Emerging Technologies Summit

MAKING THE CONNECTION:

From Energy Efficiency Innovation to Delivery

April 19 – 21, 2017

The Role of Real Time EM&V in Overcoming Barriers

JESSICA GRANDERSON, SOPHIA FRANCOIS, JAMIE PETERS, BRIAN MCCOWAN

The Role of Real-Time EM&V in Overcoming Barriers

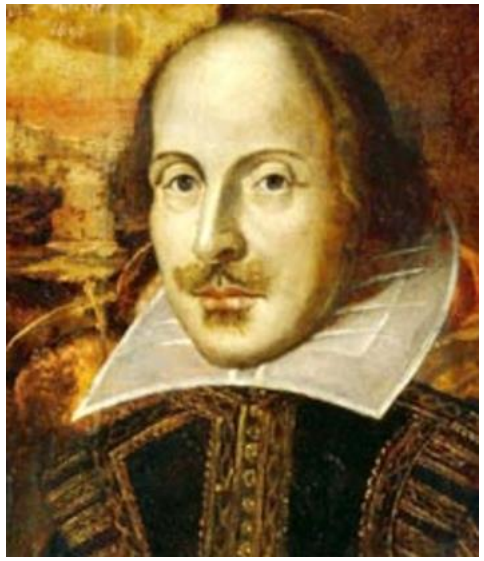
Jessica Granderson, Lawrence Berkeley National Laboratory

Barriers to scaled realization of EE (EM&V-related)

- Performance visibility, timeliness of feedback
- Time, cost, complexity to ‘get it right’
- Promising next-gen measures, program designs difficult to quantify
  - Operational, behavioral, RCx
  - Controls, multi-measure, interactive effects
  - Tough to deem, expensive to custom calculate or simulate
  - Untapped potential for deep savings
- Limited ability to provide time-resolved, location-specific, gross (demand and absolute energy), as well as net savings results

What is real-time EM&V?

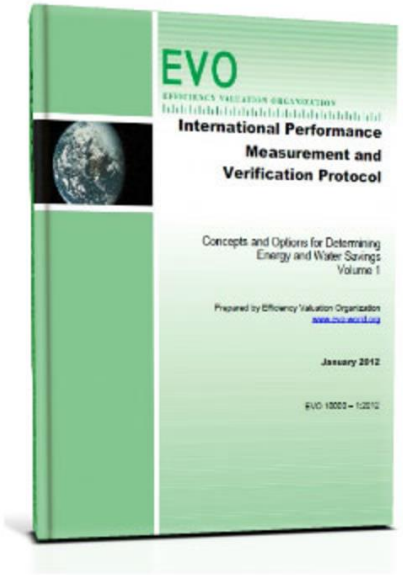
- Advanced M&V, continuous M&V, M&V 2.0, EM&V 2.0, EDGE, embedded EM&V, automated M&V …

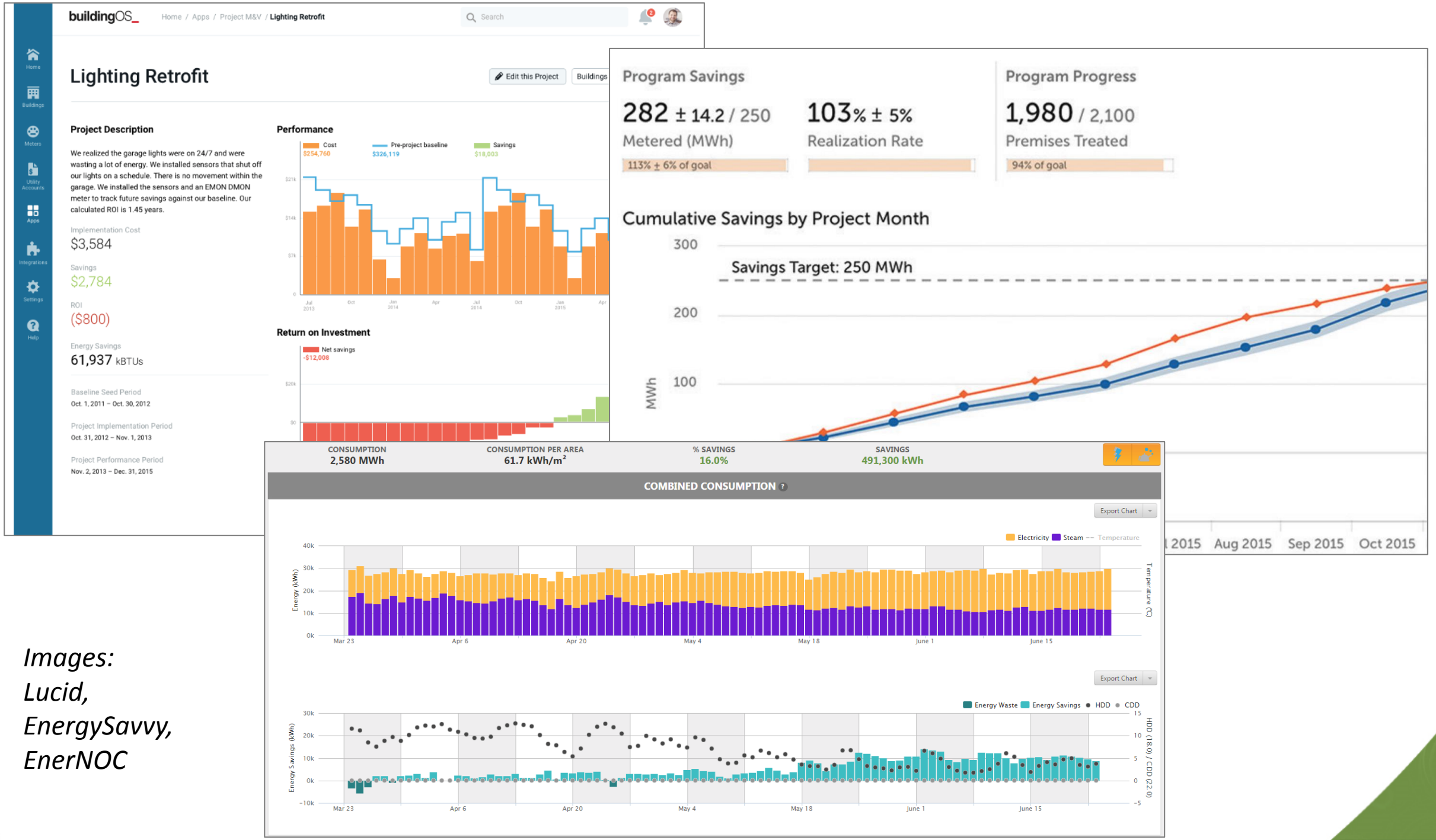


What is in a name?

Common elements

- Leveraging computation and IT
- More data – quantity, time resolution, submeters and devices
- Continuous accessibility via modern software platforms
- Foundation built upon proven savings estimation techniques





Images:
Lucid,
EnergySavvy,
EnerNOC

The vision

- Massive data availability to baseline load for any building
- Analytics to target high optimal EE, DER, storage opportunities, engage customers
- Savings tracking from day 1 -- for project, program, or sample
- Course correction insights to maximize realization
- Process streamlining enables scale, increasing delivery pipeline
- Transparency and rigor bring deeper capital investment

Recent and current research

- Opening the black box of proprietary real-time EM&V

- Investigation of advanced and traditional approaches
  - Are the results comparable?
  - What accuracy and uncertainty can be achieved?
  - What are the time/cost impacts of streamlining through automation?

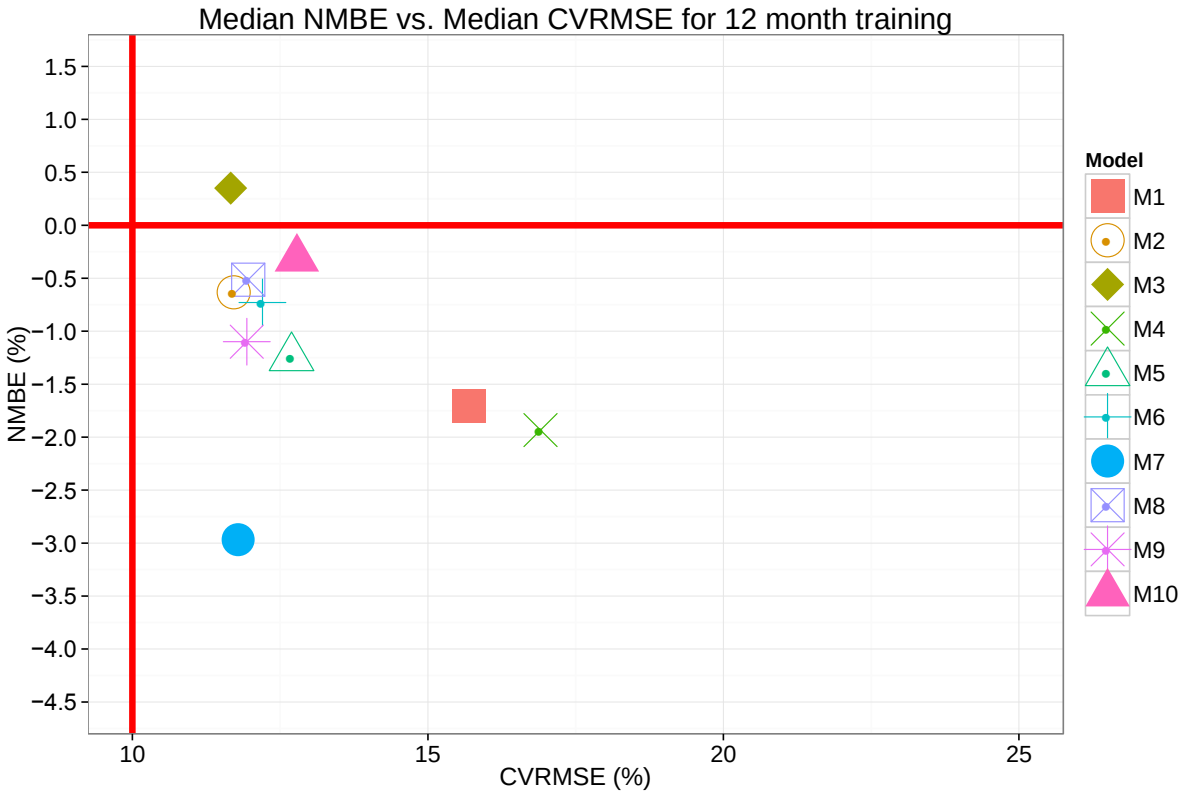
- Practitioner workflows
  - How does a professional use real-time tools complemented with professional expertise to ensure a quality result?
  - What can and can’t be done automatically, and how do you know?

