Energy Trust of Oregon
Request for Proposals:
Impact Evaluation of the 2015-2016 Existing Buildings Program

RFP Issued:	**March 10, 2017**
Proposals Due:	**April 7, 2017**

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Introduction

Energy Trust of Oregon is seeking proposals for a contractor to perform an impact evaluation of Energy Trust's commercial building retrofit program, the Existing Buildings (EB) program. The EB program began in March 2004 and is implemented by a program management contractor (PMC). ICF International has been the PMC since January 1, 2013. The program has four main tracks: Custom, Lighting (including standard, direct-install, and street lighting measures), Standard (prescriptive), and Strategic Energy Management (SEM). The program also maintains a few other tracks and pilots, which represent a small portion of program participants and savings, and will be excluded from this evaluation.

Custom track projects have their savings estimated through energy studies conducted by Allied Technical Assistance Contractors (ATACs). These studies may involve engineering calculations or energy simulation modeling. Standard Lighting track measures are installed directly by trade allies, while direct-install lighting measures are installed by a trade ally subcontractor to SmartWatt, under subcontract to the PMC. Standard track measures use savings estimates from reliable sources (including the Regional Technical Forum, ENERGY STAR, and others), as documented in Energy Trust measure approval documents (MADs). SEM savings are estimated based on a top-down analysis of building-level energy use and do not include savings from capital measures completed at the site through other program tracks during the SEM engagement. After completing a first year of SEM, participants have the option of participating in Continuous SEM, where they can claim additional savings and incentives for furthering their SEM activities.

Tables 1 and 2 show the number of completed measures, sites, and savings for program years 2015 and 2016, respectively. Tables listing program electric and gas savings by measure category are included in **Appendix B**.

Table 1. 2015 Measures, Sites and Savings by Track

Track	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Custom	279	231	26,123,758	24%	921,730	44%
Lighting	7,947	2,139	65,850,551	60%	-	-
Standard Lighting	*5,026*	*1,813*	*51,288,483*	*46%*	-	-
Direct-Install Lighting	*2,911*	*320*	*4,120,570*	*4%*	-	-
Street Lighting	*10*	*6*	*10,441,498*	*9%*	-	-
Standard	1,477	1,191	6,801,035	6%	585,301	28%
SEM Year 1*	55	54	6,744,701	6%	204,952	10%
SEM Continuation	64	63	3,669,563	3%	334,242	16%
Other tracks and pilots	107	20	1,472,073	1%	60,450	3%
Total	**9,929**	**3,472**	**110,661,681**	**100%**	**2,106,675**	**100%**

* Includes only participants in their first year of SEM in 2015.

Table 2. 2016 Measures, Sites and Savings by Track

Track	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Custom	273	231	28,094,668	21%	707,816	34%
Lighting	8,174	2,603	82,663,052	62%	-	-
Standard Lighting	*5,677*	*2,056*	*62,459,269*	*47%*	-	-
Direct-Install Lighting	*2,477*	*538*	*5,351,758*	*4%*	-	-
Street Lighting	*20*	*9*	*14,852,025*	*11%*	-	-
Standard	1,670	1,337	11,135,588	8%	881,680	42%
SEM Year 1*	61	61	3,440,440	3%	120,887	6%
SEM Continuation	107	107	6,366,269	5%	10,781	17%
Other tracks and pilots	109	33	2,465,367	2%	10,781	1%
Total	**10,393**	**4,123**	**134,165,384**		**2,082,048**	

* Includes only participants in their first year of SEM in 2016.

Of the 54 sites participating in SEM in 2015, 22 sites also installed capital measures (98 in total) during 2015 and/or 2016. Of the 61 sites participating in SEM in 2016, 11 sites also installed capital measures (28 in total) in 2016.

Energy Trust is particularly interested in tubular LED (TLED) measures. Over the last two years, the volume of TLEDs incentivized through the program has grown substantially, and savings from TLEDs accounted for 19% of Standard Lighting track savings in 2016. Table 3 below shows the total savings in 2015 and 2016 from TLED measures incentivized through the Existing Building program. Through this impact evaluation, Energy Trust is interested in learning more about TLEDs – specifically, lighting system design/controls used, measure performance, and customer satisfaction.

