

BPA Strategic Energy Management (SEM) C&I M&V Reference Guide Development

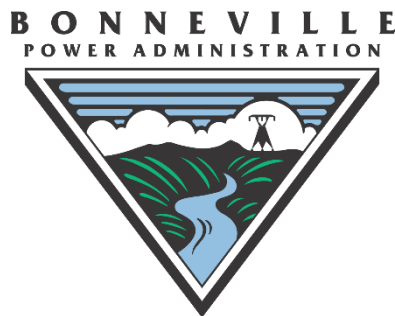
Task 2

Market Research Findings Summary Report

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Submitted by



Facility Energy Solutions LLC

www.facilityenergysolutions.com

lwebster@facilityenergysolutions.com

Bend, OR 97703

720-470-9297



OVERVIEW

This report is submitted by Facility Energy Solutions, with contributions from Energy 350, and Stillwater Energy, to Bonneville Power Administration (BPA) under contract number BPA-2-C-88404.

In this report we present findings from market research conducted to inform updates and development of a combined commercial and industrial Strategic Energy Management guideline for Bonneville Power Administration (BPA). This report was prepared by Facility Energy Solutions, with contributions from Energy 350, and Stillwater Energy.

The primary objectives of this research were to:

1. Conduct market research to assess industry activities related to Commercial SEM program offerings, and
2. Develop an outline of the new *Commercial and Industrial SEM M&V Reference Guide*.

Progress to-date on these items are provided below. These will be completed and updated, if needed, after discussing this Draft Market Research Findings document with BPA staff.

1. MARKET RESEARCH

The team reviewed SEM and related M&V industry activities, including evaluating approaches for inconsistencies and consensus best-practices. An overview of the market research plan is provided in Table 1.

TABLE 1: OVERVIEW OF MARKET RESEARCH PLAN

Item	Includes
1. Review Existing M&V Guides	SEM M&V Guides, IPMVP Option C guidance, other M&V guidelines
2. Review related DOE program guides	Referenced in the MT&R Guide_Rev9
3. Review SEM EM&V findings related to M&V	Gather and review EM&V findings from commercial and industrial SEM programs.
4. Identify Commercial SEM Programs	Gather and review commercial SEM technical requirements

A uniform review method was used to assess items included in # 1 – 3 above. All these existing documents were reviewed and assessed for unique M&V strategies and specific details. The assessment included several detailed items which fell into three categories – General, Models, and Summary, as shown in Table 2 below.



Table 2: Details Collected from M&V Documents

General	Application (commercial, industrial, other)?
	Includes step by step guidance for model development?
	Includes monthly model guidance?
	Data requirements for baseline period
	Are model approaches other than Forecast models included?
	Are recommended statistical criteria given?
Models	Multicollinearity Guidance
	Autocorrelation Guidance
	Coefficient of Variation - Cv(RMSE)
	Coefficient of Determination - R2
	Net Mean Bias Error - NMBE
	Independent variables (p-value, T-stat)
	Model Uncertainty (FSU or other)
	Annualization of savings
Summary	Other Requirements
	Notes

Details of the research conducted as well as a summary of the related findings follow.

1.1 EXISTING M&V GUIDES

The selection of M&V guidelines was identified by the FES project team based on professional experience and related literature reviews. These include documents that are currently being used in other SEM programs or which provide guidance on IPMVP’s Option C M&V methods or similar approaches.

A total of **16 existing M&V guidelines** were identified, shown in Table 3 below. Notes from the review were provided to BPA in a separate file.

TABLE 3: EXISTING M&V GUIDES REVIEWED

#	Owner	Document Name	Pub. Date
1	ASHRAE	ASHRAE 14 – 2014	Dec-14
2	BC Hydro	Strategic Energy Management Industrial Cohort Energy Modeling Guideline	Oct-21
3	BPA	3_BPA_Regression for M&V: Reference Guide	Jul-18
4	BPA	7_BPA_Verification By Energy Modeling Protocol v2	Oct-18



