

APRIL 18, 2024

Energy Management and Efficient Electrification Series
for Ontario Municipalities

M&V for energy projects with RETScreen

**Presented by Stephen Dixon
and Maelys Fillon, P.Eng, CEM, CMVP**



SEM Program Support



Training & Workshops



One-on-One Coaching



Peer Learning



Performance & Enabling Incentives

"The forum is a great resource for energy professionals to collaborate and share lessons learned. Instead of making cold-calls to references provided by marketing agents, you can get unbiased information from industry colleagues who have first-hand experience in what you're inquiring about."

Sr. Project Manager, City Housing Hamilton

"The courses on the learning platform are helpful and give me new avenues for thinking about my energy projects. In the SEM Program, the online courses reinforce what needs to be done to meet our goals, and the exercises embedded in the course help to formalize what actions we should take."

Energy Champion, City of London

"I found the Monitoring & Reporting workshop validated the energy monitoring and analysis we've been working on and how critical it is to gauging progress instead of relying on assumptions. With our coach's help we've identified opportunities to simplify our analysis to better drive energy-saving actions."

Technical Manager Engineering, KARMAX Heavy Stamping

Commit Resources to Energy Management

Cohort Activities

Internally



Executive Sponsor

~ 4-6 hrs per year

2-4 hrs per month



Energy Champion

~ 2.5 hrs per month

10-20 hrs per month

SEM Program Update

7

Cohorts
launched

80

Enrolled
participants

NEW Municipalities cohort
launching **May 14th**

Featuring Coach Kady Cowan

2

More cohorts planned to launch before end of 2024

Contact us for more information



Program Inquiries & Applications

sem@ieso.ca

Connect with a Coach



Learning objectives

This session will help you to:



Explain what M&V is (and is not), why it is useful, and how M&V is used in energy-efficiency projects.



Describe the four basic M&V methods (options), and understand what adjustments are.



Apply M&V concepts for Option C in RETScreen

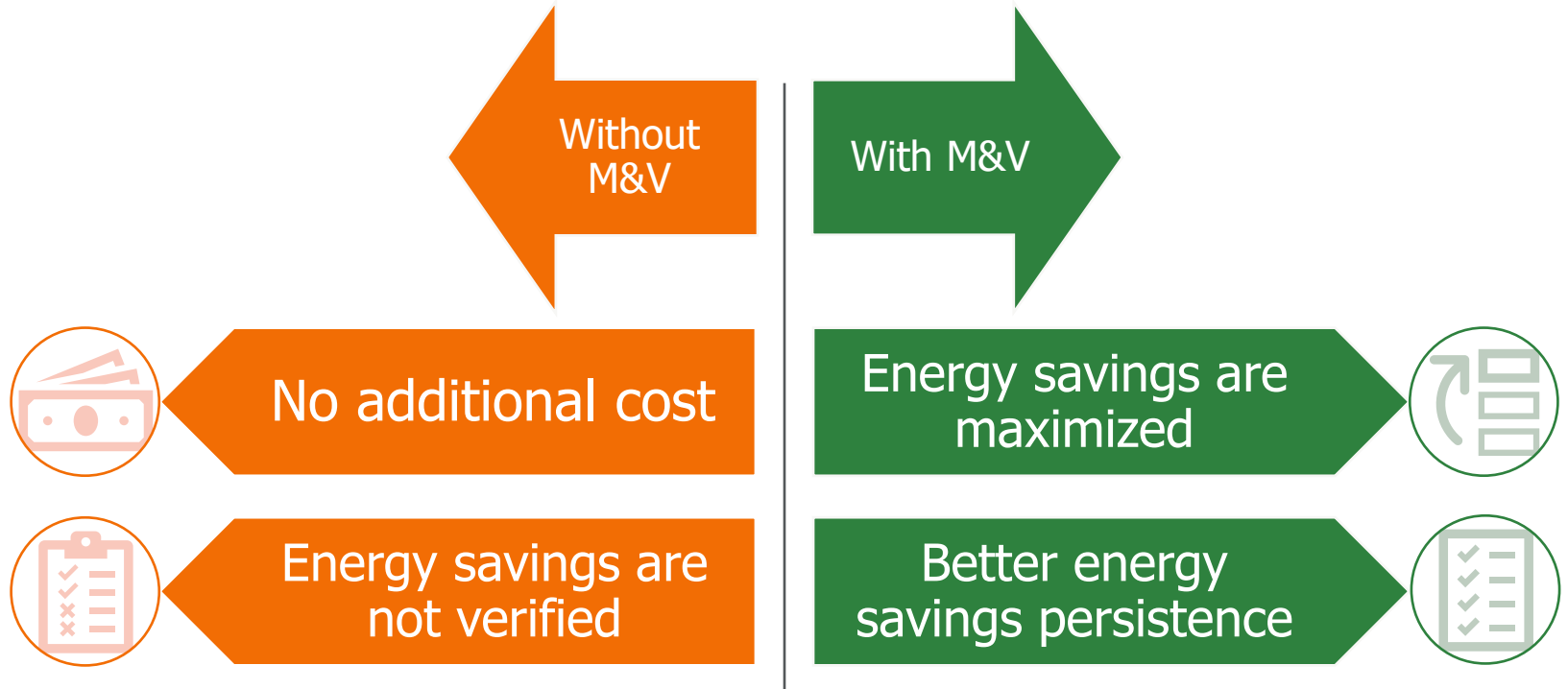
Definition

“Measurement and verification (M&V) is the process of planning, measuring, collecting, and analyzing data to verify and report energy savings resulting from the implementation of energy-efficiency measures (EEMs) ” in one or more facilities.

