Energy Performance Program

Measurement & Verification Technical Guide

September 2019

Agenda

- Program Overview and Eligibility
- Baseline Model Basics
- Submission Requirements
  - Model Requirements
- Savings Calculation
- Baseline Adjustments in the Pay-for-Performance Period
- Examples
- Helpful Templates (https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Energy-Performance-Program)

Program Overview

- Program provides customers with Commercial & Institutional facilities located in the Province of Ontario with the opportunity to receive energy efficiency incentives on a pay-for-performance basis.
- Participants receive $0.04/kWh of sustained savings every year for up to two (2) and a half consecutive years.
- Savings measurement and verification (M&V) is performed at the whole-building level, comparing metered consumption to the baseline established by a building-specific energy model.
- For each Pay-for-Performance Period, the Performance Incentive for each Facility will be limited by maximum savings equal to 20% of the annual electricity consumption for the period used to establish the Facility's Baseline Energy Model.

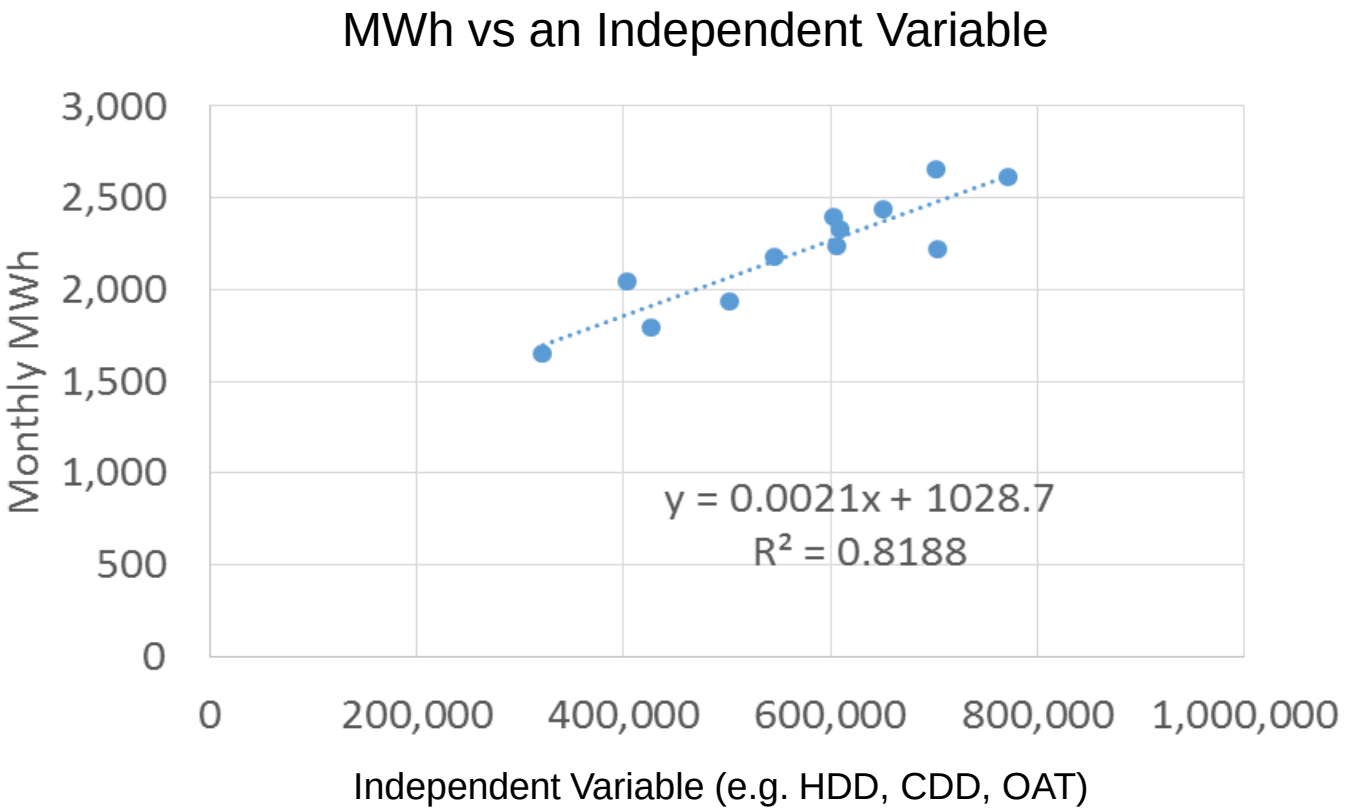
Program Overview Cont'd

- Individual Facility with historical annual consumption ≥ 1,500,000 kWh, and available 24 months of hourly metered data.
- Up to 5 similar types of buildings can be aggregated into a single energy model (with annual consumption ≥ 1,500,000 kWh).
- Commit buildings to participate for at least two years and plan to realize at least 5% energy savings per building.
- Participating buildings are ineligible for other Save on Energy programs (with exception of Energy Manager incentives). Such buildings may participate but must make baseline adjustments.
- Participants are entitled to receive a Modelling Incentive of $1,500 for each approved Facility, up to a maximum of $15,000 for 10 Facilities.

Energy Baseline Models

- Energy baseline models are not that complex
- Past consumption used to build a straightforward model
  - Normalizing consumption to occupancy, weather, etc.
- Model predicts energy consumption
- Actual consumption relative to predicted shows savings
- IPMVP Option C approach

Energy Baseline Models are Typically Straightforward



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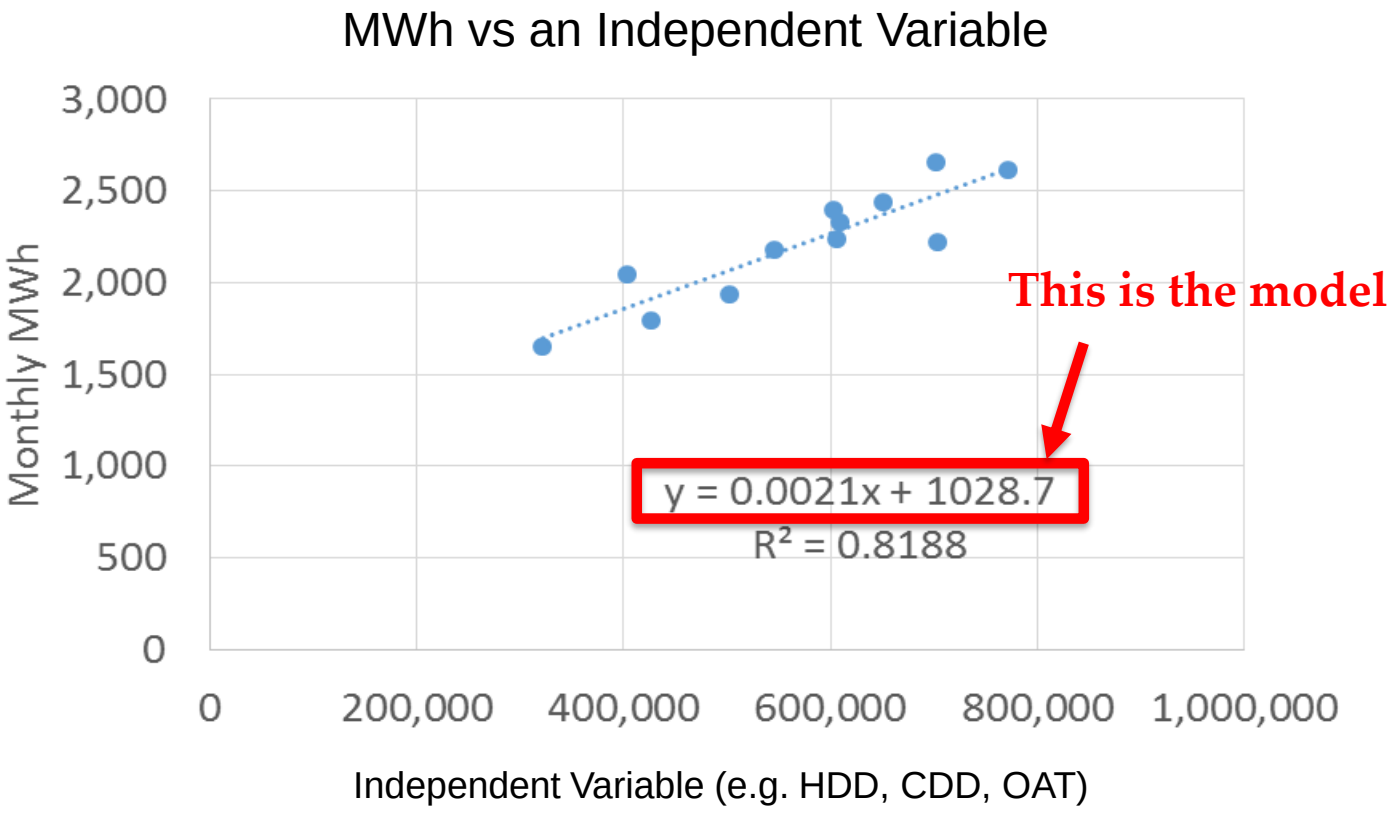
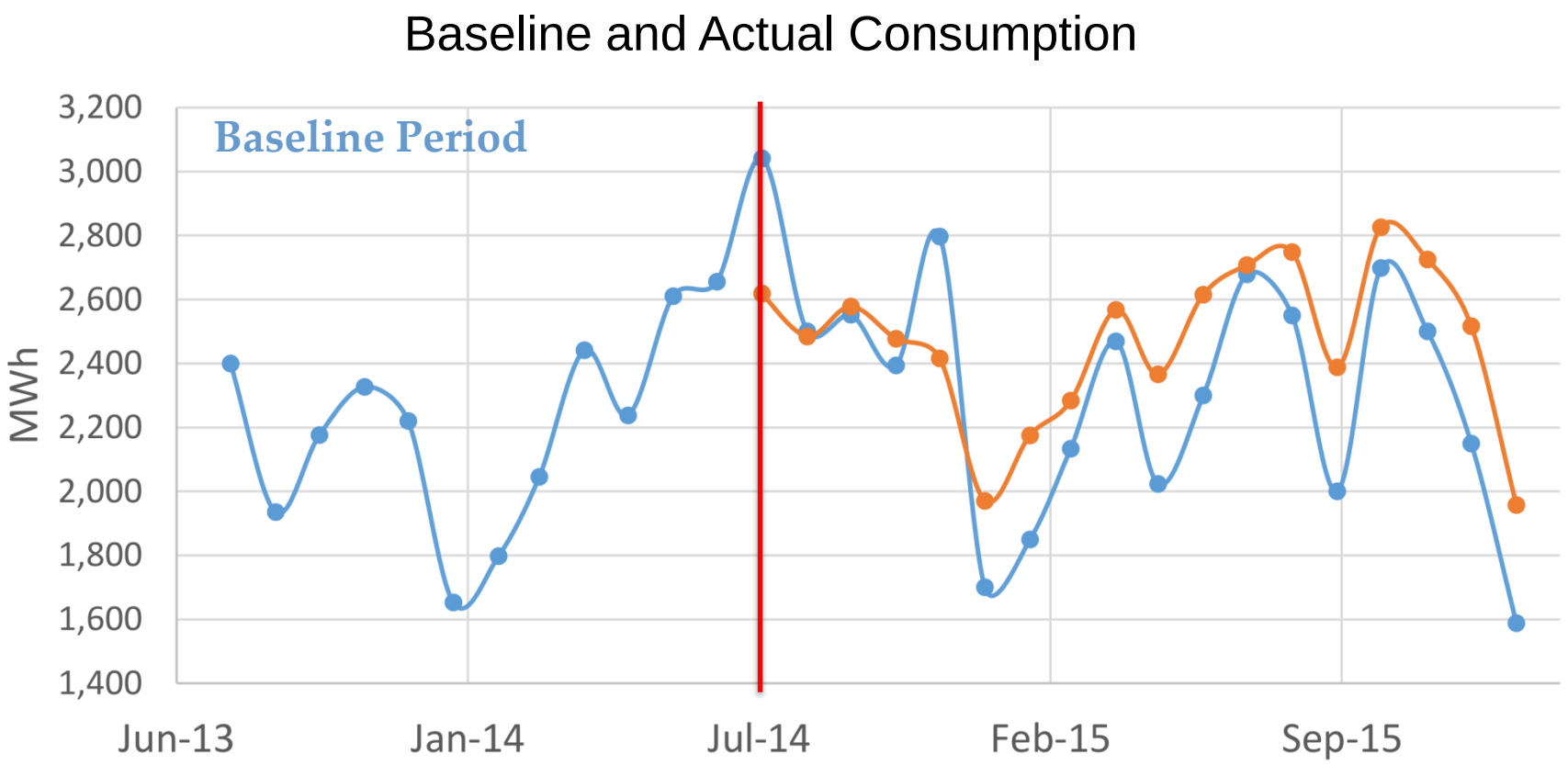


Baseline vs Actual Consumption



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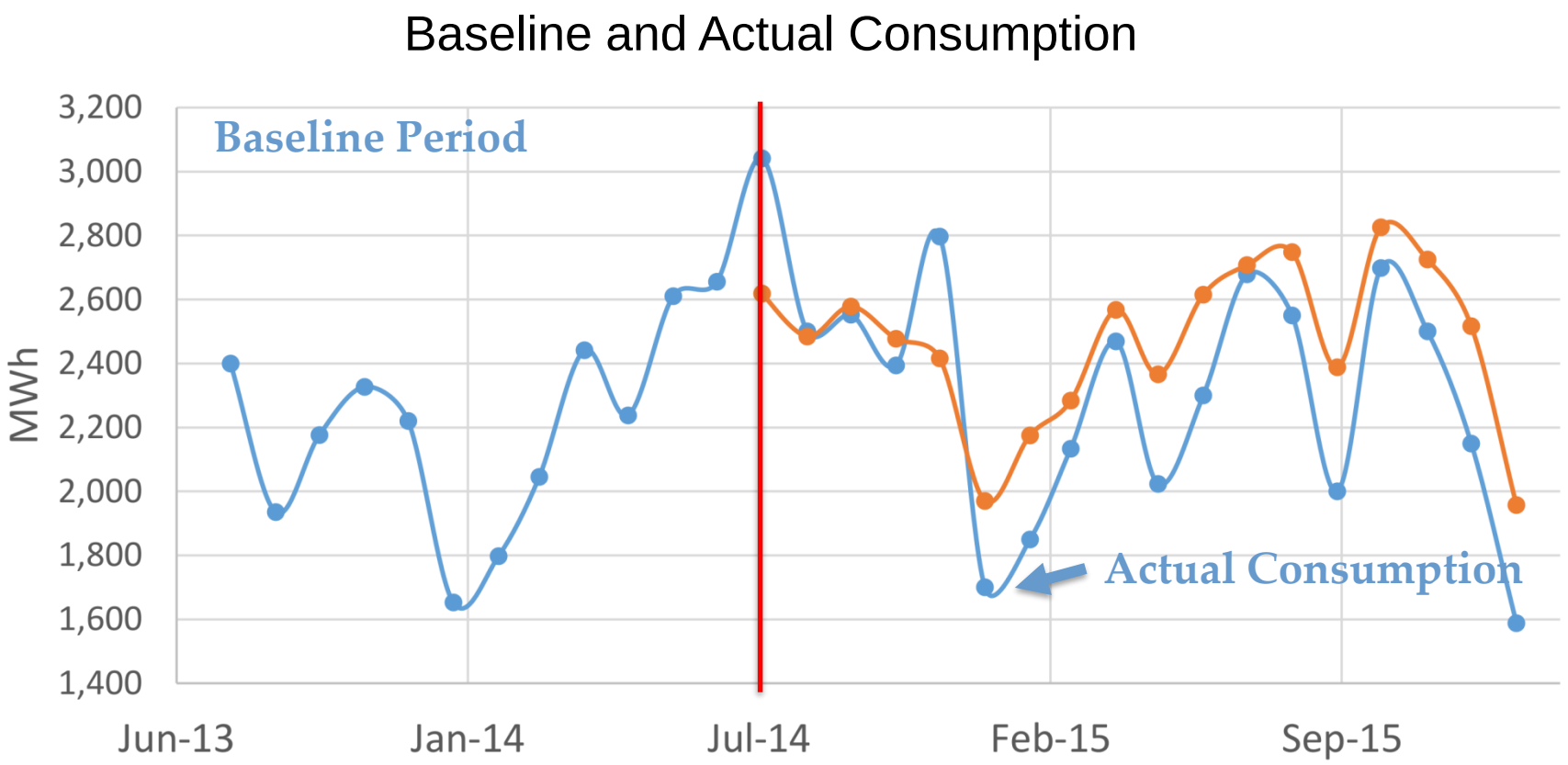