#	Owner	Document Name	Pub. Date
5	CA / Sergio Dias	CA Industrial SEM Design Guide Manual v1.1	Mar-17
6	CPUC / Sergio Dias	California Industrial SEM M&V Guide v2.02	Sep-20
7	ETO	2016_Energy Intensity Modeling Guideline v1.1	Jan-16
8	EVO	IPMVP 2012	Jan-12
9	EVO	IPMVP Application Guide on NRE/A	Jan-20
10	LBNL / CA	LBNL Guidance on Requirements for Meter-Based IPMVP Option C Savings Claims, Version: 6/30/2019	Jun-19
11	NEEA	Energy Baseline Methodologies for Industrial Facilities	Oct-13
12	NW SEM Collaborative	NW SEM ETSP - WP1 - Tools and Methods for Addressing Multicollinearity in Energy Modeling (SEM)	Sept-13
13	NW SEM Collaborative	NW SEM ETSP - WP2 - Tools and Methods for Addressing Autocorrelation in Energy Modeling (SEM)	Sept-13
14	NW SEM Collaborative	SEM Energy Modeling Method Selection Guide	Jun-19
15	SCL	P4P Deep Retrofit Manual for Commercial Customers Version 1.0 - Seattle City Light	Sep-18
28	CPUC	Rulebook for Programs and Projects Based on Normalized Metered Energy Consumption	June-19

Key findings from our review of M&V guides are noted below.

- ❖ Generally, the guidelines provide a uniform consensus on approach to model development and acceptance criteria. The inventory of M&V guidelines indicates there is generally a consensus on model goodness of fit metrics and required model statistical analyses across industry documents, although some are more detailed and stringent. The individual metrics were documented for each.
- ❖ Some M&V Guidelines provide related content to that which may be included in the new BPA Guide.
- ❖ General M&V guides are high-level enough to apply to any application, such as the IPMVP and others. Most of the detailed SEM-specific guides are currently more aligned with industrial applications. There is a gap with guidance on commercial SEM.
- ❖ Some guidelines provide soft-guidance on uncertainty evaluation, sidestepping setting hard rules on Fractional Savings Uncertainty (FSU) developed by ASHRAE/ Sun-Baltazar. A few of the guides use standard error rather than FSU, including items #15 – Seattle City Light P4P, #16 – DOE’s UMP SEM Evaluation Protocol, and #8 – IPMVP 2012.



- ❖ Most guidelines include similar direction related to energy model development process and are generally in alignment with the current MT&R Guide. Some others provide deeper coverage on certain types of models (e.g., pre-post models).
- ❖ The MT&R Guide includes specific guidance on models with irregular time intervals, which is not included in many of the other M&V guides.
- ❖ Annualization of savings was categorized as a topic across documents but may not apply to BPA’s programs since avoided energy savings are reported.
- ❖ Tips and specific examples are often more clearly represented in figures and examples. Guides that included more figures and examples are more helpful and provide better guidance to the modeler than those with mainly text. The clarity of the MT&R_V9 is about average in this capacity compared with other documents.

1.2 REVIEW DOE’S PROGRAM GUIDES

M&V guidelines used by DOE’s Superior Energy Management Program as well as those related to ISO 50001 certification were identified by the FES project team based on professional experience and related literature reviews. A total of **3 related documents** were identified for review and are detailed in Table 4.

TABLE 4: DOE AND ISO DOCUMENTS REVIEWED

#	Owner	Document Name	Pub. Date
23a	DOE	Superior Energy Performance 50001 (SEP 50001) Program Measurement & Verification Protocol: 2019	Oct-19
23b	DOE	Superior Energy Performance 50001 (SEP 50001) Guidance for the SEP Program Measurement & Verification Protocol: 2019	Jan-19
24	ISO	ISO 17741: 2016 General Technical Rules for Measurement, Calculation and Verification of Energy Savings of Project	2016

Review of these documents was completed as detailed in Table 2 above. Key findings from our reviews of DOE’s and ISO’s related program guides are noted below. Notes from the review were provided to BPA in a separate file.

- ❖ The new SEM M&V Guideline should include more direct statistical guidance like other guides (noted in Section 1.1). The references made in MT&R_v9 to the DOE documents should be updated to use hard values as much as possible. The team suggests that we do not include cross-references to DOE’s SEP program.
- ❖ We also suggest avoiding any discussion of ISO standards or programs. Inclusion of these is likely to confuse users since these programs are unrelated but complementary to SEM program offerings.