Source: *International Performance Measurement and Verification Protocol (IPMVP), CORE CONCEPTS 2022*



Reminder: the advantages of M&V

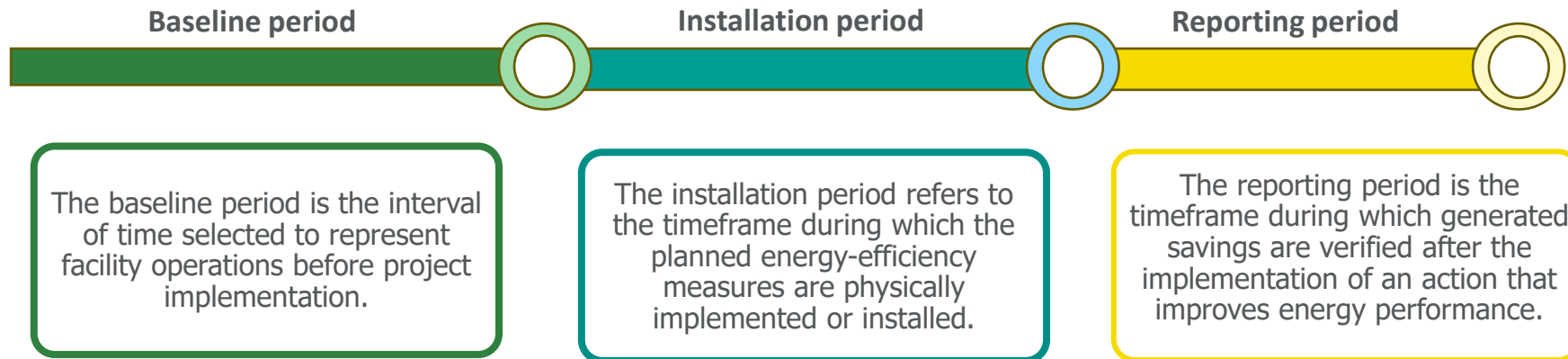


Measurement boundary and independent variables

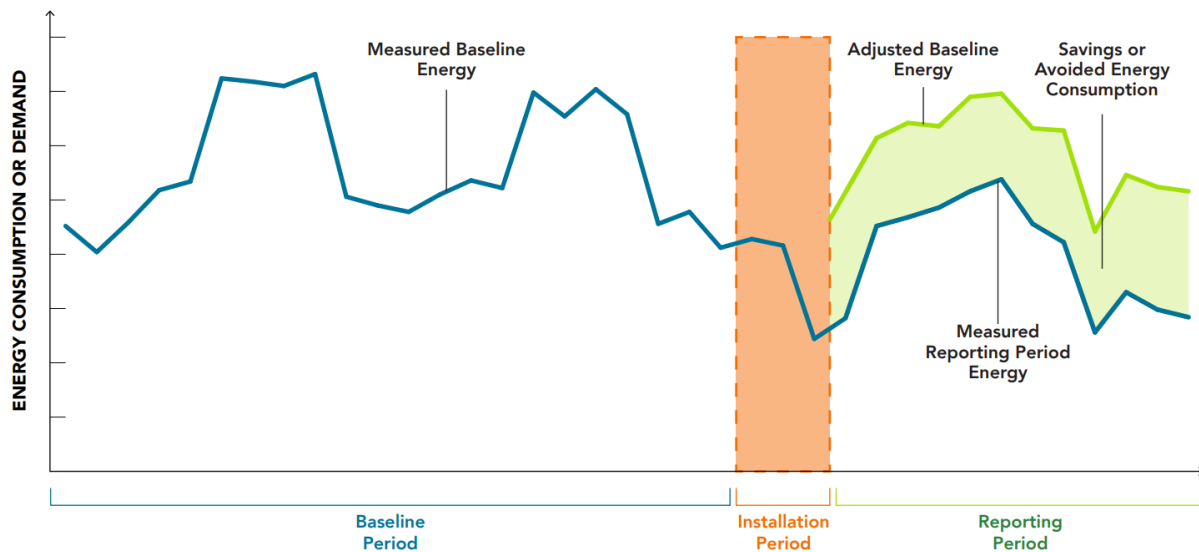
The measurement boundary is a notional perimeter drawn around the equipment, system, or facility relevant to savings calculations.



Measurements in baseline and reporting periods



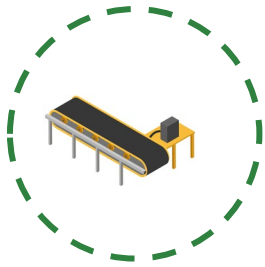
M&V basic equation for energy savings



$$\text{Baseline Period Energy} - \text{Reporting Period Energy} + \text{Adjustments} = \text{Energy Savings}$$

IPMVP options

IPMVP offers several options that specify different approaches for measuring and verifying the performance of projects.



Retrofit
isolation

- Option A: key parameter(s) measurement
- Option B: all parameter measurement



Whole
facility
approach

- Option C: whole facility
- Option D: calibrated simulation

Option C: Whole facility

Option C consists of using energy data from utility meters, meters or submeters throughout the entire facility, as well as independent variables to evaluate facility energy performance.

