The Advanced M&V Proving Ground:

It's Working and It's Yielding Great Results

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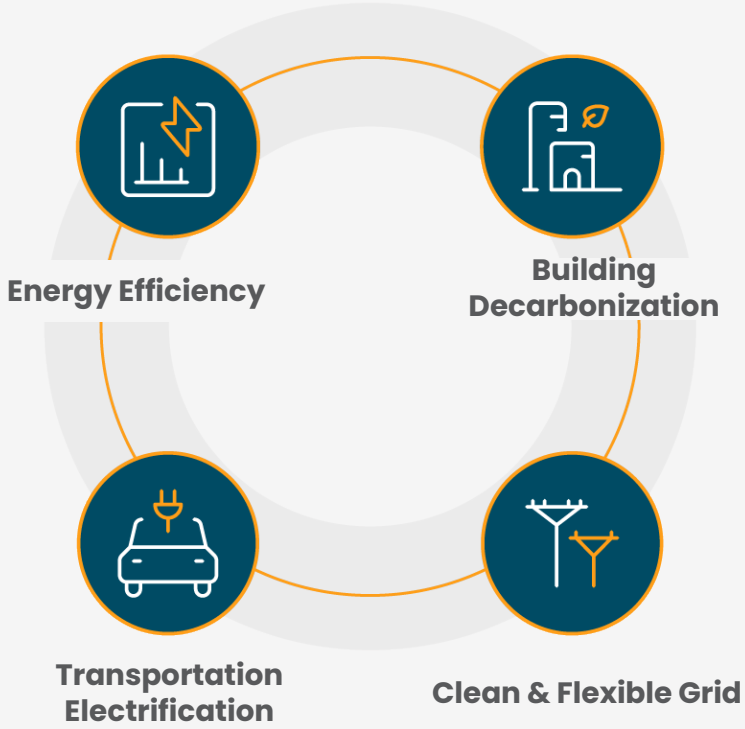
VEIC: High-impact energy solutions that decarbonize buildings, transportation, and utility grids, today.

- Nonprofit founded in 1986
- National consulting practice working across over 75% of the country
- Program design & implementation for award winning energy efficiency and clean energy programs

Making an impact



Advanced M&V

Opportunity

- Building performance tracking, pay-for-performance, strategic energy management, flexible load management
- Focus on savings evaluation
- Quicker, more accurate, and potentially lower cost

Challenges

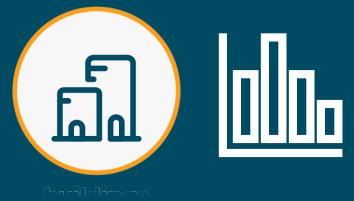
- Incomplete understanding of appropriate project types
- Methods do not meet M&V requirements in some cases
- Insufficient access to advanced M&V case studies and literature
- Adequate data management systems

Research Objectives

- Illustrate how well-designed data infrastructure can support broad application of advanced M&V
- Identify the parts of custom commercial and industrial (C&I) portfolios where advanced M&V is effective
- Help evaluators understand the applicability of advanced M&V
- Evaluate the use of advanced M&V for pre-screening projects for method appropriateness