1.3 SEM EM&V FINDINGS RELATED TO M&V

Evaluation Measurement & Verification (EM&V) studies related to SEM were identified by the FES project team based on professional experience and related literature reviews. The most current studies were considered and a total of **11 related documents** were identified for review, which are listed in Table 5.

TABLE 5: SEM EM&V DOCUMENTS REVIEWED

#	Owner	Document Name	Pub. Date
16	DOE	The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures NREL Chapter 24 - SEM Evaluation Protocol	May-17
17	ETO	Energy Trust Production Efficiency Strategic Energy Management Evaluation Final Report	Feb-19
18	IEPEC	SEM Modeling-Strategic Energy Management Modeling: What's good enough?	2017
20	NEEP	Evaluation, Measurement & Verification (EM&V) Best Practices & Recommendations for Industrial Strategic Energy Management Programs	May-17
21	SBW Consulting / BPA	SBW BPA Evaluability Assessment for the BPA Commercial SEM Pilot Program	Aug-17
22	ETO / DNV GL	Industrial O&M Persistence Study	Apr-20
26	North American SEM Collaborative	Strategic Energy Management Program Persistence and Cost Effectiveness: An Analysis of the SEM Program Landscape	April-21
27	RTF	Guidance on Evaluated Energy Savings for Industrial SEM	Jul-21
29	VT / Cadmus	Evaluation of Continuous Energy Improvement - Draft Report	Jun-19
32	CPUC	Industrial SEM Programs Early Feedback Report	Mar-21
33	BPA / SBW / Cadmus	Industrial Strategic Energy Management (SEM) Impact Evaluation Report	Apr-21

Review of these documents was completed, as detailed in Table 2 above.

Key findings from our reviews of EM&V guides which relate to M&V of savings are noted below. There were many interesting recommendations, and notes from the review were provided to BPA in a separate file.

These evaluation reports provide some direct suggestions to SEM program implementers.

- ❖ *The Uniform Methods Project* (Item #16) is an Evaluation Protocol which provides higher level direction to program administrators and evaluators.
 - The level of technical detail provided in this document is very high.



- The SEM Evaluation Protocol outlines differences between Commercial and Industrial SEM models.
- ❖ The document *SBW BPA Evaluability Assessment for the BPA Commercial SEM Pilot Program* (Item # 21, above), was developed in anticipation of BPA's Commercial SEM program offerings and has four primary recommendations:
 1. Engineers use models with the fewest number of parameters that still fit the data.
 2. A model of the reporting period data always be created.
 3. Significant modeling choices should be traceable.
 4. Analyses and decision-making rationales should be documented.

Other observations from #21 that are relevant to M&V include:

- The program needs to document whether the applicable baseline is pre-conditions or current practice and ensure a current practice baseline period is established.
- The study notes that estimated savings are needed since savings were in the noise of the model on several previous projects.
- The study notes the need to screen models for bias, as well as issues observed due to use of multiple weather sources.
- ❖ The *Industrial Strategic Energy Management (SEM) Impact Evaluation Report* (Item #33) was an evaluation study on BPA's SEM program. Several recommendations related directly to program level M&V included:
 - BPA should improve the accuracy of the reported savings by recording negative SEM savings estimates or making program-level adjustments to savings.
 - Further investigation is needed on how uncertainty of capital project savings estimates affects SEM savings estimates.
 - Assess the effect of BPA's new policy of establishing a new baseline for participant facilities every two years on savings realization rates.
 - To support an assessment of program cost-effectiveness, BPA should collect data on participant engagement with the program,
 - BPA should continue to collect data from participant facilities after engagement ends to better assess the program's long-term value and cost-effectiveness.
 - Collect high frequency data for use in daily or weekly models.
 - Use discretion in reporting saving uncertainty.
 - Routinely test for significance of weather variables in regression model.
- ❖ One of the most recent studies is #26 by the North American SEM Collaborative was published in April 2021. This report details SEM program practices including re-baselining and persistence of savings.
- ❖ Persistence of SEM measures was generally reported to be strong, with SEM measure lives generally exceeding three-years (e.g., *Industrial O&M Persistence Study*- Item #22).