Used for projects where expected savings are large relative to the random or unexplained variations that occur at the whole facility level.

Mathematical models are developed to describe how the independent variables explain the variations in energy consumption.

May use monthly utility data or short time interval energy consumption data to develop a model.

Option C: Independent variables

Weather

- Outdoor air temperature (heating degree days or cooling degree days)
- Solar radiation

Production

- Production rate (tons, quantity of product)
- Product quality

Operation

- Operating schedule
- Cleaning or maintenance schedule
- Annual shutdown
- Occupancy

Example

A building's monthly natural gas consumption can be calculated using the following equation:

$$\text{Natural gas consumption} = 150 * HDD (17^{\circ}\text{C}) + 13,845$$


Let's calculate the natural gas consumption in February:

$$\text{Heating degree days}_{\text{february}} = 682$$

$$\begin{aligned}\text{Natural gas consumption}_{\text{february}} &= 150 * 682 + 13,485 \\ &= 116,845 \text{ m}^3\end{aligned}$$

When can you use Option C?

| Program | Option C? | Details |
|---|-----------|--|
| Existing Building Commissioning Program | Yes | For projects with estimated savings ≥ 500 MWh |
| Retrofit Program | Yes | Dependent on project type |
| Industrial Energy Efficiency Program | Yes | Dependent on project type |
| Energy Performance Program | Yes | For all projects (model developed by the IESO) |
| Strategic Energy Management Program | Yes | For all projects (model developed by the IESO) |



Using RETScreen Expert to measure and verify savings for a simple lighting retrofit

[RETScreen Step-by-Step Performance Analysis Video:](#)

Assemble historical data

RETScreen Expert - 13b Performance Analysis - Building with Cooling in RETScreen Expert - Bldg #43 (Elec).rctx

File Location Facility Data Analytics Report Custom

Consumption Electricity production... Weather... Production level... Occupancy...
 Transportation Other

Step 1 - Consumption | Production Step 2 - Factors of influence

Enter data... Data source... Degree-days... Solar - tilted... Merge... Filter

Step 3 - Data processing

Summary Performance Tracker... GHG emission factor... Export to file... Copy data to clipboard
 Format table... Insert... Show/Hide columns... 50001 Ready - Help eLearning

Step 4 - Summary | Portfolio Options Help

RETScreen - Data

Data

- Weather - Canada - Ontario - London - NASA
- NASA data
- Office Electricity
- Event log

Summary

| Period | Begin | End | Duration Days | Electricity kWh | Cooling degree-days 18°C °C-d | Cooling degree-days 12°C °C-d |
|--------|------------|------------|---------------|-----------------|-------------------------------|-------------------------------|
| 1 | 2009-12-15 | 2010-01-13 | 30 | 147,719 | 0 | 0 |
| 2 | 2010-01-14 | 2010-02-13 | 31 | 151,876 | 0 | 0 |
| 3 | 2010-02-14 | 2010-03-15 | 30 | 144,003 | 0 | 2 |
| 4 | 2010-03-16 | 2010-04-14 | 30 | 155,876 | 5 | 32 |
| 5 | 2010-04-15 | 2010-05-15 | 31 | 165,287 | 8 | 49 |
| 6 | 2010-05-16 | 2010-06-15 | 31 | 225,817 | 79 | 213 |
| 7 | 2010-06-16 | 2010-07-15 | 30 | 254,126 | 141 | 298 |
| 8 | 2010-07-16 | 2010-08-14 | 30 | 278,402 | 173 | 346 |
| 9 | 2010-08-15 | 2010-09-14 | 31 | 254,973 | 119 | 272 |
| 10 | 2010-09-15 | 2010-10-14 | 30 | 184,822 | 20 | 89 |
| 11 | 2010-10-15 | 2010-11-15 | 32 | 160,089 | 1 | 21 |
| 12 | 2010-11-16 | 2010-12-15 | 30 | 142,109 | 0 | 1 |
| 13 | 2010-12-16 | 2011-01-15 | 31 | 142,935 | 0 | 0 |
| 14 | 2011-01-16 | 2011-02-13 | 29 | 139,964 | 0 | 0 |
| 15 | 2011-02-14 | 2011-03-14 | 29 | 132,370 | 0 | 0 |
| 16 | 2011-03-15 | 2011-04-13 | 30 | 139,338 | 1 | 7 |
| 17 | 2011-04-14 | 2011-05-12 | 29 | 138,656 | 4 | 24 |
| 18 | 2011-05-13 | 2011-06-12 | 31 | 202,999 | 43 | 145 |
| 19 | 2011-06-13 | 2011-07-12 | 30 | 231,160 | 105 | 255 |
| 20 | 2011-07-13 | 2011-08-14 | 33 | 305,790 | 218 | 411 |
| 21 | 2011-08-15 | 2011-09-15 | 32 | 244,017 | 114 | 271 |
| 22 | 2011-09-16 | 2011-10-15 | 30 | 171,816 | 25 | 114 |
| 23 | 2011-10-16 | 2011-11-14 | 30 | 134,897 | 0 | 9 |
| 24 | 2011-11-15 | 2011-12-13 | 29 | 132,993 | 0 | 0 |
| 25 | 2011-12-14 | 2012-01-13 | 31 | 142,609 | 0 | 0 |

Access variables of influence – weather

RETScreen Expert - 13b Performance Analysis - Building with Cooling in RETScreen Expert - Bldg #43 (Elec).retx

File Location Facility Data Analytics Report Custom

Consumption Electricity production... Transportation Production level... Other Occupancy...

