional Achievable Energy Efficiency (AAEE) & PV forecast



Deliverable: Incorporate DER Scenario Projections into LoadSEER

- *Significance:*
  - Provides transparent and consistent insight into which DER penetration scenarios (e.g. “high DG penetration” or “high EE penetration”) can mitigate potential feeder, bank or DPA overload.

Engineer | Supervisor | Area Senior | Manager | Admin | Logout

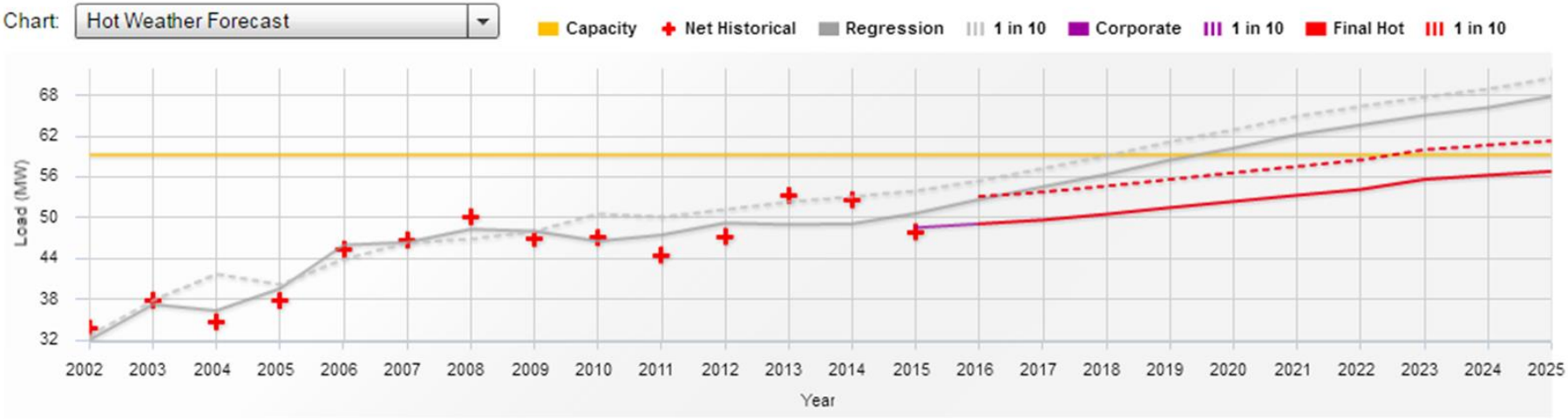
Edit Forecast: Fresno / Central Fresno / ASHLAN AVENUE BANK 2

Forecast for: ASHLAN AVENUE BANK 2

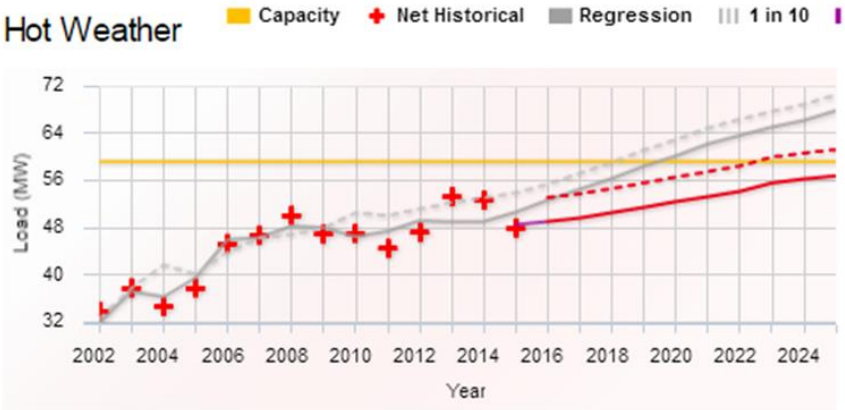
Before Projects | After Projects

Model | Results

Chart: Hot Weather Forecast



Hot Weather



Cold Weather

Corporate
Adjusted R Square: 0.71
Spatial Growth: 0.67

100% 0%
45% 55%
Blend

Regression
Adjusted R Square: 0.83
Variables...

