DR Emerging Technology:

Baseline Assessment

Load Shifting Working Group – June 19, 2018

Together, Building
a Better California

PG&E's Objectives

PG&E commissioned SLAC/Stanford to:

1. Conduct a baseline assessments that quantify loads accurately for each customer and variety of aggregations for supply side (possibly for distribution or other grid services served by customers and BTM technologies). The intent is to identify deficiencies, if any, with the existing and proposed methods under CAISO's ESDER Phase 2 in order to propose ways to improve these methodologies.
2. Look at how existing and CAISO ESDER phase 2 baselines could apply to a **dispatchable load shift/ take/charge DR model**.
3. Look at existing and CAISO ESDER phase 2 baselines are adequate to handle ***frequently* dispatch resources**.
4. Identify and assess the pros/cons of **premise based calculation vs device specific** (sub-meter).

As a result, SLAC/Stanford's research should help better understand residential and non-residential availability for DR, whether single or aggregated resources.

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GISMO Grid Integration, Systems & Mobility

PG&E Baseline Study

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Overview

1) Goal of the Project
2) Methodology
    a) Baselining Methods in Scope
        i) Weekday
        ii) Weekend
    b) Accuracy Metrics
    c) Data
        i) Phase 1 - DR participants
        ii) Phase 2 - + Non-DR participants
        iii) Phase 3 - + Excess Supply Participants
3) Phase 1 Data summary
4) Preliminary Results
5) Next Steps

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Goals of the Project

1) Identifying the accuracy (Mean Percentage Error) and precision (Coefficient of variance and Mean Absolute Percentage Error) of each proposed baselining method for different customer segments
2) Exploring improvements to existing methods
    a) ESDER baselines
    b) Machine Learning-based forecasting applications
    c) Regression Models

Weekday Baselining Methods

- 10-in-10 Eligible
  - No Adjustment
  - Adjustment with upto 50% Cap
- 3-in-10 Eligible
  - No Adjustment
  - Adjustment - upto 50% Cap
- Temperature
  - 4-in-90 Any
  - 5-in-10 Eligible
  - 10-in-10 Eligible

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			-10	-9	-8	
	-7	-6	Holiday	-5	-4	
	-3	-2	-1	**DR Event**		

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Weekend (+Holiday) Baselining Methods

- 10-in-10 Eligible
  - No Adjustment
  - Adjustment - upto 50% Cap
- 3-in-10 Eligible
  - No Adjustment
  - Adjustment with upto 50% Cap
- Temperature
  - 4-in-90 Any
  - 3-in-5 Eligible
  - 4-in-4 Eligible

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
-9						-8
-7						-6
-5						-4
-3			Holiday -2			-1
DR Event						

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Other methods being developed and tested

- ESDER baselines
  - Control Group
  - Day Matching
  - Weather Matching
- ML-based forecasting methods:
  - Decision Tree Regressor
  - Adaptive Boosting Regressor composed of Decision Tree Regressor
  - Ordinary Least Squares (OLS)
  - Least Absolute Shrinkage and Selection Operator (Lasso) model using Bayes Information criterion
  - Linear model fitted by minimizing a regularized empirical loss with Stochastic Gradient Descent (SGD)
  - **Support Vector Regression (SVR)**
  - Long-Short Term Memory based Deep Learning Model
- Regression Models (Time-of-week)