Retrospective Advanced M&V Case Study

Efficiency Vermont



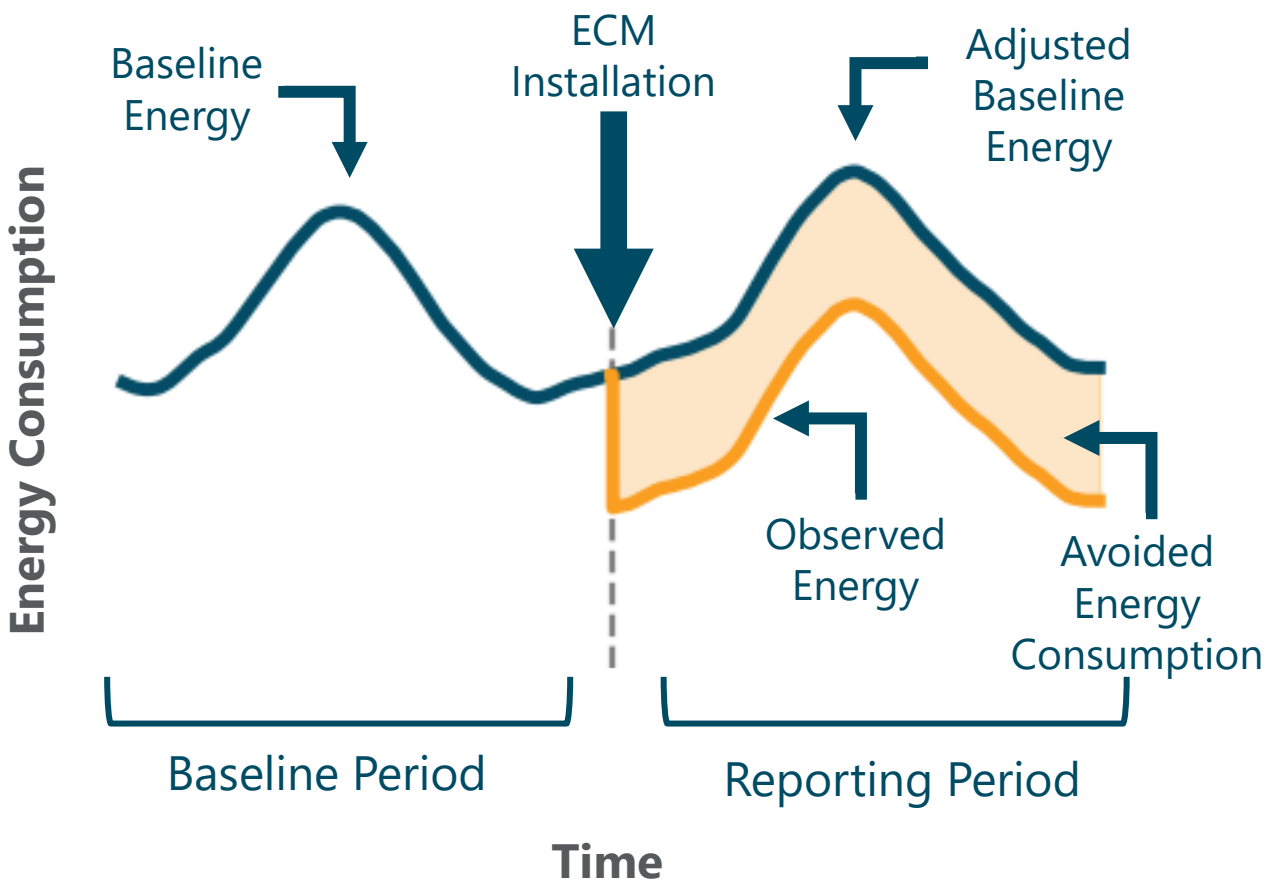
Forward Capacity Market

- Claimed energy savings for historical **commercial** and **industrial retrofit** projects
- Opportunity to **reduce evaluation efforts** by replacing site metering for certain projects with **Option C evaluation**

Data

- 70% of project claims had 15-minute advanced metering infrastructure (AMI) data
- 40% (142 projects) met **data requirements** for **Option C**

Analysis Methods



Baseline Model	Source	Data Frequency
Change-point	EE Meter	Daily
Time-of-week & Temperature (TOWT)	EE Meter	Hourly
Gradient Boosting Machine (GBM)	Lawrence Berkeley National Laboratory	Hourly

Simple

Complex

Data Infrastructure Components

Project tracking warehouse

- Measures, installation dates, claimed savings
- Utility accounts and identifiers
- Business end use and address

AMI warehouse

- **Automated** extract, transform, load (ETL)
- Accessible, standard format, **ready for analysis**

Curated weather

- Semi-automated ETL
- Data for all weather stations within service area
- Enables **automated data retrieval** for any building