OK | Cancel

Version 10.8

Engineer | Supervisor | Area Senior | Manager | Admin | Logout

Edit Forecast: Fresno / Central Fresno / ASHLAN AVENUE BANK 2 ×

Forecast for: ASHLAN AVENUE BANK 2

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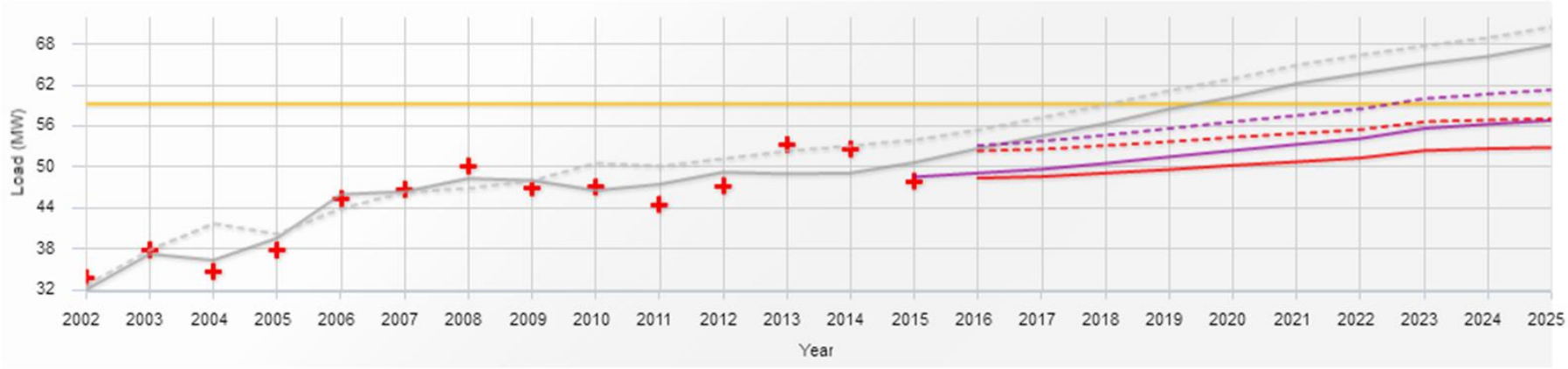
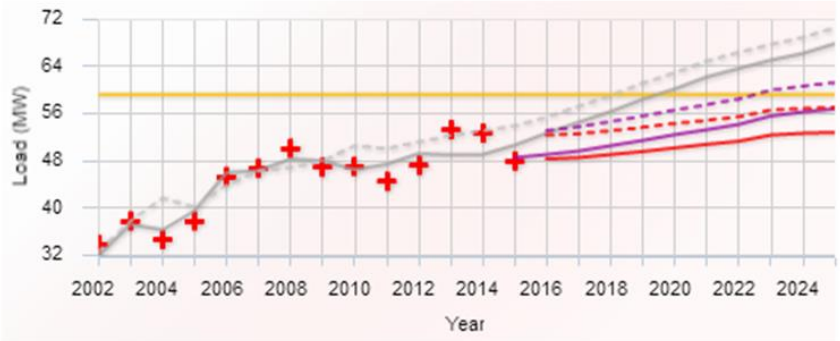
Chart: Hot Weather Forecast

Capacity | Net Historical | Regression | 1 in 10 | Corporate | 1 in 10 | Final Hot | 1 in 10



Hot Weather

Capacity | Net Historical | Regression | 1 in 10



Cold Weather

+AAEE

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Variables...

OK | Cancel

Version 10.8

Edit Forecast: Fresno / Central Fresno / ASHLAN AVENUE BANK 2

Forecast for: ASHLAN AVENUE BANK 2

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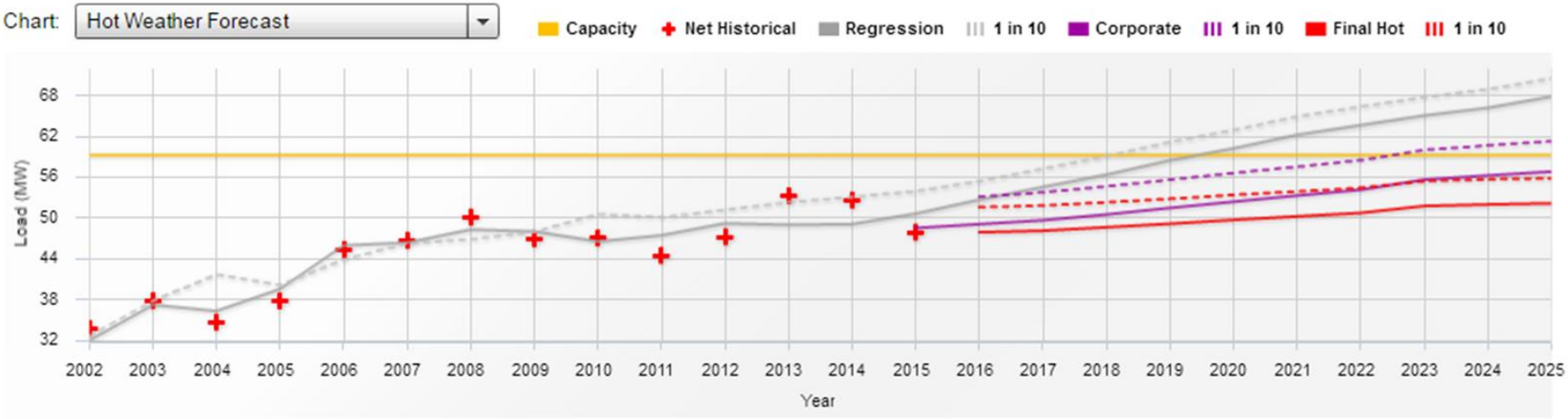
Chart: Hot Weather Forecast



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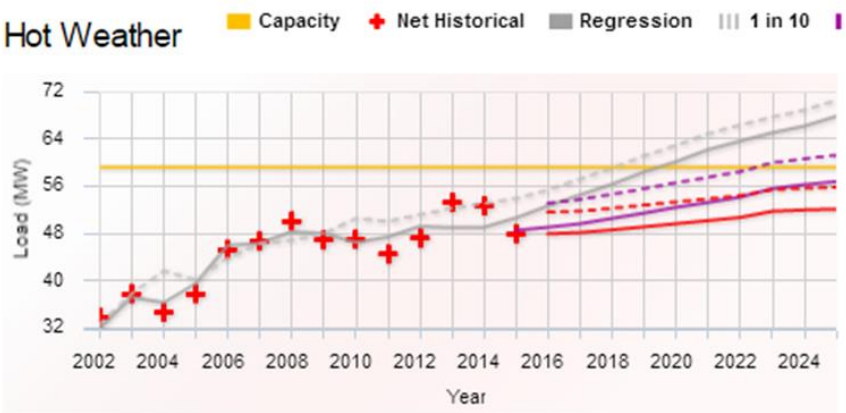

Cold Weather

+AAEE +DG

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100% 0%
45% 55%
Blend

Regression
Adjusted R Square: 0.83
Variables...

OK | Cancel

***Learn about California's leading model for energy efficiency and how PG&E works with customers and partners to achieve success in saving energy*.**

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Thank you!