Is Simple Best: Can Programs Get More Done by Simplifying Calculations?

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ABSTRACT

Energy efficiency programs use energy models to back up their savings claims. Energy modelers commonly follow the rigorous International Performance Measurement and Verification Protocol (IPMVP), but simpler models and non-intrusive verification methods often yield similar results. Simpler Measurement and Verification (M&V) protocols for energy savings may streamline engineering and administrative efforts if the models achieve a similar overall accuracy. Simpler approaches will free up resources to fund aggressive energy savings projects and empower resource-constrained utilities to provide a wider array of projects to their customers.

This paper shows results from three Custom impact evaluations of measures installed in 2019-2023 in Bonneville Power Administration's service territory. Prior to 2019, simplified methods were allowed for projects below 200,000 kilowatt-hour (kWh). This entity increased the maximum threshold allowed for simplified models to 400,000 kWh.

This paper's analysis compares both model types from recent and past studies and evaluates which non-lighting end uses and project sizes show similar results with simpler models, how the outcomes varied, and estimates new thresholds for accuracy for the combined data set across different end uses, measure types, and expected savings sizes.

Weighted ECwV methods show savings results within 8% of traditional IPMVP adherent models at a portfolio level for projects with less than 800,000 kWh, and within 16% for all project types. Analysis for some individual projects still show large variances between the two evaluation protocols. If portfolio level accuracy is the primary concern for a utility, then ECwV may be an acceptable approach for custom M&V.

Introduction

Bonneville Power Administration (BPA) is a federal power marketing administration that markets wholesale electric power at cost. BPA's service territory is located in the Pacific Northwest, including Washington, Oregon, Idaho, Western Montana, and portions of California, Nevada, Utah, and Wyoming. BPA provides energy efficiency engineering and support services to utilities as part of their acquisition of Conservation as a resource. BPA requires its engineering staff and energy efficiency program implementers to follow the custom project energy measurement and verification (M&V) protocols developed for their agency. BPA's custom project M&V protocols come in two general categories: Energy Calculation with Verification (ECwV) and International Performance Measurement and Verification Protocol (IPMVP) adherent. The guidelines for all BPA M&V protocols were updated in September 2024 and reflect higher acceptable thresholds for ECwV as an M&V approach based on the first of three impact evaluation data used in this paper. The typical characteristics of two categories are highlighted in Table 1.

Table 1. Comparison of ECwV to other M&V protocols

ECwV	All other custom M&V
< 400,000 kWh estimated savings	≥400,000 kWh estimated savings

Not IPMVP adherent	IPMVP adherent
Little or no pre/post energy metering	Pre/post energy metering needed
Short time frame for implementation	Longer time frame for implementation
Lower cost for M&V	Higher costs for M&V
Low expected variance in savings (year to year)	

Note that while these differences are typical, ECwV projects are not limited to all listed characteristics in Table 1. Projects that do not meet the <400,000 kWh size threshold may still follow an ECwV protocol if they exhibit other ECwV qualities. ECwV and IPMVP-adherent methods primarily differ in their requirement for pre/post energy measurement for verification. A typical ECwV M&V process may include spot energy measurements of baseline conditions or even short-term metering, but the only requirement is to have enough knowledge of baseline conditions and installed equipment to develop an engineering model. Well understood measures such as a change in motor efficiency may only need nameplate efficiency values and operating hours for the savings calculation, while more complex measures may also need other operating conditions verified, like average power or flowrate (Facility Energy Solutions, 2024a).

The guidelines for selecting a protocol were originally developed in 2012 and updated in 2024, and are outlined in the flow chart in Figure 1 (Facility Energy Solutions, 2024b). ECwV features prominently as a preferred protocol under a variety of M&V conditions. The engineering judgment noted in the decision tree depends on the expected reliability of the non-EcWV model compared to the ECwV model. If a project included the installation of a variable speed drive on a compressor motor, a short verification period of average post-install speeds for up to four weeks of occupancy would be comparably reliable to an eight-week true power measurement of the compressor system. Projecting the operating schedule to a full year with varying production would present a greater overall risk of inaccuracy than the approach of collecting simple measurements for a short interval. The engineering decision is based on a combined risk assessment factoring in the following:

- The size of the expected savings
- Ability to collect data without risking critical processes or safety
- Reliability of models predicting outcomes
- Time frame available to collect data

Engineering costs were not a part of this study, but generally the ECwV M&V approach requires fewer resources to implement than other custom project M&V protocols. The selection guide considers ECwV as the first option among M&V methods because it is efficient to deploy and consumes fewer engineering resources for implementers. The cost efficiency of deploying ECwV projects conserves staffing resources for other energy efficiency measures.