Analytics Infrastructure

Utilizes open source

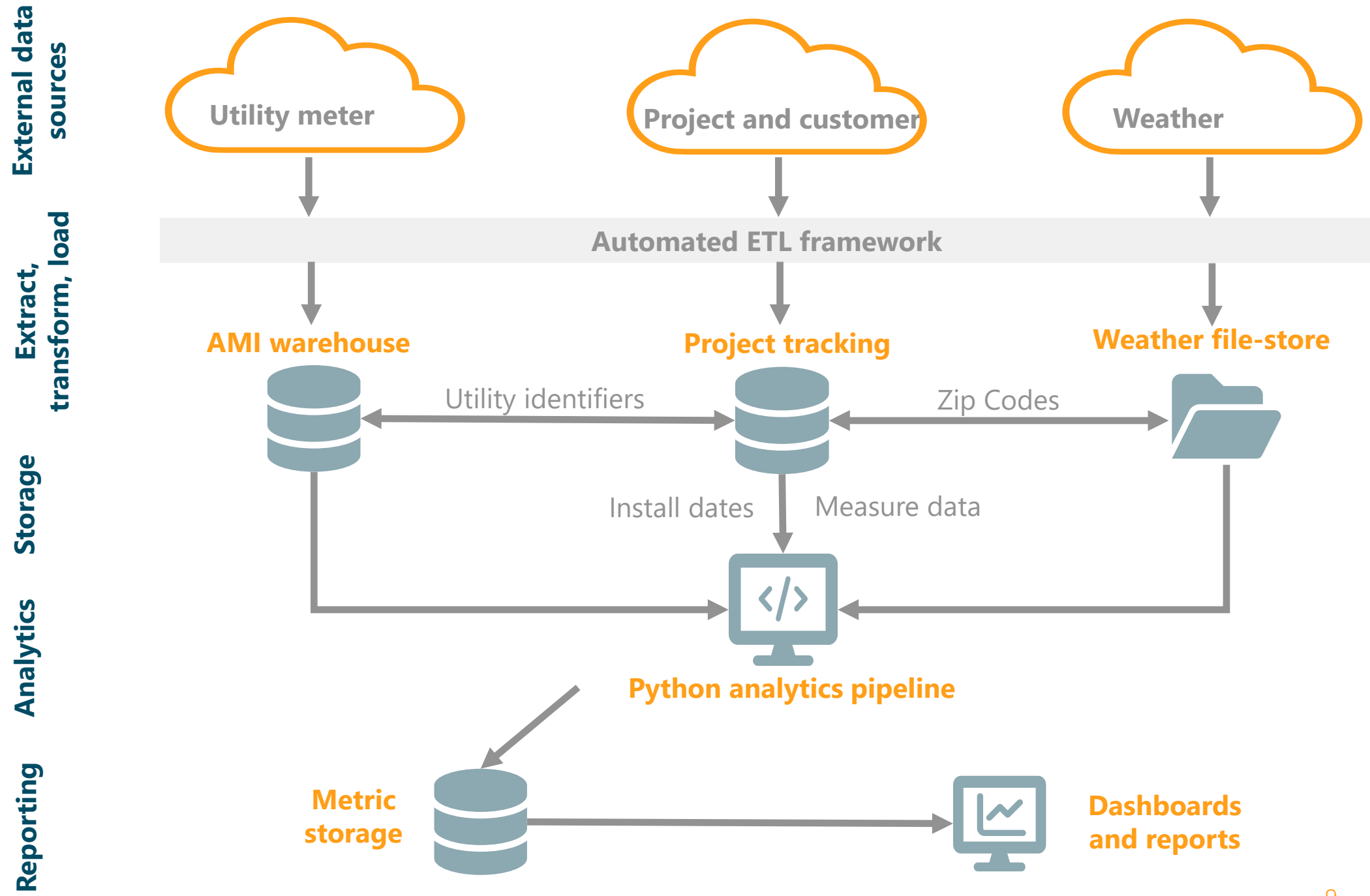
- Wraps open-source EEmeter to perform energy modeling, savings estimates, and model diagnostics
- Creates **transparency**

Modular framework

- Analysis pipelines
- Parallelized computing
- Data persistence

Results storage

- Database schema applicable to a wide variety of energy efficiency applications
- Enables **reporting**


External data sources
Extract, transform, load
Storage
Analytics
Reporting
Utility meter
Project and customer
Weather
Automated ETL framework
AMI warehouse
Project tracking
Weather file-store
Utility identifiers
Zip Codes
Install dates
Measure data
Python analytics pipeline
Metric storage
Dashboards and reports

Uncertainty and Bias by Model Type

Hourly methods showed **lower uncertainty and bias** compared to **daily** model

Different industry standards result in different sets of projects

Percent and number of projects with goodness-of-fit metrics within industry standard thresholds