Table 3. TLED Measures in 2015 and 2016

Measure Description	2015 Measures	2015 Sites	2015 kWh Savings	2016 Measures	2016 Sites	2016 kWh Savings
2' TLED lamp at line voltage	-	-	-	4	4	4,887
2' TLED lamp using existing fluorescent ballast	-	-	-	3	3	102,779
2' TLED lamp with new T8 ballast	-	-	-	2	2	119
4' TLED lamp at line voltage	49	41	377,859	480	407	5,414,680
4' TLED lamp using existing fluorescent ballast	44	28	671,191	127	114	3,578,255
4' TLED lamp with new T8 ballast	5	5	19,557	52	47	970,357
4' TLED lamp with remote driver	171	115	2,468,876	58	40	1,574,910
8' TLED lamp at line voltage	-	-	-	5	5	36,878
TLED linear replacement lamp	121	85	1,509,684	-	-	-
TLED x lamp fixture in circuit with fluorescent ballast	3	3	6,951	-	-	-
Total	**393**	**267**	**5,054,118**	**731**	**579**	**11,682,865**

Energy Trust Background

Energy Trust is an independent nonprofit organization, selected and overseen by the Oregon Public Utility Commission, to lead Oregon utility customers in benefiting from saving energy and generating renewable power. Our services, cash incentives and solutions have helped participating customers of Portland General Electric, Pacific Power, NW Natural, Cascade Natural Gas, and Avista save more than $2.3 billion on their energy bills since 2002. The cumulative impact of our leadership since 2002 has been a contributing factor in our region’s low energy costs and in building a sustainable energy future. More information about Energy Trust’s background, funding sources, strategic and action plans, policies and programs are available on our website at www.energytrust.org/about.

Some of Energy Trust’s requirements in this RFP and in any subsequent negotiating and/or contracting phases are driven by governing law, the provisions of our grant agreement with the OPUC (the OPUC Grant Agreement) and our funding agreements with each utility.

Research Objectives

Energy Trust performs process and impact evaluations on all of its programs on a regular basis. The most recent impact evaluation of the Existing Buildings program, covering the 2013-2014 program years, was completed in 2017; a separate impact evaluation of the Commercial SEM offering for 2012-2014 was also completed in 2017. These evaluation reports can be found on Energy Trust’s website at: http://www.energytrust.org/about/reports-financials/documents/.

The goals of this evaluation are to:

- Develop estimates of EB program gas and electric savings to establish realization rates for the 2015 and 2016 program years individually. Realization rates need to be provided separately for SEM and non-SEM measures. This information will be used for future program savings projections and budget developments and will be incorporated into Energy Trust's annual true-up of program savings.
- Report observations from the evaluation and make recommendations to help Energy Trust understand substantial deviations from claimed savings and to improve ex ante savings estimates and the effectiveness of future engineering studies and impact evaluations of Existing Buildings projects.

Tasks

If selected through this Request for Proposal (RFP), it is anticipated that the selected evaluator will be engaged by written contract(s) to undertake the following major tasks and the submitted proposal should address these topics:

Task 1. Conduct Study Kick-off

The evaluator will meet with Energy Trust and PMC staff to present the proposed evaluation research methodologies, data collection, analysis, report preparation and other activities. The meeting will also be used to discuss measures and projects of particular interest to be called out in the evaluation. The evaluator will write up a summary of the discussion and decisions made at the kick-off meeting and provide it to the Energy Trust Evaluation Sr. Project Manager. The results of this discussion will be used in Task 2 below.

Deliverables:

- Kick-off meeting agenda
- Summary notes from the kick-off meeting

Task 2. Develop Work Plan, Sampling Plan and Data Collection Guides

Energy Trust will provide the evaluator with a dataset of program activity for 2015 and 2016, along with other project documentation necessary to develop a sampling plan. Based on the kick-off meeting discussion and a review of program activity and project documents, the evaluator will develop a detailed work plan and schedule of tasks and deliverables. The work plan will contain:

- Evaluation goals
- Evaluation methodologies
- Sampling plan (see below)
- Schedule of tasks and deliverables

A draft work plan will be presented to the Energy Trust Evaluation Sr. Project Manager for review before finalization.