Opening the black box of proprietary tools

- Performance testing of predictive accuracy using large test data sets (n~500) with statistical cross validation

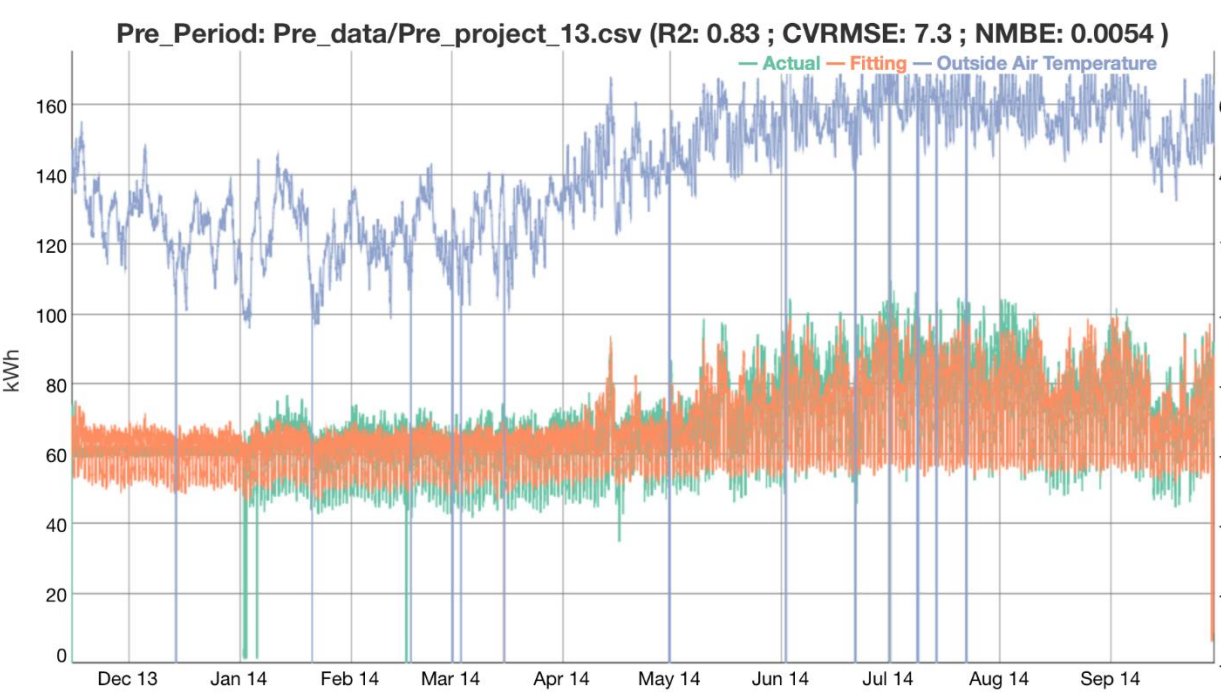
- Models in proprietary tools just as accurate as industry standard benchmark models

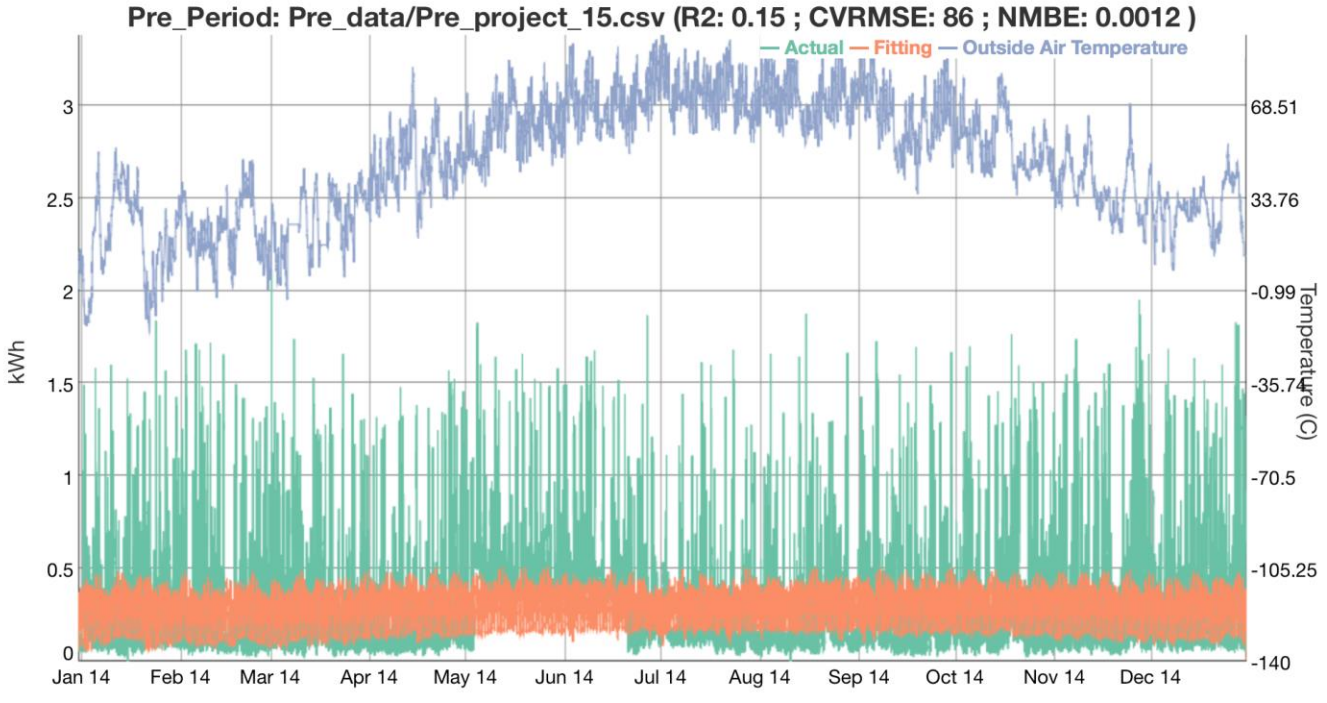
- Average median error 1.2% in predicting 12 mo. consumption with 12 mo. training



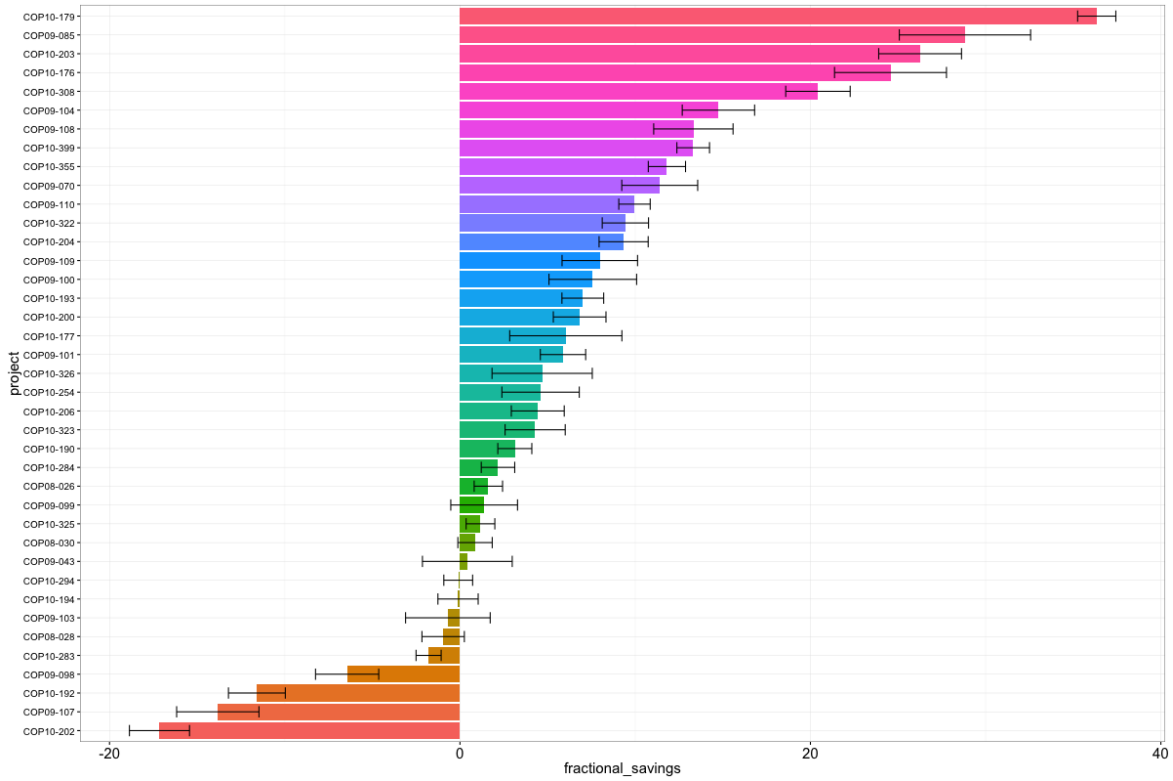
Where and how well does automation work?