- ❖ Evaluators consistently recommend that negative savings be counted or tracked at the SEM program level to avoid the introduction of bias in savings estimates from excluding negative savings, while others suggest verifying estimates using other means.
- ❖ Several evaluation studies raised concerns about the accuracy of saving estimates from capital measures, and the impact on SEM’s program savings accuracy. Recommendations of verifying the baselines used in the estimates for capital improvements was included.

1.4 COMMERCIAL SEM PROGRAM REVIEW

The FES project team collected information related to Commercial SEM program offerings and technical approaches across the US and Canada. A substantial portion of this information was made available by the American Council for an Energy Efficient Economy (ACEEE) based on data collection ACEEE had previously compiled. Additionally, the FES team added other known commercial SEM programs to the list. Once collected, the FES team worked to researched additional details related to the SEM programs identified, as described in Table 6.

TABLE 6: COMMERCIAL SEM PROGRAM DATA

ACEEE Program Data	Program Name
	Status
	Program Sponsor/Administrator
	Customer Sectors
	Start Year
	End Year
	Website
BPA Market Research Review	SEM?
	C-SEM?
	Documents Available
	What are technical differences in commercial SEM from Industrial?
	Technical Documents Referenced in C-SEM
	Notes
	State/ Province
Avoided Energy or Normalized Savings	

The review of program offerings was achieved with mixed success. High-level investigation revealed a substantial number of commercial SEM program offerings across the US and Canada, but related information was not always published or readily accessible to the FES team. However, some conclusions are applicable to this effort. Additional dedicated research would be needed to better understand the nuances of commercial SEM programmatic landscape.



The programs identified as Commercial SEM are listed in Table 7 below.

- ❖ **72 continuous improvement type programs** are included in the list identified
- ❖ 44 of the initially identified programs are **SEM or SEM-related programs**
- ❖ **Of the 44 programs, and 20 programs** were categorized as Commercial SEM.

TABLE 7: COMMERCIAL SEM PROGRAMS IDENTIFIED

#	Program Sponsor/ Administrator	Program Name	Customer Sectors	Start Year	End Year
i.	BC Hydro	SEM Commercial	Commercial	2007	
ii.	Bonneville Power Administration	Commercial SEM	Commercial; Municipal Gov. Facilities; Nonprofits		
iii.	Clark Public Utility District	Commercial SEM	Commercial		
iv.	Commonwealth Edison and Nicor Gas	Premium Industrial and Commercial SEM	Commercial; Hospitals; Industrial; Municipal Gov. Facilities; Schools; Universities; Water Treatment/Waste Management	2014	
v.	DC Sustainable Energy Utility	University SEM	Universities	February 2020	2021
vi.	Efficiency Nova Scotia	Strategic Energy Management Program	Commercial; Industrial	2015	2022, but expected to renew
vii.	Efficiency Vermont	CEI-Light [Continuous Energy Improvement = SEM]	Commercial		
viii.	Energy Trust of Oregon	Commercial SEM	Commercial; Correctional Facilities; Hospitality; Hospitals; Multifamily; Nonprofits; Schools; State Gov Facilities; Universities	2011	
ix.	Focus on Energy Wisconsin	Wisconsin SEM Leaders	Agricultural; Commercial; Hospitals; Industrial; Water	2015	



#	Program Sponsor/ Administrator	Program Name	Customer Sectors	Start Year	End Year
x.	Focus on Energy Wisconsin	SEM Healthcare	Hospitals		
xi.	Government of Alberta	Strategic Energy Management	Commercial; Industrial		
xii.	Idaho Power	School Cohort	Schools	2017	2022
xiii.	MCE (PG&E?)	MCE Community Choice			
xiv.	National Grid	Strategic Energy Management Partnership (New York)	Commercial; Industrial; Water Treatment/Waste Management	2019	2022
xv.	New York State Energy Research and Development Authority	Strategic Energy Management Program	Commercial; Industrial	2017	
xvi.	Pacific Power	Wattsmart Business Program	Commercial; Water Treatment/Waste Management	2014	
xvii.	Public Service Company of New Mexico	Strategic Energy Management Business Program			
xviii.	Puget Sound Energy	Commercial Strategic Energy Management	Commercial	2003	
xix.	Puget Sound Energy	Multifamily SEM	Residential		
xx.	Tacoma Public Utilities	Commercial Strategic Energy Management	Commercial; Hospitals; Schools; Universities	2018	
xxi.	University of Oregon	Energy Management Program	Universities		