Step 1 - Consumption | Production Step 2 - Factors of influence Step 3 - Data processing Step 4 - Summary | Portfolio

Canada - Ontario - London (43°N, -81.1°E) Elevation: 275 m (Facility) 291.5 m (NASA)

| | Cooling degree-days 12°C | Cooling degree-days 18°C | Period | Begin | Air temperature - average °C | Air temperature - minimum °C | Air temperature - maximum °C | Relative humidity % | Precipitation mm | Daily solar radiation - horizontal kWh/m ² /d | Atmospheric pressure kPa | Wind speed m/s | Earth ten ° |
|---|--------------------------|--------------------------|--------|------------|------------------------------|------------------------------|------------------------------|---------------------|------------------|--|--------------------------|----------------|-------------|
| 0 | 0 | 0 | 1 | 2010-01-01 | -4.4 | -7.5 | -2.3 | 82.4% | 1.4 | 1.48 | 98.2 | 6.8 | -4 |
| 0 | 0 | 0 | 2 | 2010-01-02 | -10.1 | -11.2 | -7.9 | 77.3% | 0.2 | 1.92 | 98.5 | 9.0 | -9 |
| 0 | 0 | 0 | 3 | 2010-01-03 | -8.6 | -10.8 | -6.4 | 83.9% | 0.4 | 1.24 | 98.3 | 9.8 | -6 |
| 0 | 0 | 0 | 4 | 2010-01-04 | -8.2 | -9.2 | -6.4 | 83.4% | 0.5 | 1.74 | 98.1 | 6.4 | -7 |
| 0 | 0 | 0 | 5 | 2010-01-05 | -5.9 | -8.2 | -4.0 | 86.8% | 0.8 | 1.93 | 98.0 | 5.6 | -5 |
| 0 | 0 | 0 | 6 | 2010-01-06 | -4.6 | -6.2 | -2.5 | 86.5% | 0.4 | 1.63 | 98.2 | 4.7 | -4 |
| 0 | 0 | 0 | 7 | 2010-01-07 | -4.7 | -6.4 | -1.9 | 85.6% | 0.4 | 1.61 | 98.1 | 1.9 | -4 |
| 0 | 0 | 0 | 8 | 2010-01-08 | -7.9 | -9.6 | -6.3 | 82.1% | 1.3 | 2.22 | 98.3 | 7.1 | -7 |
| 0 | 0 | 0 | 9 | 2010-01-09 | -12.2 | -15.8 | -7.0 | 80.9% | 0.1 | 2.36 | 99.3 | 4.7 | -1 |
| 0 | 0 | 0 | 10 | 2010-01-10 | -8.7 | -13.6 | -2.9 | 83.5% | 0.1 | 2.40 | 99.1 | 6.3 | -6 |
| 0 | 0 | 0 | 11 | 2010-01-11 | -7.6 | -8.9 | -6.7 | 84.5% | 1.0 | 1.32 | 98.5 | 4.5 | -7 |
| 0 | 0 | 0 | 12 | 2010-01-12 | -7.9 | -12.2 | -4.5 | 84.3% | 0.1 | 2.05 | 99.1 | 5.0 | -7 |
