PILOTS: PRESENT AND FUTURE

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Standardized, Sustainable and Transparent EM&V – Integrating New Approaches in Connecticut Pilots: Present and Future

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Diane Duva, CT DEEP Presenter

November 7, 2018
Burlington, Vermont

Connecticut Department of Energy and Environmental Protection

The Connecticut M&V 2.0 Pilot

Funding:

DOE Funding: $743,998
Cost Match: $538,100 (72%)

Project Goals:

This project will test the use of advanced data analytics and collection tools (M&V 2.0) through a statewide pilot, and compare these findings with traditional M&V practices in terms of savings certainty, timeframe, and other aspects.

Inform and coordinate EM&V 2.0 learning and results with Regional organizations and US DOE Uniform Methods Projects.

Impact:

- Develop M&V 2.0 software tool standards and protocols
- Broad scale adoption and use of M&V 2.0 tools in CT based on pilot results
- State and regional education on automated versus traditional approaches to EM&V

The Connecticut Project Team:

- NH, NY, RI, VT, NEEP, LBNL
- Eversource Connecticut (utility)
- United Illuminating (utility)

Stakeholders:

- State energy offices, regulators, utilities, program administrators, evaluators, system planners, facility managers

Objectives

Task 1 :

- Test advanced data collection/analytics tools in commercial and residential buildings.

Task 2:

- Track the process of using these tools and share results with states.

Task 3

- Assess how these M&V 2.0 tools can be integrated with traditional evaluation.

Task 4

- Regulators will expect these auto-M&V tools to be a valid method for determining energy savings.

Speakers

C&I Pilot:

Jessica Granderson, Lawrence Berkeley Labs

Miles Ingram, Eversource

Residential Pilot:

Claire Miziolek, NEEP

Connecticut Advanced M&V Pilots
November 7, 2018

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Technical Goals

- Understand broad-scale suitability of M&V 2.0 based on customer load profiles

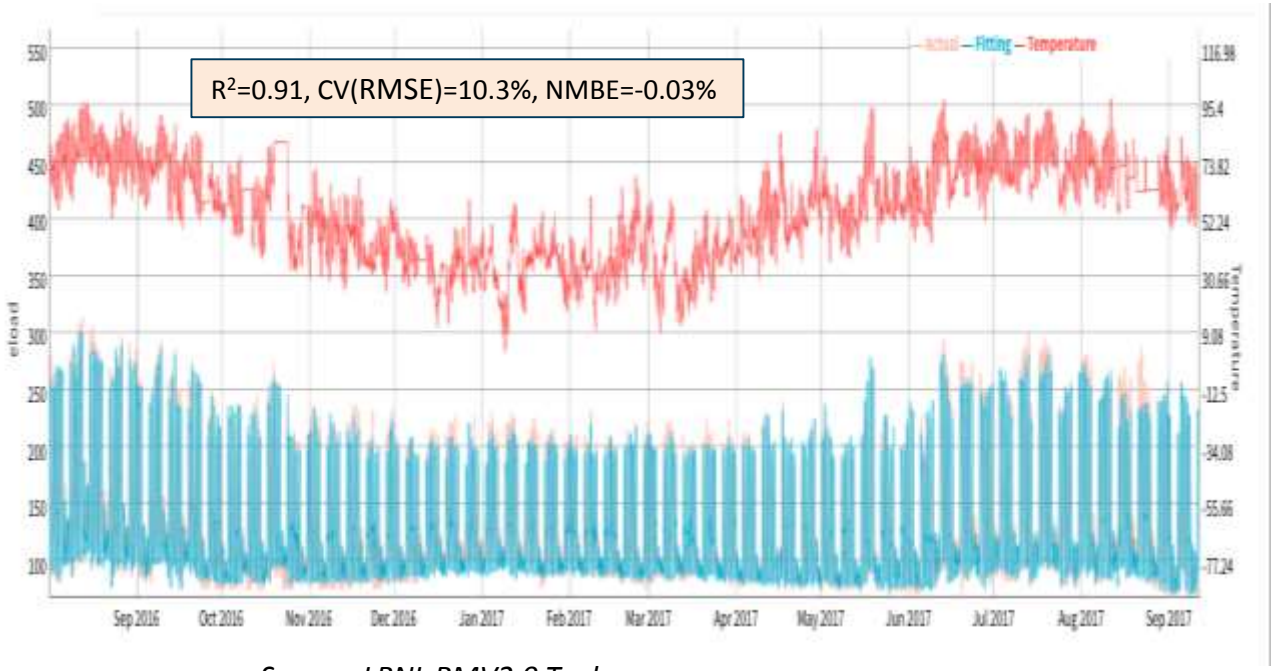
- Assess M&V 2.0 value proposition
  - How do savings compare with currently used methods?
  - What are the process needs? Streamlining?
  - What is the value of continuous feedback?

- Document findings, incorporate into application guidance

C&I PILOT SCREENING AND PROJECT SELECTION

Generalized Suitability of Advanced M&V

- Baseline models for 137 meters
- Model fitness target thresholds
  - R2 > 0.7
  - CV(RMSE) <25%
  - NMBE between -0.5% and +0.5%



Source: LBNL RMV2.0 Tool

Generalized Suitability of Advanced M&V

- 71% of buildings could be modeled to meet all model fitness screening criteria – no model customization OAT and time only

- Consistent w experience with other data sets, which ranged ~70%-85%

Screening Criteria	Sites Meeting Screening Criteria (n =137)	
	Quantity	**%**
R^2 >0.7	111	81%
CV(RMSE) <25%	109	80%
NMBE within -0.5% to +0.5% range	136	99%
Sites Meeting All Screening Criteria	**97**	**71%**

M&V 2.0 Pilot Cohort

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Selection criteria:

- CT *Energy Opportunities* participants (large commercial retrofit program)
- Participants with “pipeline” projects scheduled for installation
- Interval meter in place for at least 12 months
- Expected whole building savings >5%

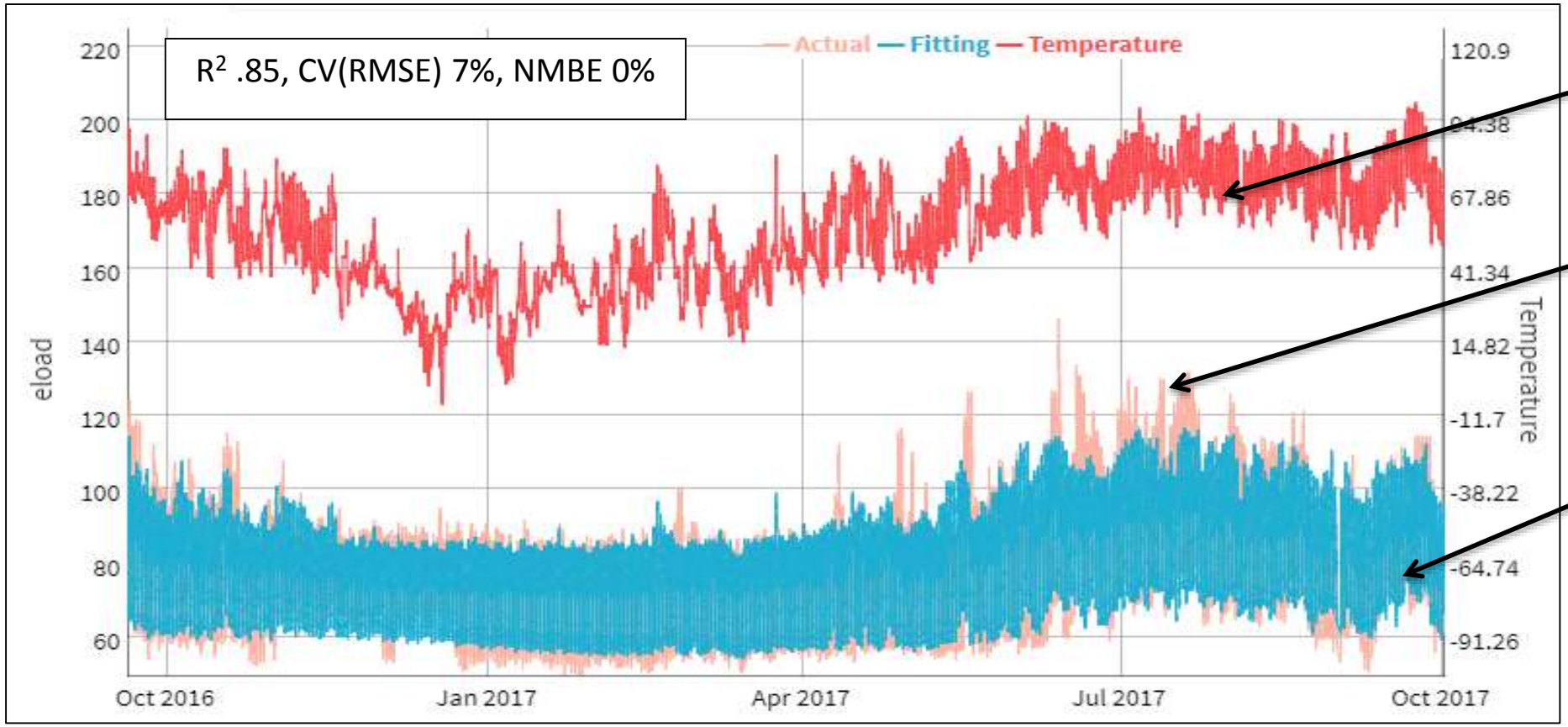
Business type	Measure type
Grocery	Refrigeration
Grocery	Lighting (interior)
Grocery	Lighting (interior)
Aerospace & Defense	Lighting (interior)
Office Building	Lighting (exterior) Cooling (VFD) Heating (VFD)
Grocery	Lighting (interior)
Retail	Lighting (interior and exterior)
Office Building	Lighting (interior) Cooling (EMS) Motors
Museum	Lighting (interior)
Retail	Lighting (interior)
Grocery	Refrigeration
Insurance Office	Cooling (EMS) Motors (Kitchen Fans)
Retail	Lighting (exterior)
State Prison	Lighting, Refrigeration, Heating, Cooling
Manufacturing	Lighting, Heating, Cooling

Pilot Screening and Site Selection

- Baseline model fitness check, 34 pilot candidates

Screening Criteria	Sites Meeting Screening Criteria (n =34)	
	Quantity	**%**
R^2 >0.7	31	91%
CV(RMSE) <25%	28	82%
NMBE within -0.5% to +0.5% range	34	100%
Sites Meeting All Screening Criteria	**28**	**82%**