The evaluator will develop a site sampling plan based on project data provided by Energy Trust and identify the methods that will be employed to evaluate measures installed at each site. The sampling plan will detail the number of site visits for different fuel types, types of buildings, program tracks, and measure categories. It will also include a data collection and analysis plan detailing the equipment to be inspected and the expected data collection methods to be used for each site.

The final list of measure categories to be analyzed will be determined after discussions at the kick-off meeting. The evaluator should use a stratified sampling approach to select sites that represent the bulk of program savings and measure types in each year, while oversampling TLEDs. Sites selected as part of the SEM track must have all their capital measures evaluated as well. Sampling strategies should be considered that will address both the need for precision in measure level savings as well as the need for representative estimates of overall 2015 and 2016 program gas and electric savings.[1]

The entire sampling plan will be presented by the evaluator to Energy Trust and PMC staff via web conference. Energy Trust and PMC staff will then review the sampling plan in detail and provide feedback to be incorporated by the evaluator. The sampling plan must be approved by Energy Trust staff prior to any site data collection.

Energy Trust will provide electronic project files for all sites in the sample. The evaluator shall review all project files to identify any potential issues prior to planning data collection activities. Projects that have major documentation issues or other issues that could impede the evaluation of savings should be dropped from the sample and replaced. Project files for SEM participants will include opportunity registers and the models/workbooks used to estimate savings. There may be more than one model per SEM site, based on whether savings are claimed for one or both fuels, estimated at one or more meters, and whether the site participated in SEM Continuation.[2]

The evaluator will develop a data collection guide to be used during data collection activities. This tool should include both the data elements to be collected at each site as well as interview questions for facility managers about facility operations. The draft will be provided to the Energy Trust Evaluation Sr. Project Manager for review before finalization. For sites that installed TLEDs, questions should cover the participant experience with installation and operation of TLEDs (see Task 5 for specific questions), as well as data needed to estimate energy savings.

[1] Measures implemented through pilot initiatives will be excluded from the sampling plan because each pilot is evaluated separately.

[2] Each year of SEM Continuation results in a separate model of savings, which is usually based on the original model. Prior SEM savings claims are subtracted from the computed savings to achieve the incremental savings to be claimed for that continuation year.

Respondent proposals should include a suggested sampling plan, including general approach, the number of measures to be included in the evaluation for each fuel – in total, by track, and for TLEDs specifically – and the estimated confidence and precision levels.

Deliverables:

- Draft and final work plan
- Draft and final sampling plan
- Draft and final data collection guides
- Section in report outlining sampling methodology and sample selection

Task 3. Collect Data through Site Visits and Facility Operator Interviews

Energy Trust anticipates that the evaluator will conduct primary data collection activities during visits to sites that participated in the EB program in 2015 and 2016, according to the agreed upon sampling plan. Information gathered during the site visits will be used to develop reliable estimates of electric and gas program savings by program track and measure category. Site assessments are, at minimum, anticipated to include both physical inspection of the installed equipment and gathering of relevant building characteristics and operations data. The use of short term end use metering, collection and analysis of Energy Management System (EMS) data, and simulations is also anticipated for a select set of measures. Energy Trust also expects that the evaluator will use site energy usage data (provided by Energy Trust) to calibrate simulation models for custom projects that used modeling.

Facility operators will be interviewed to provide the evaluator with information about the operations of their buildings, installed equipment, and, for SEM participants, O&M activities undertaken.[3] For some measures or projects, particularly standard measures and some lighting, a site visit may not be necessary; data collection via a phone interview with facility operator staff may suffice.

All site visits will be coordinated with the PMC and facility operators to minimize disruption to customer personnel. Information on occupant characteristics and building operations and management should also be collected. For projects where a simulation model was used to estimate ex ante savings, these data should be sufficient to perform a calibrated building simulation model comparing the building to the pre-retrofit operations. Energy Trust will provide the original simulation models and energy usage data from electric and/or gas utilities for applicable sites; other data - such as data from an EMS or weather and occupancy data that feed into an SEM model - may be obtained directly by the evaluator. Before receiving utility usage data, the selected evaluator and all staff working with utility usage data must sign and submit to Energy Trust the Utility Customer Information Confidentiality Agreements (see **Appendix C**).

[3] It is expected that this will be done as part of the site visit but, if necessary, additional interviews will be performed via phone.

For each SEM site in the sample, the evaluator will put all model parameters and data into a database for analysis.