Due to the limited availability of accessible information related to SEM programs, it is somewhat difficult to draw overall conclusions about commercial SEM programs in general. Conclusions are that the current commercial SEM programs share many fundamental concepts, but the specific programmatic details (e.g., type of savings claimed, approach to negative savings) vary widely, so it is difficult to draw more direct conclusions at this point.



2. DRAFT OUTLINE FOR SEM C&I M&V REFERENCE GUIDE

The FES team proposes an updated outline for the new SEM M&V Guideline. The team started with the outline from BPA's existing MTR Reference Guide Rev9, and then considered the sequence of headings, missing commercial-specific SEM content, best practices from other sources,¹ and previous input from BPA².

A copy of the outline is presented to BPA along with this memo as an attached file. Below are a summary of the more significant changes and proposed additions:

Section 1.0 Characterizing the Facility

- ❖ Relocated *1.1.1 Identify Utility Meters and Submeters* to a new section 1.2 called *Utility Meters and Submeters*. This section will include content on existing meters and potential to expand meter infrastructure.
- ❖ Under *1.3 Identify Energy Drivers*, added *1.3.1 Schedule Data* section to discuss commercial specific energy drivers pertaining to building and occupancy schedules, and *1.3.4 Indicator Variables* to provide introduction and definition of this topic
- ❖ Added a new section *1.3 Identifying and Documenting Static Factors*

Section 2.0 Establishing a Baseline Data Set

- ❖ Create a new Section 2.1.1 *Adjusting for Baseline Energy Projects and Non-Routine Events*. This section will contain a brief prompt for context and an illustrative graphic. It will then point the reader to the Appendix *Treatment of EEMs During the Baseline Period*, where the existing table will be retained.
- ❖ Moving the existing *Appendix E Models with Irregular Time Intervals* into Section 2.4, a newly proposed section. Section 2.4 will provide brief text and then point the reader to the existing Appendix for more detail.

Section 3.0 Developing a Baseline Energy Model

- ❖ Moving the existing content from *Appendix F Summary of Competing Models* into Section 3.5, a newly proposed section
- ❖ Propose BPA to consider a new section *3.6.4 Bottom-Up Calculations* to provide guidance on the bottom-up as an alternative method, bottom-up was previously introduced under section 4.4.4

Section 4.0 Making Adjustments for Non-Routine Events

- ❖ We propose moving this entire section, so it is now Section 4 and comes before the section on *Calculating Energy Savings During the Reporting Period*

¹ Other sources as identified in Notes from the review were provided to BPA in a separate file.

Table 3.

² Refer to Task 1 Memo: BPA_Final High_Level_Memo_8.30.2021.docx



Section 5.0 Calculating Energy Savings During the Reporting Period

- ❖ Moving some existing content from *Appendix B Treatment of Incentivized EEMs Installed During the Reporting Period* into *Section 4.2 Adjusting for Concurrent Incentivized Projects* an existing section. As with the section regarding making adjustments during the basement period, this section will contain some text and an illustrative graphic. It will then point the reader to the Appendix for the full table.
- ❖ Propose BPA to consider a new section *5.4.4.1 Acceptable Level of Rigor for Bottom-Up Calculations*
- ❖ Propose BPA to consider a new Section titled *5.5 Reporting Energy Savings for Multiyear SEM Projects* and moving the existing content from the memo titled *Multiyear SEM Project Clarifications* into this new section

Section 6.0 Projecting Energy Savings

- ❖ Propose BPA to consider a new section titled *6.5 Bottom-Up Calculations*

Appendices

- ❖ We propose BPA to consider eliminating the existing *Appendix I M&V Methodologies for Compressed Air O&M Measures*
- ❖ We propose to reset the existing *Appendix J Revision History*

End document.