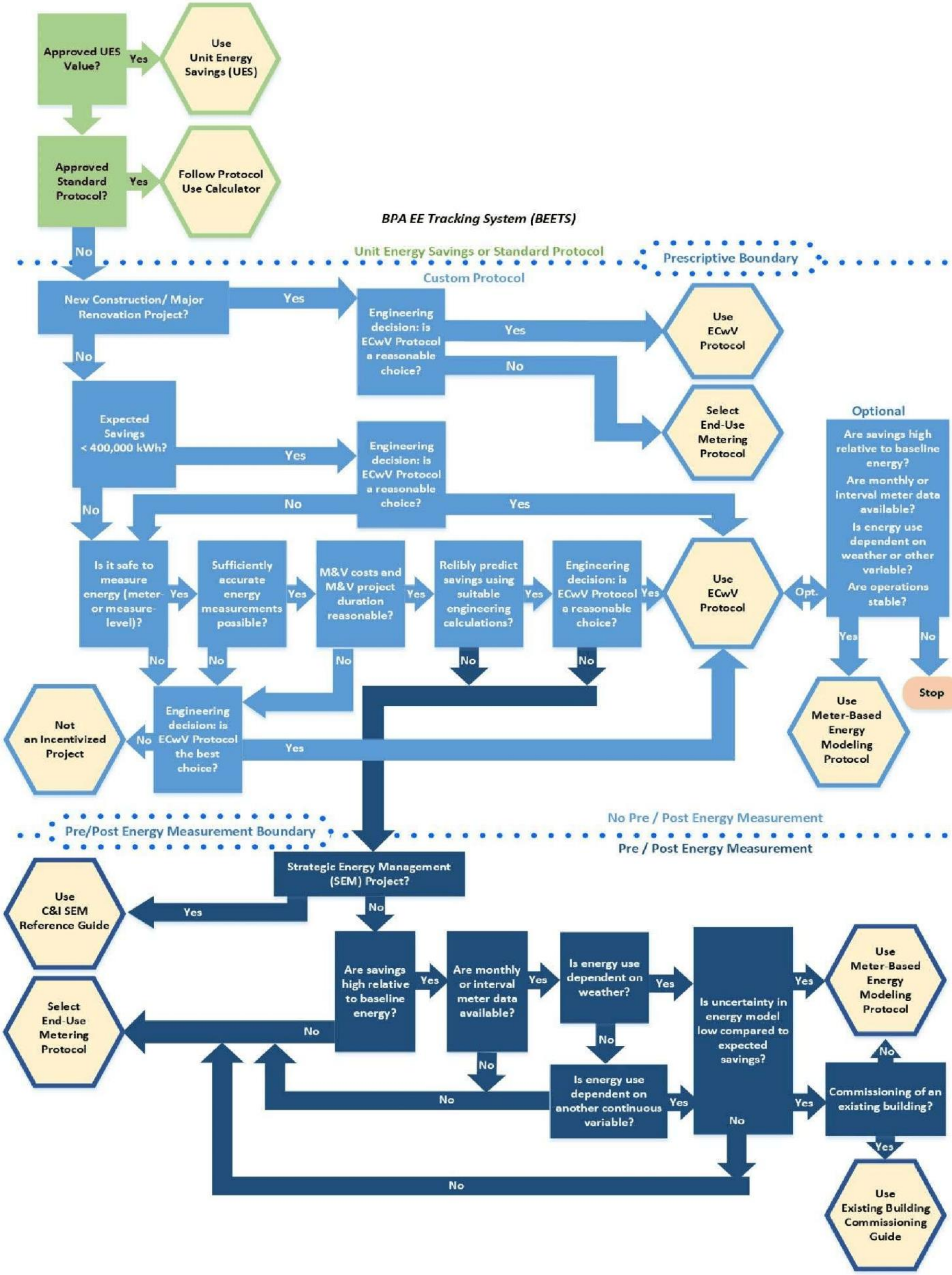
Approved UES Value?
Yes
Use Unit Energy Savings (UES)
Approved Standard Protocol?
Yes
Follow Protocol Use Calculator
BPA EE Tracking System (BEETS)
No
Unit Energy Savings or Standard Protocol
Prescriptive Boundary
Custom Protocol
New Construction/ Major Renovation Project?
Yes
Engineering decision: is ECwV Protocol a reasonable choice?
Yes
Use ECwV Protocol
No
Select End-Use Metering Protocol
No
Expected Savings < 400,000 kWh?
Yes
Engineering decision: is ECwV Protocol a reasonable choice?
No
Yes
No
Optional
Are savings high relative to baseline energy?
Are monthly or interval meter data available?
Is energy use dependent on weather or other variable?
Are operations stable?
Is it safe to measure energy (meter- or measure-level)?
Yes
Sufficiently accurate energy measurements possible?
Yes
M&V costs and M&V project duration reasonable?
Yes
Relibly predict savings using suitable engineering calculations?
Yes
Engineering decision: is ECwV Protocol a reasonable choice?
Yes
Use ECwV Protocol
Opt.
Yes
No
Use Meter-Based Energy Modeling Protocol
Stop
No
No
No
No
No
Not an Incentivized Project
No
Engineering decision: is ECwV Protocol the best choice?
Yes
Pre/Post Energy Measurement Boundary
No Pre / Post Energy Measurement
Pre / Post Energy Measurement
Strategic Energy Management (SEM) Project?
Use C&I SEM Reference Guide
Yes
No
Are savings high relative to baseline energy?
Yes
Are monthly or interval meter data available?
Yes
Is energy use dependent on weather?
Yes
Is uncertainty in energy model low compared to expected savings?
Yes
Use Meter-Based Energy Modeling Protocol
Select End-Use Metering Protocol
No
No
No
Is energy use dependent on another continuous variable?
Yes
No
Yes
Commissioning of an existing building?
No
No
Yes
Use Existing Building Commissioning Guide
No