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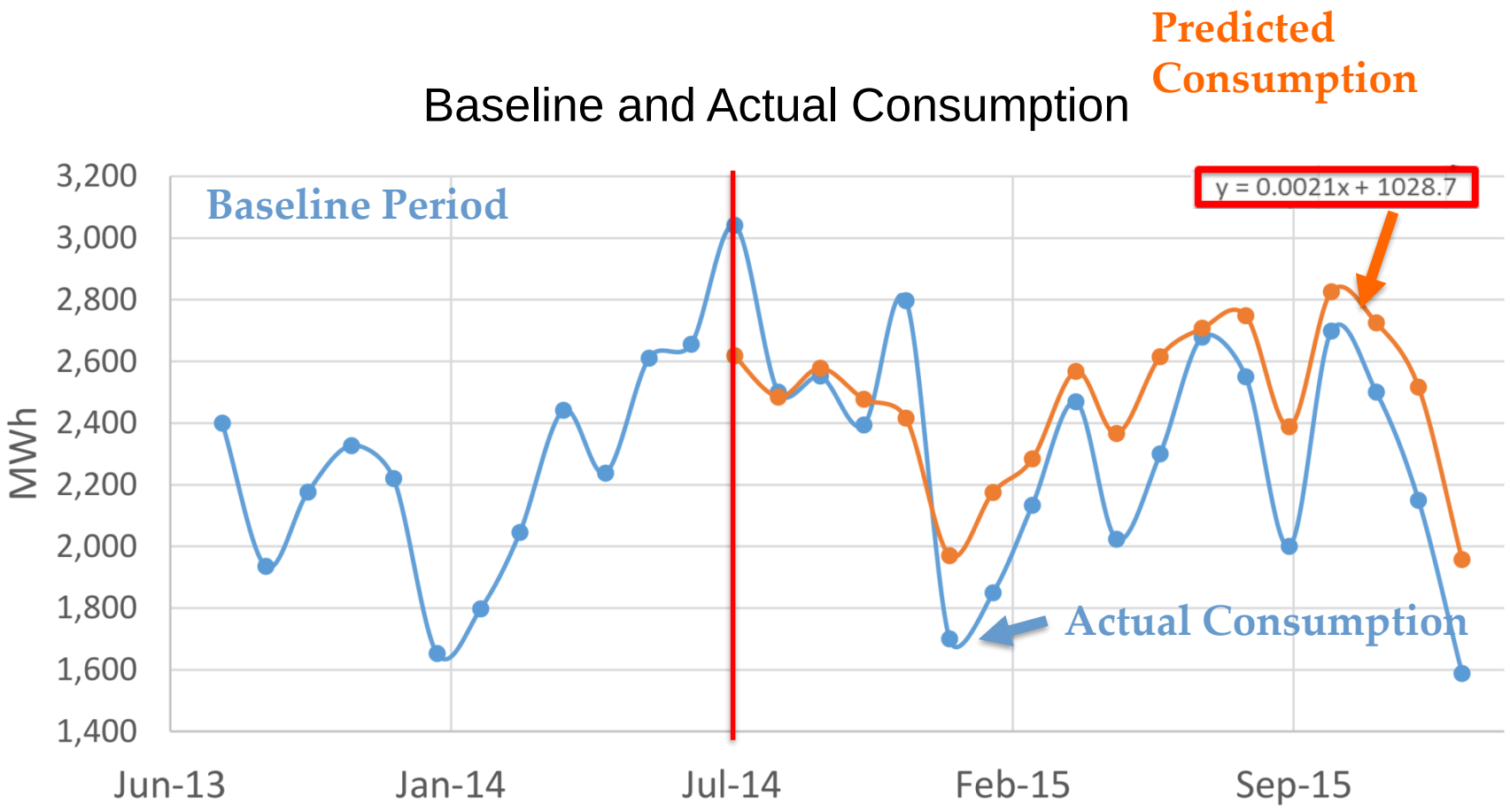

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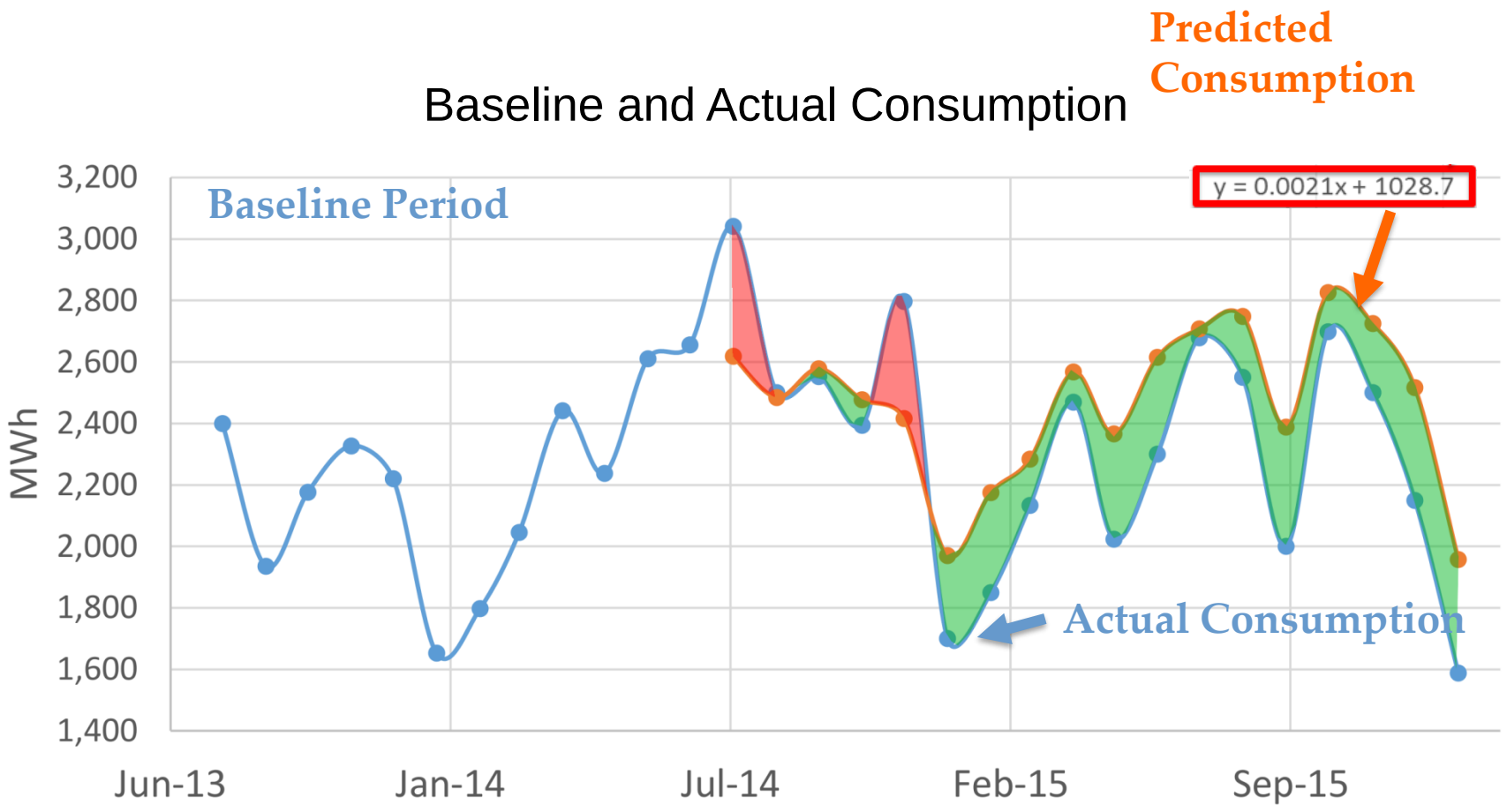


M&V Template Sample

Timestamp (hourly)	Electricity Consumption (kW)	Variable 1	Variable 2	…

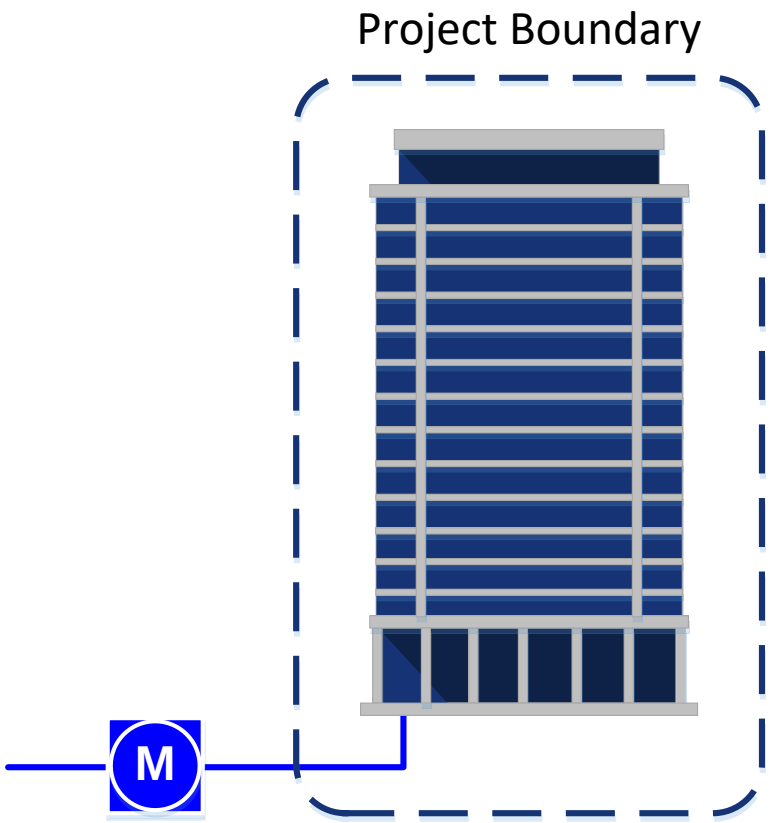
Statistics	Model Statistics
# of Data Points	
RMSE	
CV(RMSE)	
NDBE	
R2	

Statistics	Variable 1	Variable 2	…	Intercept
Coefficient				
T-statistic				

Submission Requirements

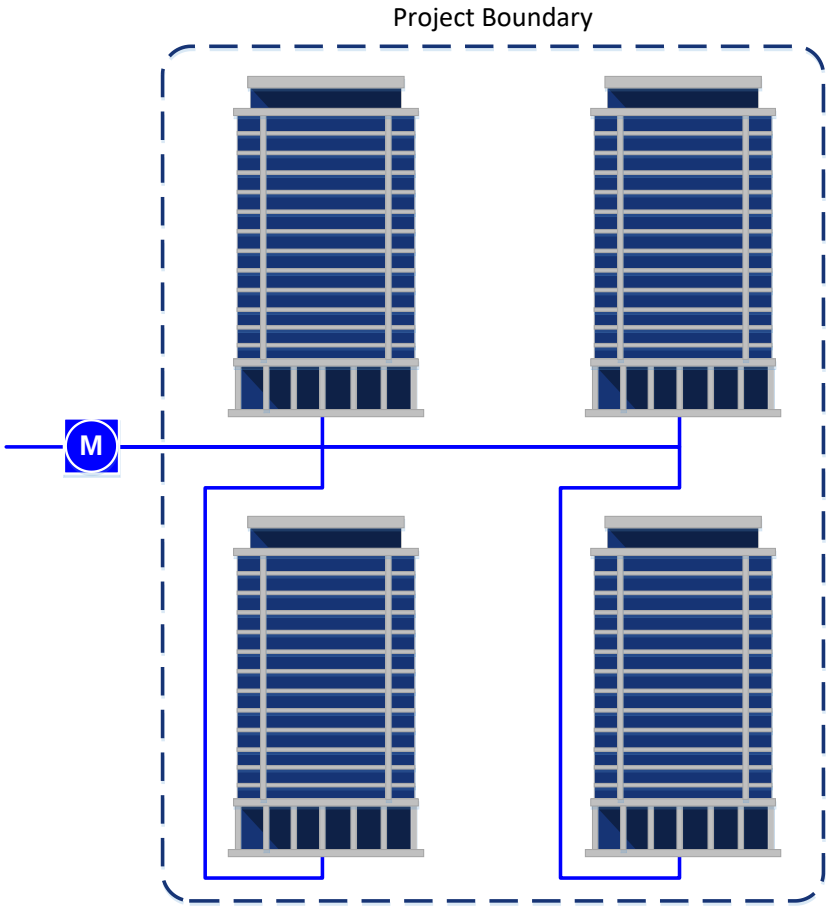
- Project Boundary
- Data Requirements
- Model Description
  - "Approval will be contingent upon a clear understanding of the Baseline Energy Model…"
- Model Statistics