Accuracy/Precision Metrics

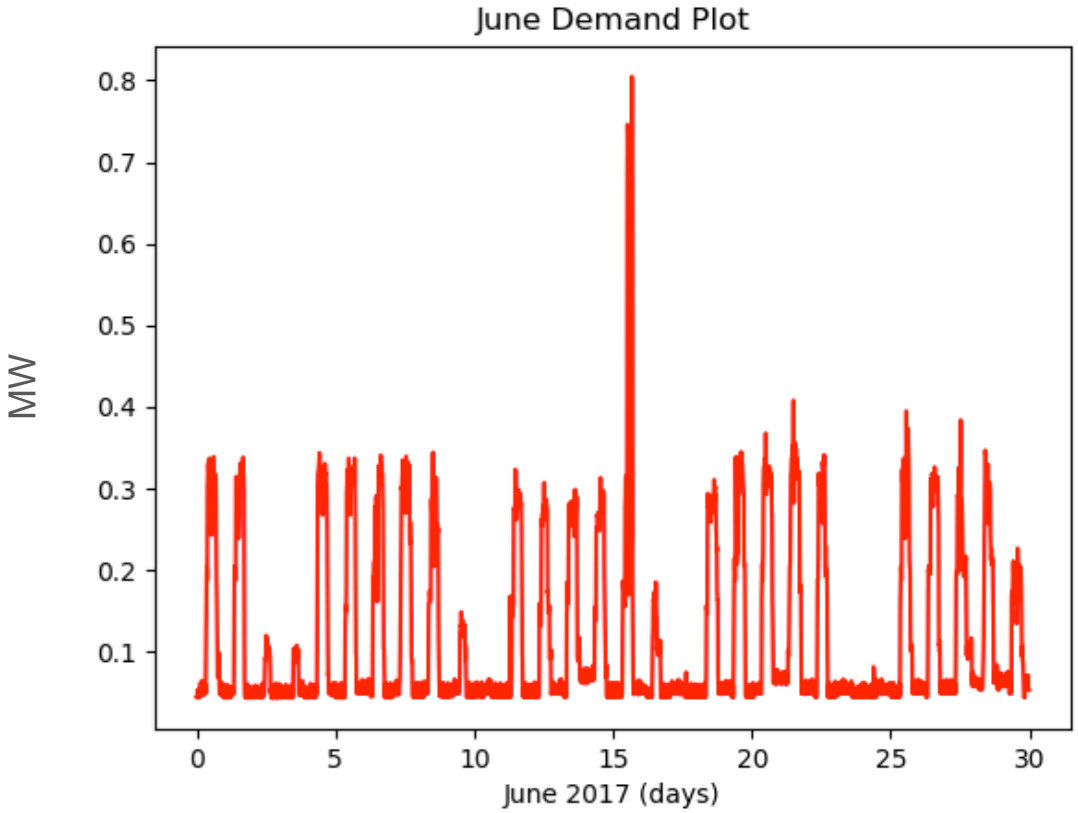
Type of Metric	Metric	Description	Mathematical Expression
Accuracy (Bias)	Mean Percent Error (MPE)	Indicates the percentage by which the measurement, on average, over or underestimates the true demand reduction.	$MPE = \frac{\frac{1}{n}\sum_{i=1}^{n}(\hat{y}_i - y_i)}{\bar{y}}$
Precision (Goodness-of-Fit)	Mean Absolute Percentage Error (MAPE)	Measures the relative magnitude of errors across event days, regardless of positive or negative direction.	$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left\|\frac{\hat{y}_i - y_i}{y_i}\right\|$
	CV(RMSE)	This metric normalizes the RMSE by dividing it by the average of the actual demand reduction.	$CV(RMSE) = \frac{RMSE}{\bar{y}}$