Deliverables:

- Chapter in final report documenting the data collection processes
- Appendices in final report detailing the methods and findings from each site, to include measure- and project-level savings and realization rates

Task 4. Impact Analysis

The evaluator will compile and conduct a detailed analysis of the data collected as part of Task 3 to determine:

- Accurate estimates of program, track, and major measure category electricity and gas savings by year,
- Main reasons for large variances in savings, whether they are factors that exist in the current program and can be controlled by the EB program, and,
- Program, track, and major measure category electricity and gas realization rates.

Building characteristics and energy usage data will be used to estimate gross electricity and gas savings at the whole building level and for major end-use categories. In all cases, the evaluator will compare the as-occupied characteristics of the building and its savings measures with those documented by the program. Site- and measure-level gross savings should be weighted by total savings and aggregated to achieve program-level savings estimates and realization rates.

For sites that participated in SEM, the selected evaluator will follow Energy Trust guidelines for estimating savings in **Appendix D**. These guidelines lay out best practices and standardize the creation and adjustment of SEM models, and incorporate findings from the 2012-2014 Commercial SEM Impact Evaluation. While models to estimate savings are created for each site during participation, for 2015 participants and some 2016 participants, the model(s) predate the Energy Trust guidelines. This may require the selected evaluator to construct a new model that conforms to the guidelines. To determine the savings for SEM, the evaluator will subtract the evaluated savings of any capital measures installed at the site, prorating for the time of capital measure installation.[4] For sites that participated in SEM Continuation, the evaluator will estimate savings separately for each year of SEM engagement.

Energy Trust Planning, EB program and PMC staff will be available to the evaluator to answer questions about individual projects and measures, including SEM and deemed measure savings estimation methods, and the selected evaluator is expected to make use of these staff in order to gain a thorough understanding of the program, measures and projects.

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[4] Energy Trust claims full first year savings for all capital measures, regardless of when they are installed during the program year.

Deliverables:

- Chapters in the final report on the analysis methods and findings
- Tables of savings estimates and realization rates

Task 5. Report Observations and Make Recommendations

The evaluator will report observations about the EB program made during the course of the evaluation work and make recommendations to help Energy Trust improve the effectiveness of future engineering and evaluation studies and improve the accuracy of its savings estimates for commercial retrofit and SEM projects. Beyond reliable savings estimates, Energy Trust is also interested in having the evaluator answer the following questions:

- Are there project files for every site and do those files contain complete information? Are there obvious errors in any of the assumptions used in the energy analysis? Are the original SEM models and results well documented? Were there any deviations from the SEM modeling guidelines, and if so, was there a satisfactory explanation, and were the deviations justified?
- Were there any post-installation changes in operating parameters and associated assumptions? If so, what were the consequent changes in energy savings estimates for individual projects (e.g., changes in operating hours for lighting)?
- What are the factors that result in large variances in energy savings from program estimates (e.g. assumptions too conservative, incorrect hours of operation)?
- For Custom track measures, are there trends in savings realization by ATAC firm completing the energy study?
- For Standard track measures, do the measure approval documents used by the program include sufficient information to estimate reliable savings, and if not, what specific changes should be made improve them?
- For SEM participants, how did the original models compare to the models used for evaluation? Were any important variables omitted from the original model? Were capital measures properly accounted for in the estimation of SEM savings?
- Were recommendations made in previous impact evaluations implemented, and if so, how have these changes affected the realization or verification of program savings?
- What recommendations does the evaluator have regarding analysis approaches and assumptions, or customer behavior or decision-making that would be helpful to Energy Trust in designing, implementing, and evaluating its programs in the future?
- Are there economic or other trends that are impacting the program’s ability to forecast and estimate savings?

For TLEDs specifically, Energy Trust would like to know:

- Are TLEDs installed through the program in 2015 and 2016 operating well? Are participants satisfied with their TLED products and overall lighting system design?
- Are participants experiencing any issues with TLEDs, like buzzing, flickering, early failure, etc.?
- What controls strategies are being used with TLEDs? Did these controls receive incentives from the EB program? If not, why? Were the controls installed before, at the same time as, or after TLEDs were installed? Is the operation of these controls satisfactory or are there issues to be addressed?
- Are there any differences in operation and satisfaction by TLED installation type (at line voltage, with existing or new ballast, etc.), space use or customer type?
- Have any participants replaced TLEDs installed in 2015 and 2016? If so, when and why were they replaced, and what type of lighting replaced them?