Project Boundary: Stand-alone building

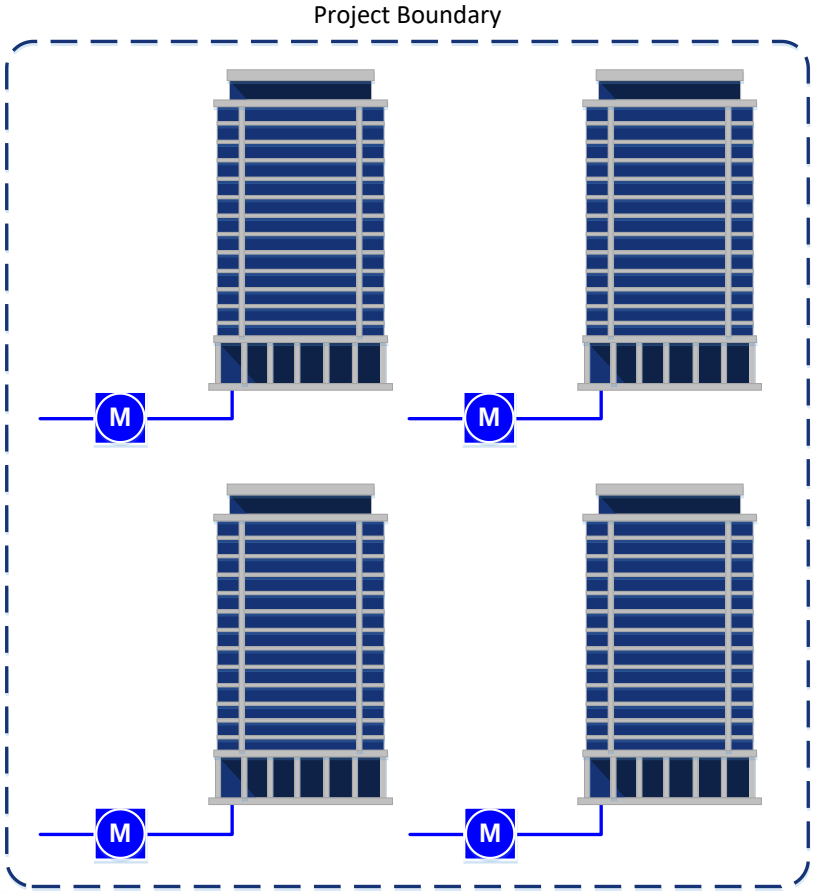


- All the building's general service accounts must be included

Project Boundary: Multiple Buildings, one meter

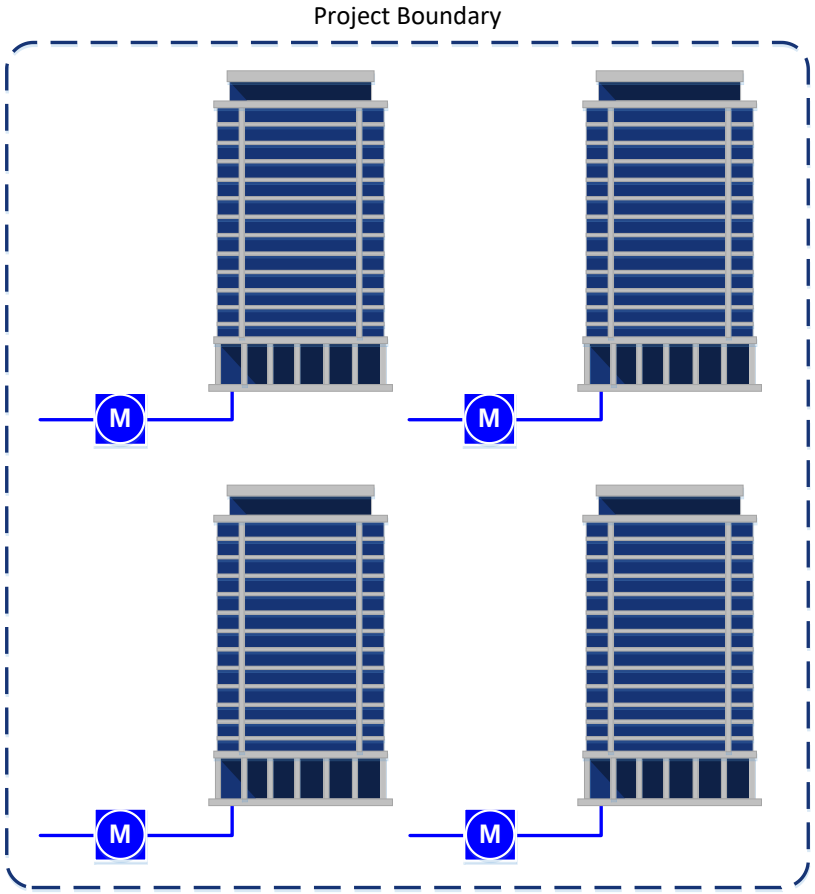


Project Boundary: Multiple Buildings, multiple meters



- Aggregate Facility

Aggregate Facilities



- Similar type buildings, load profiles
- Single weather station
- Must all be served by General Service accounts
- Maximum of five buildings per Facility
- No individual building above 1,500 MWh/year

Data Requirements

- 24 months of hourly electricity data
  - Measurement Canada approved metering
    - LDC meters are certified
    - All submeters used must have been tested and sealed by an accredited Measurement Canada meter shop, and have had Measurement Canada S-E-04 inspection by a firm accredited by Measurement Canada
  - Not ending more than 5 months prior to application

Data Requirements

- Independent variable data must be verifiable
  - Weather data
    - Environment Canada or NASA but not both with the same application
  - On-site data
    - Automatically and continuously recorded, source data provided
  - Occupancy data: A special case
    - Must be automatically and continuously recorded
    - Rooms rented per day may count
  - Vacancy (rental vacancy) is not acceptable
  - Daily or better time resolution

Model Requirements: Reproducibility

- Model must be reproducible in a spreadsheet
  - No black box models
    - Modelling software, e.g. RETScreen Expert permitted
    - Raw data, model equation, etc. must still be submitted
  - Data must be available and model stats must be reproducible

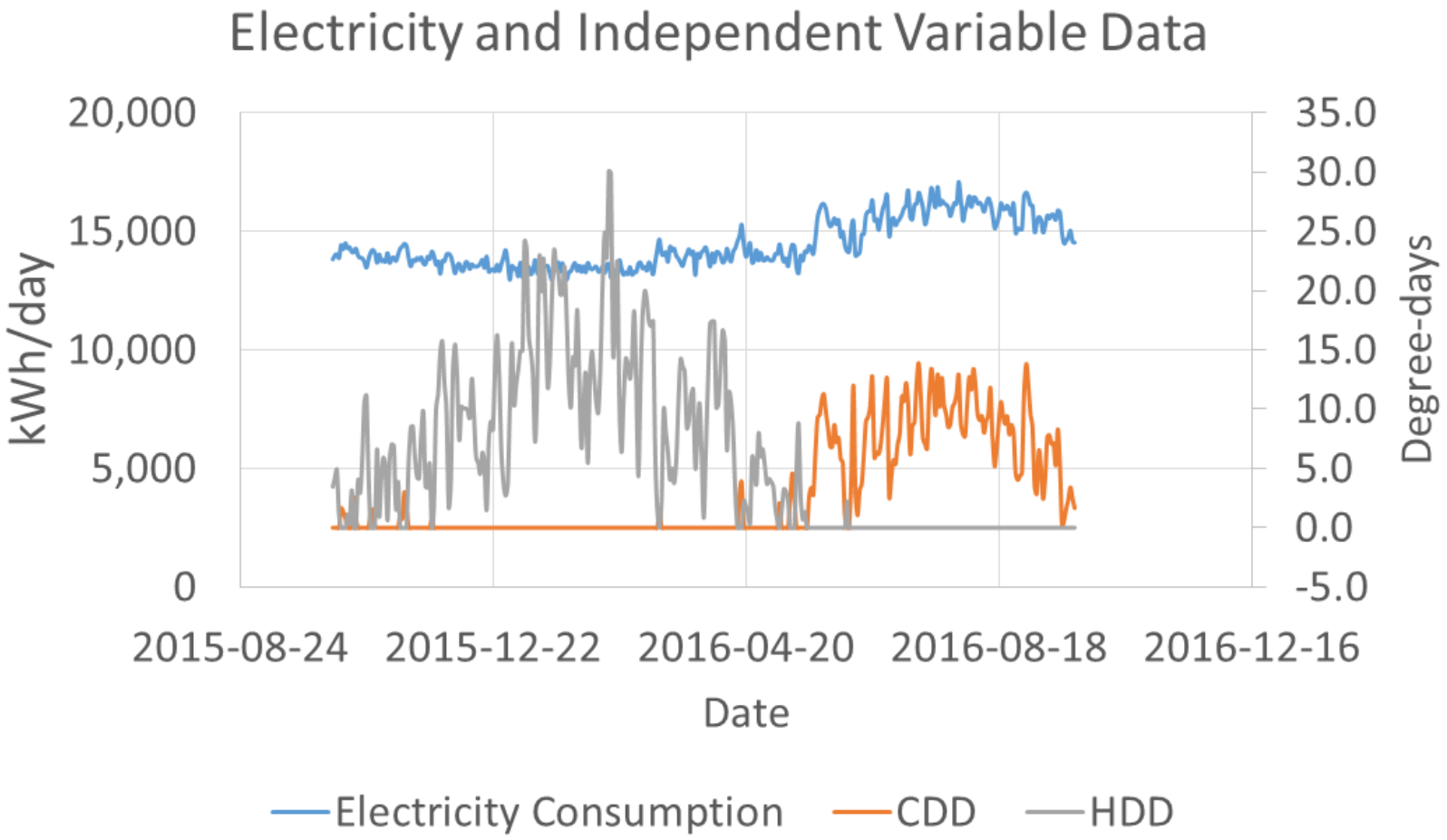
Model Requirements

- Most recent 12 months data
  - Not necessarily hourly data
  - Not 24 months
  - Not ending more than 5 months prior to Application
- Model description must provide the basis for the model and model statistics
- Model output data must be daily granularity or better

Multiple Regressions in a Model

- A single time period can have multiple regression models
  - E.g. Weekday vs weekend
- Where it makes sense, break up the year

Example Baseline Model



Example Baseline Model

SUMMARY OUTPUT								
Regression Statistics								
Multiple F	0.963913							
R Square	0.929128							
Adjusted I	0.928722							
Standard E	276.3124							
Observati	352							
ANOVA								
	df	*SS*	*MS*	*F*	*gnificance F*			
Regressio	2	3.49E+08	1.75E+08	2287.697	2.6E-201			
Residual	349	26645646	76348.56					
Total	351	3.76E+08						
	Coefficients	*andard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	14065.08	28.4833	493.8009	0	14009.06	14121.1	14009.06	14121.1
0	197.4998	4.294719	45.98665	3.6E-150	189.053	205.9465	189.053	205.9465
3.458334	-37.064	2.624508	-14.1223	3.92E-36	-42.2258	-31.9021	-42.2258	-31.9021

Example Baseline Model

- Run Multiple Linear Regression

Model Equation: $Y = 197 * CDD - 37\ HDD + 14{,}065$

$R^2 = 0.92$

Tstat for CDD = 46.0, Tstat for HDD = -14.1

Example Baseline Model

- Run Multiple Linear Regression

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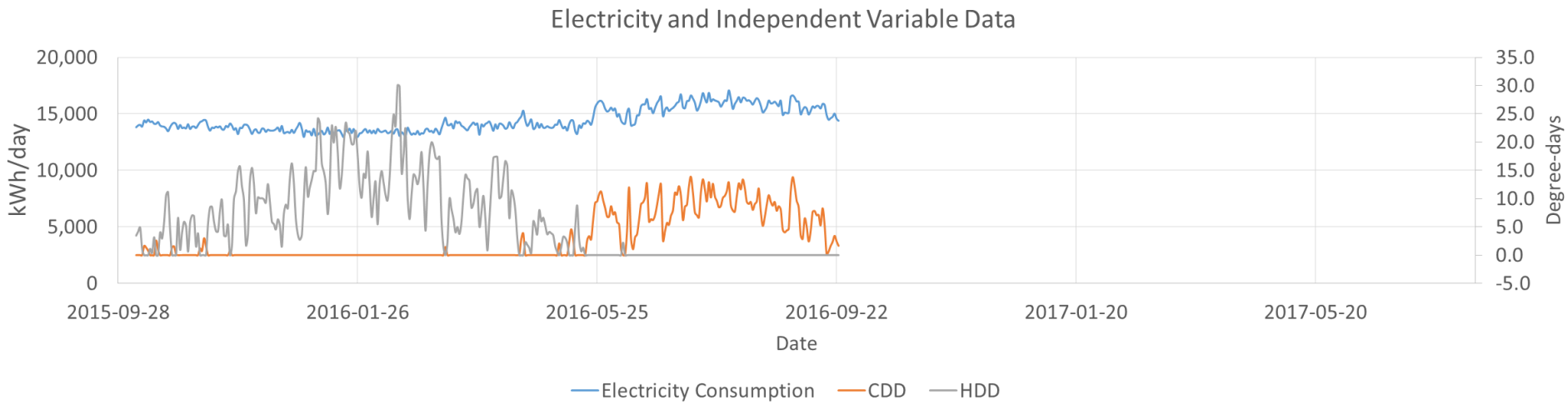

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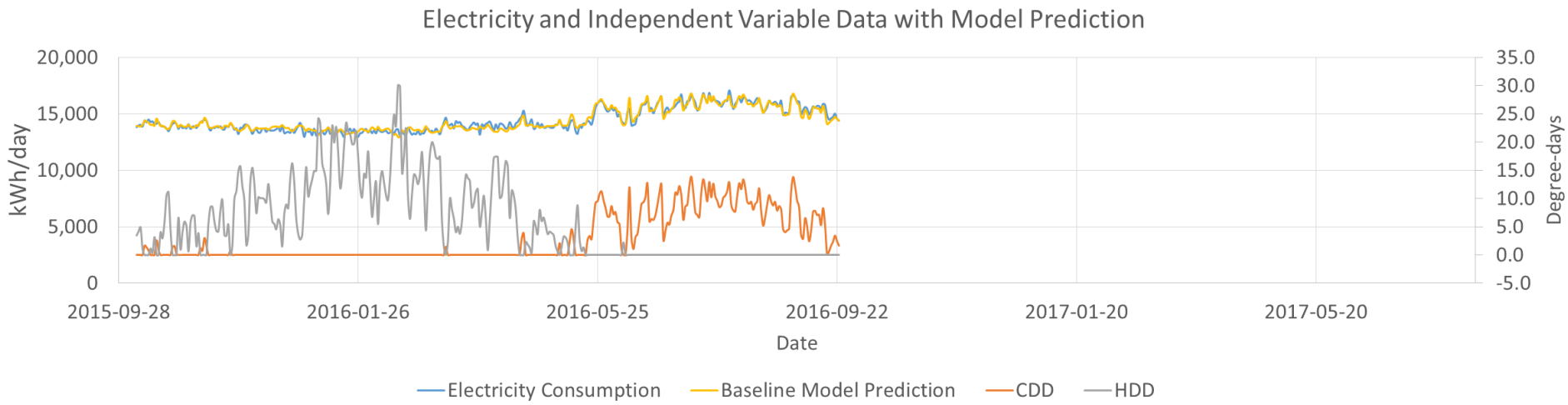

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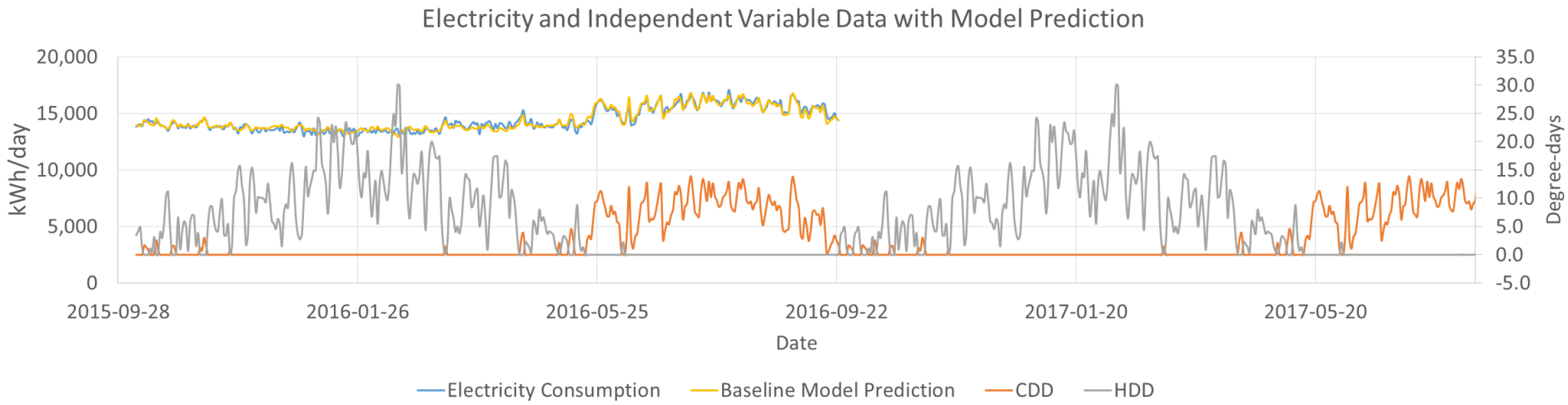