| 0 | 0 | 0 | 13 | 2010-01-13 | -4.0 | -7.0 | -1.0 | 89.3% | 0.1 | 2.29 | 98.7 | 6.8 | -3 |
| 0 | 0 | 0 | 14 | 2010-01-14 | -1.0 | -4.1 | 1.2 | 93.0% | 0.1 | 2.36 | 98.4 | 6.7 | -1 |
| 0 | 0 | 0 | 15 | 2010-01-15 | -0.3 | -2.5 | 1.9 | 88.5% | 0.3 | 1.62 | 98.8 | 4.4 | -0 |
| 0 | 0 | 0 | 16 | 2010-01-16 | -2.2 | -4.9 | 1.7 | 90.0% | 0.0 | 1.97 | 98.8 | 4.2 | -2 |
| 0 | 0 | 0 | 17 | 2010-01-17 | -1.2 | -4.5 | 2.2 | 94.8% | 0.0 | 2.00 | 97.8 | 2.2 | -1 |
| 0 | 0 | 0 | 18 | 2010-01-18 | -1.9 | -3.2 | -0.3 | 90.4% | 0.1 | 1.49 | 97.9 | 3.7 | -1 |
| 0 | 0 | 0 | 19 | 2010-01-19 | -2.5 | -4.7 | 0.6 | 87.3% | 0.2 | 1.88 | 98.0 | 3.6 | -2 |
| 0 | 0 | 0 | 20 | 2010-01-20 | -6.1 | -10.1 | -2.5 | 81.8% | 0.1 | 2.63 | 98.5 | 4.1 | -5 |
| 0 | 0 | 0 | 21 | 2010-01-21 | -4.8 | -10.1 | 0.9 | 85.0% | 0.0 | 2.71 | 98.5 | 7.1 | -4 |
| 0 | 0 | 0 | 22 | 2010-01-22 | -2.9 | -6.0 | 2.8 | 84.9% | 0.0 | 2.87 | 98.3 | 7.2 | -2 |
| 0 | 0 | 0 | 23 | 2010-01-23 | -1.6 | -5.6 | 2.4 | 85.5% | 0.1 | 2.86 | 98.5 | 7.3 | -1 |
| 0 | 0 | 0 | 24 | 2010-01-24 | 2.0 | 0.7 | 2.9 | 91.4% | 2.7 | 1.29 | 97.0 | 8.6 | 1 |
| 0 | 0 | 0 | 25 | 2010-01-25 | 0.7 | -2.0 | 2.8 | 91.1% | 4.9 | 1.21 | 95.9 | 7.0 | 0 |
| 0 | 0 | 0 | 26 | 2010-01-26 | -2.3 | -3.7 | -1.3 | 81.3% | 0.9 | 2.00 | 97.0 | 8.8 | -1 |
| 0 | 0 | 0 | 27 | 2010-01-27 | -5.1 | -6.1 | -3.9 | 72.9% | 0.3 | 2.81 | 98.2 | 9.0 | -4 |
| 0 | 0 | 0 | 28 | 2010-01-28 | -8.7 | -11.2 | -5.3 | 70.9% | 2.1 | 2.57 | 98.5 | 10.4 | -6 |
| 0 | 0 | 0 | 29 | 2010-01-29 | -11.0 | -13.4 | -9.4 | 71.0% | 1.1 | 2.28 | 99.4 | 6.1 | -11 |
| 0 | 0 | 0 | 30 | 2010-01-30 | -12.3 | -16.9 | -7.4 | 68.0% | 0.0 | 3.29 | 99.1 | 2.5 | -1 |
| 0 | 0 | 0 | 31 | 2010-01-31 | -7.7 | -10.8 | -5.0 | 76.8% | 0.4 | 2.41 | 98.5 | 7.0 | -7 |
| 0 | 0 | 0 | 32 | 2010-02-01 | -7.1 | -10.8 | -4.9 | 72.2% | 0.0 | 3.06 | 99.0 | 5.5 | -6 |
| 0 | 0 | 0 | 33 | 2010-02-02 | -5.2 | -8.3 | -2.5 | 82.3% | 0.5 | 2.99 | 98.6 | 2.1 | -5 |