Initial Data from Demand Response Participants

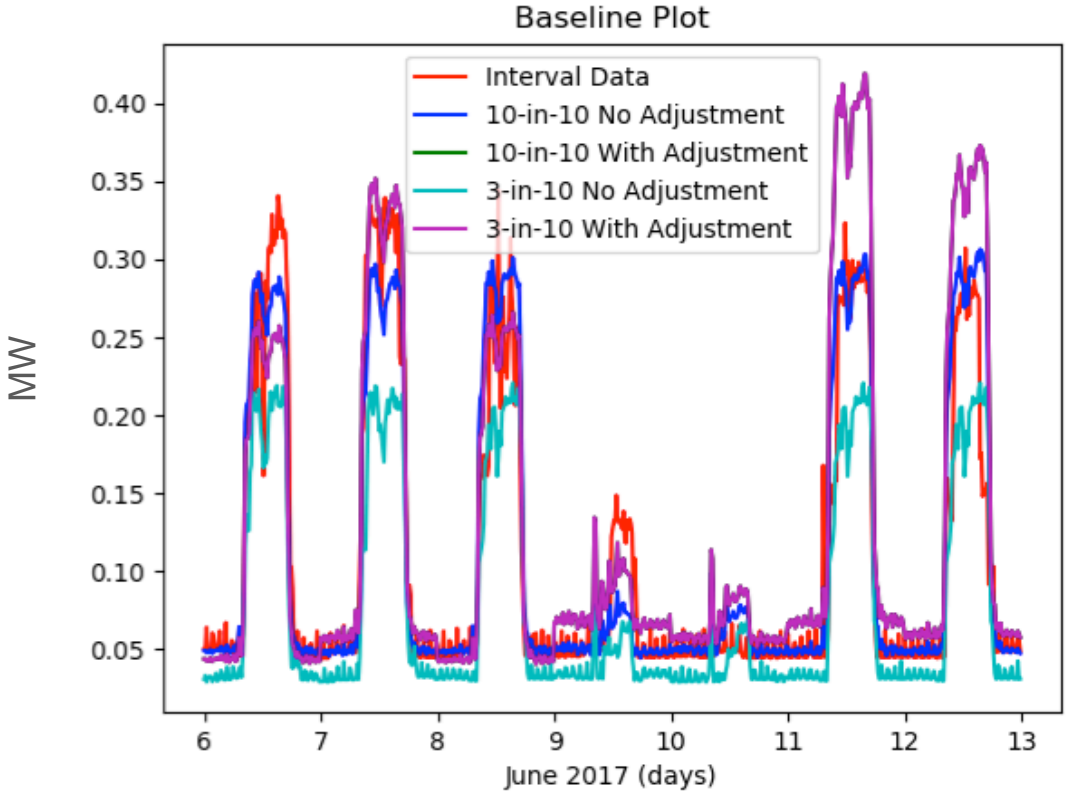
Program	# of Meters	
- Aggregator Managed Portfolio	4,994	15 min data
- Capacity Bidding Program	2,433	
- Base Interruptible Program	559	
- Peak Day Pricing	391,842	
- SmartAC	251,305	Hourly data
- SmartRate	275,291	

We are gathering additional data from non-DR participants and excess supply pilot

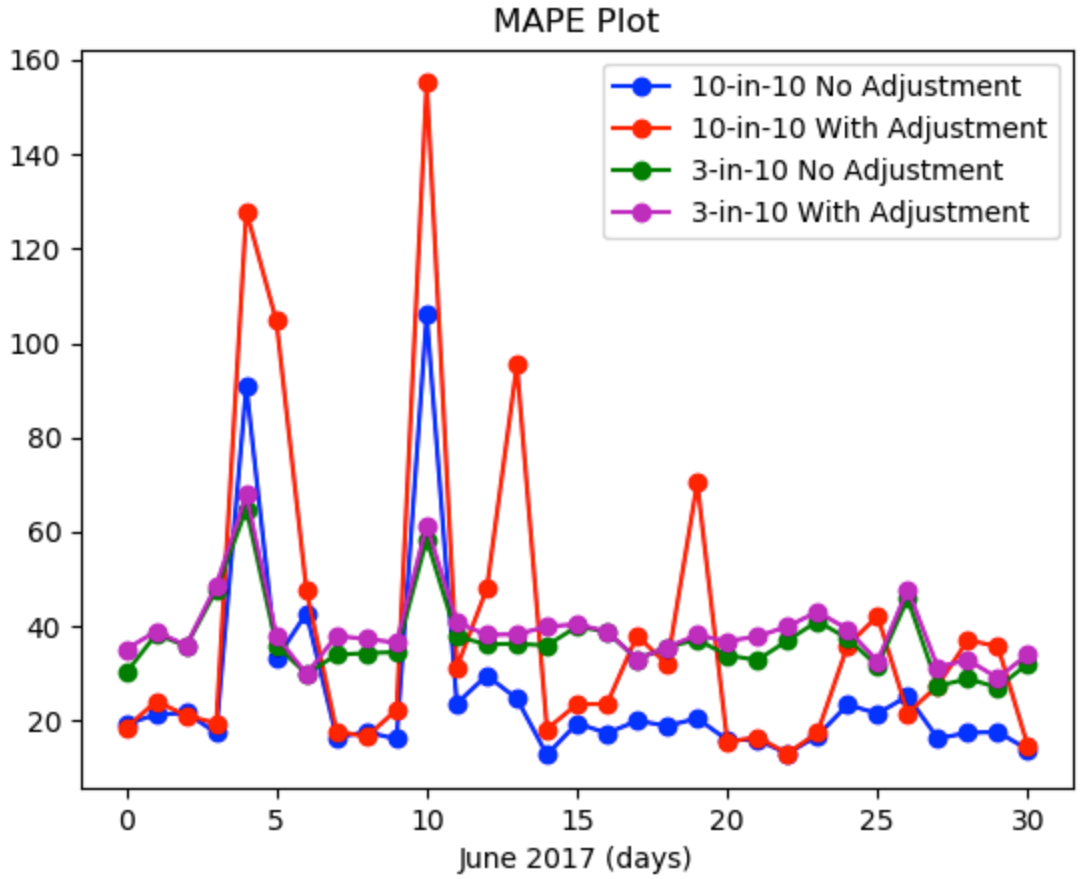
Preliminary calculations - Demand plot for June 2017