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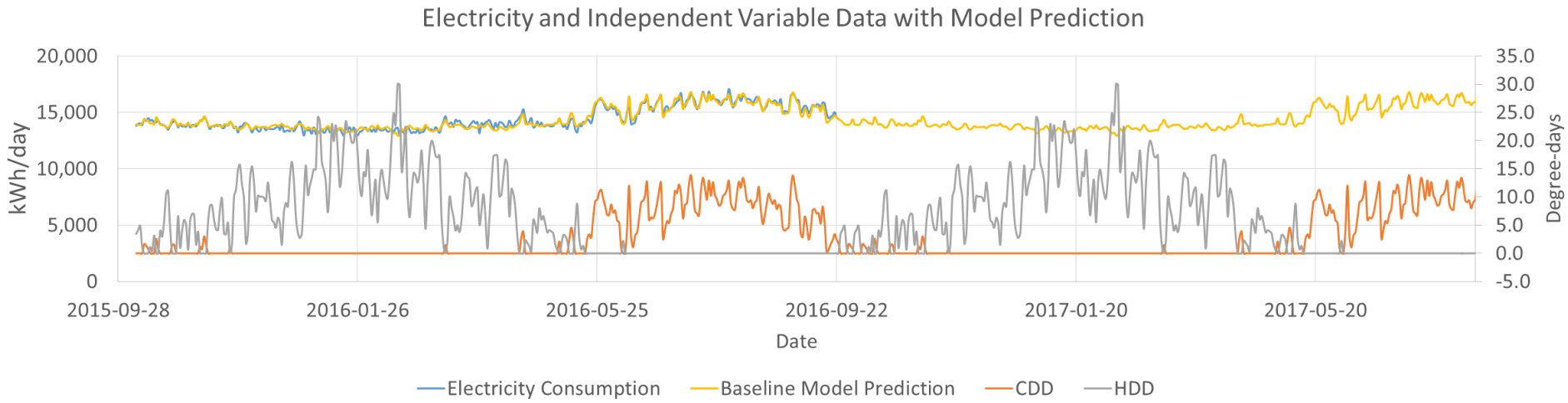

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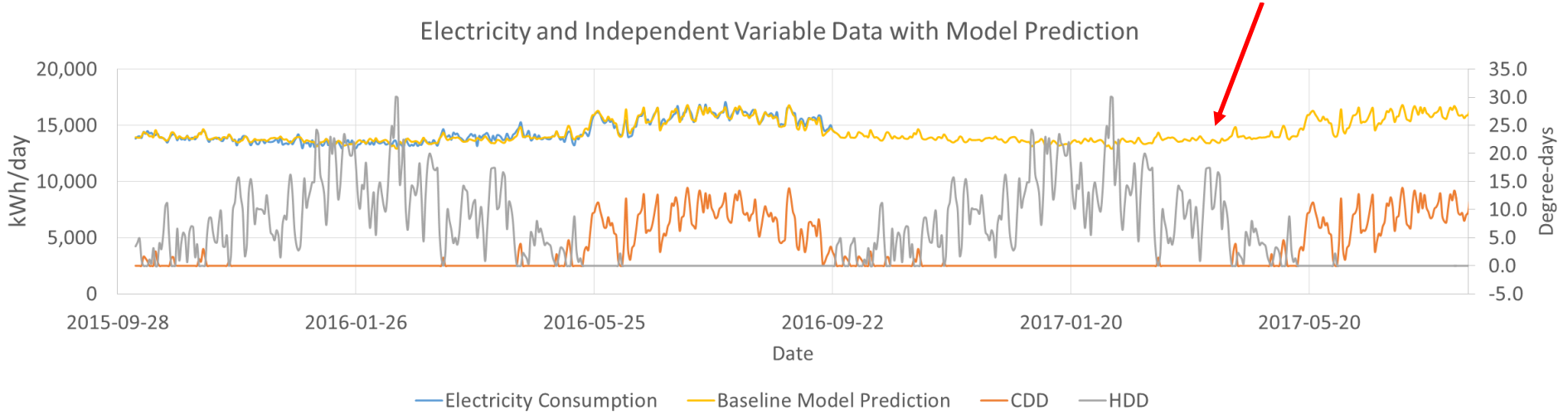

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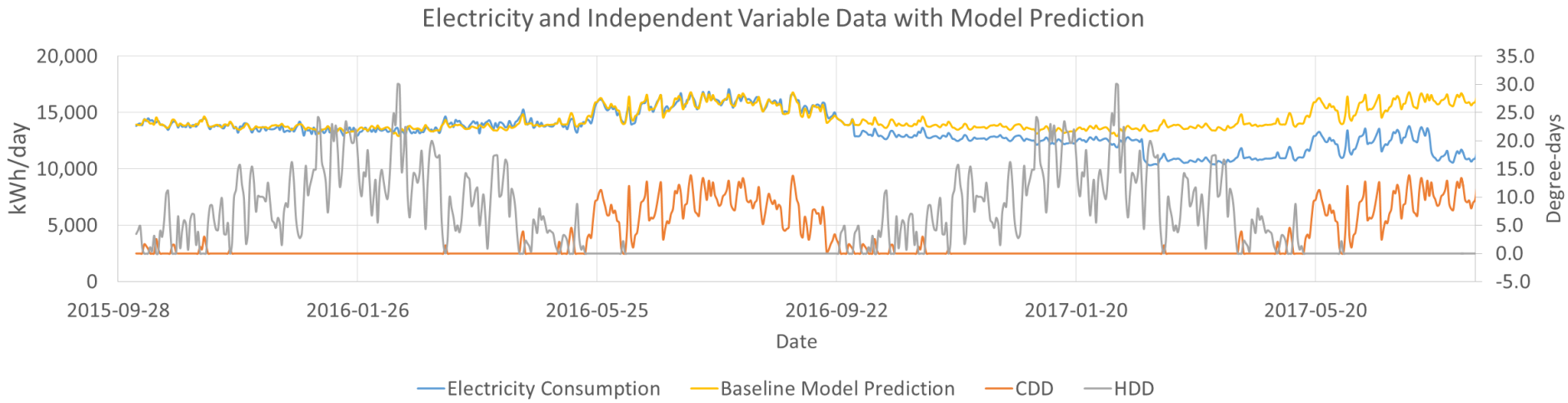

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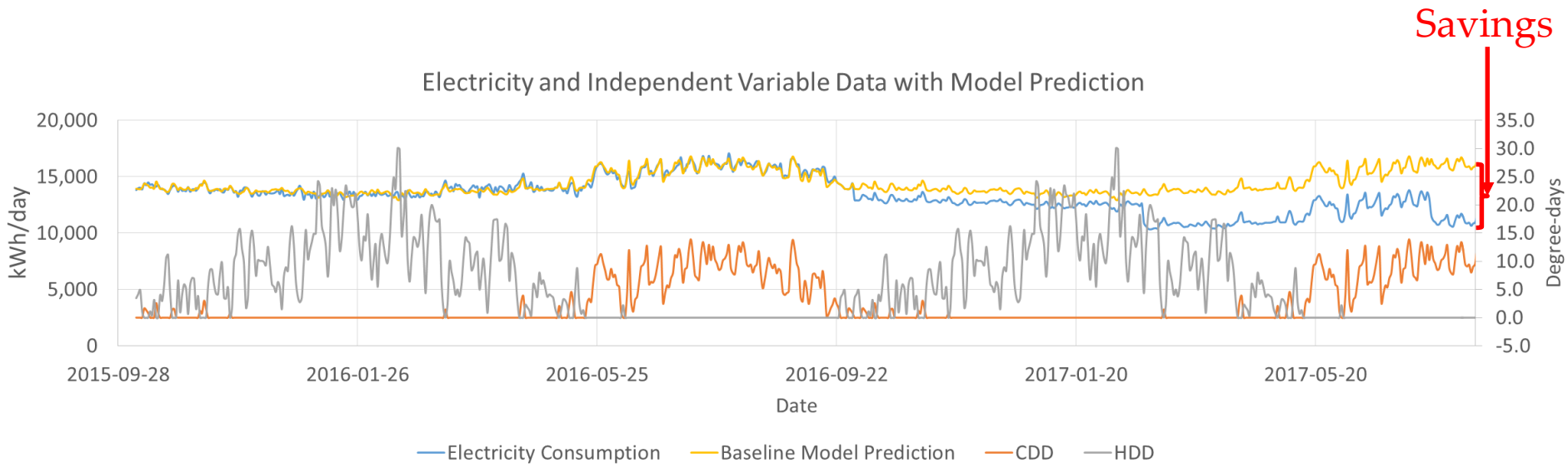


Model Description

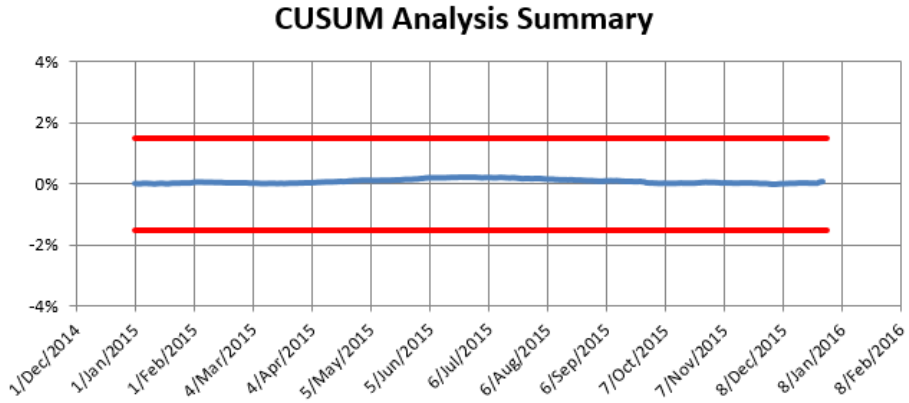
- A description of the model (that is not a spreadsheet)
- Document existing conditions at the building
  - e.g. Floorplan, tenant listing, BAS logs
- Example claims:
  - “Electricity consumption is/is not weather dependent."
  - “Data for the year was broken into summer and winter periods.”
  - “An adjustment to the baseline was made for X reason”

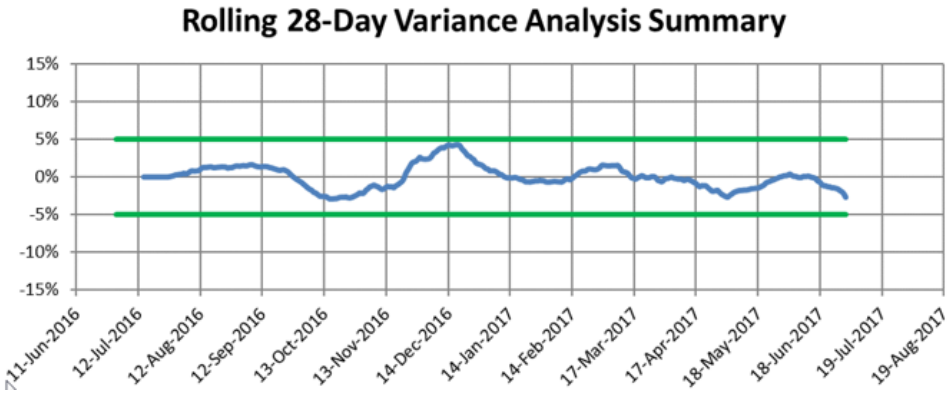
Model Spreadsheet

- Spreadsheet showing:
  - Model input data
    - Independent variables
    - Actual electricity consumption
  - Model form
    - y = m*x + b
  - Model Statistics

Baseline Model Assessment Reports

- Template spreadsheet provided by IESO
- Assesses "CUSUM Analysis" and "Rolling 28-day variance analysis"





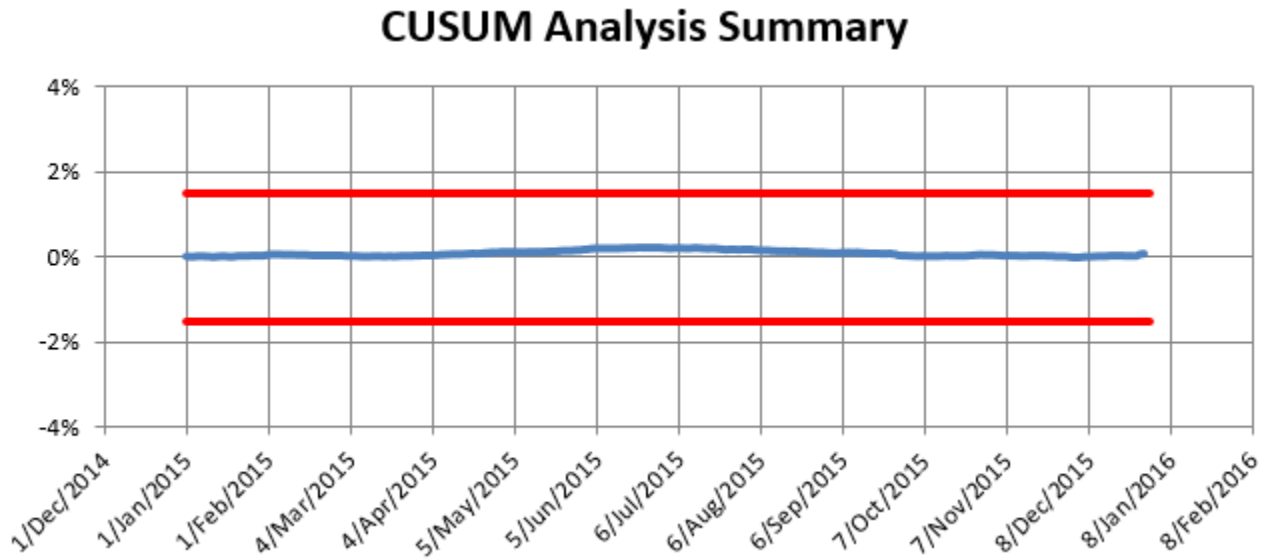
Model Statistics

- CUSUM Analysis
- Rolling 28-day Variance Analysis
- Baseline model statistics

https://saveonenergy.ca/-/media/Files/SaveOnEnergy/Industry/IESO-EPP-Baseline-Energy-Model-Validation-Reports-Tool.xlsx?la=en

Model Statistics: CUSUM Analysis

- Spreadsheet provided
- Communicates quality of model results
- Lets user know where problems may exist