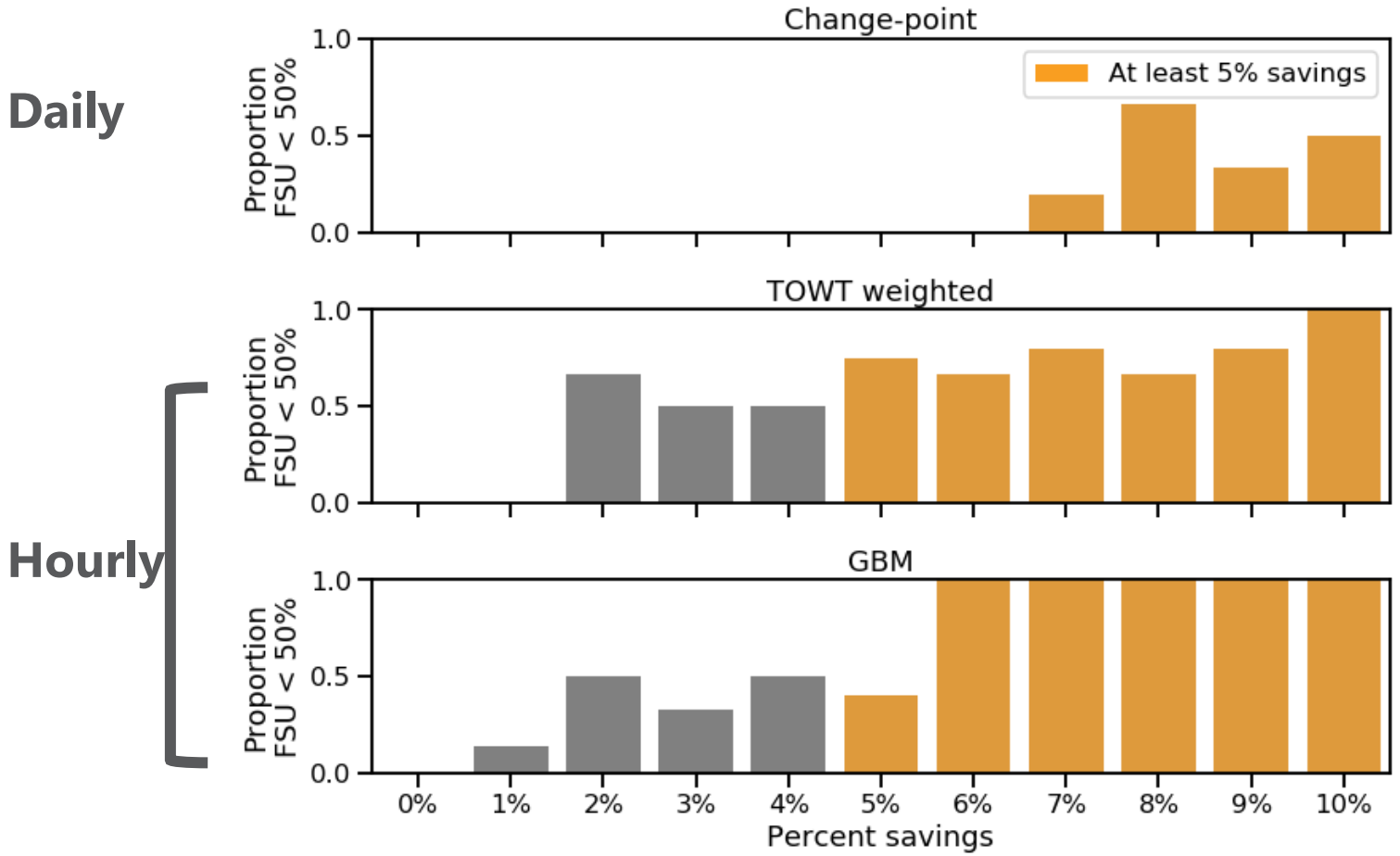
Model type	FSU	FSU and NMBE	All Metrics
Change-point	41% (58)	41% (58)	23% (33)
TOWT	77% (110)	61% (87)	37% (52)
GBM	80% (113)	80% (113)	39% (56)

FSU < +/- 50% at 90% confidence. **NMBE** < +/- 0.5%. **CVRMSE** < 0.25.