- For whole building electricity using hourly load data and OAT
- Automatic baseline creation met industy standard fitness thresholds for 70% of data set of 77 retrofit, RCx, and custom projects





What is the savings uncertainty due to model error?



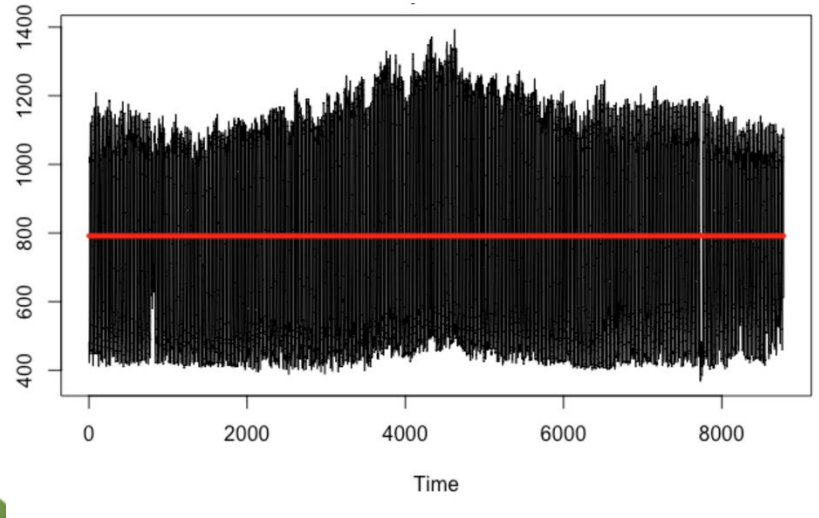
Once fitness is confirmed, savings can often be discerned with high confidence, low uncertainty

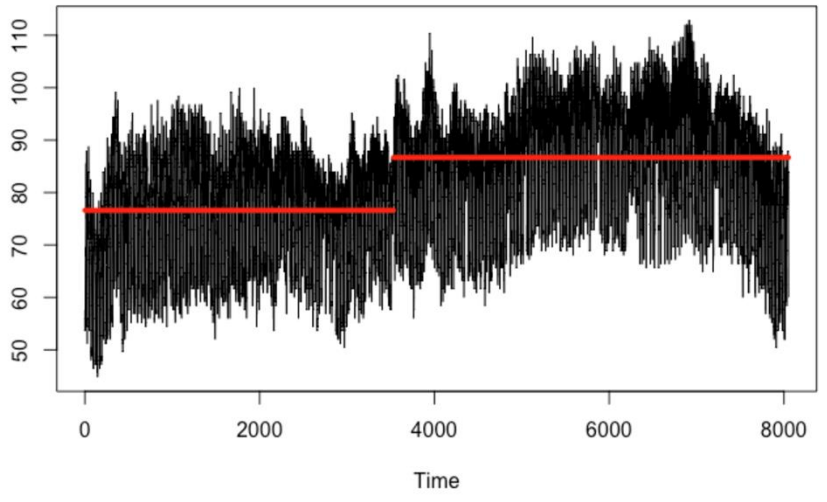
This project data set was analyzed at the 95% confidence level (ASHRAE requires 68%)

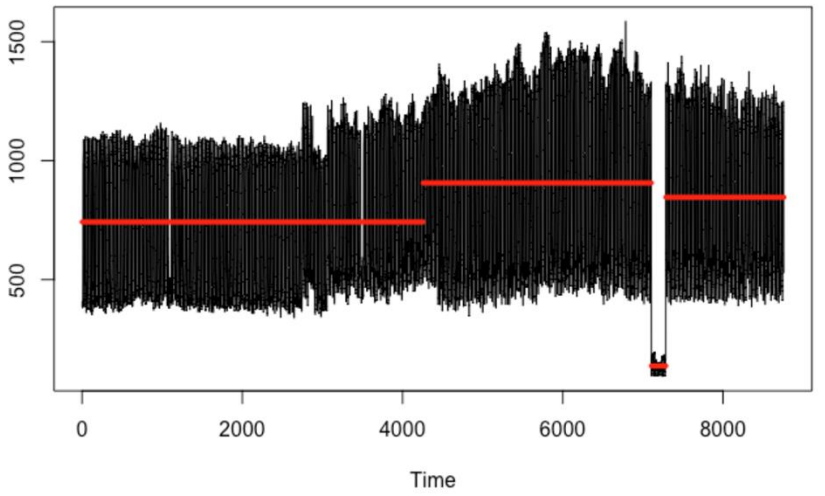
Data Set		Aggregated Fractional Savings with the Uncertainty Range	FSU	Fraction Meeting ASHRAE Guidance	Median of FSU At Building Level
Data Set 1	Screened for model fit, n = 39	[3.66; 3.96; 4.26]	7.6%	82%	27%

How can we identify and quantify non-routine events at scale?

- Changes in consumption that are not related to the installed measures or variables already normalized for
- Statistical time series analytics are being researched to automatically account for these - today's tools don't yet do this

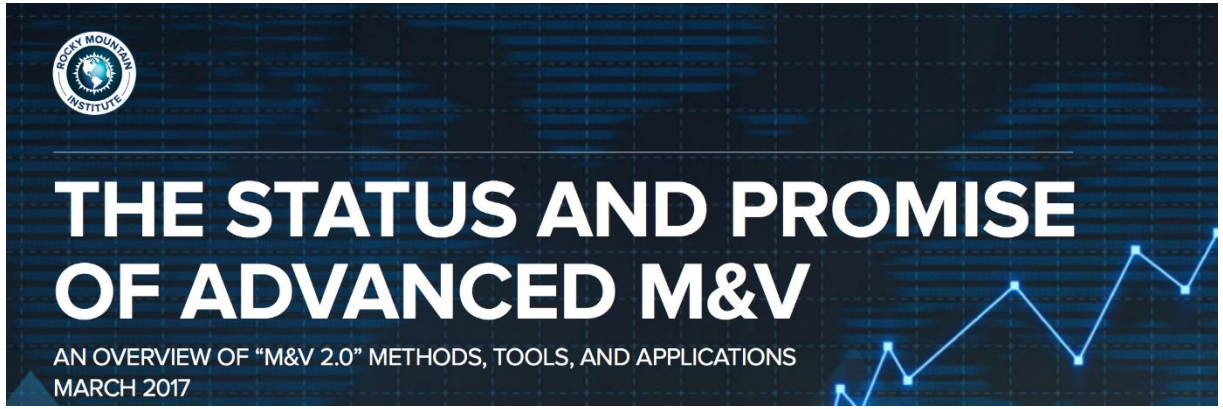






Advanced EM&V is a topic being actively pursued across the country

- RMI-LBNL white paper, NEEP EM&V Forum series
- BPA and CT DEEP public pilots of advanced vs traditional techniques
- Growing number of utility-driven internal pilots (may not be public)
- CA PUC ongoing development of guidance in context of legislation AB802 and anticipated HOPPs
- New York PSC encouraging advanced M&V where appropriate
- …… Your efforts?