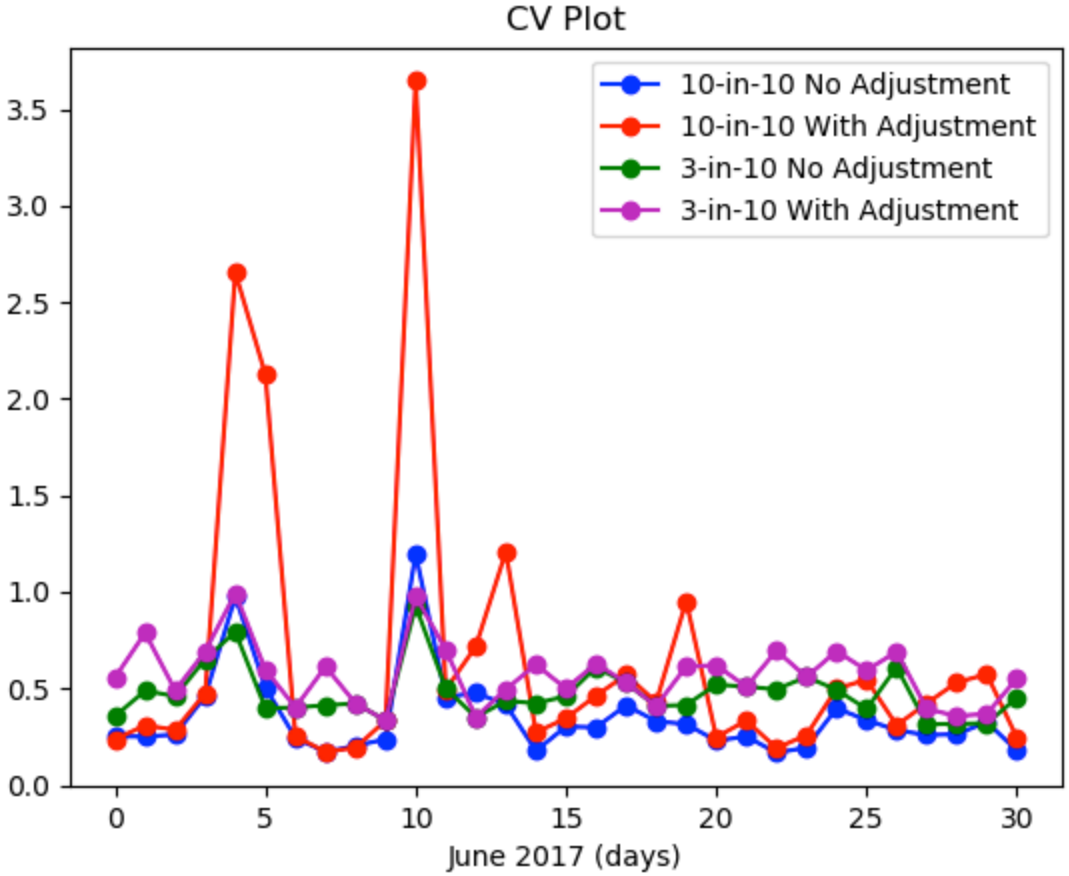
Preliminary calculations - Demand and baseline plot for one week