Ability to Detect Lower Savings

Reliable whole building modeling

- Daily or monthly data require savings levels of at least 10%
- Sub-hourly data require savings levels of at least 5%



Areas of Potential for Advanced M&V

Building end-use - Standard Industrial Classification (SIC)

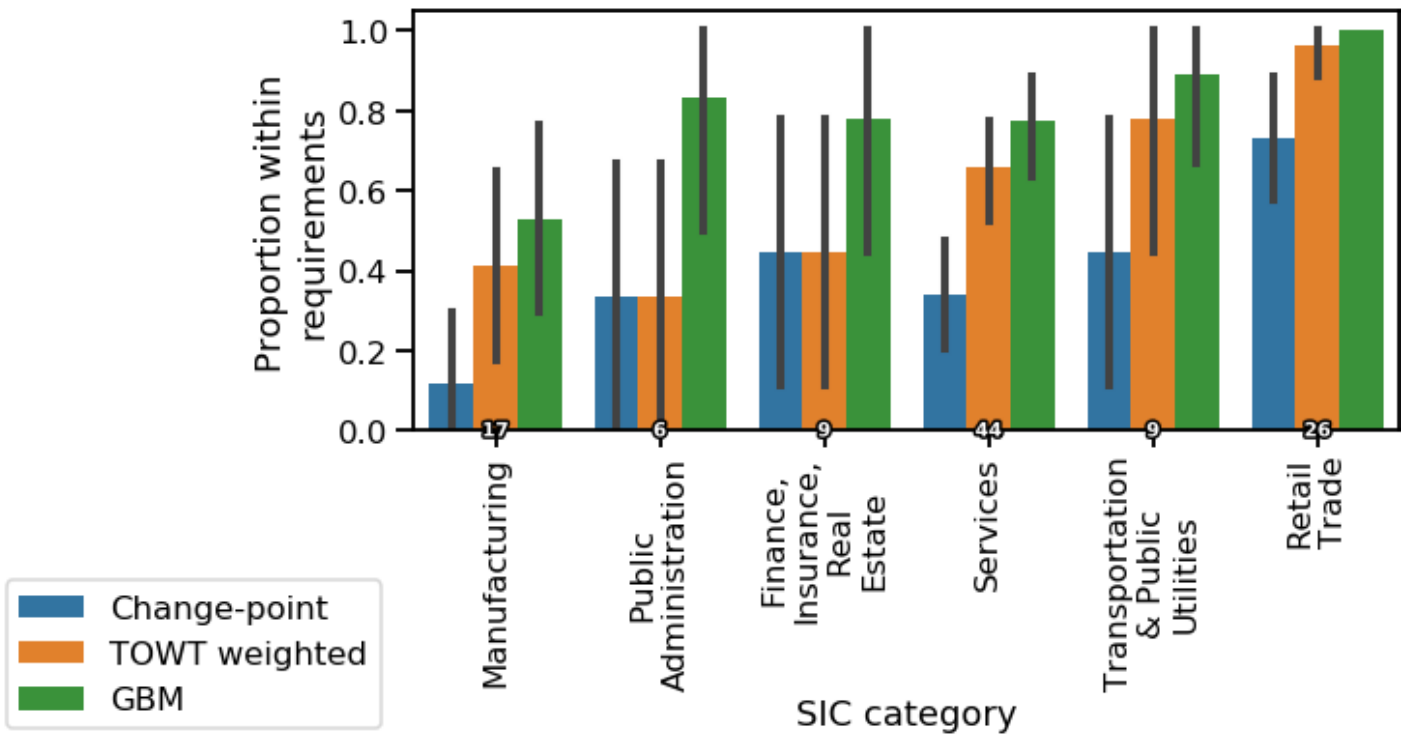
× Large industrial and manufacturing facilities