Deliverable:

- Chapter in final report on observations and recommendations

Task 6. Reporting

The evaluator will be required to provide Energy Trust with a draft report, submitted to the Evaluation Sr. Project Manager. The draft will be reviewed and commented on by Energy Trust staff, PMC staff, Energy Trust Board Evaluation Committee members, and other parties deemed appropriate. Based upon these comments, the evaluator shall make revisions and deliver to Energy Trust a final version of the report. Achieving an acceptable final report will take more than one iteration between the evaluator and Energy Trust. Where applicable, data, phone conversations, non-confidential sources, publications, and other media used in the report must be referenced and cited. It is anticipated that any respondents or sources can be promised confidentiality in terms of attribution of responses. Findings and conclusions shall be based on the information collected by the evaluator and referenced in the reports. The use of tables and graphs is recommended for material that does not lend itself well to narrative form, as well as for key findings, including savings estimates and realization rates. All evaluation reports must include, at a minimum, executive summary, background, methodology, findings, and recommendations sections.

The contractor will be required to submit monthly status reports presenting (1) a summary of accomplishments during the previous month, (2) current month's activities/plans; (3) variances in schedule and budget, including any necessary explanations; and if applicable, (4) issues or concerns to be addressed with proposed solutions. These reports are due by the 10th of every month and must accompany the invoice, starting with the first month after work on the project begins.

Deliverables:

- Draft and final evaluation report
- Monthly status reports

Schedule

The draft report will be delivered to Energy Trust by November 30, 2017. A final report will be delivered within two weeks of having received all comments and edits on the submitted draft. The contractor will be required to provide a monthly evaluation update to Energy Trust on the 10th of every month.

Budget

It is anticipated that the budget for the evaluation work as described in this RFP will be in the neighborhood of $600,000; however, Energy Trust reserves the right to revise budget assumptions at any time.

Proposal Requirements

Respondent's proposal must contain:

1. Proposal Information

1) A description of the firm's qualifications to conduct this impact evaluation of an existing commercial construction energy efficiency and strategic energy management program.
2) A project proposal, not to exceed 15 pages, including proposed approach to the specific tasks identified in the "Tasks" section above as well as the firm's proposed approach to the evaluation overall, and a management plan.
3) Proposed schedule of deliverables. This should include a kickoff meeting scheduled within two weeks of awarding the contract and a provision for a "final" statement of work, if warranted by the kickoff meeting.
4) A detailed budget broken out by task and by individual. Key individuals should be identified by name, with billing rates for each.
5) Resumes of key staff and subcontractor team members who will be executing the work scope.

Please note that the 15-page limit for the project proposal referenced in (2) above does not include the firm's experience, qualifications and references; schedule of deliverables; detailed budget; and the experience of proposed staff.

2. Conflict of Interest Disclosure

Respondents should disclose any direct or indirect, actual or potential conflicts of interest Respondents may have with Energy Trust in its proposal. A "direct or indirect conflict" is defined as any situation in which an individual or a member of their family or close business or personal acquaintance, is employed by Energy Trust or the OPUC, or may be reasonably construed to have a direct or indirect personal or financial interest in any business affairs of Energy Trust, whether because of a proposed contract or transaction to which Energy Trust may be a party or may be interested or is under consideration, or whether such conflict is purely conceptual, because of similarity of business interests or affairs.

If no conflict is identified by Respondent, the proposal will explicitly provide such a statement in their RFP response. The determination of whether a conflict of interest exists is left to the sole discretion of Energy Trust.