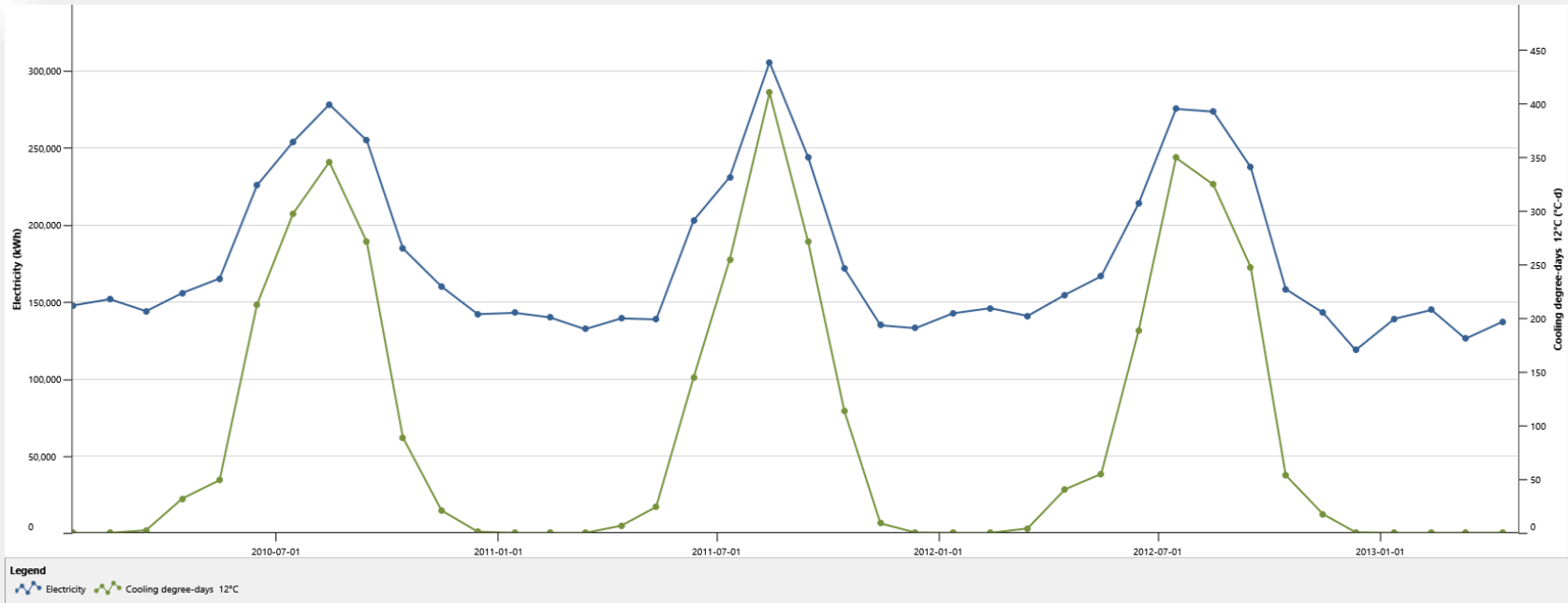
RETScreen - Data

Data

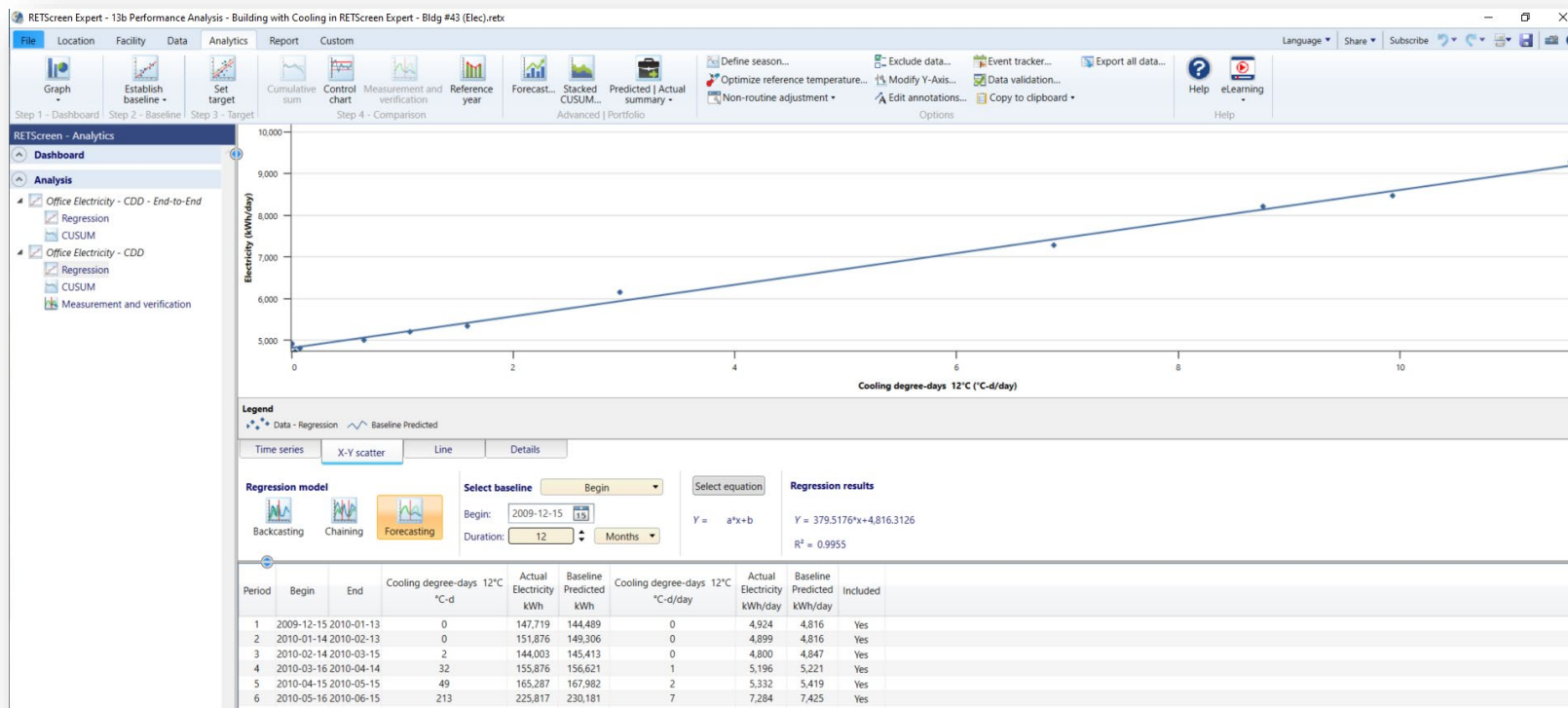
- Weather - Canada - Ontario - London - NASA
- NASA data
- Office Electricity
- Event log