Example Site: Met Fitness Criteria



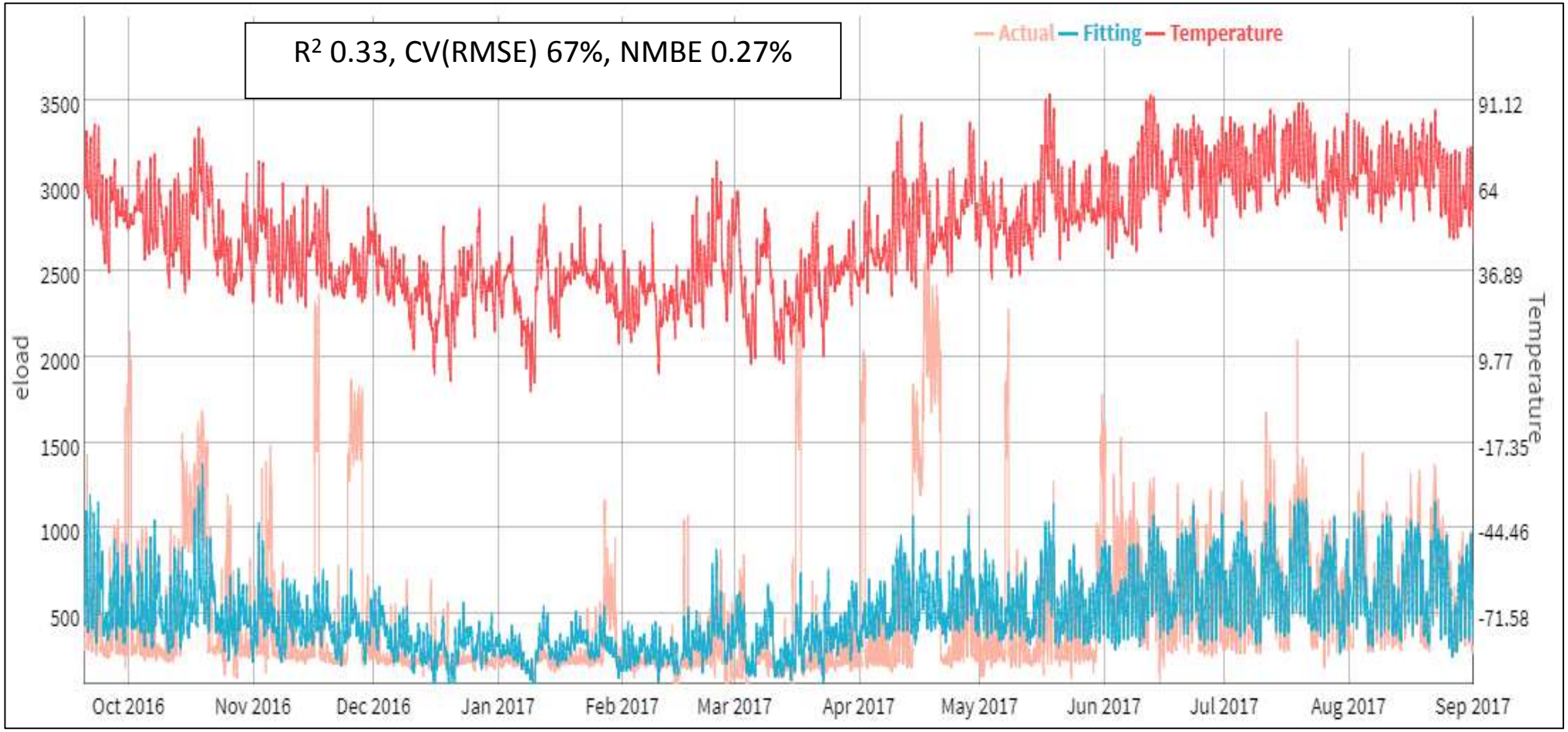
Temperature Data

Meter data (orange)

Model fitted data (blue)

Actual and fitted consumption data, and ambient temperature, for site EV-02

Example Site: Did Not Meet Fitness Criteria



Actual and fitted consumption data, and ambient temperature, for site EV-17

TRADITIONAL M&V

Typical Approaches: Engineering and Billing Analysis

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Pre-project:

- Engineering analysis and review (in-house and/or third-party)
- Monthly billing analysis (in-house)
  - **adjusted for weather** if measures are weather-dependent
  - **sanity check** of current end use vs. total consumption

Post-project:

- Engineering analysis and review, *adjusted for as-built conditions*
- Selective billing analysis (e.g., large custom projects, projects with changes at the site, projects with questionable pre-project analysis)

Typical Approaches: Engineering Analysis of Pilot Sites

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Engineering analysis, adjusted for as-built conditions, per post-inspection

Business type	Measure type	Estimated annual savings (kWh)	Estimated Savings, % of 2016 Annual Usage
Grocery	Refrigeration	59,738	4.4%
Grocery	Lighting (interior)	409,097	13.9%
Grocery	Lighting (interior)	254,003	13.5%
Aerospace & Defense	Lighting (interior)	49,013	2.3%
Office Building	Lighting (exterior) 198,658 kWh Cooling (VFD) 50,024 kWh Heating (VFD) 19,877 kWh	268,559	1.7%
Grocery	Lighting (interior)	140,746	10.3%
Retail	Lighting (interior and exterior)	175,348	1.3%
Office Building	Lighting (interior) 106,819 kWh Cooling (EMS) 39,248 kWh Motors, 631,587 kWh	777,654	5.4%
Museum	Lighting (interior)	241,775	9.7%
Retail	Lighting (interior)	108,238	13.8%
Grocery	Refrigeration	66,805	5.2%
Insurance Office	Cooling (EMS) 658 kWh Motors (Kitchen Fans) 20,147 kWh	20,805	0.3%
Retail	Lighting (exterior)	33,730	3.6%
State Prison	Lighting, Refrigeration, Heating, Cooling	TBD – Project Delayed	
Manufacturing	Lighting, Heating, Cooling	TBD – Project Delayed	

Typical Approaches: Third Party "Traditional" EM&V

- **CT statute** requires EM&V to ensure that programs are cost effective, achieve optimal levels of savings, are administered efficiently, and comply with statutory requirements

- **ISO-NE Forward Capacity Market** criteria for statistical precision and confidence of demand resources

- **Insight** into factors driving savings discrepancies:

Figure 1-3. Key Drivers Behind Electric Realization Rate

	Negative Impact		Positive Impact		Overall	
Discrepancy Category	# Instances	Impact on RR	Impact on RR	# Instances	Impact on RR	# Instances
Difference in baseline assumptions	7	-6%	12%	2	6%	9
Difference in calculation methodology	4	-2%	0%	0	-2%	4
Difference in installed quantity	3	-16%	0%	0	-16%	3
Difference in operating hours	3	-1%	3%	4	2%	7
Documentation differences	1	0%	0%	0	0%	1
Difference in equipment load profiles	7	-4%	20%	2	16%	9
Measure not implemented	1	0%	0%	0	0%	1
Total	**26**	**-31%**	**36%**	**8**	**5%**	**34**

Typical Approaches: Third Party "Traditional" EM&V

- Five pilot sites were sampled for a third-party evaluation, est. completion in 2019
- Methods include on-site metering and installation verification at a representative sample of sites, to produce statistical estimates of program-wide savings

DNV·GL

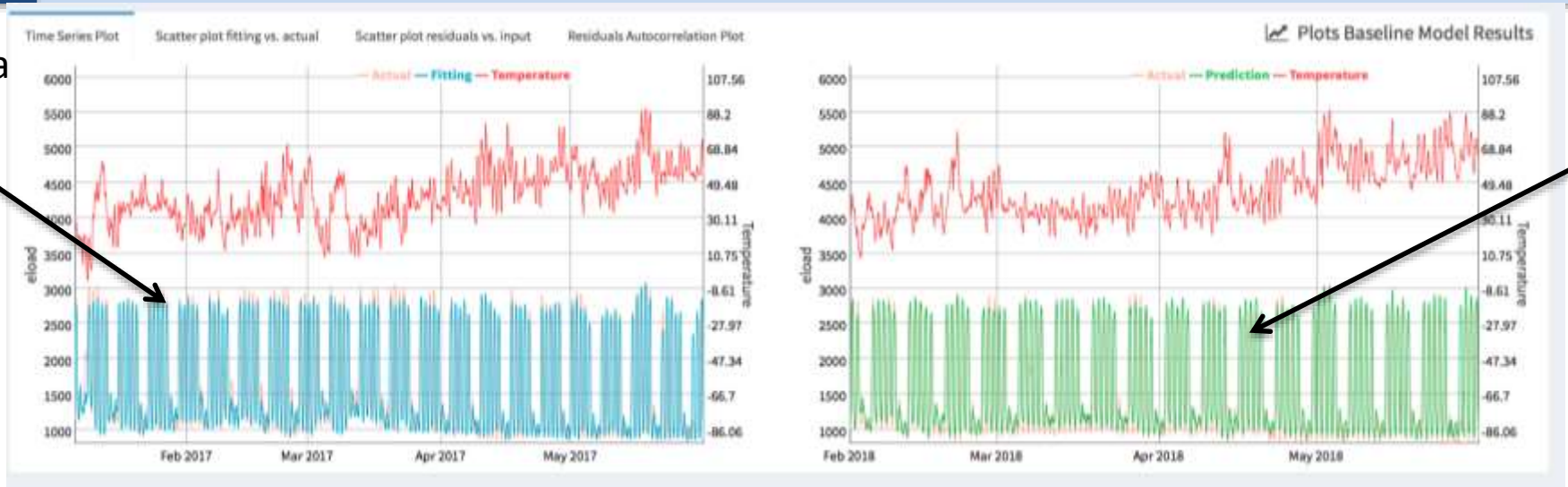
C1635 Impact Evaluation of the CT Energy Opportunities Program

Connecticut Energy Efficiency Board

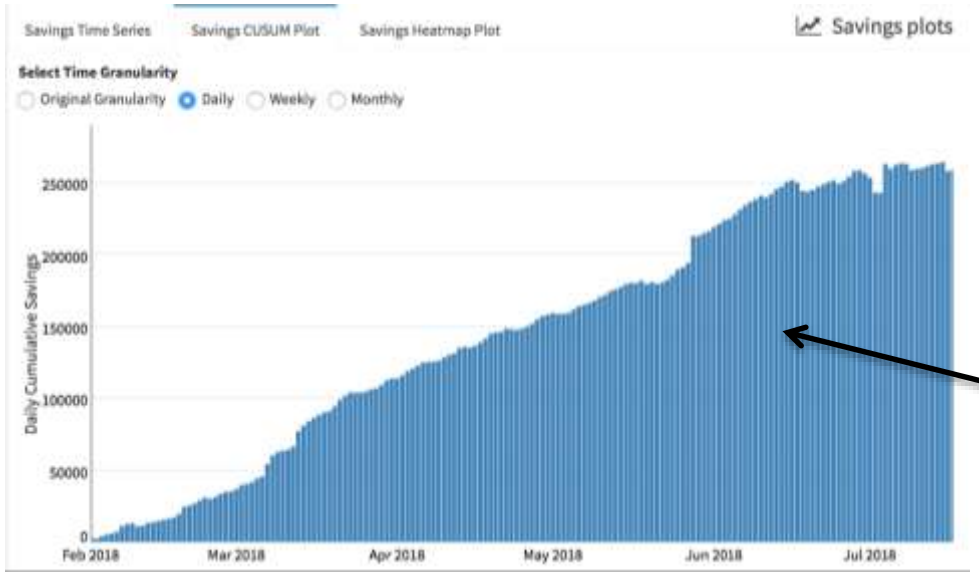
APPLICATION OF ADVANCED M&V

CT Savings Tracking (Example #1)