Figure 1: M&V Selection flowchart. Source: Facility Energy Solutions, BPA M&V selection-guide, September 2024

Consider an example: a new building will add variable frequency drives (VFDs) and demand control ventilation to air handlers that serve an assembly space. Ventilation requirements for the space are not met in the baseline conditions, so appropriate baseline energy conditions could not be measured. Engineers develop a spreadsheet analysis of heating and cooling loads based on operating schedules and the nominal building size assuming the ventilation fans run at full speed when the building is occupied. The analysis is done again assuming variable requirements for ventilation.

The spreadsheet analysis shows that expected savings are less than 400,000 kWh with a steady and predictable relationship between fan speeds and energy savings. The M&V selection protocol recommends the ECwV M&V protocol. The ECwV model will be like what was used in the initial proposal, with an additional verification of average fan speeds taken from the fan VFD controls during the two weeks of normal building operation. Alternately, building occupancy could be tracked with standalone occupancy sensors.

If the project was expected to save more than 400,000 kWh with varying fan speeds during occupancy, the End-Use Metering protocol will be used. The IPMVP adherent End-Use Metering Absent Baseline Condition M&V plan would require logging samples of true fan power at a variety of speeds for part of the heating and cooling seasons and then build a baseline case model assuming fixed speeds for those heating and cooling loads.

BPA continues to evaluate the validity of its ECwV methods and to determine whether the criteria used to select ECwV projects should be changed. The 400,000 kWh savings threshold was set after an evaluation found that there was no notable bias in savings results from ECwV methods at a portfolio level, even if there was variance in individual projects (Evergreen Economics, 2022).

If the expected savings limit for ECwV could be increased, then a portion of projects in BPA's portfolio would have lower M&V costs. Lower M&V costs for some projects would improve cost effectiveness and allow for more projects with the same amount of resources.

Methodology

This paper covers a subset of data from three of BPA's custom energy efficiency impact evaluation studies across industrial and non-industrial sectors from 2019 to 2023 (Evergreen Economics 2022), (Evergreen Economics 2023), (Evergreen Economics 2025). Evaluators estimated first-year savings for each of 87 sampled measures based on actual operations during the first year.