Outstanding issues

- Regulatory and evaluation acceptance of new technology
- Intersection between M&V and EM&V, implementation and evaluation, gross and net
- Effective handling of attribution
- Need for independent public investigations to dis/prove the many facets of the value proposition
- Data access and interpretation

Contact

Jessica Granderson
JGranderson@lbl.gov
510.486.6792
eis.lbl.gov

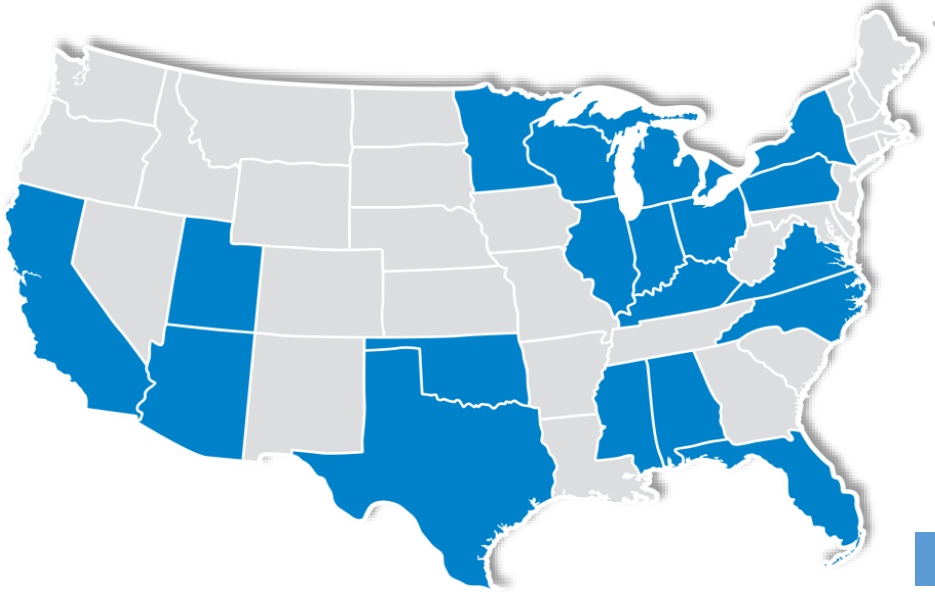
Overcoming Market and Technology Barriers: The Role of Real Time EM&V in Overcoming Barriers

SOPHIA FRANCOIS, DTE ENERGY

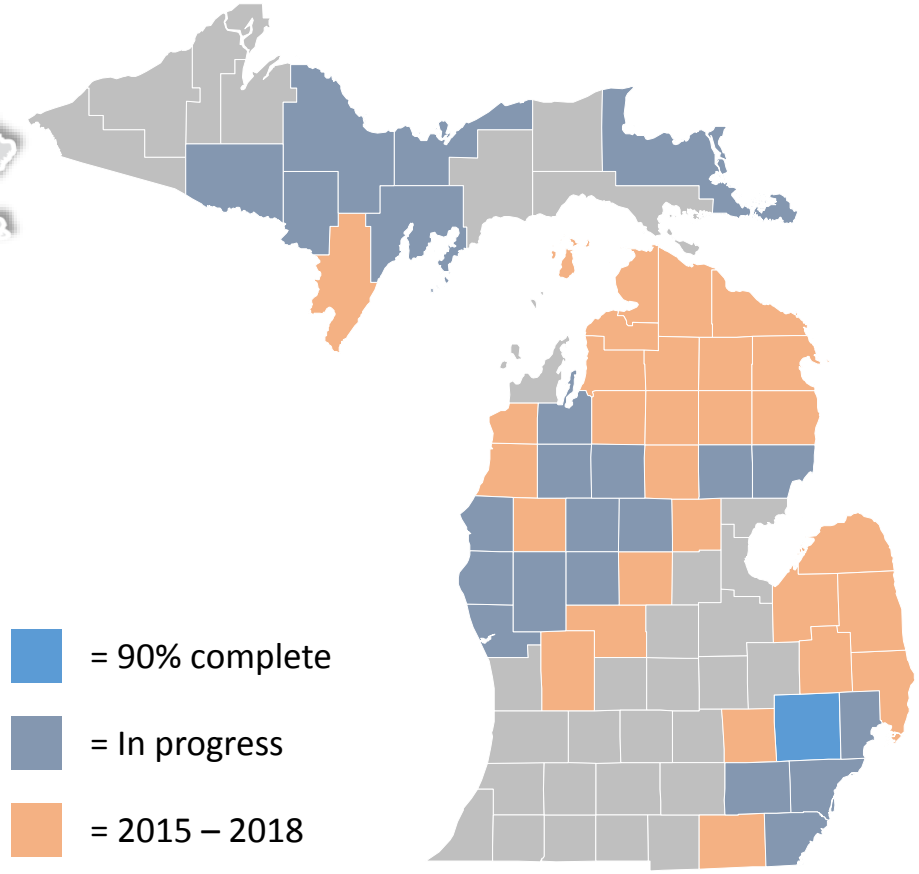
JAMIE PETERS, ENERGYSAVVY

About DTE

- **Employees**
- 10,000
- **Retirees**
- 12,000
- Fortune 300 company
- Two utilities serving Michigan
  - DTE Electric (founded 1886)
  - DTE Gas (founded 1849)
- Non-utility businesses with operations in nearly 20 states
- 2.1 million electric customers
- 1.2 million gas customers
- **Electric EO Participants**
- 1,800,000
- **Gas EO Participants**
- 1,100,000



AMI Rollout: 95% have smart meters, with full rollout expected by 2018



EnergySavvy at-a-Glance

Transform the utility-customer experience

- Cloud Software & Services
- Nearly 40 Utility Clients
- $27M funding to date, including APS and KCP&L

What is M&V 2.0
&
How Does it Work?

What is M&V 2.0?

> A defining criterion for automated M&V software is that it continuously analyzes data as it becomes available.
>
> New York Dept. of Public Service, EM&V Guidance, Nov 2016

Floating Names

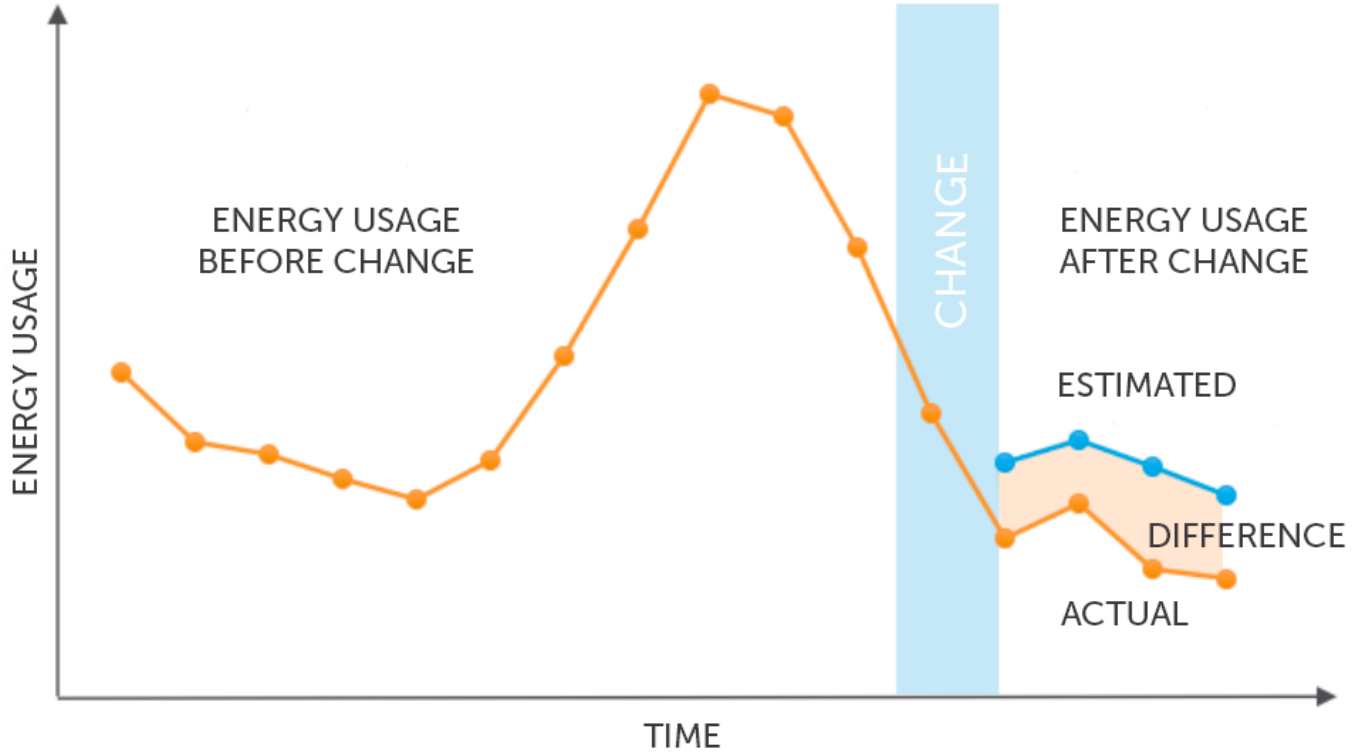
M&V 2.0	EM&V 2.0	Advanced M&V (NY REV)	Automated M&V (NEEP)	ICT-Enabled EM&V (ACEEE)

M&V 2.0 – Translated to California

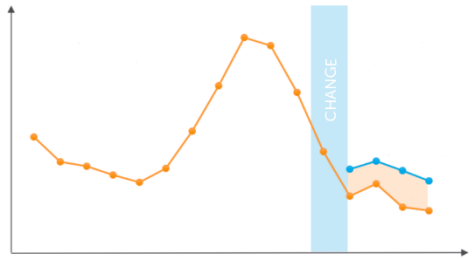
Understanding this presentation with CA industry and regulatory terms

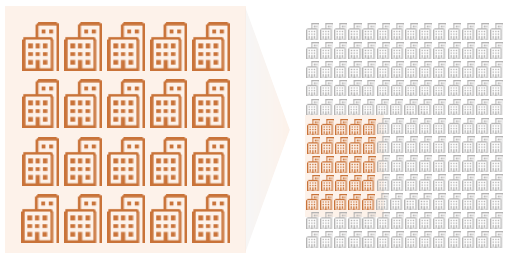
Presentation Term	California Term
M&V 2.0	Embedded M&V
Billing analysis or metered measurement	Normalized Metered Energy Consumption
Continuous analysis	Internal performance analysis during deployment

How Does M&V 2.0 Work?