3. Representations and Signatures Page

Respondent's proposal must contain the signature of a duly authorized officer or agent of the company submitting the proposal. Respondent's duly authorized officer or agent shall sign ***Appendix A*** certifying to the representations stated on ***Appendix A.***

Proposal Selection Criteria

Proposals will be judged on the following criteria, and any other factors deemed relevant by Energy Trust:

- Proposal, including proposed approach to specific evaluation tasks and the evaluation overall
- Experience of proposed staff (including key staff from all subcontractors that will be involved in the evaluation) and management plan
- Experience of firm (including all subcontractors that will be involved in the evaluation)
- Proposed budget and schedule of deliverables

Schedule & Administration of Proposal Selection Process

RFP Schedule:

- **March 10, 2017** RFP issued
- **March 24, 2017** **Intent to bid due**
- **March 24, 2017** Questions/request for additional information due
- **March 31, 2017** Response to questions sent no later than
- **April 7, 2017** **Proposals due**

Requests for Additional Information and Proposal Submission

Any questions and/or requests for clarification or additional information regarding this RFP, as well as stating intent to bid on the project, must be submitted via email to the contact named below by **March 24, 2017**. Responses to questions and requests for additional information will be posted on Energy Trust's website no later than **March 31, 2017**. Energy Trust cannot accommodate individual phone, mail, or fax inquiries about the RFP. All questions must be submitted via email.

Stating intent to bid does not obligate a respondent to submit a proposal. Only electronically submitted proposals (in PDF form) will be accepted; faxed or print proposals will not. A signed letter of transmittal (cover letter) is required, but can be scanned and submitted along with the proposal. All proposals must be received by 5pm PST on **April 7, 2017**. Energy Trust will not be obligated to consider information received outside this time interval for the purposes of this RFP. Please submit proposal to:

Sarah Castor
Evaluation Sr. Project Manager
Energy Trust of Oregon
Phone: 503.445.7619
Email: sarah.castor@energytrust.org

Revisions to RFP

If it becomes necessary to revise any part of this RFP, an addendum will be issued by Energy Trust and will be posted on the website. Respondents should contact Energy Trust if they find any inconsistencies or ambiguities to the RFP. Clarification given by Energy Trust may become an addendum to the RFP.

Withdrawal and Modification of Proposals

Respondents may withdraw their proposal and submit a revised proposal prior to the response deadline. After the response deadline, Respondent initiated changes will not be accepted. Respondents may withdraw their proposal from consideration at any time.

Proposal Evaluation and Notification for Negotiations

Energy Trust will review the proposals as received and will initiate negotiations with the leading Respondent(s).

RFP GOVERNING PROVISIONS

All submitted proposals are subject to the following additional provisions.

Right to Accept or Reject Proposals, Multiple Awards

Energy Trust reserves the right to make multiple awards, reject any and all proposals and to waive any nonconformity in proposals received, to accept or reject any or all of the items in the proposal, and award the contract in whole or in part as it is deemed in Energy Trust's best interest. Energy Trust may also choose to negotiate any of the details of proposals prior to contracting.

Confidentiality

Respondents shall clearly identify only those portions of their proposals that they do not want revealed to third parties and label such portions as "Confidential Information".

Except as required under law or for regulatory purposes Energy Trust will maintain confidentiality of such information. Energy Trust will not accept proposals or other documents that are marked to indicate the entire document is the confidential or proprietary information of the sender or that restricted handling is required. Normal business practices will be observed in handling proposal materials.

Ownership and Return of Proposals

All materials submitted in response to this RFP shall become the property of Energy Trust and shall not be returned to the respondent.

No Verbal Addendums

No verbal agreement or conversation made or had at any time with any officer, agent, or employee of Energy Trust, nor any oral representation by such party shall add to, detract from, affect or modify the terms of the RFP, unless specifically included in a written addendum issued by Energy Trust.

Proposal Costs

Each proposal prepared in response to this RFP will be prepared at the sole cost and expense of the Respondent and with the express understanding that there will be no claims whatsoever for reimbursement from Energy Trust.

Waiver of Claims

Respondent waives any right it may have to bring any claim, whether in damages or equity, against Energy Trust or its officers, directors, employees, or agents, with respect to any matter arising out of any process associated with this RFP.

Energy Trust Rights Reserved

Energy Trust reserves the right, in its sole discretion, to reject any or all proposals in whole or in part, to waive any minor irregularities or informalities in a proposal, and to enter into any agreement deemed to be in their best interests. In addition to any other enumerated reserved rights and/or options as stated in this RFP, Energy Trust may in its sole discretion do any one or more of the following:

- Determine which proposals are eligible for consideration in response to this RFP.
- Disqualify proposals that do not meet the requirements of this RFP, in the sole determination of Energy Trust.
- Negotiate with any Respondent to amend any proposal.
- Select and negotiate and/or enter into agreements with Respondents who, in Energy Trust's sole judgment, are most responsive to the RFP and whose proposals best satisfy the interests of Energy Trust, in its sole discretion, and not necessarily on the basis of price alone or any other single factor.