This paper compares savings calculated from traditional rigorous M&V approaches used for evaluation to approaches that follow simpler ECwV methods. Projects were randomly sampled and stratified by size and end use in Study 1 and Study 2, while Study 3 was sampled by size only. Projects with large savings were selected, while the smallest projects representing 5% of portfolio savings were excluded from the sample.

Each project measure within the sample was defined as a unique Technology/Activity/Practice. All measures were evaluated through a review of energy savings calculations, interviews with project engineers and end-users, and, when possible, onsite data collection. Traditional M&V models and ECwV models were developed in parallel where the ECwV models were intentionally constrained according to ECwV guidelines (e.g., using shorter data collection periods without true power measurements). The analysis examines the realization rates of ECwV approaches to determine whether the current recommended size of ECwV projects should remain at 400,000 kWh and to show the qualitative risks for increasing the benefit of reducing M&V costs. All three study parameters are described in Table 2 below.

Table 2. Evaluation Parameters

Study	Population Description	Sample Interval
1	Custom industrial projects for small to medium sized public utilities in service area	2019-2020
2	Custom industrial Projects for large public utilities in service area	2019-2020
3	Custom non-industrial projects for all public utilities in service area	2022-2023

Table 3. Evaluation Sample Summary

Study	Strata	Average Size (kWh)	Population	Sample count
1	1	199,675	22	15
1	2	495,339	33	17
1	99	2,929,241	6	6
2	1	49,158	6	3
2	99	448,227	19	19
3	1	98,814	104	13
3	2	399,841	26	13
3	99	2,021,533	1	1

Results and Analysis

The IPMVP adherent evaluated savings and ECwV savings results for the sample weighted population are shown in Table 4. The results for the evaluated savings, which use all available data and models adopted or developed during impact evaluation engineering review, are in the column labeled “Sample Weighted Evaluated Savings.” These values represent the reported impact evaluation portfolio savings. The evaluation results modeled with an ECwV compliant method are shown in “Sample Weighted ECwV Savings.” The ratio of these two results represents the closeness of the two methods for a given stratum. Results close to 100% have the most similar observed savings and ECwV savings results. The overall weighted result shows a ratio of 107%.

Table 4. Sample weighted evaluated savings and ECwV savings results

Study	Strata	Sample count	Sample Weighted Evaluated Savings (kWh)	Sample Weighted ECwV Savings (kWh)	Ratio of ECwV to Evaluated Savings
1	1	15	3,612,004	3,427,629	95%
1	2	17	12,168,413	10,580,106	87%
1	99	6	15,881,501	10,343,720	65%
2	1	3	600,822	600,822	100%
2	99	19	33,811,412	35,561,908	105%
3	1	13	116,400,331	136,784,401	118%
3	2	13	77,506,156	80,958,609	104%
3	99	1	1,677,772	1,853,665	110%
Total		87	261,658,411	280,110,861	107%

The results from Table 4 show that the ECwV method applied by evaluators typically underestimated savings across the sampled population in Study 1, while Studies 2 and 3 show typical overestimation of savings using ECwV. The differences between the results for each measure are shown in Figure 2. The unweighted ECwV model results are plotted against the weighted evaluation model results, with each dot representing a single measure. The gray middle line represents a theoretical 100% match, while the solid dark lines indicate ±25% deviation from a perfect match. The dotted blue line indicates that ECwV projects tend to be estimated 16% higher across all project sizes. Figure 3 shows the same results for measures with evaluated savings less than 800,000 kWh. The trend of ECwV-modeled results in this range tends to be 8% higher than the evaluation model results. This size range shows an overall savings result that is closer to the 10% range desired from evaluation. The plotted results in Figure 2 show 35% projects outside of the 25% difference boundary while figure 2 shows 29% outside of the boundary. There are clearly large variances in results between ECwV and standard M&V projects although the variance does appear to decrease with decreased project size. There is a risk of variance on a project-by-project basis, even though the aggregate portfolio has an acceptable realization rate.