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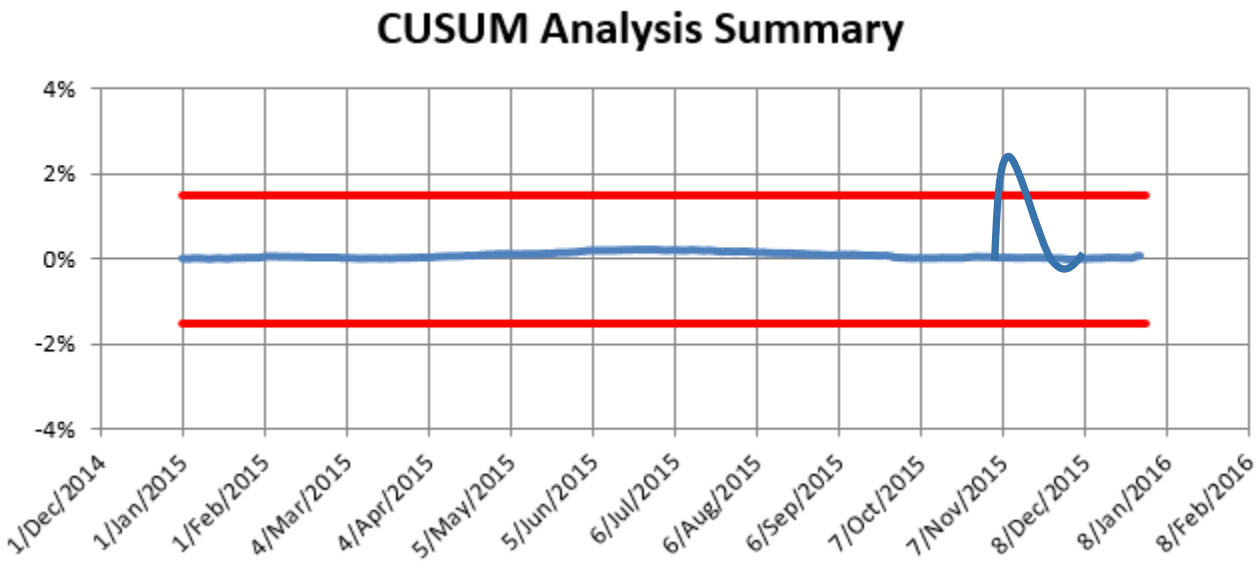
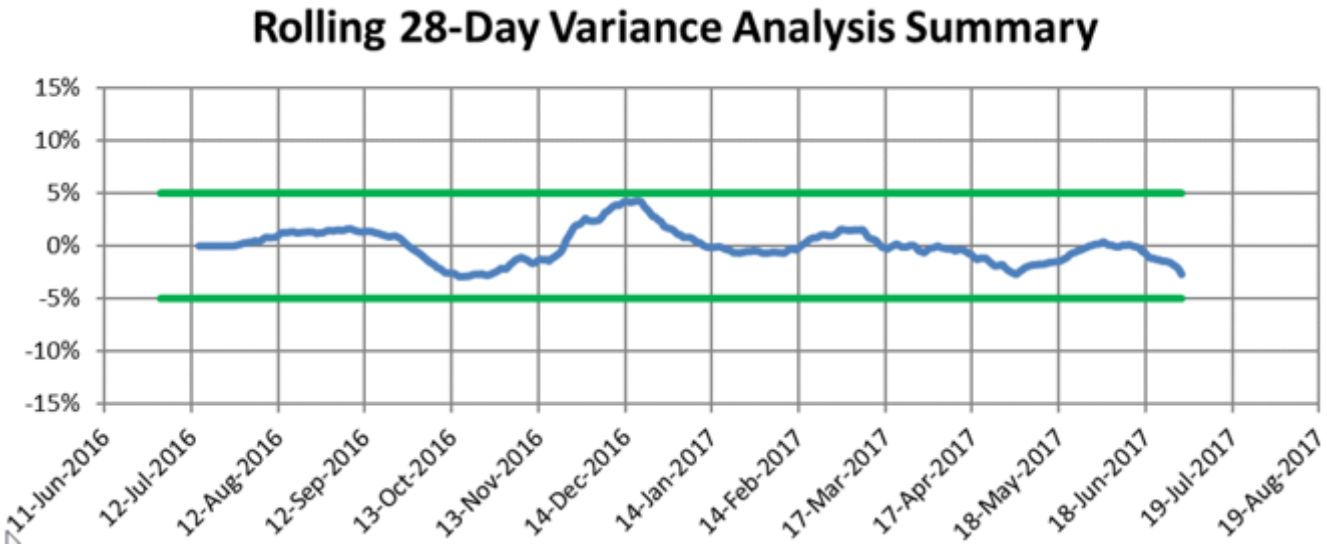


Model Statistics: Rolling 28-day Variance

- Spreadsheet provided
- Lets user know where problems may exist
- Shows that error is not accumulating



Model Statistics: Report Must Include

Statistic	Description/Name	Preferred Range
n	Number of points	>=365
p	Number of parameters	>=2
R^2	Coefficient of determination	>0.75
T_{stat}	T-Statistic	>2 for each coefficient
CV(RMSE)	Coefficient of Variation of Root Mean Squared Error	<15%
NDBE	Net Determination Bias Error	<0.005%

Formulae are in Schedule "E", M&V Procedures

Outliers in Baseline Raw Data

- Outliers must be declared
  - List them in your model description
- Outliers
  - Missing/bad data
  - Contractual demand response calls
  - Other outliers with reasonable explanation and supporting data
    - E.g. power failure
- Avoid large periods of bad data
  - Shift to an earlier 12-month period

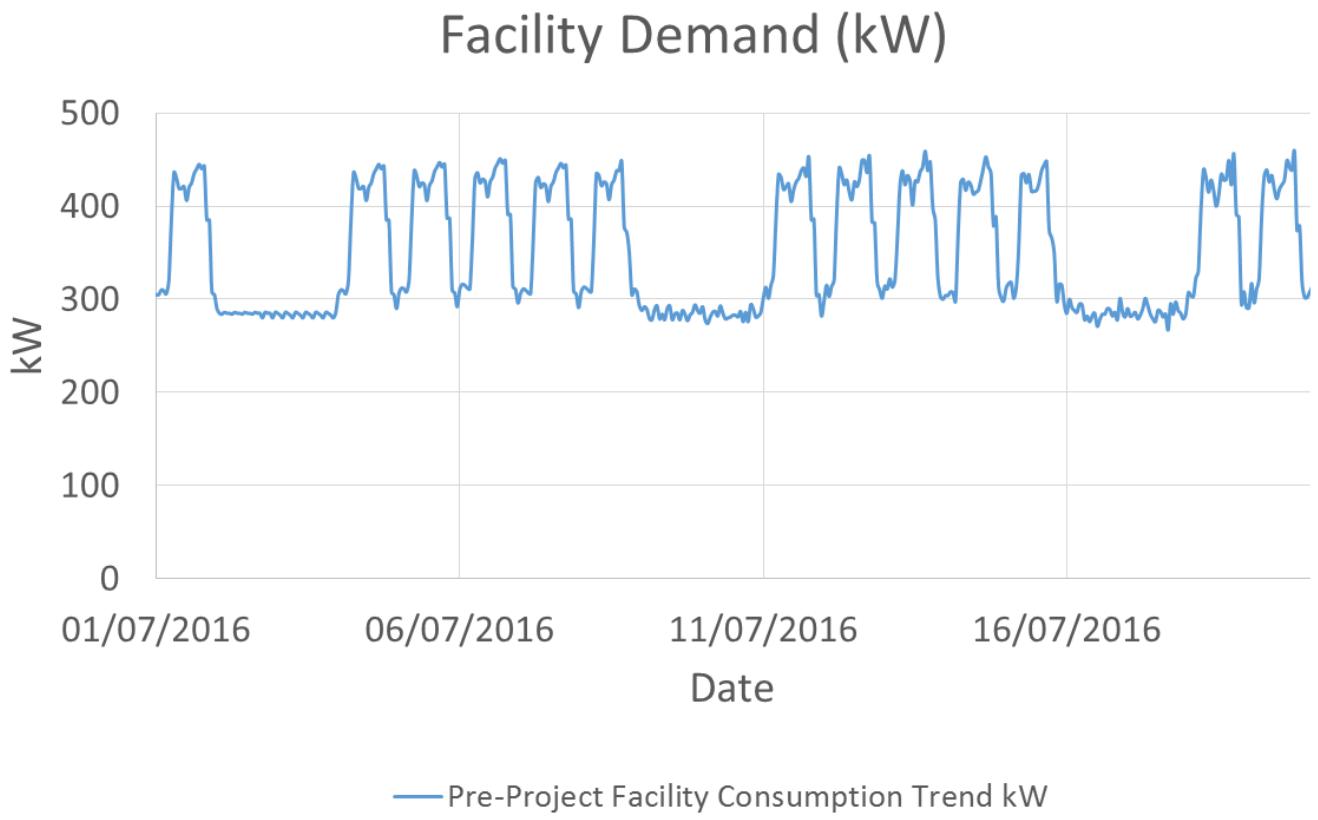
Baseline Modifications Within the Baseline Period

- Aiming to represent "Day 1" of the Pay-for-Performance Period
- There will be savings going into service during the baseline period
- Calculate savings from projects
  - Plot the trend of those savings
  - Net them out of the pre-project measured data
  - Use the net data as inputs into your regression

Baseline Modifications Within the Baseline Period: Example

- Lighting retrofit with timers
  - Lights were on 24/7
  - Post-retrofit they are more efficient and turn off 10:00 PM – 5:00 AM

Baseline Modifications Within the Baseline Period: Example



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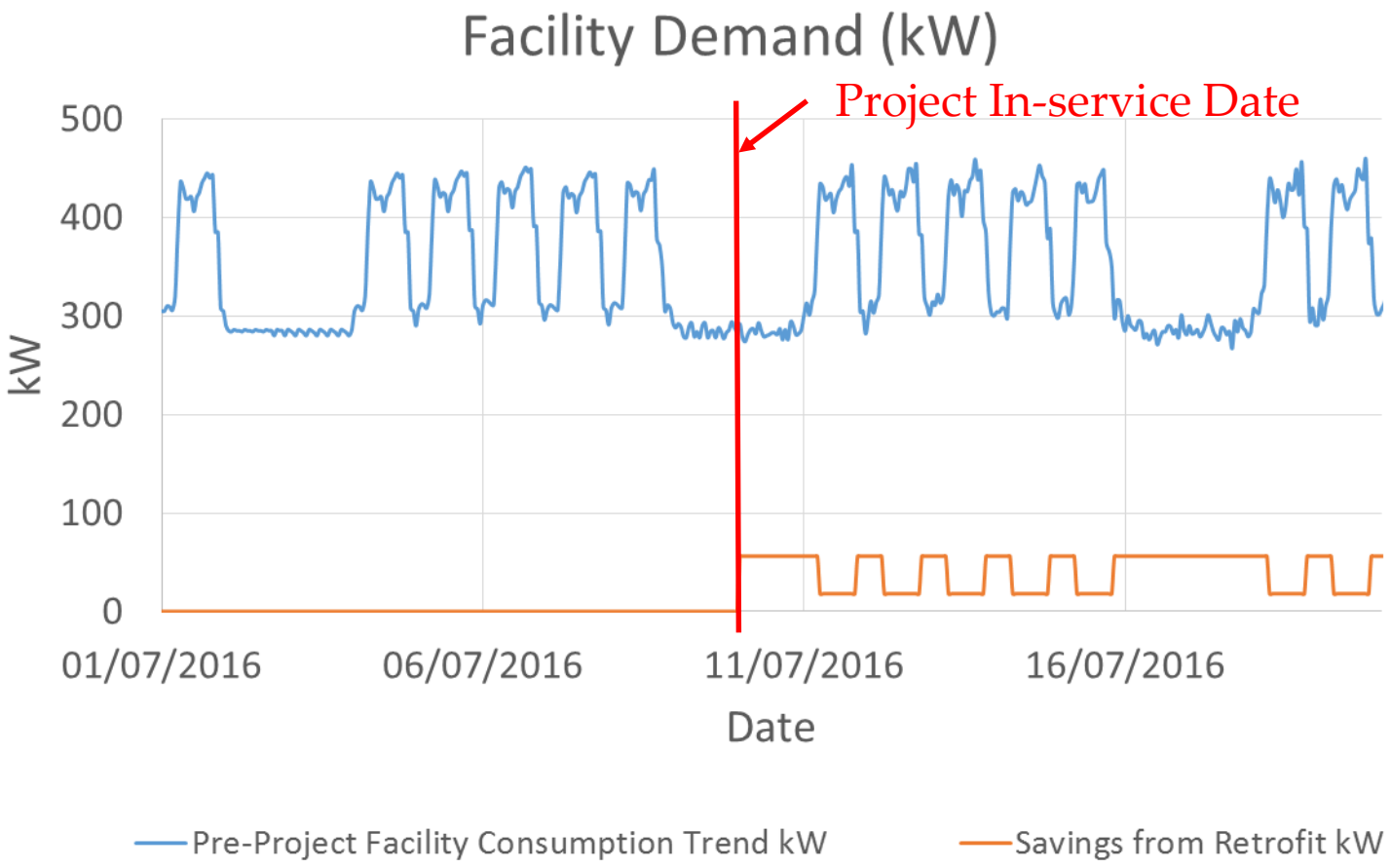

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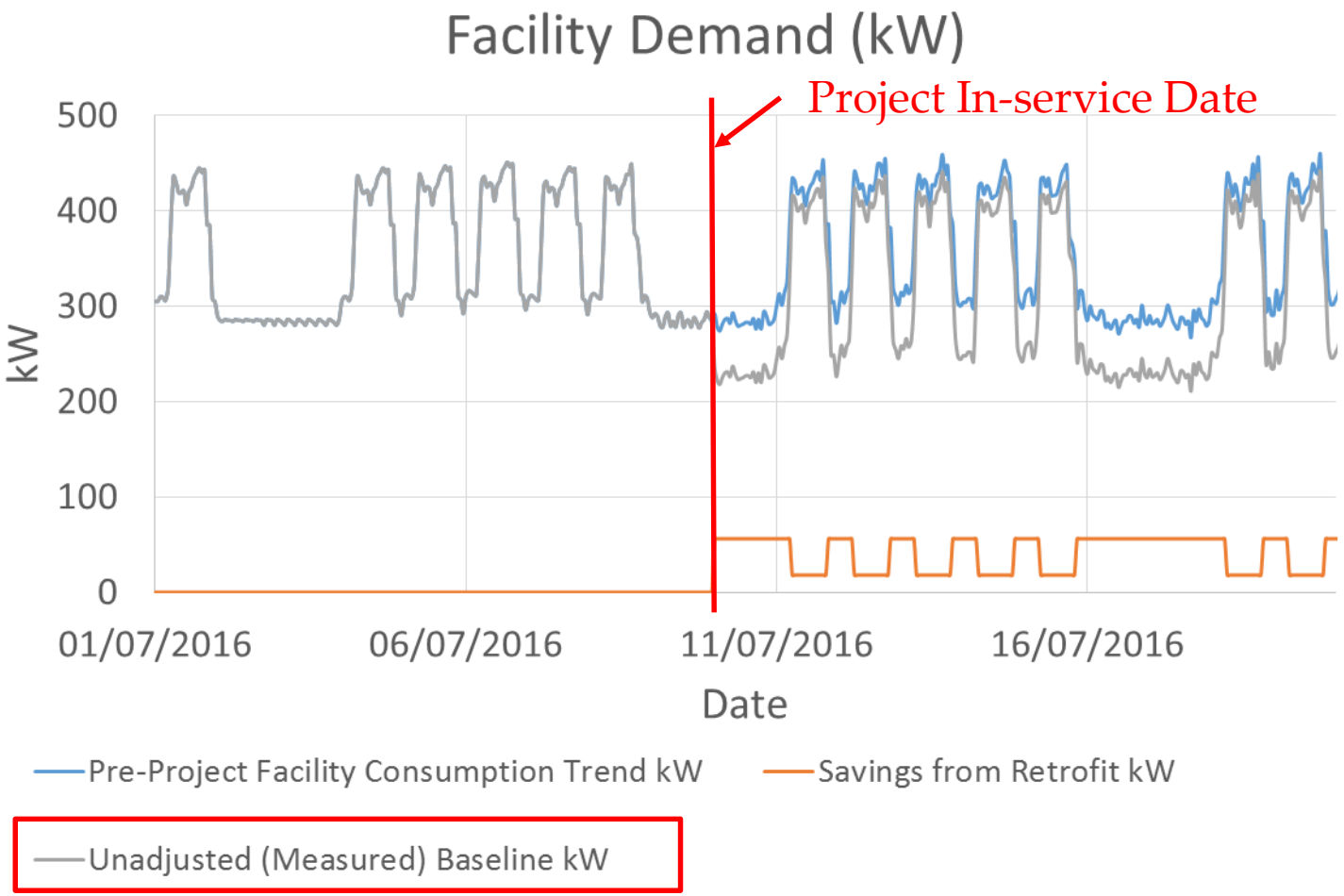