How Does M&V 2.0 Work?





Build weather-normalization models for each customer (Res & SMB)

Compare changes in usage for treated customers vs. overall population

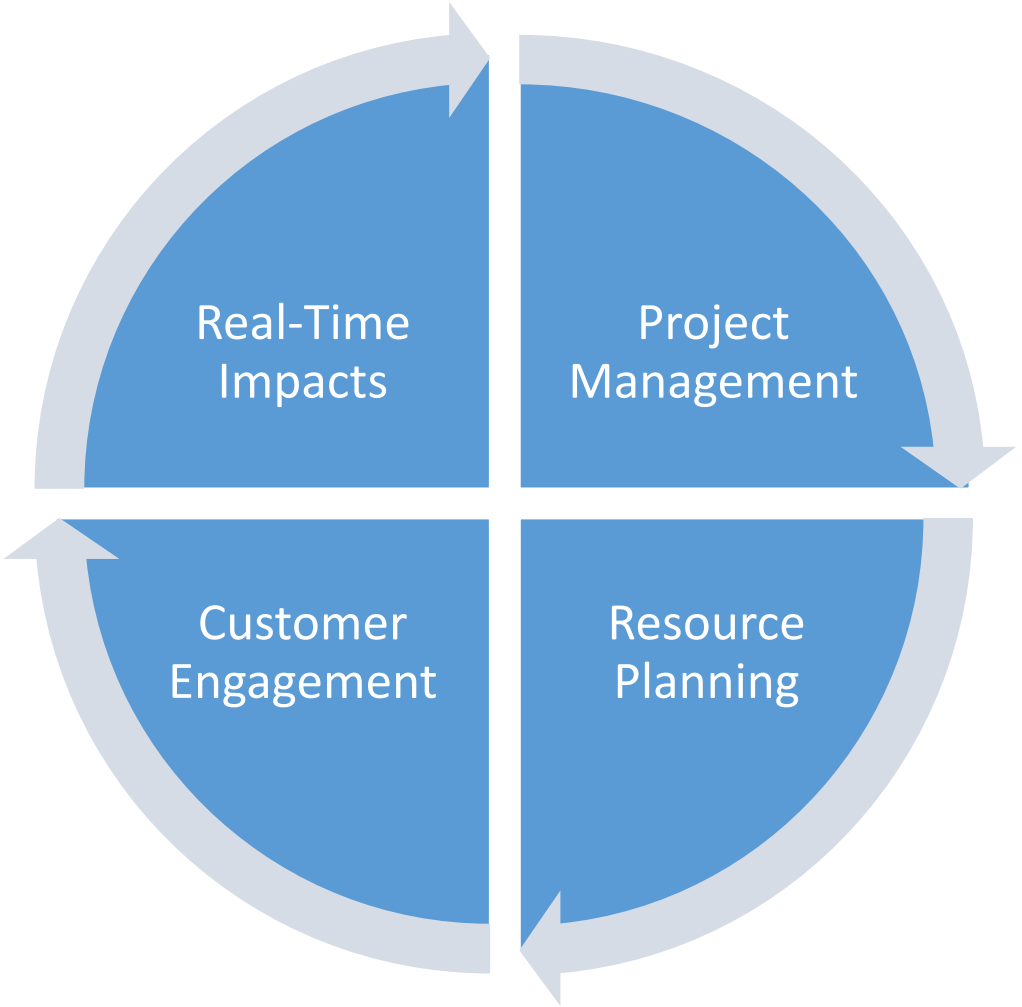
Repeat analysis for all customers with each new addition of data

Generate dashboard of findings, analytics and actionable insights

DTE’s M&V 2.0 Pilot

Why Pursue M&V 2.0?

Benefits of M&V 2.0



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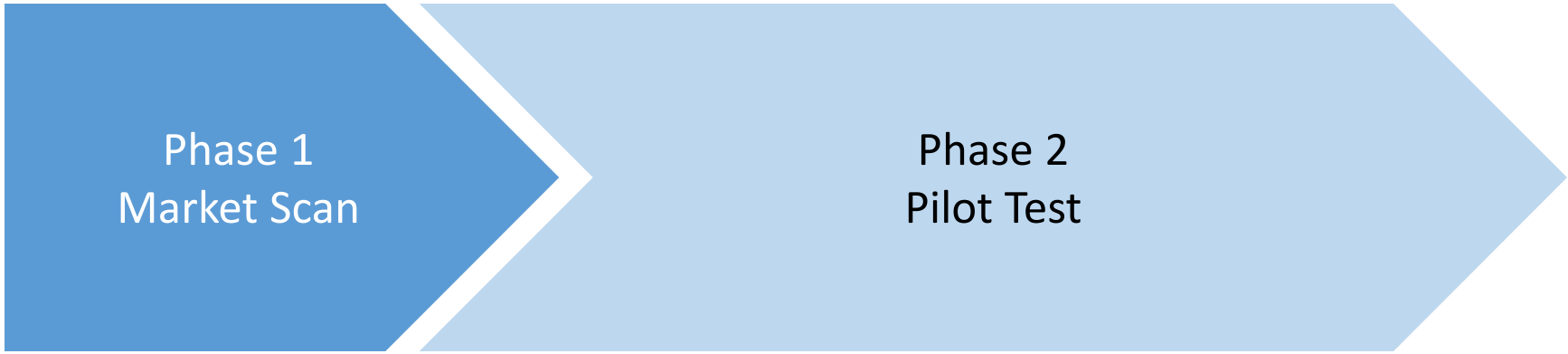
Pilot Phase 1

DTE Energy and Navigant Consulting

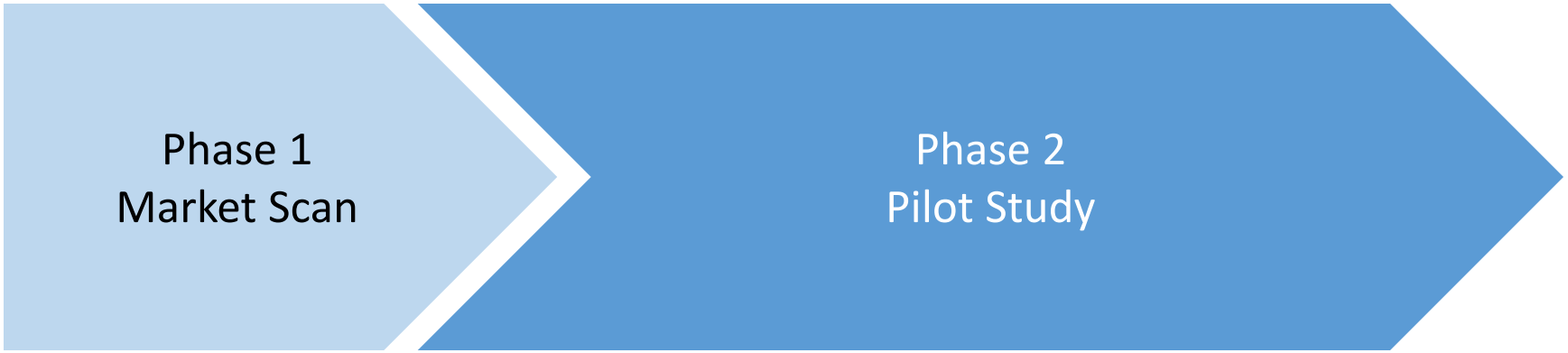


Phase 1 Objective:

Determine which M&V 2.0 software platforms are sufficiently flexible, scalable, and robust for the use in evaluation of residential energy efficiency programs. In addition, collect lessons learned from other utilities who have used these tools for the purposes of residential measurement & verification

Pilot Phase 2

DTE Energy, Navigant Consulting, and EnergySavvy



Phase 2 Objective:

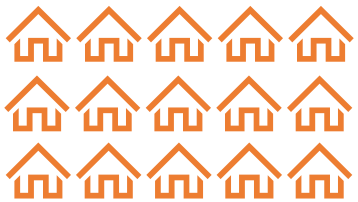
Compare the methodology, results, accuracy, usefulness in program management, and cost between custom econometric M&V 2.0, software-based M&V 2.0, and traditional measurement & verification methods

Phase 2: By the Numbers

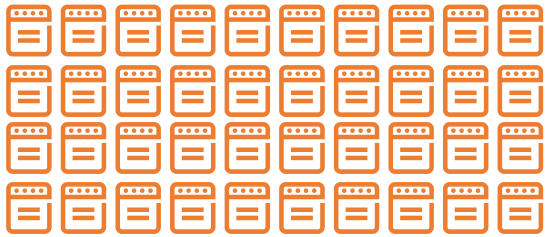
Data Analyzed

1+	2.5	30	20
Billion calculations	Million customers	Billion usage data points	Thousand weather data points

Results From



172,000 projects



262,000 measures

250 contractors

DTE Energy M&V 2.0 Pilot: Phase 2 Key Findings

1) M&V 2.0 is accurate.

NAVIGANT

DTE Energy

ENERGYSAVVY

VALIDATION PLAN:

Outlined specific criteria by which M&V 2.0 would be judged

GOAL:

Determine if M&V 2.0 produced replicable, accurate results

Residential HVAC Program—energy savings (kWh)	Residential HVAC Program—coincident peak demand (kW)	Insight Behavioral Program
✓ 2015 program-wide realization rate within 10 percentage points?	✓ 2015 program-wide realization rate within 10 percentage points?	✓ 2015 average per-premise kWh savings have overlapping 90% confidence intervals?