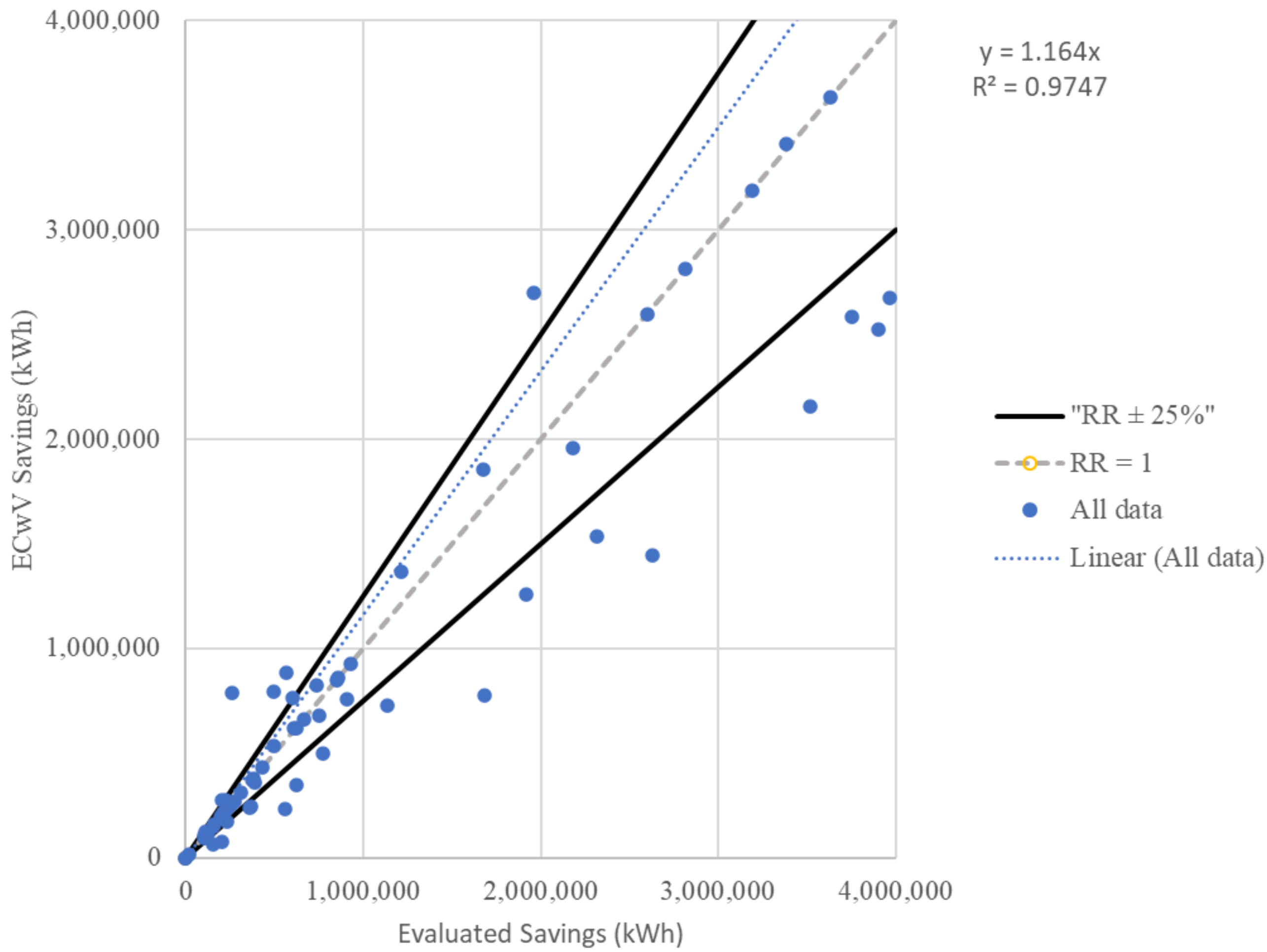

Figure 2. Evaluated model and ECwV model savings results for all measures

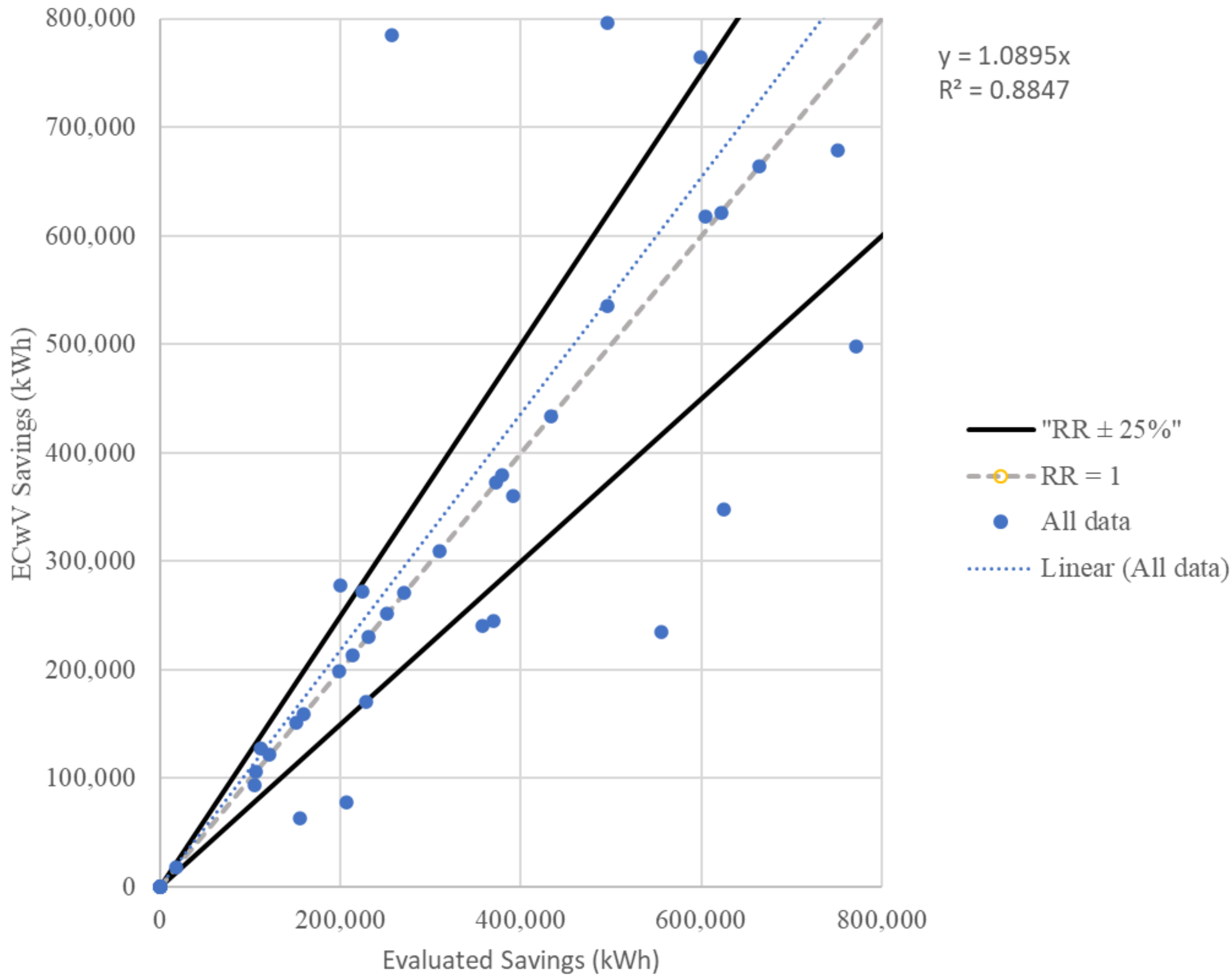

Figure 3. Evaluated model and ECwV model savings results for measures less than 800,000 kWh evaluated savings

Conclusion

Energy conservation program managers must meet applicable conservation targets and deliver verifiable and reliable outcomes. Simpler protocols for smaller measures may allow resources to be redirected to achieve additional energy savings without adding significant risk. A future risk assessment should compare overall value of lifetime savings in nominal dollars against typical M&V costs to test the benefit of simpler protocols and higher variances in the evaluated savings of individual projects.

BPA's ECwV protocol is designed to be less expensive for energy efficiency implementers and to use ratepayer resources more efficiently. BPA's 2020-2021 Industrial Impact Evaluation (Evergreen Economics, 2022) showed that the ECwV protocol performed as expected by the designers of the protocol. The new threshold for automatic ECwV consideration according to BPA protocols is 400,000 kWh. Larger values up to 800,000 kWh may be defensible, although the combined data of 3 studies indicates that there is a risk of overestimation and overall variance while the portfolio level savings are within the 10% certainty targets from impact evaluation studies.

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