- Issue additional subsequent solicitations for proposals, including withdrawing this RFP at any time and/or issuing a new RFP that would supersede and replace this one.
- Vary any timetable or schedule, add or change any provisions discussed herein.
- Conduct any briefing session or further RFP process on any terms and conditions.
- Suspend or modify the RFP process at any time.
- Enter into relationships with more than one Respondent.

Resulting Contract(s)

The selected respondent will be required to execute a written contract(s) with Energy Trust to perform the evaluation work. No award will be considered a commitment, and no obligations or legal relations shall exist between Energy Trust and the selected respondent until a final and binding contract has been executed by and between Energy Trust and the contractor. Time is of the essence with regard to this program, and prolonged contract negotiations will not be undertaken. In general, Energy Trust strongly prefers contracts that are consistent with Energy Trust's standard terms and conditions; negotiations for such contracts can generally be completed quickly. In some cases, a few terms and conditions may need to be substituted or waived, in accordance with contract negotiations. Any party involved in these contract discussions can terminate negotiations at any time and for any reason. If it appears that contract negotiations are not proceeding in a timely manner, Energy Trust may opt to terminate the discussions and select another respondent.

APPENDIX A: REPRESENTATIONS AND SIGNATURE PAGE

I, the undersigned declare that;

1. I am an authorized agent of the respondent and have authority to submit this proposal on behalf of the respondent.
2. The information provided in this proposal is true and correct to the best of my knowledge.
3. I have read this Request for Proposals in its entirety and agree unconditionally to all of its conditions and requirements.
4. The respondent has not directly or indirectly induced or solicited any other respondent to submit a false or sham proposal.
5. The respondent has not solicited or induced any other person, firm, or corporation to refrain from proposing.
6. The respondent has not sought by collusion to obtain for itself any advantage over any other respondent or Energy Trust.
7. The respondent’s proposal is genuine; not made in the interest of, or on behalf of, any undisclosed person, firm, or corporation; and is not submitted in conformity with an agreement of rules of any group, association, organization, or corporation.
8. I understand and accept that the approval or rejection of respondent's request is within the sole discretion of Energy Trust and that there is no legal commitment until all due diligence has been performed and a properly authorized contract has been duly and properly executed.
9. I authorize the representatives of Energy Trust to investigate the business and personal financial credit history of respondent, its affiliates, and all associated partners, principals and management and authorize the release of all said information.
10. I agree that I will report immediately in writing to Energy Trust any changes to the information contained herein at any time while I am under consideration for funding.

The information contained in this proposal and any part thereof, including its exhibits, schedules, and other documents and instruments delivered or to be delivered to Energy Trust is true, accurate, and complete. This proposal includes all information necessary to ensure that the statements therein do not in whole or in part mislead Energy Trust as to any material fact.

Date: ____

Authorized Signature: ____

Name and Title: ____

(please print)

APPENDIX B: MEASURES, SITES AND SAVINGS BY MEASURE TYPE

Note: Only measures in tracks subject to this evaluation are included in these tables.

Table B1. 2015 Measures, Sites and Savings by Measure Type

Measure Type	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Boiler	11	10	-	-	63,920	3%
Ceiling insulation	35	34	133,477	0%	88,657	4%
Clothes washer	2	2	3,196	0%	1,316	0%
Controls	64	42	904,302	1%	-	-
Custom boiler	1	1	-	-	70,432	3%
Custom building controls	73	67	7,676,666	7%	448,679	22%
Custom chiller	8	8	5,424,616	5%	15,906	1%
Custom de-lamping	37	36	172,627	0%	-	-
Custom ducts	1	1	3,009	0%	148	0%
Custom economizer	1	1	16,565	0%	-	-
Custom energy management system	13	13	313,120	0%	3,487	0%
Custom gas measure	7	6	34,165	0%	68,320	3%
Custom heat recovery	2	2	8,907	0%	20,722	1%
Custom HVAC	75	68	7,262,752	7%	155,710	8%
Custom lighting	285	250	7,653,746	7%	-	-
Custom lighting control	45	44	515,315	0%	-	-
Custom other measure	56	50	2,344,375	2%	119,664	6%
Custom refrigeration	4	4	257,315	0%	-	-
Custom thermostat	2	2	6,079	0%	303	0%
Custom variable air volume	1	1	7,512	0%	-	-
Custom variable frequency drive	37	33	3,025,992	3%	10,784	1%
Custom ventilation	1	1	-	-	7,006	0%
Dishwasher	5	3	872	0%	9	0%
Food equipment	592	542	858,455	1%	368,775	18%
Gas furnace	19	13	-	-	5,574	0%
Gas unit heater	2	1	-	-	872	0%