2) M&V 2.0 can produce reliable savings estimates mid-way through a program year.

One of the promises of M&V 2.0 is that it allows for program impacts to be understood during the program year due to:

Measure-as-you-Go nature of the analysis

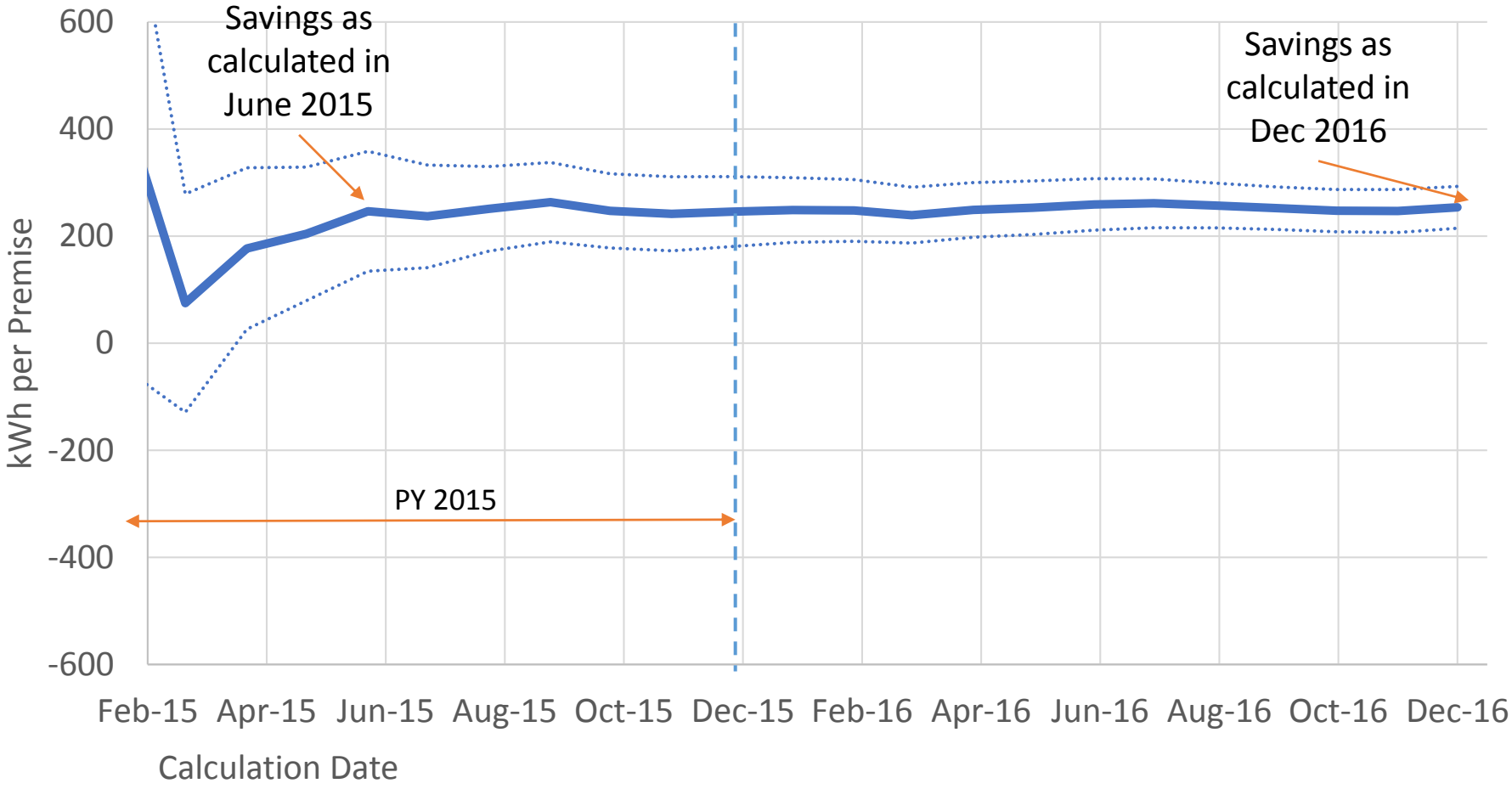
High volume of projects that are directly analyzed

Large one-to-many comparison group methodology

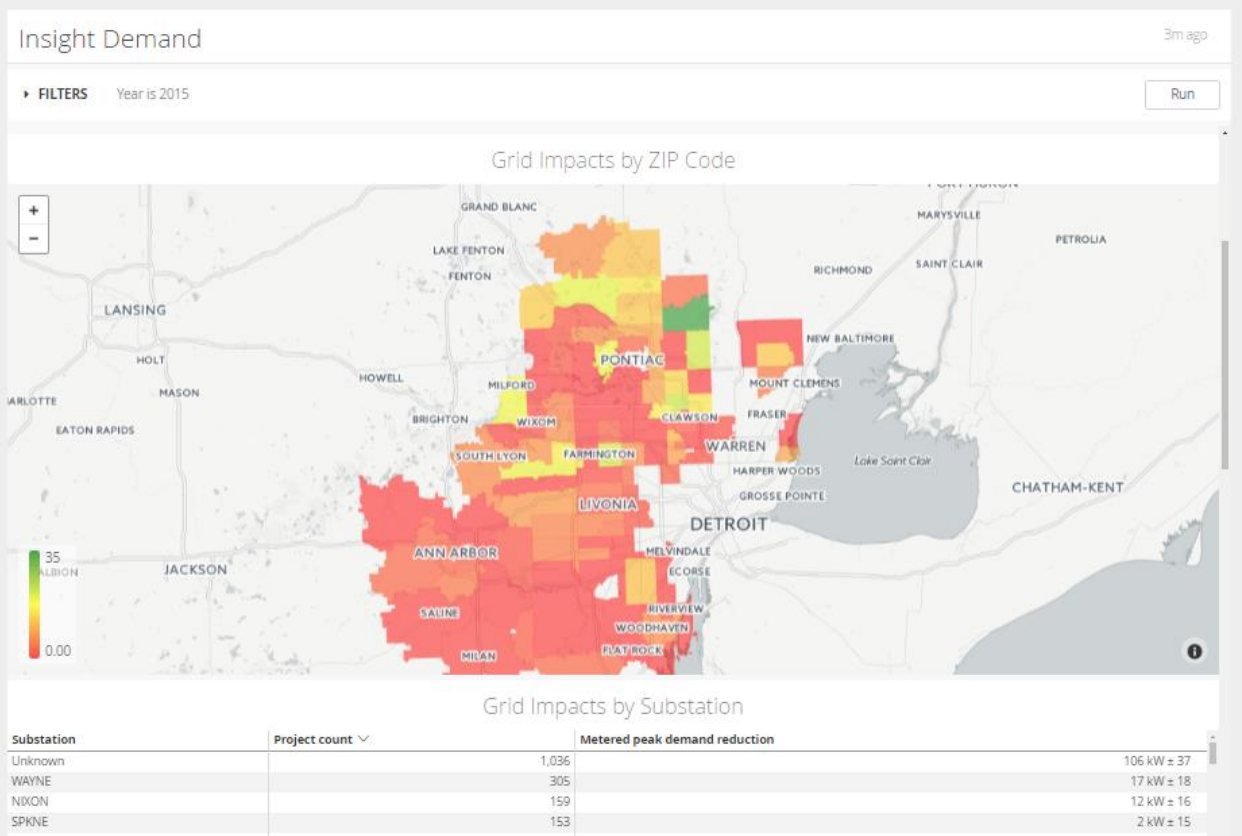
The pilot indicates that this is indeed possible.

“Measure-as-you-Go” Example

M&V 2.0 provided a reliable estimate of per-measure savings by June



3) M&V 2.0 can measure low-level energy savings (1-2% of annual energy use) & coincident peak demand reduction.



- M&V 2.0 is a good fit for behavioral programs
- Methodology can include a control group
- Tangible EE and PDR difference between lower- and higher-engagement customers

How Does This Compare to Findings Elsewhere?

Case Study: PSEG Long Island

Can M&V 2.0 match the existing results in less time?

Yes, and with bi-monthly data!