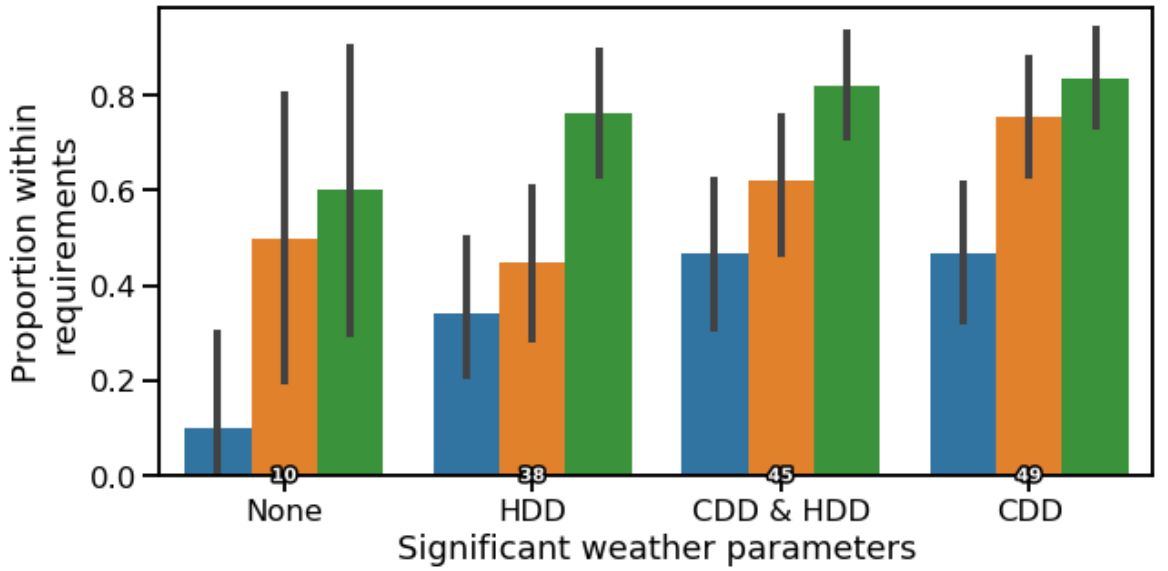
✓ Retail, transportation and public utilities and services

✓ Gradient boosting machine

Weather dependency

✓ Weather- and occupancy-driven loads





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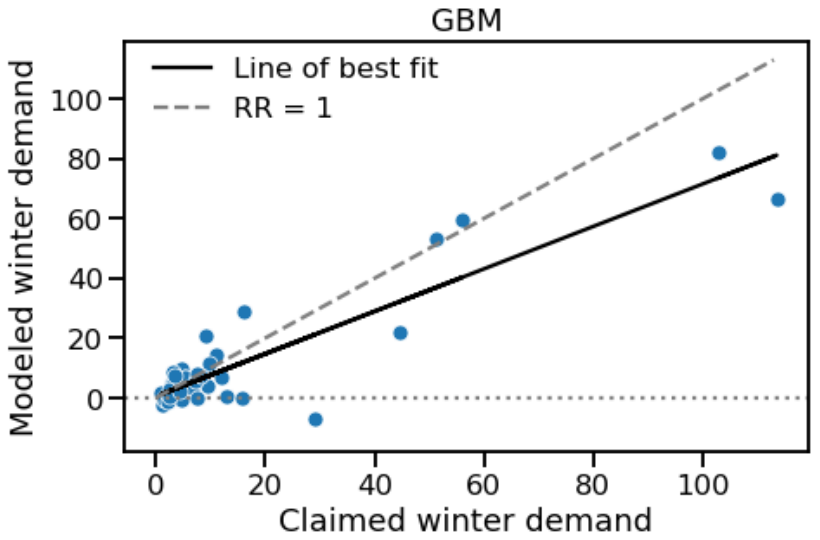
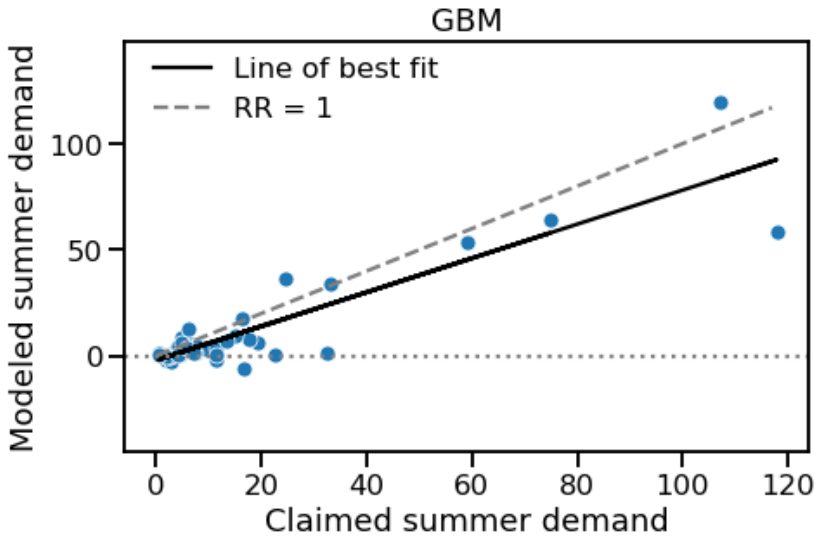
Claimed Savings Comparison