Baseline data



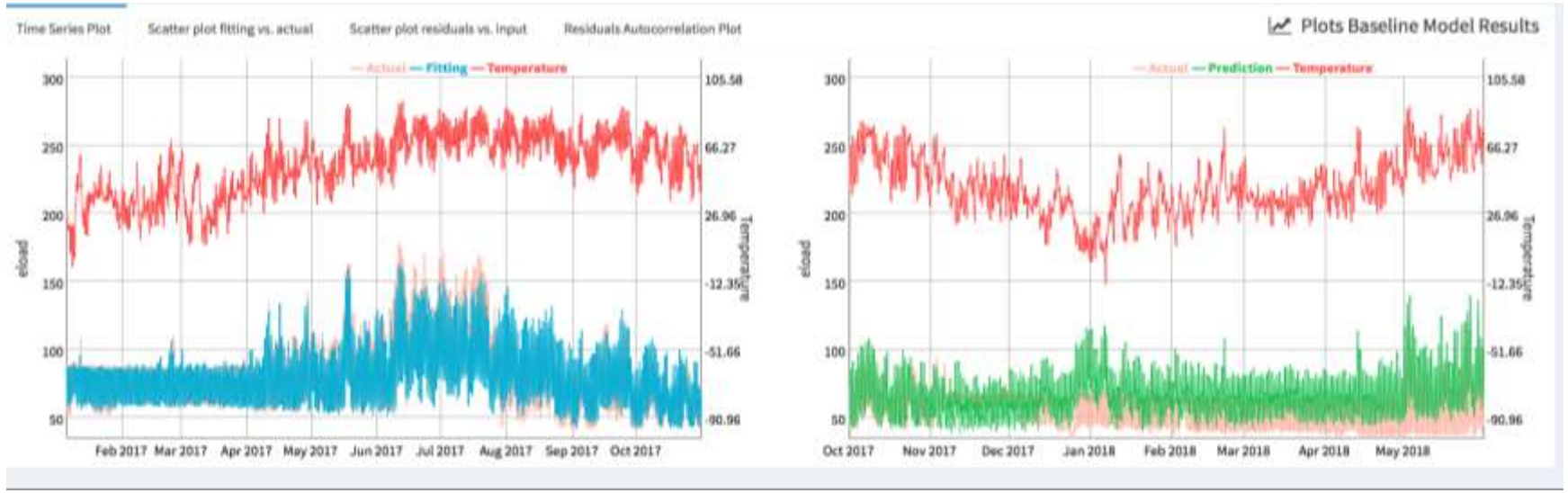
Predicted data (green) vs Actual data (orange)

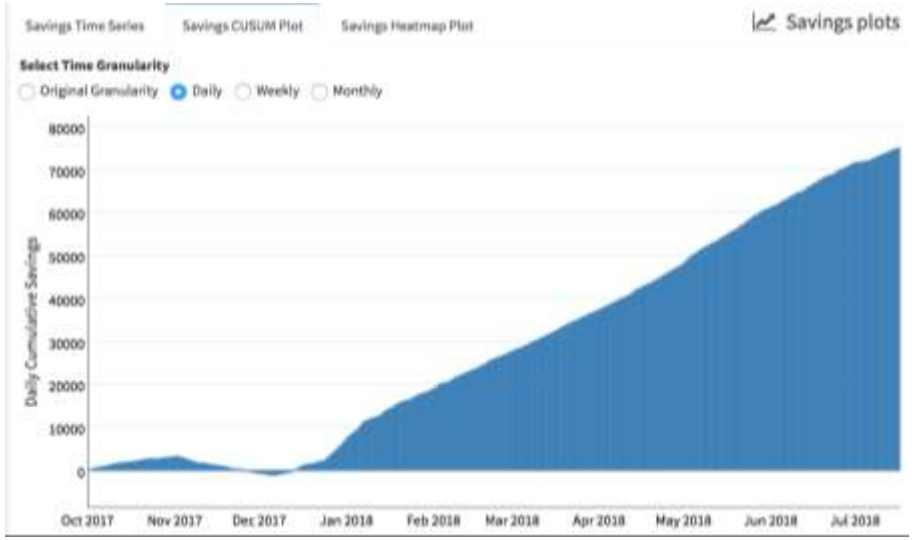


Motor/Lighting/Cooling
Program calculated savings 5.4%
Meter-based savings 4% (168 days post)

"CUSUM" – Cumulative sum of savings over the post-retrofit period

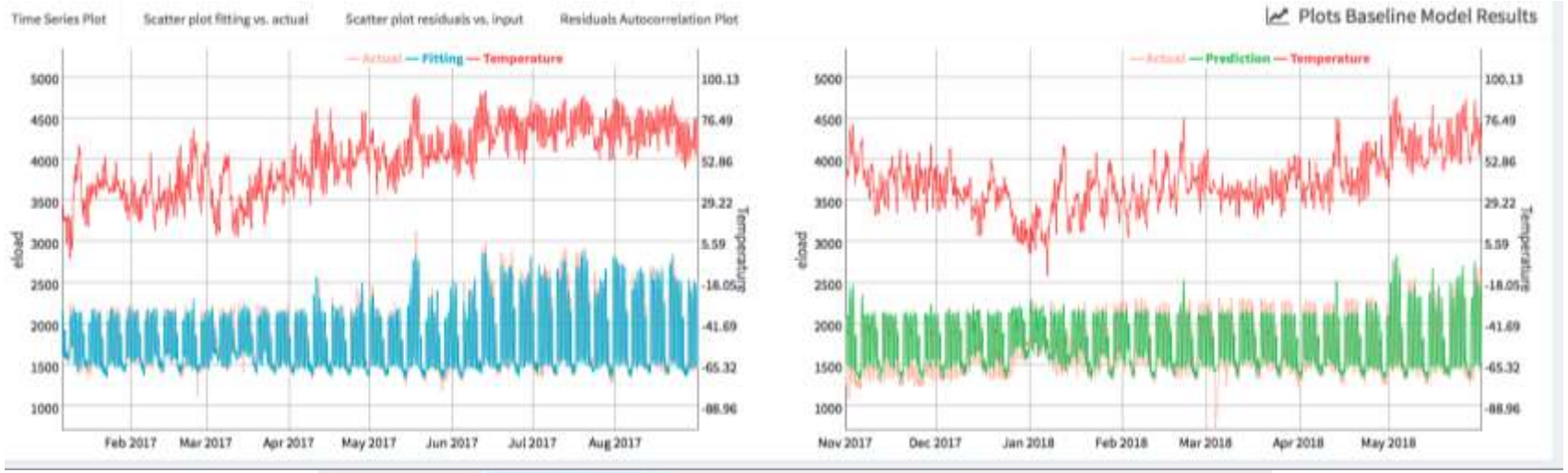
CT Savings Tracking (Example #2)