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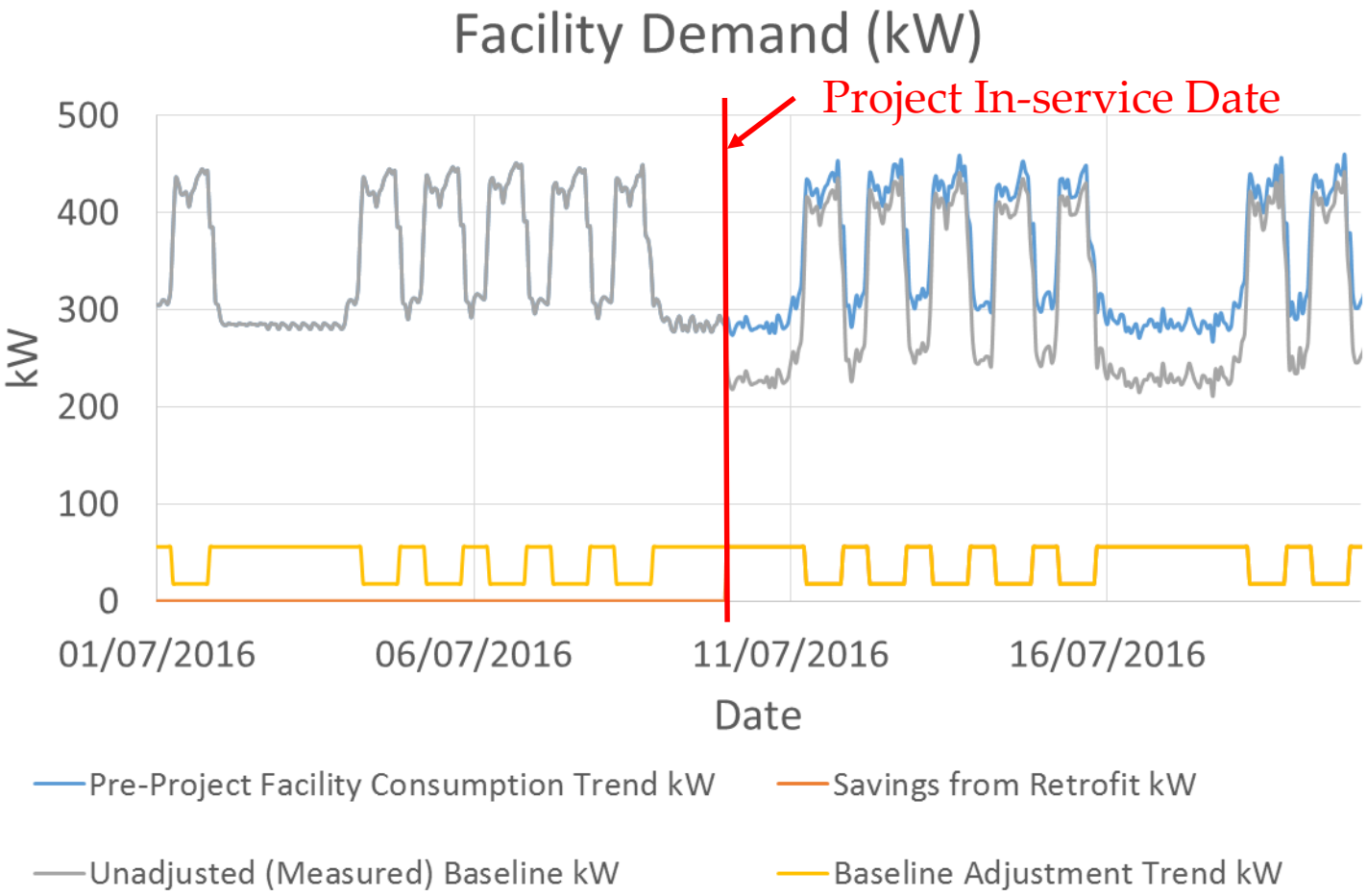

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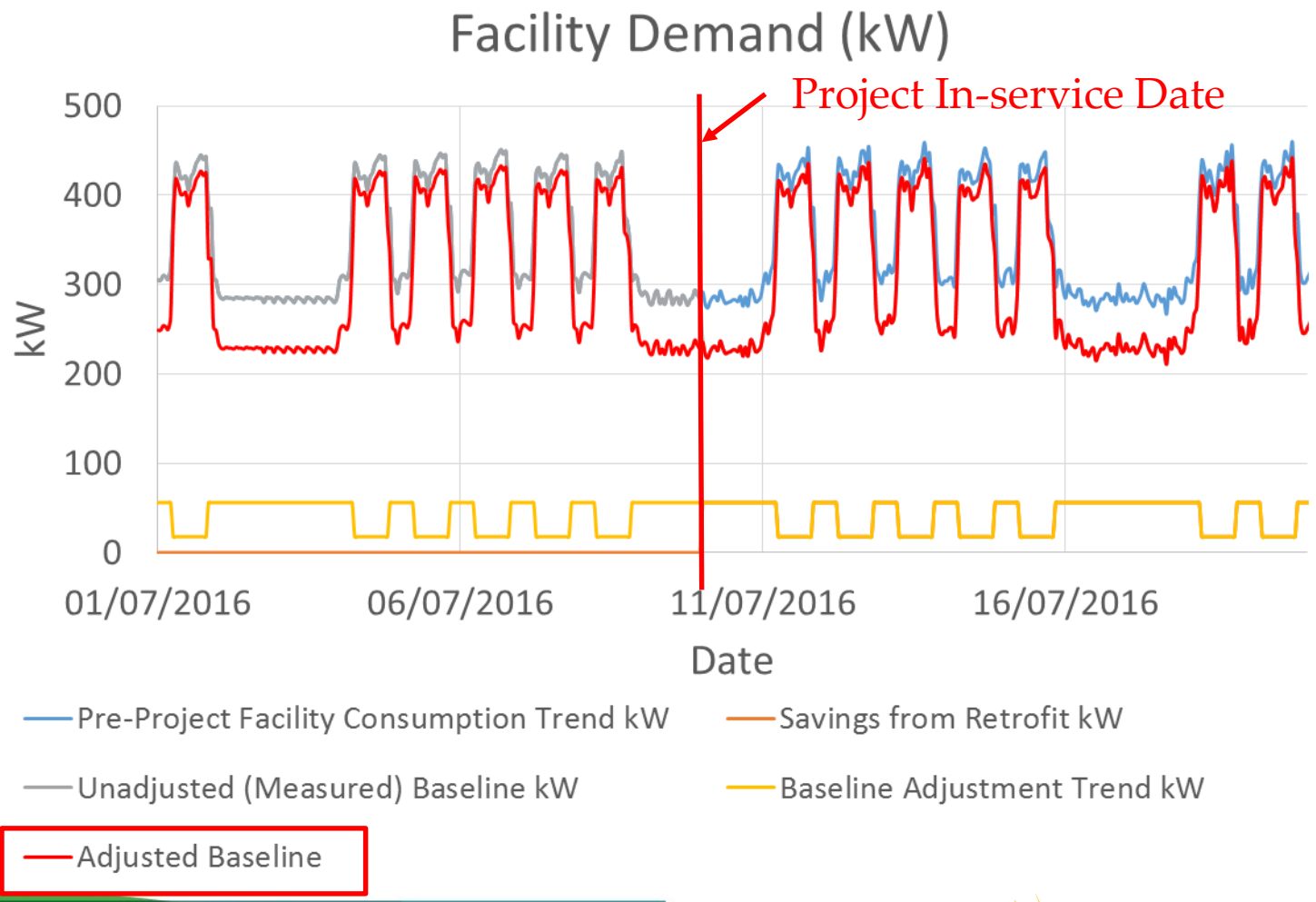

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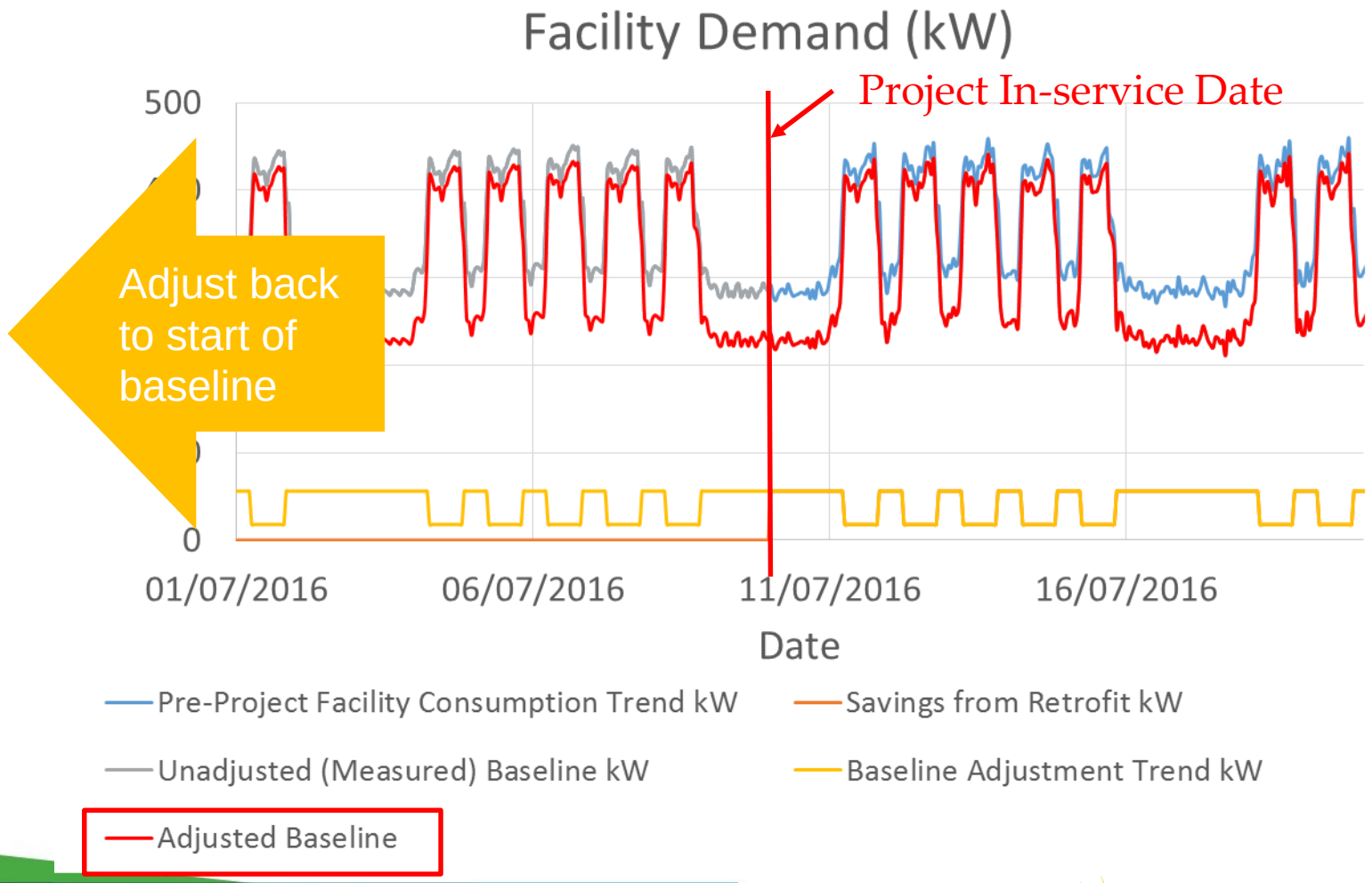


Baseline Modifications Within the Baseline Period: Other modifications

- Removal or addition of loads
- Building expansion/contraction
- Renovation
- Well-documented operational adjustments

Baseline Modifications Within the Baseline Period: Guidelines

- Representation of a known change with a known, specific start time
  - Possibly an end time
- Can be positive or negative
- Multiple adjustments possible
  - Each will be reviewed
- Temporary change: Apply for the affected period
- Permanent change: Apply from start of baseline to the start of the change
- All changes will be reviewed

Model Requirements and Validation Methodologies

- CUSUM Analysis Report
- Rolling 28-day Variance Analysis Report
- Independently verifiable independent variable data
  - Weather data
  - On-site data
- Declaration, details on baseline model adjustments in the baseline period

Savings Calculations

Savings = (Baseline Energy Use) – (Pay-for-Performance Period Energy Use)

- Baseline Energy Use is the energy use your model predicts
- Like IPMVP Option C
- Must save 5% of total load by end of 2nd Pay-for-Performance Period
- Negative savings will not be zeroed out

Savings Calculations

SAVINGS

Baseline Model Output

–

Pay-for-Performance Period Actual Use

+

Baseline Adjustments in the Pay-for-Performance Period

Baseline Adjustments In the Pay-for-Performance Period

- Account for changes occurring after the baseline period
- Baseline adjustments must be reviewed and approved by technical reviewer
- Must be approved in writing by the IESO
- Adjustments should result in >10% of 5% savings threshold

Baseline Adjustments In the Pay-for-Performance Period

- Must notify within 60 days
- Adjustments occur through a baseline adjustment request
  - One request for each adjustment
  - A template will be provided
- Technical Reviewer is available to discuss baseline adjustments
  - Technical Reviewer cannot make the adjustment for you
- If you foresee many baseline adjustments in the near future, the program may not be a good fit for you