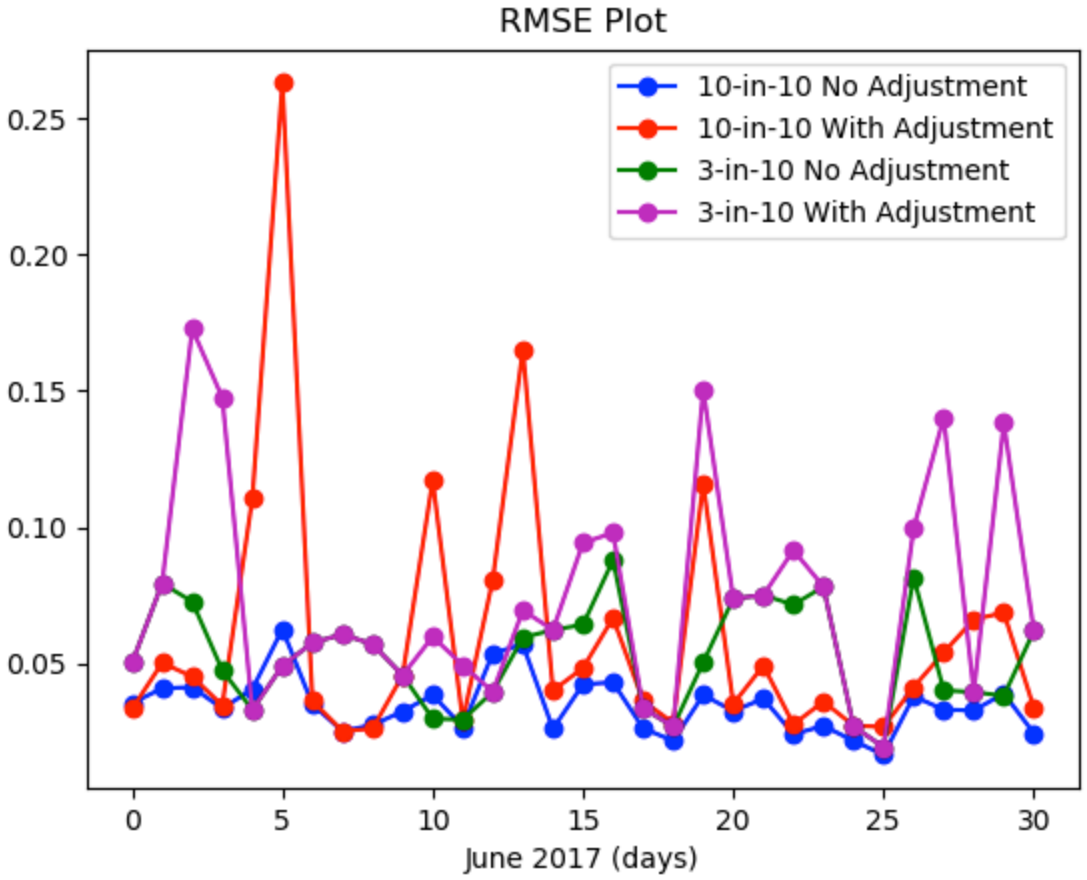
Mean Absolute Percentage Error



Coefficient of Variation



Root Mean Square Error



Next Steps and Future Research

Phase 1 is being completed end of June

Phase 2 and 3 are going to be completed by the end of summer

Research Questions:

Impact of clustering – changes in customer loads?

Impact of more frequent dispatch – addition of more “DR events”

Load shed vs. Load increase – adjustment factor gaming?

Device specific baselines – baseline gaming?