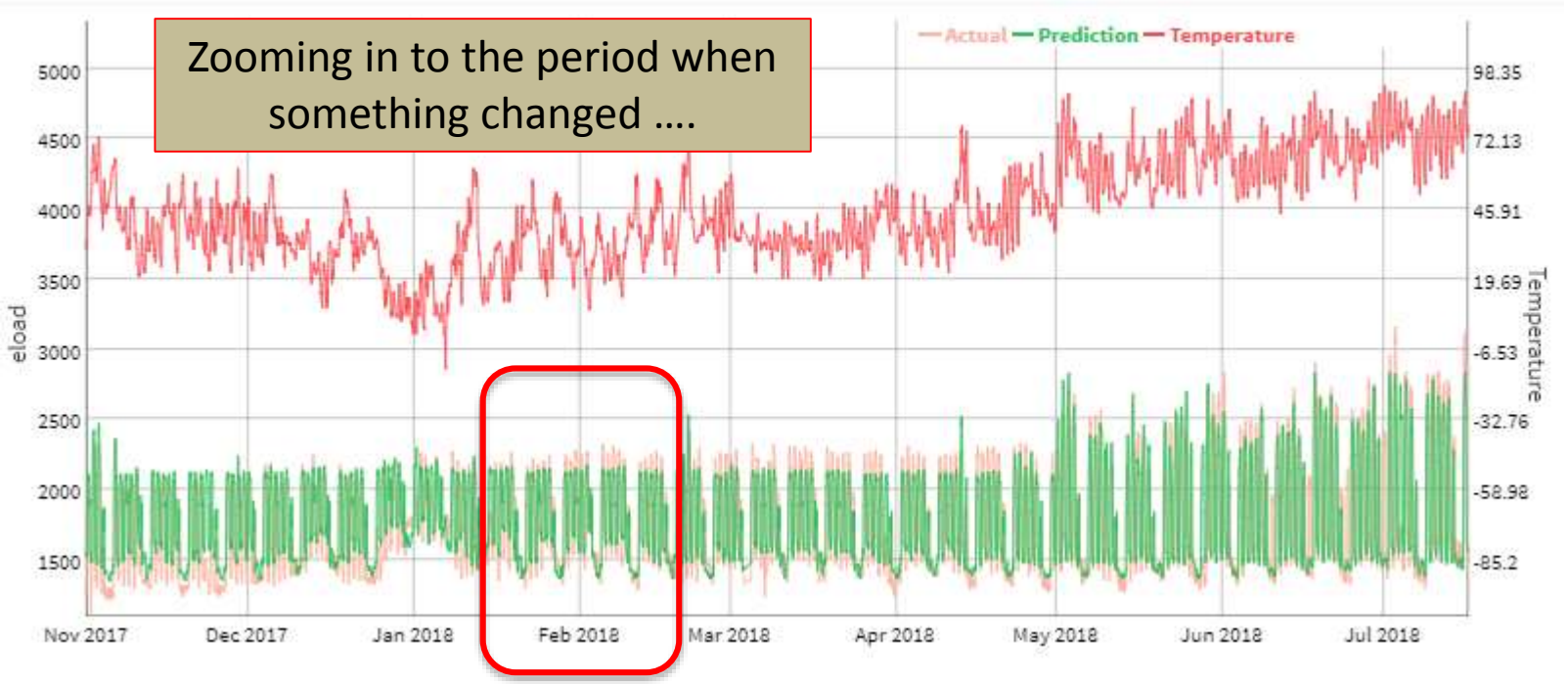


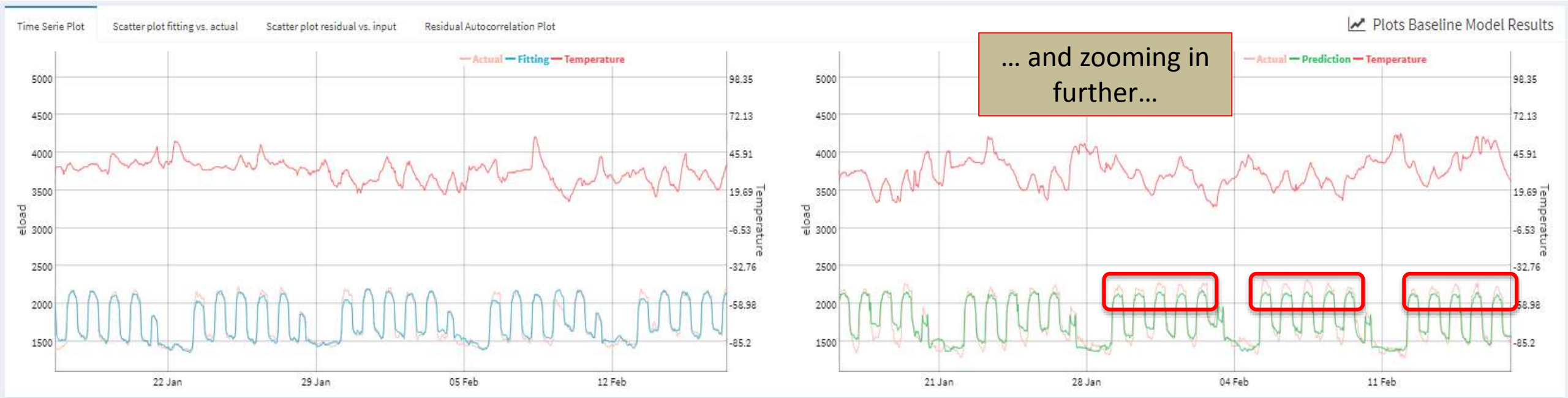
Lighting
Program calculated savings 13.8%
Meter-based savings 15.3% (291 days post)