1,100 Participants in Home Performance Direct program

Reproduce evaluation results with M&V 2.0

Reliable estimate of performance 7 months into program

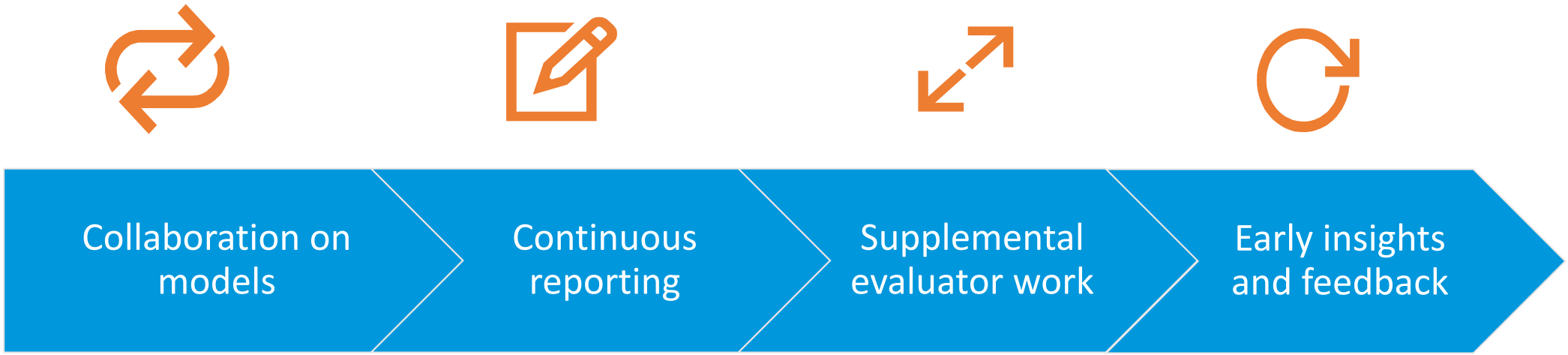
Replicated within

6%

margin of error

Embedding 2.0 into formal EM&V: illustrative example

EnergySavvy & EM&V firms jointly work together to evaluate programs



Thank You!

Questions?

Contact Information:

Jamie Peters, EnergySavvy
jamie@energysavvy.com

Sophia Francois, DTE Energy
sophia.francois@dteenergy.com

Real Time EM&V

Granular Approaches for Continuous Program Improvement

Brian McCowan Vice President ERS

How and when we evaluate matters

We have apparently hit an iceberg.

Or;

There appears to be an iceberg ahead – Let’s change course.

Two basic evaluation approaches

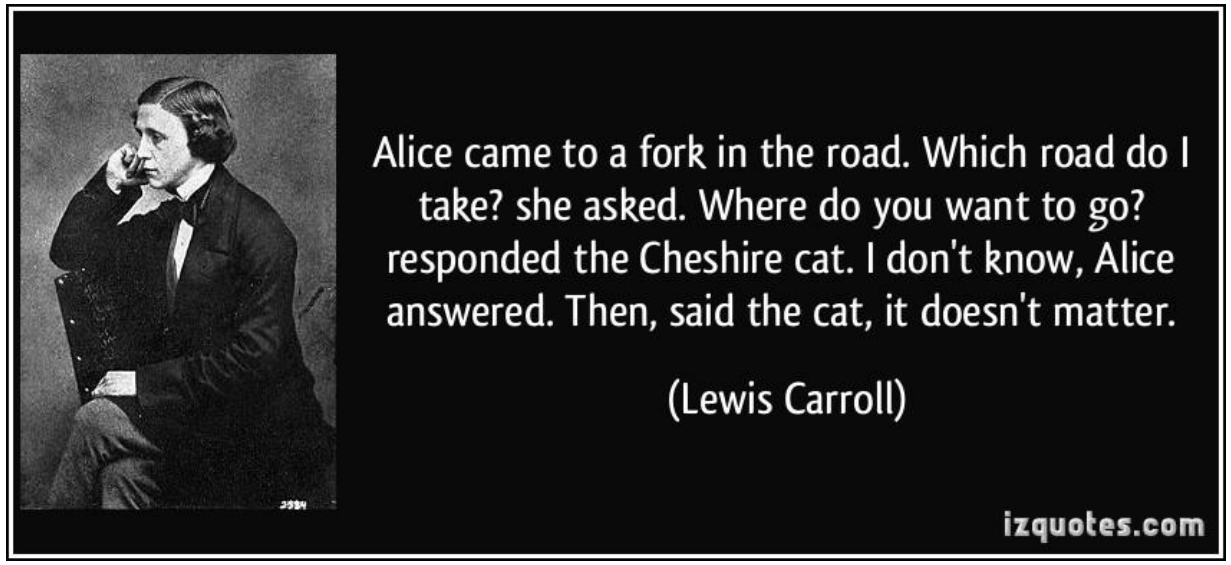
Post program EM&V

- Verify and adjust gross and net savings
- Identify free ridership and spillover
- Evaluate overall program operation and effectiveness

Real time EM&V focus

- All of the above, plus:
  - Feedback to implementers
  - Mid-course corrections
  - Measure by measure progress
  - Address specific sponsor/regulator issues
  - Get back on target

Real time fits all



Standard metering approaches

Or: Advanced EM&V

- Whole building analysis (M&V 2.0)
- Advanced granular - Energy-focused deep granular evaluation (EDGE)

Each approach has situational advantages

All approaches benefit from real-time M&V

Closing a nuclear power plant – two views

NEW YORK POST

New York has no idea how to keep the lights on when Indian Point closes

- 03/04/2017

THE HUFFINGTON POST

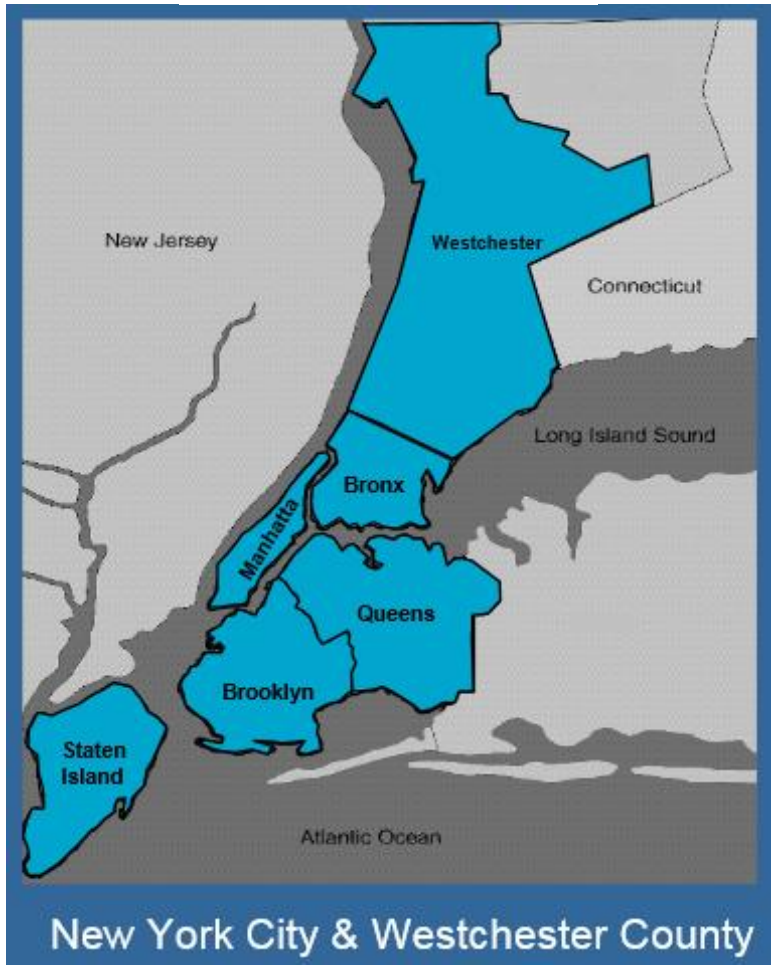
Replacing the Indian Point Nuclear Power Plant with Energy Efficiency

03/06/2017

A real-time example

Closing down of Indian Point nuclear plant

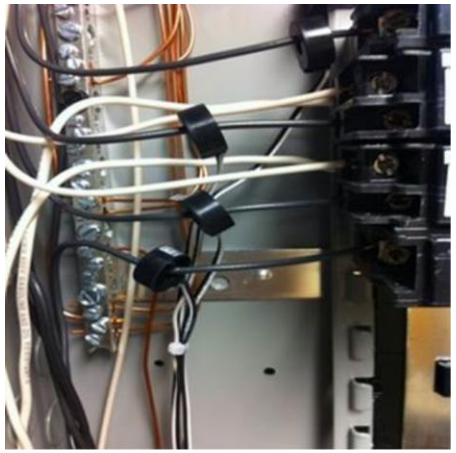
- Need - replace 2 GW of lost generation:
  - New generation
    - Includes renewables and 25 MW of CHP
  - New transmission
    - 1 GW Hydro-Quebec
  - Demand Management Program (DMP)
  - **Energy Efficiency**
    - **100 MW**
    - **Targeted - 2-6 pm, Jun-Sep**
- **And -** Install $200 million <u>customer side</u> resources to defer building a $1 billion substation



Why real-time granular M&V for this project?