Summary

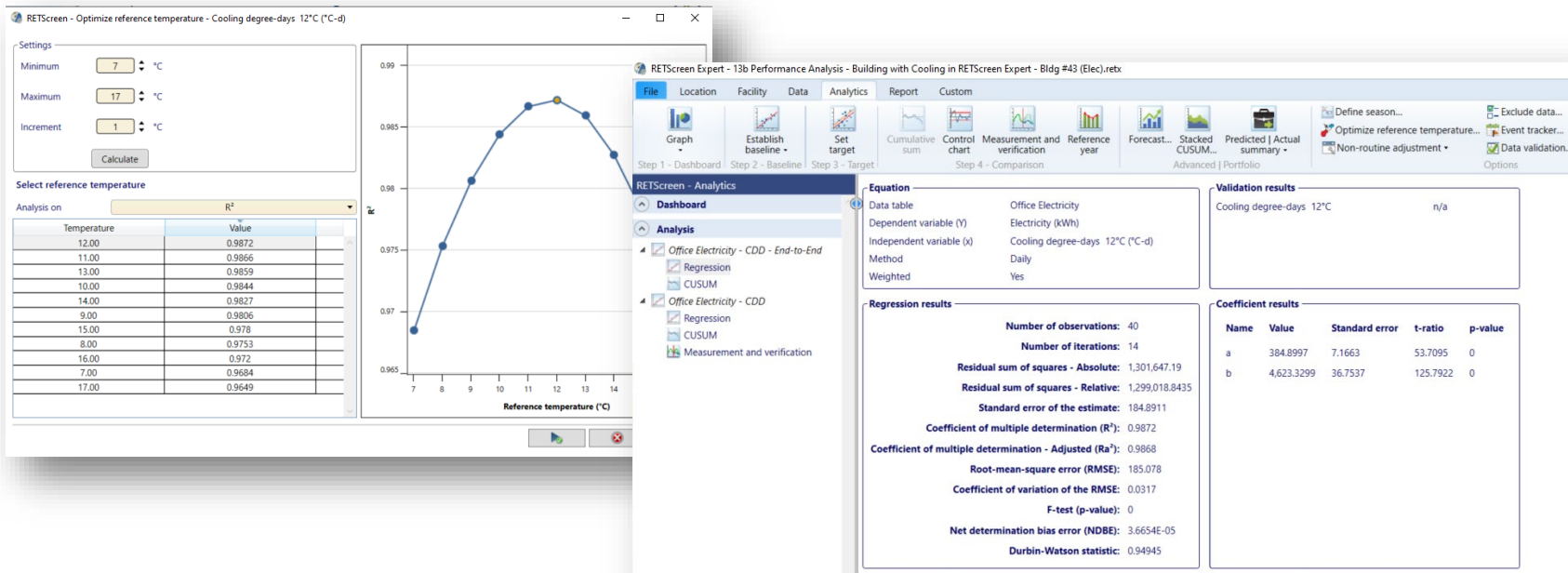
Examine function relationships



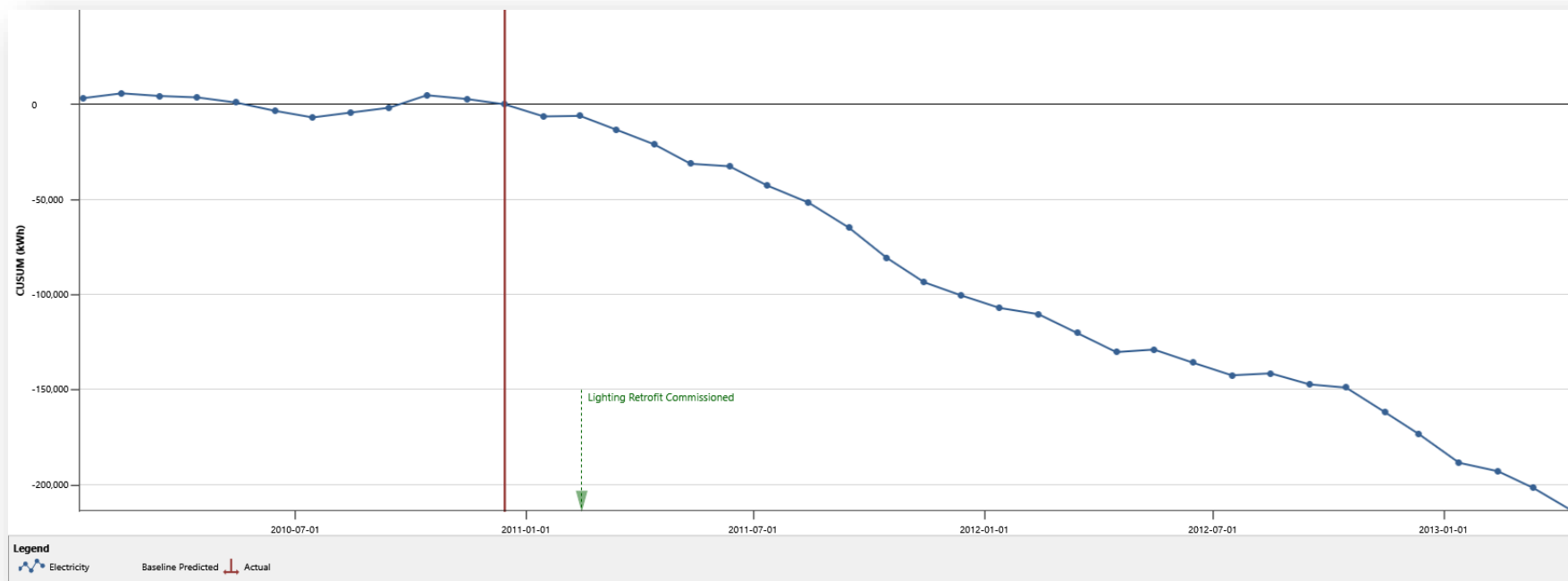
Develop regression-based performance models