Investigating Changes in Savings Profile (Example #3)



- Lighting retrofit
- Calculated 314,259kWh annual savings
- Metered: 149,779kWh savings over 260-day period (1.4%)


Zooming in to the period when something changed ….
Actual
Prediction
Temperature
eload
Temperature
5000
4500
4000
3500
3000
2500
2000
1500
98.35
72.13
45.91
19.69
-6.53
-32.76
-58.98
-85.2
Nov 2017
Dec 2017
Jan 2018
Feb 2018
Mar 2018
Apr 2018
May 2018
Jun 2018
Jul 2018


Time Serie Plot
Scatter plot fitting vs. actual
Scatter plot residual vs. input
Residual Autocorrelation Plot
Plots Baseline Model Results
Actual
Fitting
Temperature
eload
Temperature
22 Jan
29 Jan
05 Feb
12 Feb
… and zooming in further…
Actual
Prediction
Temperature
eload
Temperature
21 Jan
28 Jan
04 Feb
11 Feb

REFLECTION

Advanced M&V Interim Outcomes

- Advanced M&V method works as expected
- Building a library of examples with diverse project types, facility types, and data characteristics
- Advanced M&V and associated tool visualizations allow for:
  - Early feedback on savings
  - Characterization of savings by hour/day/season
  - Investigation of possible NREs
- Model fitness metrics and charting support confidence, transparency in results
- Data increases visibility into performance, and questions about what we see

Effort Required for Advanced M&V Pilot

Approximate effort	Tasks
75%	• Data investigation • Cleaning • Preparation • Running model • Clarifying issues
25%	• Interpretation • Analysis • Communication

Expect that at scale, in 'production' environment, less time on data cleaning, prep

PA Lessons Learned: Data and Analysis Challenges

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Challenges: collecting interval data

- organizational barriers
- time consuming process for requests, cleaning, formatting
- data for certain sites not suitable for analysis
  - sites with **retired/replaced meters**
  - sites with **distributed generation**
    - ☑ kW delivered to customer
    - ☑ kW exported to the grid
    - ☒ total consumption

Solutions: Building the "data pipeline"

PA Lessons Learned: Data and Analysis Challenges

EVERSOURCE ENERGY

Where's the project?

Where's the meter?

Meters	Description	Projects*	Implications for measuring savings
1:1	Single building with single meter	Single project	Feasible, assuming savings are high enough (e.g., >5%)
		Multiple projects concurrent/overlapping	Feasible to measure combined savings for all projects. Take baseline prior to first project.
		Multiple projects at separate time periods	Feasibility depends on total time span of projects and the time period between projects.
many:1	Multiple meters serve a single building	Project(s) affect whole building	Can combine readings from multiple meters into a single dataset for model analysis. See other comments for 1:1 meters relating to quantity and timing of projects.
		Project(s) affect portion of building served by one of the meters	Could consider modeling just that meter, but need to consider if interactive effects of project are fully accounted for
1:many	Single meter serves multiple buildings	Single project on a single building	Case-by-case basis. Unlikely that savings would be high enough to be identified at the meter level, and also less likely to establish a high quality model for multiple buildings on a single meter (unless they are all the same building type with the same operating conditions)
		Single project affecting multiple buildings concurrently	
		Multiple projects	

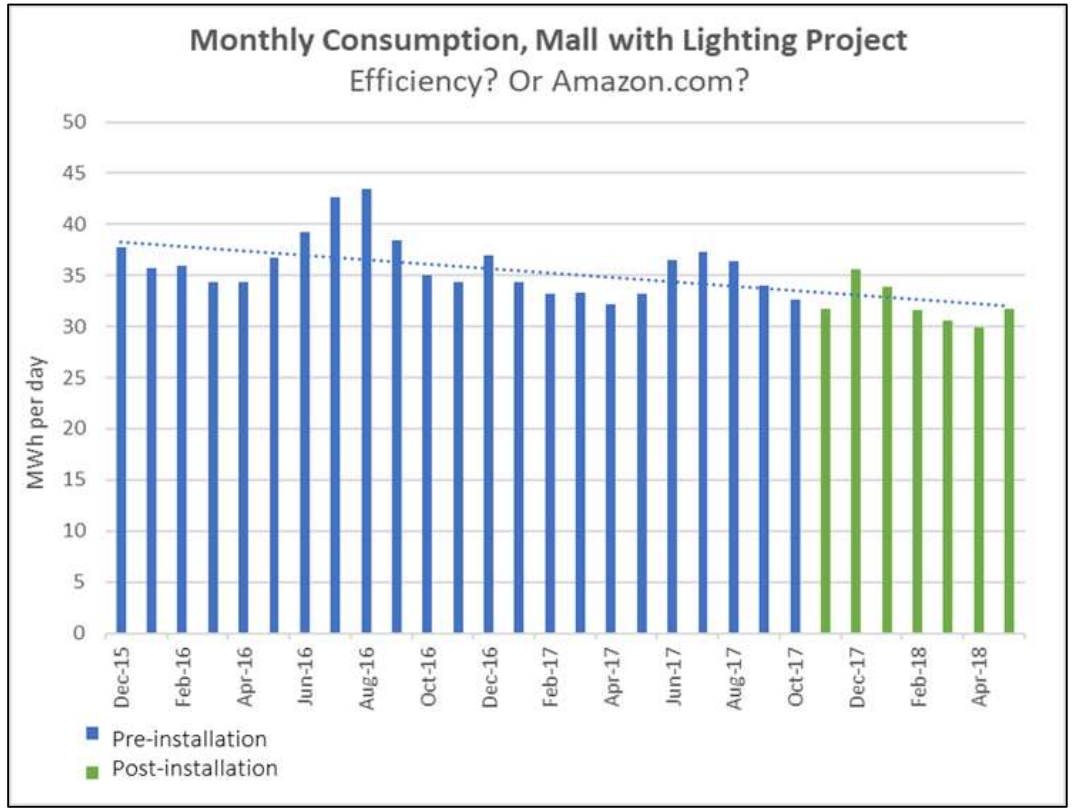
* A "project" may comprise one or more measures.