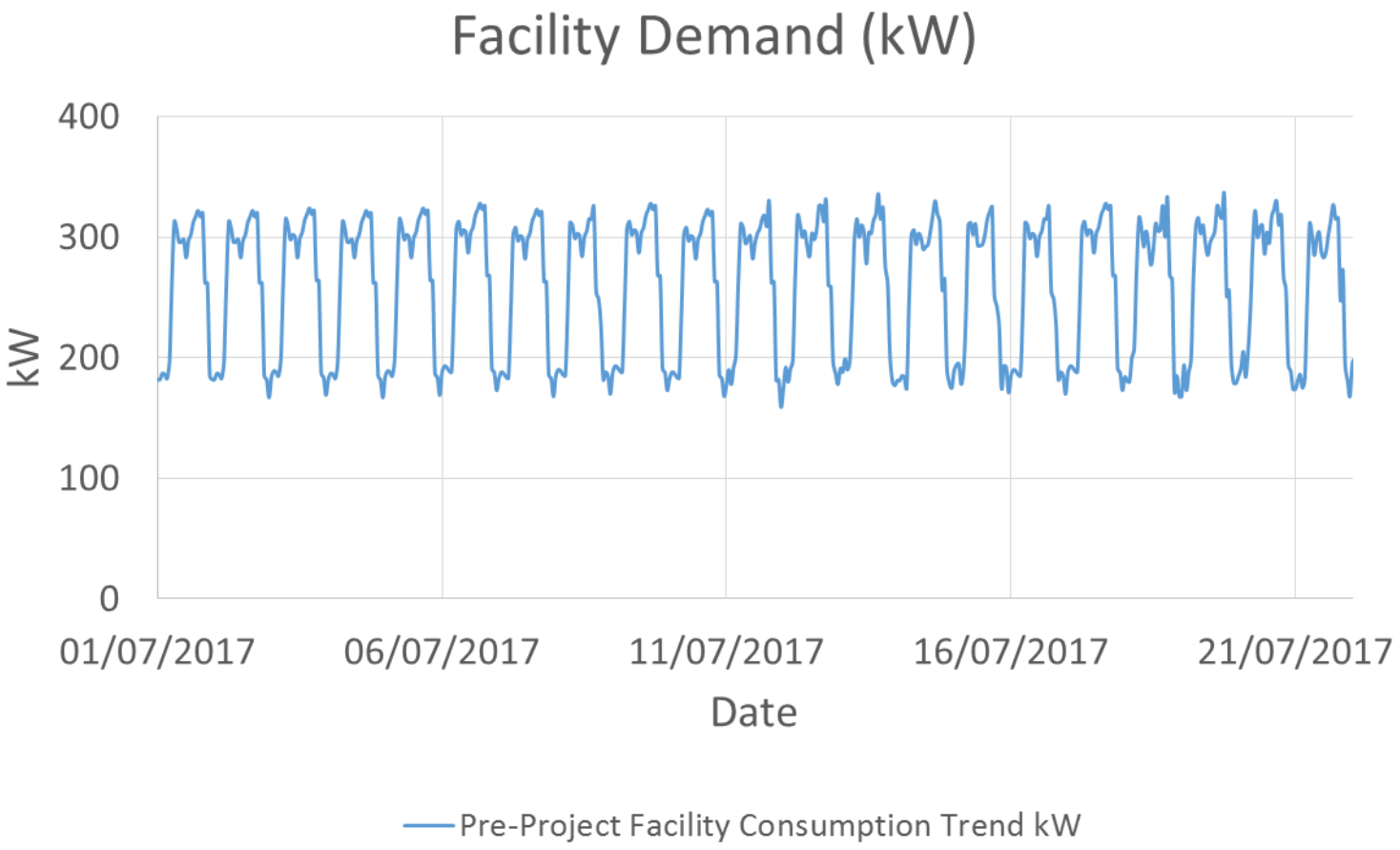
Baseline Adjustments In the Pay-for-Performance Period: Event Types

- Areas repurposed
- Building expansion
- Fuel switching not in line with fuel switching guideline
  - e.g. converting from electric to gas heat
- Behind-the-meter generation not meeting IESO BMG rules

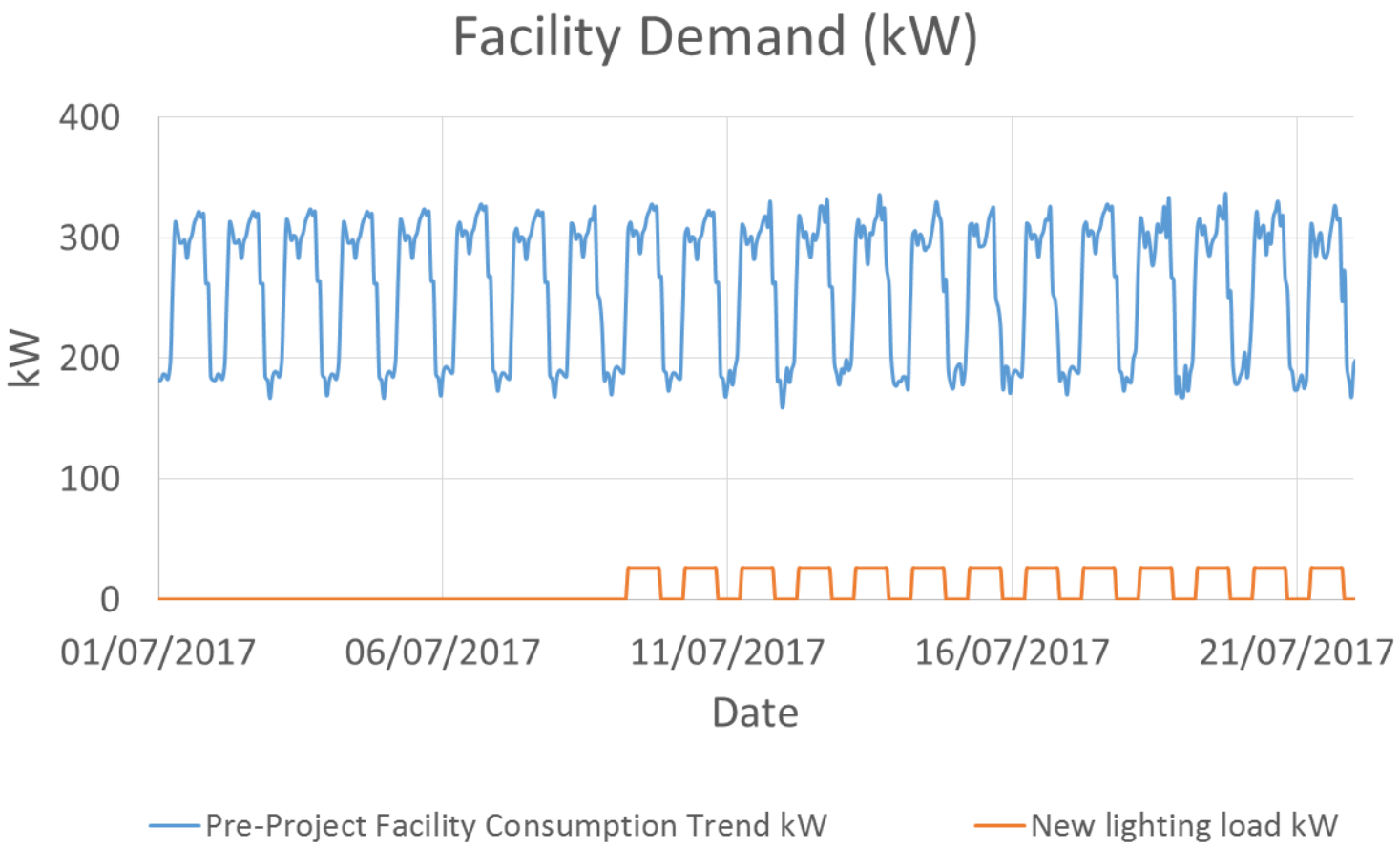
Baseline Adjustments In the Pay-for-Performance Period: Unmetered Re-zoning

- Storage space converted to retail space
  - More lighting required

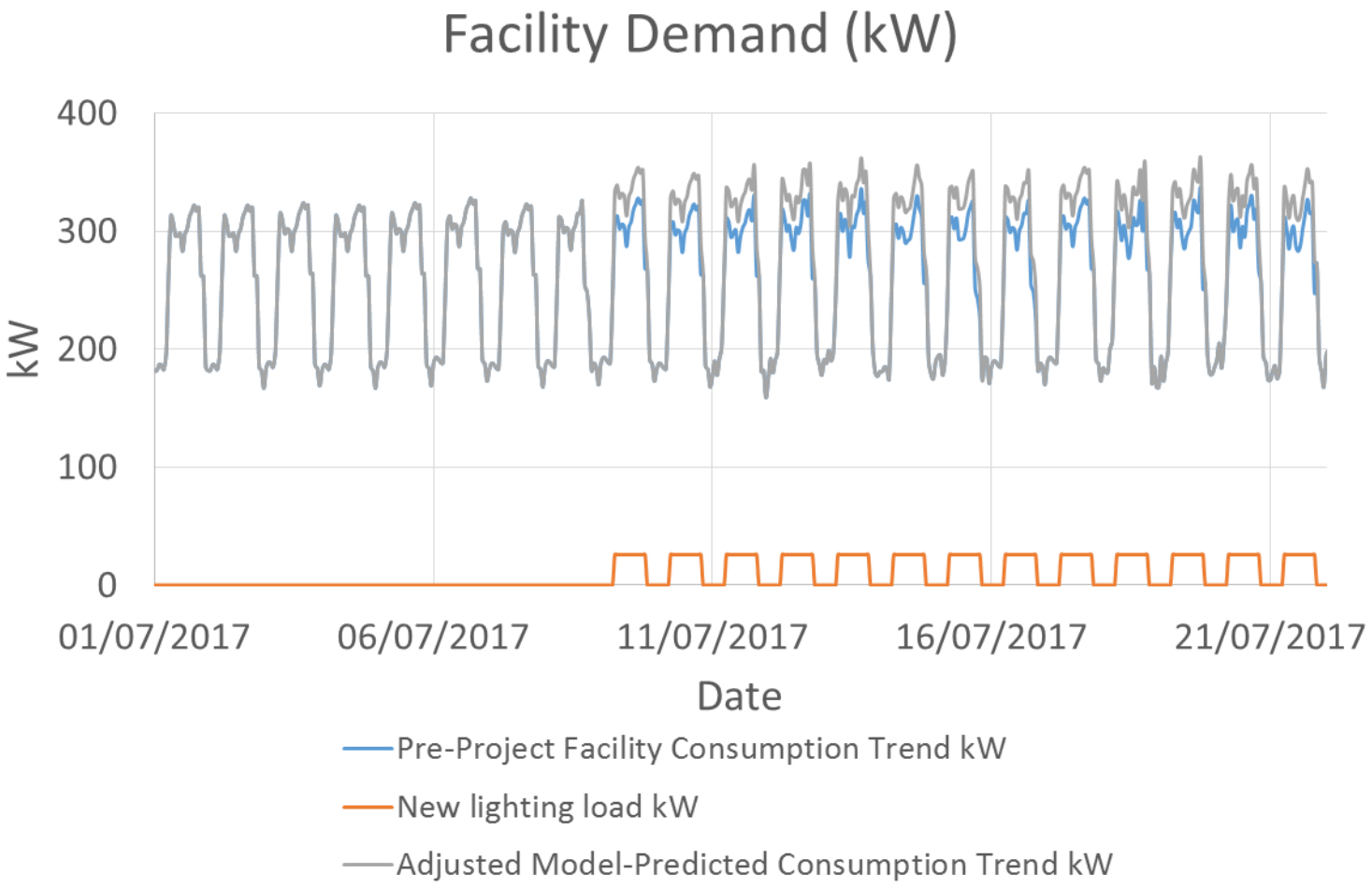
Baseline Adjustments In the Pay-for-Performance Period: Unmetered Re-zoning



Baseline Adjustments In the Pay-for-Performance Period: Unmetered Re-zoning



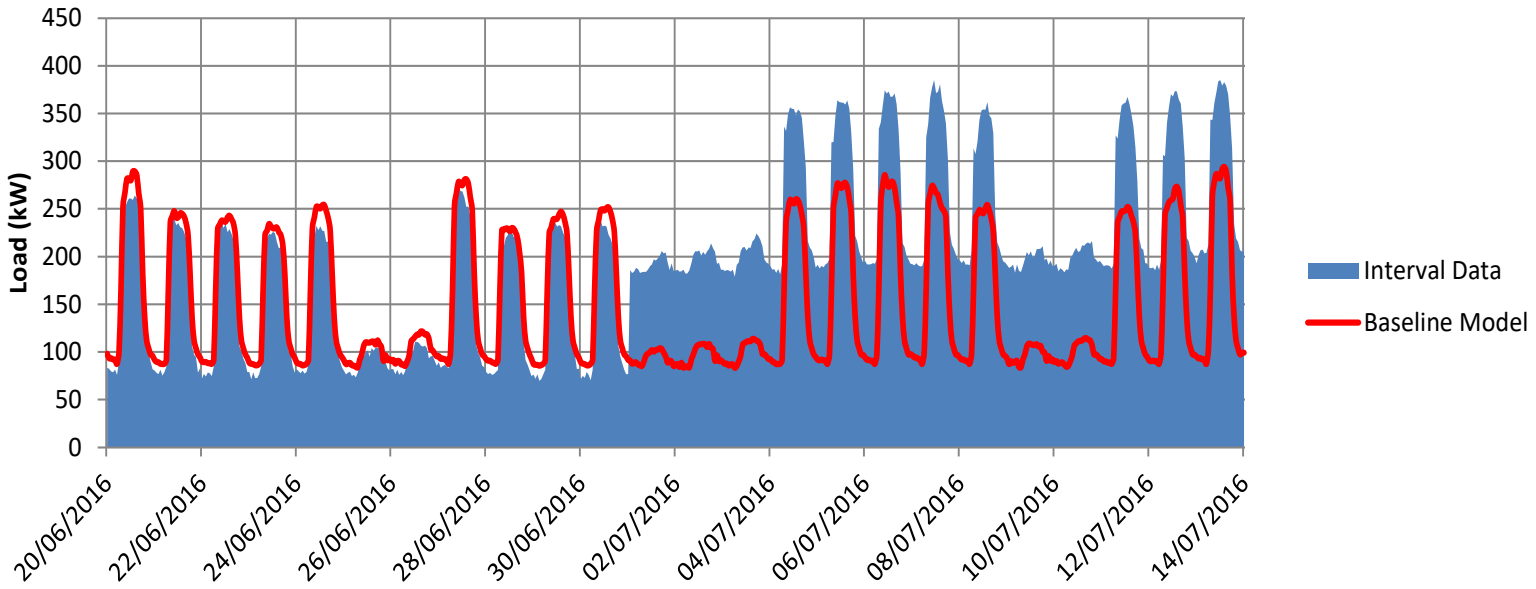
Baseline Adjustments In the Pay-for-Performance Period: Unmetered Re-zoning