Filtered subset of projects

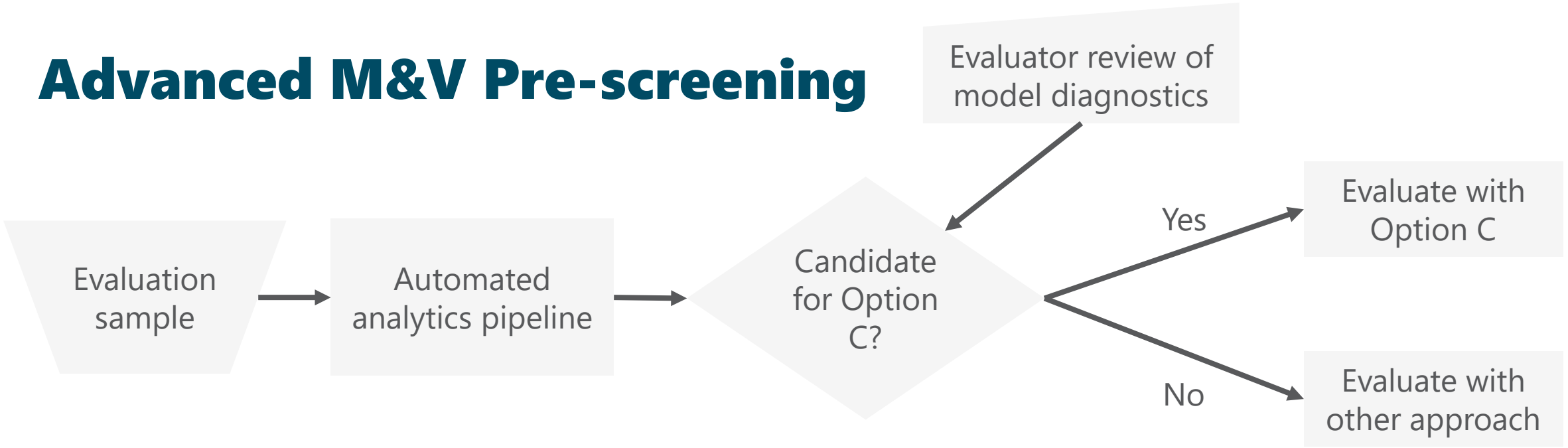
- Data requirements, model validity checks, and feasibility of the model results
- If requirements were not met, the data was far too noisy and biased





Model Type	n	Winter Demand Savings (kW)		Summer Demand Savings (kW)	
		Realization Rate	Margin of error	Realization Rate	Margin of error
TOWT	39	0.71	0.35	0.62	0.46
GBM	42	0.75	0.21	0.65	0.37

Advanced M&V Pre-screening



Pre-screening enables:

- Automated collection of data for whole-facility analysis
- Cost-effective prioritization of direct metering resources
- Ensuring AMI data are used wherever whole-facility analysis is valid
- Automatically generated diagnostics

Takeaways

Limitations

- On-site metering is still required for projects that don't pass screening criteria
- Larger sample size does not enable strict use of advanced M&V for evaluation

Opportunity

- Integrate advanced M&V more broadly
- Cost-effective and reliable insights into many savings measures
- Data infrastructure

Future

- Integrate pre-screening after evaluation sampling
- Inform implementation, design and scoping
- Support intermediate evaluation cycles
- Integrate near real-time analysis into program designs

Get in touch

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