PA Lessons Learned: Data and Analysis Challenges

Interpret with care!

Consumption may be affected by:

- Changing occupancy/tenancy
- Changing hours of use
- Other efficiency projects
- Other non-routine events such as renovations, building additions, etc.



PA Value Proposition: Risk Mitigation & Streamlining

EVERSOURCE ENERGY

RISK MITIGATION: Quickly detect savings shortfalls, and target sites/contractors/measures for improvements:

- equipment performance
- behavioral issues (e.g., temperature setpoints, EMS programming, etc.)
- removal or replacement of efficient equipment

→ **Address issues <u>in advance</u> of statutorily-required third-party evaluations**

STREAMLINED SAVINGS MEASUREMENTS: Automated, continuous monitoring of savings

- **DATA IN →**

→ SAVINGS OUT

C&I Pilot: Next Steps

- **Continue building the interval data pipeline**
  - ➢ IT team

- **Define a process** for which projects to analyze, when/with whom to share results
  - ➢ Implementation and engineering teams

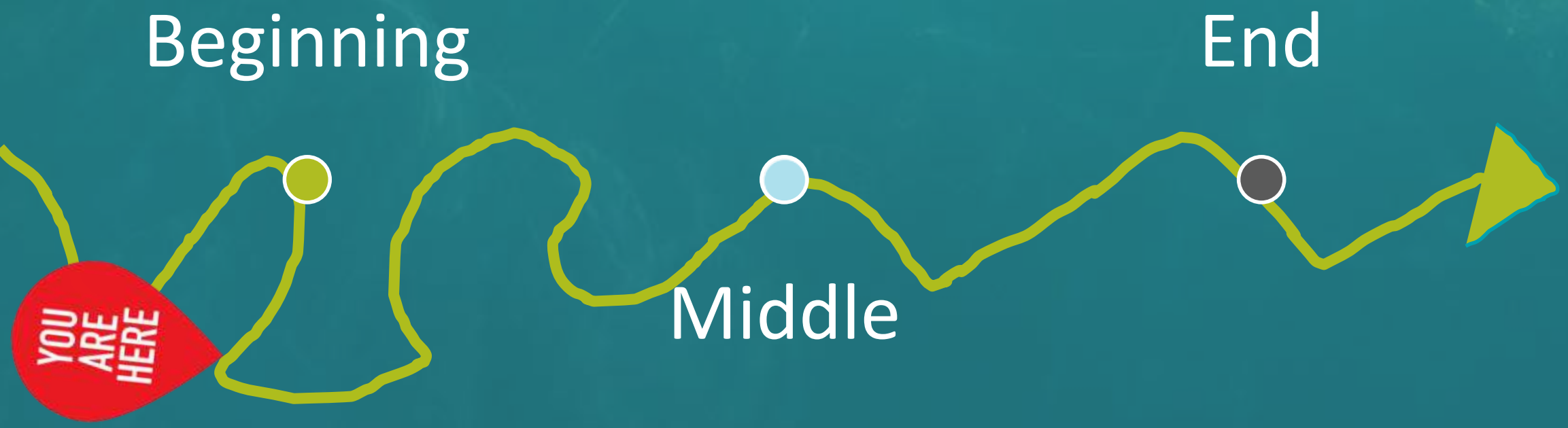
- **Address operational issues on current project** as needed (e.g., thermostat set points, EMS programming), and **inform future projects**, by identifying high & low performers
  - Contractors
  - Measure types
  - Facility types

- Continue assessing M&V 2.0 potential to **streamline traditional EM&V**

Next steps for CT M&V 2.0 Pilots: What goes in to a Residential Pilot?

Claire Miziolek, NEEP

Here’s where we are in the process



What are we trying to do?

Big goals of residential pilot:

- Test out an M&V 2.0 tool
- Compare with "traditional" residential M&V
  - "qualitatively compare and contrast the approaches used in the residential automated M&V tools to other industry-standard methods and best practices"
- Track and document the process
  - Looking for any additional learnings, insights, benefits, or pitfalls from the process
- More modest staffing and time table than C&I

Questions we're considering ?

- What data set/timing do we want to use?
- What program do we want to use?
- What are we comparing to?
- What tool should we use for the job?

What we *might* find…

- What is the time/cost/difficulty of an M&V 2.0 tool vs. traditional evaluation?
- What size of savings is detectable using M&V 2.0 tool?
- What insights can you learn? How much data do you need to see it?
- Does AMI provide more insights?
- For all-electric homes, could their M&V 2.0 analysis be useful for strategic electrification purposes?


KEEP
CALM
AND
STAY
TUNED

Questions?