Tune models – degree day balance point and statistics



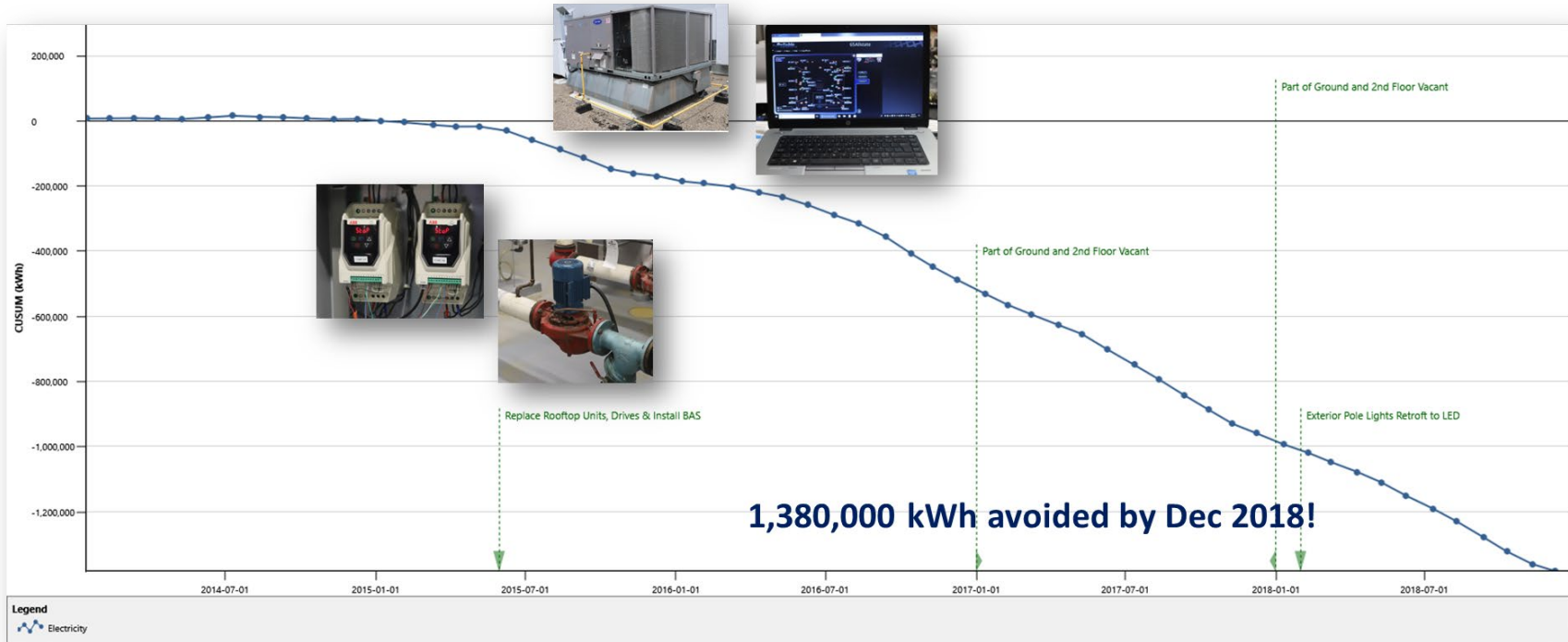
Develop a cumulative sum (CUSUM) chart – showing events



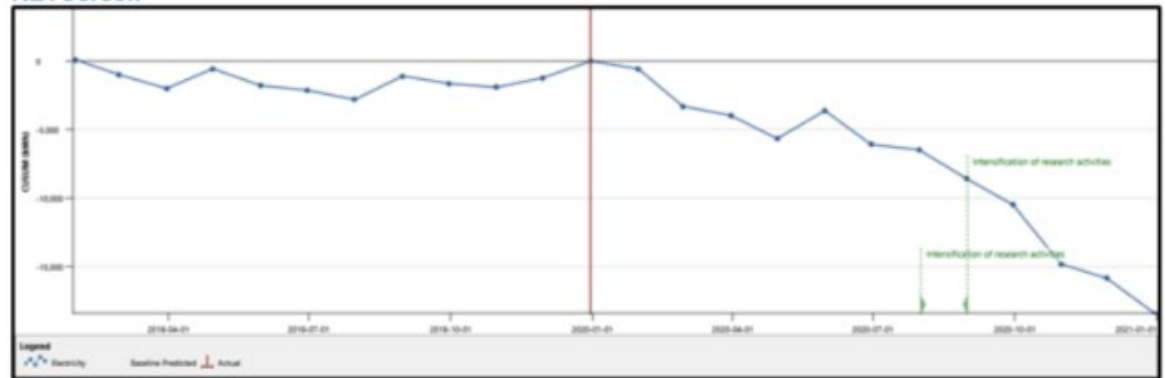
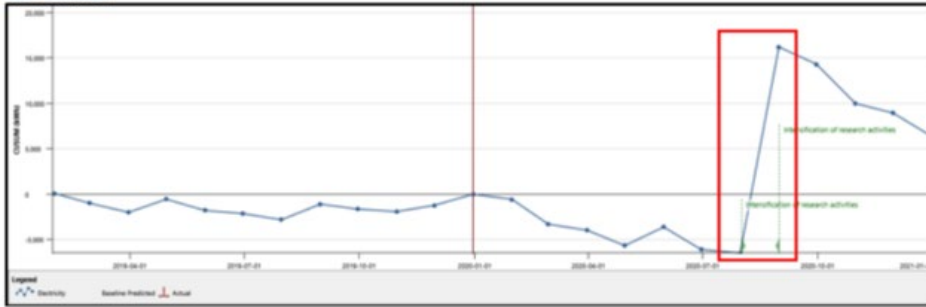
Establish measurement and verification chart and savings



RETScreen Expert can track multiple projects/actions



RETScreen Can Accommodate Non-Routine Adjustments



Multiple Resources Available

- **Find multiple type of resources on Save on Energy website :**

<https://saveonenergy.ca/Training-and-Support>

Webinars

Fact sheets

M&V templates

Practical guides

- **Sign up for a one-on-one coaching:** [Post-webinar support intake form](#)
 - Coaching sessions conducted virtually: phone, video calls, and email
 - Designed for organizations seeking guidance.

Thank you!

[SaveOnEnergy.ca](https://www.saveonenergy.ca)

trainingandsupport@ieso.ca

 @SaveOnEnergyOnt

 facebook.com/SaveOnEnergyOntario

 [linkedin.com/showcase/
SaveOnEnergy-Ontario](https://linkedin.com/showcase/SaveOnEnergy-Ontario)



Stay in the know

Sign up for Save on Energy's
quarterly business newsletter