- No room for error – resiliency of the system is at stake
- No time to waste – 2 GW offline by 2021
- Very specific metrics – demand savings 2-6pm June – September
- Specific knowledge needed:
  - Which measures
  - In which sectors
  - Which incentives to adjust
  - Measures to add/delete
  - How to adjust program marketing

Evaluation Requirements



- Review program implementation data
- Coordinate with implementation contractors
- Deploy meters across all measures and sectors - FAST
- Produce granular analysis - FAST
- Develop and utilize dashboard
- Work with implementers to develop real time program adjustments

Project Successes

- Five-day turnaround on impact results for over 1,500 businesses in 2016
- Leveraging findings to:
  - Immediately adjust program approaches
  - Plan future implementation
  - Identify specific measure and sector targets
- Measure-level granular analysis > learn how impacts are trending
- Impact projections delivered as implementation tracking data updates
- Cooperation/coordination with implementation contractor

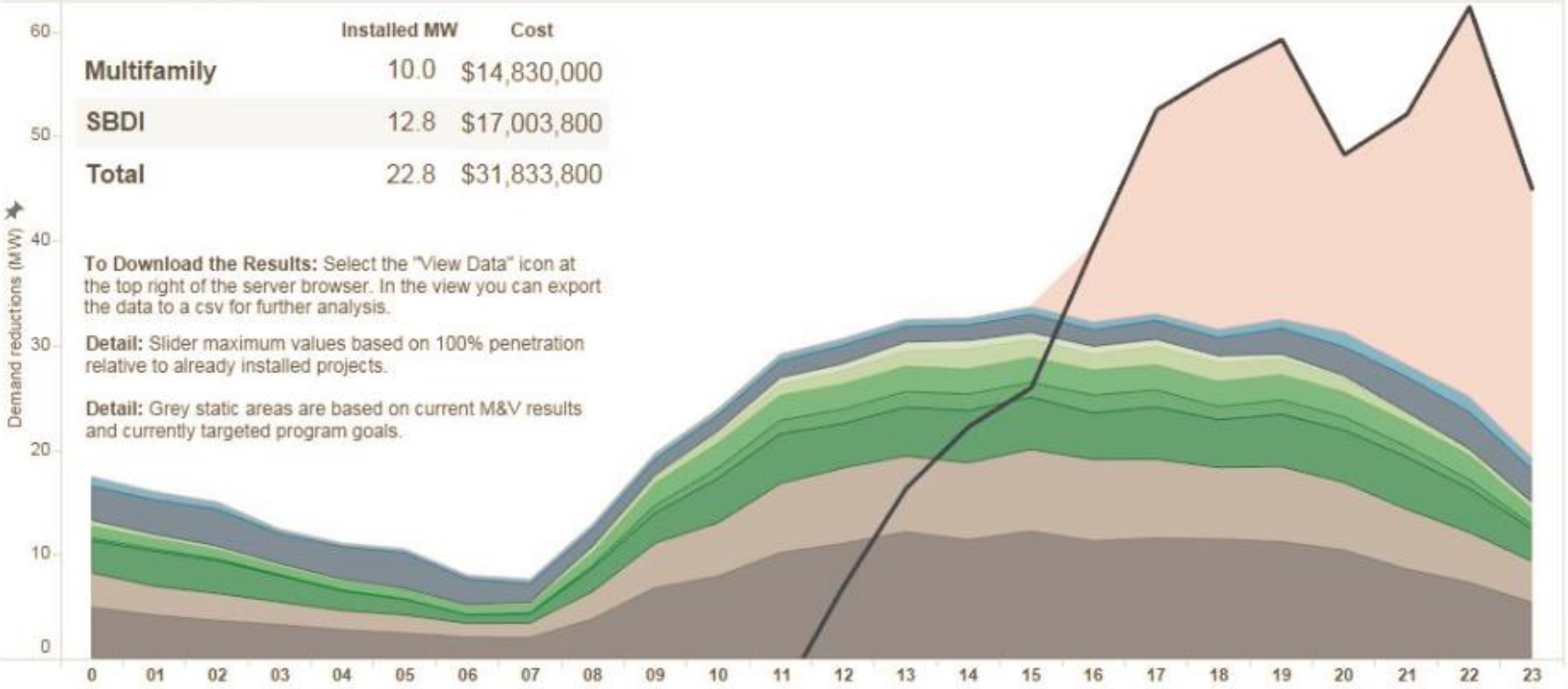
Planning & Forecasting

	Installed MW	Cost
Multifamily	10.0	$14,830,000
SBDI	12.8	$17,003,800
Total	22.8	$31,833,800

To Download the Results: Select the "View Data" icon at the top right of the server browser. In the view you can export the data to a csv for further analysis.

Detail: Slider maximum values based on 100% penetration relative to already installed projects.

Detail: Grey static areas are based on current M&V results and currently targeted program goals.



SBDI Office Installed MW: 1.2

SBDI Grocery Installed MW: 2.4

SBDI Retail Installed MW: 1.8

SBDI Industrial Installed MW: 2.4

SBDI Other MW: 0

SBDI Restaurant Installed MW: 5

MFCA Installed MW: 5

MFIU Installed MW: 5

Progress by Hour

	12	13	14	15	16	17	18	19	20	21	22	23
MW Needed	-23.7	-16.1	-10.3	-7.7	7.4	19.5	24.7	26.8	17.0	24.0	37.3	25.7
SBDI	10.0	10.9	11.7	11.2	10.8	11.5	10.7	10.8	10.2	9.3	8.0	5.7
MFCA	1.8	1.5	1.5	1.7	1.6	1.8	1.7	2.5	2.7	3.4	3.5	3.1
MFIU	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.9	1.4	1.2	1.5	1.2
Achieved MW	12.4	13.1	13.9	13.7	13.2	13.9	13.2	14.1	14.4	13.9	13.0	9.9

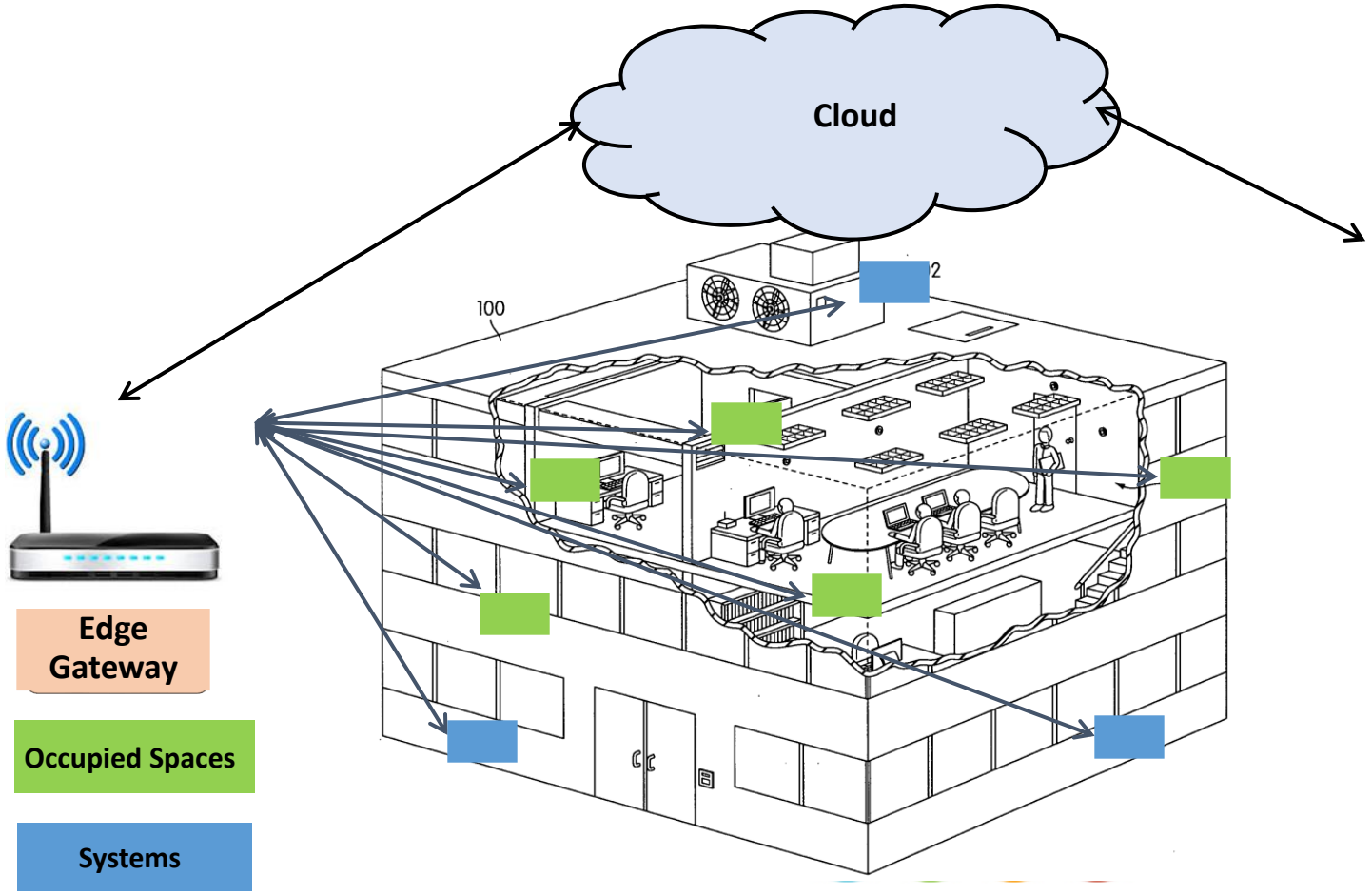
Remaining substation shortfall
MFIU
MFCA
Office
Industrial
Other
Grocery
Retail
Restaurant
Projected
Installed & verified
Demand reduction needed

What to watch for now

- Advancements in wireless metering
- Multi-function data gathering devices
  - Energy
  - Demand
  - Light
  - Occupancy
  - Temperature
  - Sound
  - Indoor air quality
  - Vibration
  - Etc. etc. etc.
- Factory installed wireless meters
- Advanced dashboards for real time reporting

Third Party Data Harvesting

- Residential
- Commercial



CONTACTS:

Brian McCowan

Vice President Policy and Emerging Technology

bmccowan@ers-inc.com

978-521-2550 x301

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