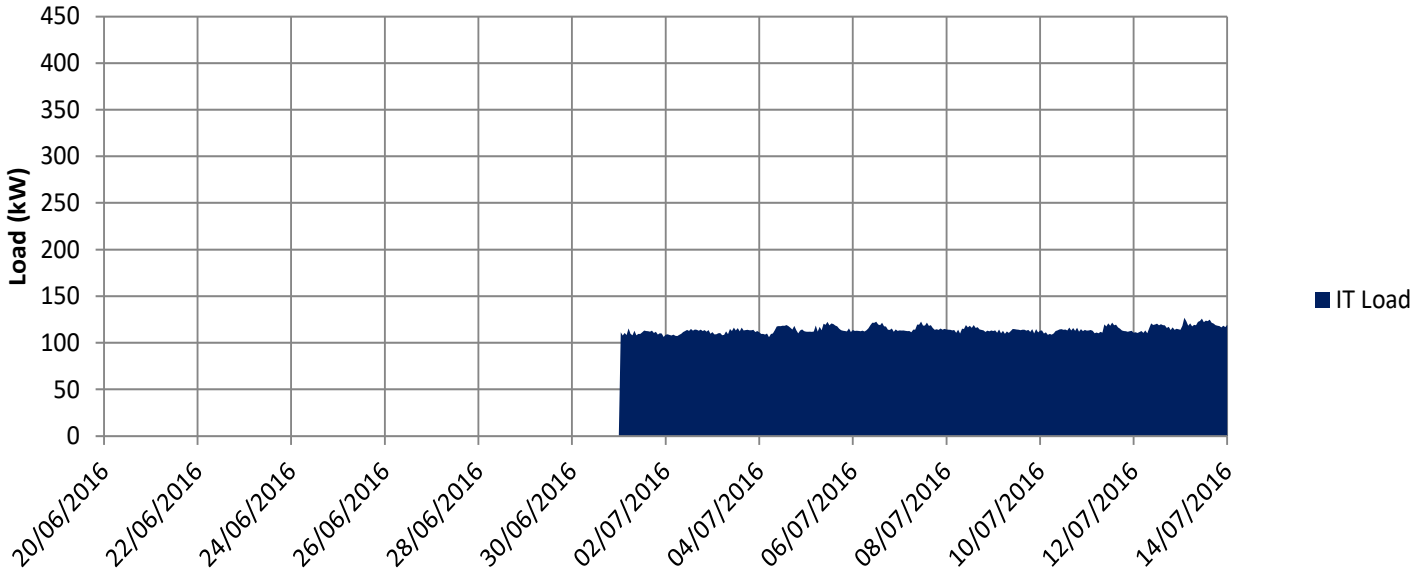
Baseline Adjustments In the Pay-for-Performance Period: Submetered Data Centre

- Space converted to data centre
  - Data centre is submetered

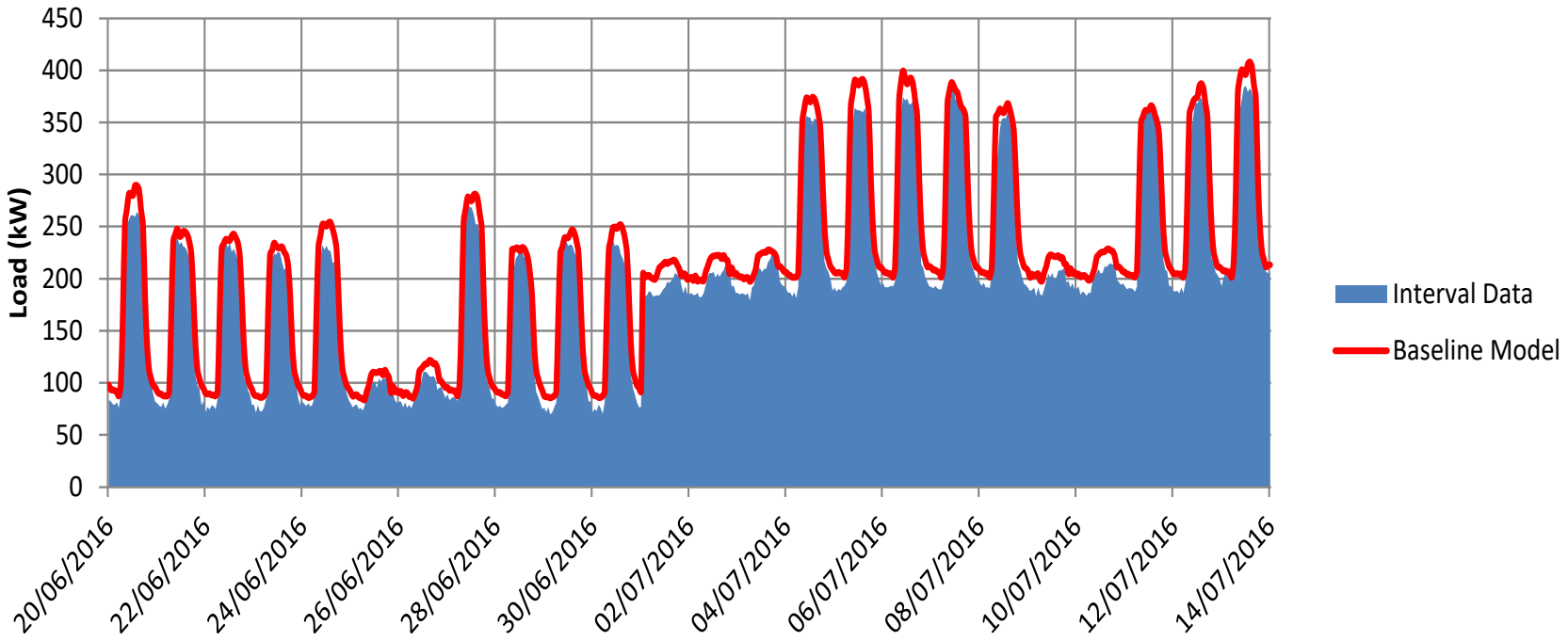
Baseline Adjustments In the Pay-for-Performance Period: Submetered Data Centre



Baseline Adjustments In the Pay-for-Performance Period: Submetered Data Centre



Baseline Adjustments In the Pay-for-Performance Period: Submetered Data Centre



Baseline Adjustment Requests

- State the expected magnitude of the adjustment
- Monthly adjustment values (in MWh)
- Type of adjustment event (e.g. fuel switching)
- Description of the event
- Allow independent verification of the details of the change
  - Provide pertinent data
    - Allows Technical Reviewer to recreate and verify the adjustment
  - Provide evidence of qualitative elements
  - Engineering calculations as necessary, and in spreadsheets
- Clearly define the affected period
- Evidence in proportion to materiality
- Template will be provided

Hourly-to-Daily Aggregator Tool

Save on Energy EPP Website:
https://saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Energy-Performance-Program

How does it work?

- The program is designed with a pay-for-performance model and encourages whole-building energy performance improvements. Incentives are provided at four cents per kilowatt hour ($0.04/kWh) of savings per year, for up to two and a half years.
- In addition to the annual performance payments, customers are entitled to receive a Modelling Incentive of $1,500 for each enrolled facility, up to a maximum of $15,000 for 10 approved facilities.
- Customers have choice and flexibility in implementing capital and non-capital energy efficiency measures, and are rewarded for energy savings at the same rate regardless of the types of projects/activities that have been implemented.
- Performance payments are paid annually and are limited to maximum savings equal to 20 per cent of the annual electricity consumption for the period used to establish the facility's baseline energy model.
- Performance payments are determined by comparing metered consumption to consumption estimated by a building-specific baseline energy model.

Application

To get started, follow these three steps. Completed documents and any participant questions can be sent to: energyperformanceprogram@ieso.ca.

1. Complete and sign the Energy Performance Program Agreement and the Application Form.
2. Complete one Facility Application Form for each facility to be enrolled.
3. Submit a baseline energy model for each facility application as described in the program's M&V Procedures and validated using the Baseline Energy Model Validation Reports Tool.

Participants are required to submit a Savings Report for each facility to receive the payments. This report needs to be completed annually, no later than 60 days following the expiration of each pay-for-performance period.

HOURLY TO DAILY METER DATA AGGREGATION TOOL

This optional tool lets you aggregate hourly interval metered data into daily electricity consumption values.

SAVE ON ENERGY
POWER WHAT'S NEXT

HOURLY-TO-DAILY METER DATA AGGREGATION TOOL

This optional tool has been provided to faciliate the aggregation of hourly interval meter data into daily electricity consumption values. Applicants for the Energy Performance Program Customers may find this tool helpful in developing Baseline Energy Models.

Instructions

1. Insert the date and time (yyyy/mm/dd hh:mm) of the first hour in the 12-month baseline period in the mint-coloured cell.
2. Paste in actual hourly consumption (kWh) for the 12-month baseline period in the blue-coloured column. Be careful to ensure that data, when pasted in, is complete (e.g. 8760 hours for a non-leap year).
3. Actual daily consumption (kWh) for the 12-month baseline period is populated in the Daily Consumption Results.

Pleae note that ERROR message will read even when zero errors.

ERROR - Missing 0 hourly interval data point(s).

Timestamp	Hourly consumption (kWh)
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	
-	

CUSUM and Variance Tool

IESO Pay-for-Performance Program

Baseline Validation Reports - Data Entry Page

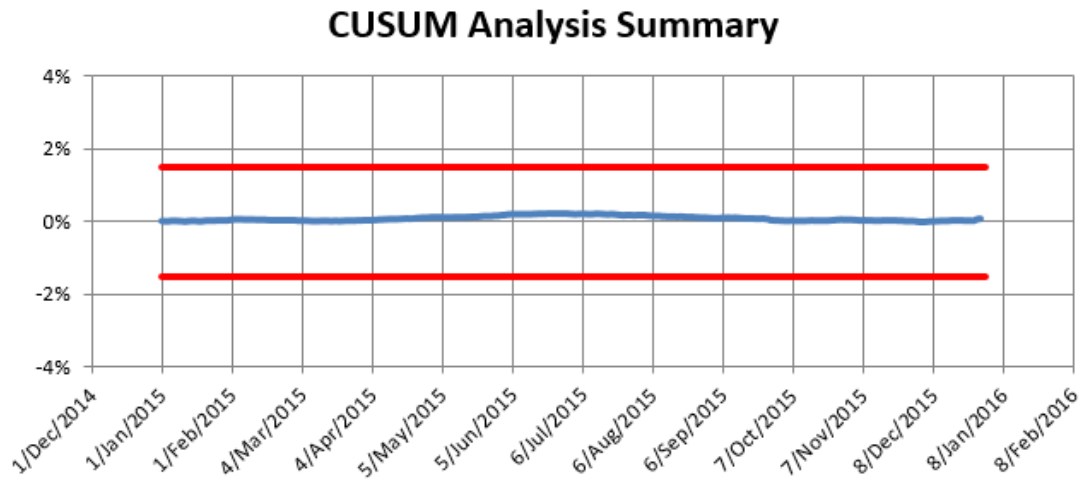
Instructions:

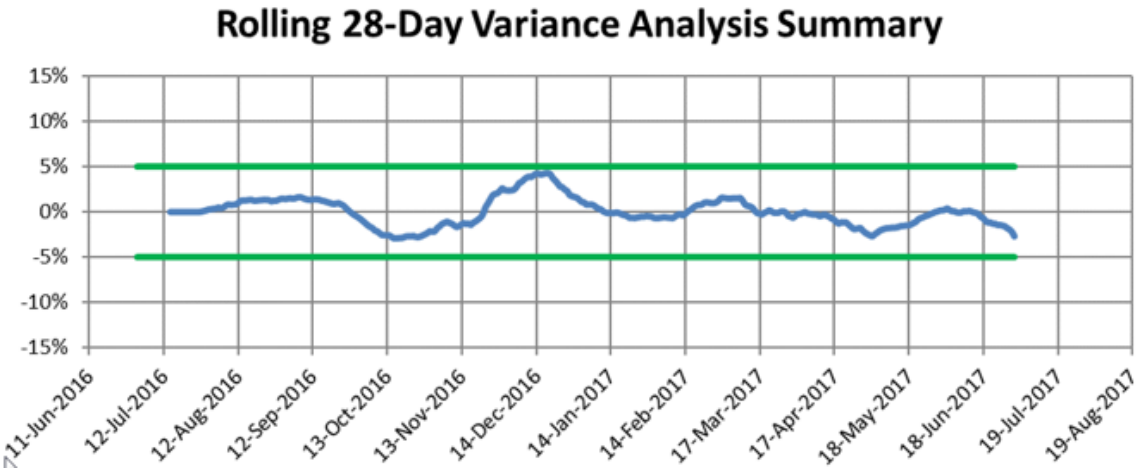
1. Insert the date (dd-mm-yyyy) of the first day in the 12-month baseline period.
2. Paste in daily actual consumption (kWh) for the 12-month baseline period.
3. Paste in daily model output (kWh) for the 12-month baseline period.

Timestamp	Daily consumption (kWh)		CUSUM Analysis (calculated)			Rolling 28 Day Variance Analysis (calculated)		
	Actual	Model	Daily Variance (kWh)	Cumulative Variance (kWh)	CUSUM	Actual (KWh)	Model (kWh)	Variance (kWh)
1/Jan/2015	9,295	9,481	-186	-186	0.0%	--	--	--
2/Jan/2015	9,180	9,346	-166	-352	0.0%	--	--	--
3/Jan/2015	9,243	9,368	-124	-477	0.0%	--	--	--
4/Jan/2015	9,942	9,929	13	-464	0.0%	--	--	--
5/Jan/2015	9,713	9,373	340	-124	0.0%	--	--	--
6/Jan/2015	10,157	10,073	84	-40	0.0%	--	--	--

Input Daily Consumption Data | Output summary Plots

CUSUM and Variance Tool





Schedule "F": Savings Report Template

FACILITY INFORMATION	
If Facility is composed of single building, please complete all fields in this section. If Facility is composed of multiple buildings aggregated in a single Baseline Energy Model, please complete starred (*)fields and complete tab Aggregated Facility Info.	
Facility Name:*	
Facility Address:	
City:	
Postal Code:	
Local Distribution Company serving Facility:	
Electricity Meter Numbers:	
Gas Distribution Company serving Facility:	
Building Type (select from list):	
If other, please specify:	
Is Behind-the-Meter Generation (BMG) present? (Yes/No):	
Is the Facility composed of multiple buildings aggregated into a single Baseline Energy Model?:*	

PAY-FOR-PERFORMANCE PERIOD INFORMATION	
Please note a Facility's first Pay-for-Performance Period begins the day IESO confirms acceptance of the Facility Application.	
Pay-for-Performance Period Start Date:	
Pay-for-Performance Period End Date:	
Pay-for-Performance Period Number (1st, 2nd, 3rd, 4th)	

SAVINGS AND INCENTIVE CALCULATION

Month	Baseline Energy	Baseline Adjustment (if applicable) (-/+ kWh)	Description of Baseline Adjustment (if applicable)	Behind-the-Meter Generation (if BMG present and not	Baseline after any Adjustments (kWh)	Actual Metered Consumption (kWh)	Calculated Savings	Percentage Savings (%)	Savings Claimed for Incentive (kWh)**	Incentive ($)
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00
					0		0	#DIV/0!		$0.00

Questions?

For more information contact the Energy Performance Program Team at

energyperformanceprogram@ieso.ca

Appendix

- "CUSUM Analysis" Variance = (Model Prediction – Actual)/Actual Annual MWh
  - Must not exceed 1.5%
- $\text{Variance}_{28day} = (\text{Model Prediction}_{\Sigma 28day} - \text{Actual}_{\Sigma 28day})/\text{Model Prediction}_{\Sigma 28day}$
  - Must not exceed 5.0%
- Tstat: $Tstat = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$

- $\overline{x_n}$ = the mean for set n
- s_n= the standard deviation for set n
- n_n= the number of data points in set n