Measure Type	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Heat pump	55	41	415,166	0%	-	-
HVAC	22	17	102,430	0%	-	-
Icemaker	112	108	101,490	0%	-	-
Lighting	7,270	2,159	57,524,471	53%	-	-
Lighting controls	435	314	1,902,743	2%	-	-
Motors	36	19	498,154	0%	-	-
Other production efficiency	1	1	1,128	0%	-	-
Powerstrip	333	328	231,556	0%	-	-
Radiant heating	5	4	6,244	0%	10,665	1%
Refrigerator	11	10	686,678	1%	22,950	1%
SEM Year 1	55	54	6,744,701	6%	204,952	10%
SEM Continuation	64	63	3,669,563	3%	334,242	16%
Showerhead	2	2	-	-	5,270	0%
Steam traps	2	2	-	-	4,704	0%
Tanked water heater	17	17	-	-	9,474	0%
Tankless water heater	4	4	-	-	2,812	0%
Virtualization	9	4	628,507	1%	-	-
Wall insulation	10	9	53,714	0%	875	0%
Total	**9,822**	**3,455**	**109,189,608**	**100%**	**2,046,222**	**100%**

Table B2. 2016 Measures, Sites and Savings by Measure Type

Measure Type	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Boiler	40	38	-	-	253,407	12%
Ceiling insulation	39	37	249,445	0%	47,537	2%
Clothes washer	2	2	2,425	0%	130	0%
Compressed air	1	1	386	0%	-	-
Controls	46	44	694,272	1%	-	-
Custom boiler	3	3	9,089	0%	59,753	3%
Custom building controls	109	102	9,413,753	7%	318,514	15%
Custom chiller	11	11	2,599,017	2%	-	-
Custom data center	1	1	183,725	0%	-	-
Custom de-lamping	33	33	79,724	0%	-	-
Custom economizer	18	18	422,678	0%	-	-
Custom energy management system	7	7	318,096	0%	3,242	0%
Custom gas measure	3	3	-	-	2,381	0%
Custom heat recovery	1	1	-	-	7,614	0%
Custom HVAC	50	49	10,669,461	8%	228,426	11%
Custom lighting	274	244	6,284,355	5%	-	-
Custom lighting control	57	56	2,097,688	2%	-	-
Custom motor	2	2	70,166	0%	-	-
Custom other measure	27	21	972,848	1%	59,855	3%
Custom refrigeration	8	7	449,302	0%	-	-
Custom thermostat	3	3	263,950	0%	10,649	1%
Custom variable frequency drive	34	29	2,611,792	2%	7,502	0%
Custom ventilation	3	3	470,603	0%	8,194	0%
Faucet aerator	13	8	14,788	0%	3,073	0%
Food equipment	681	617	744,904	1%	434,134	21%
Freezer	1	1	240	0%	-	-
Gas furnace	19	18	-	-	7,772	0%
Gas unit heater	2	2	-	-	3,321	0%

Measure Type	Measures	Sites	kWh savings	% of total kWh savings	Therm savings	% of total therm savings
Heat pump	39	30	289,992	0%	-	-
HVAC	19	12	56,906	0%	-	-
Icemaker	115	113	110,668	0%	-	-
Lighting	7,198	2,474	73,995,618	56%	-	-
Lighting controls	520	416	1,810,521	1%	-	-
Motors	64	64	688,179	1%	-	-
Pipe insulation	1	1	-	-	1,480	0%
Powerstrip	494	492	106,174	0%	-	-
Radiant heating	2	2	3,052	0%	5,216	0%
Refrigerator	104	78	5,223,993	4%	81,450	4%
Retro commissioning	1	1	89,490	0%	1,686	0%
SEM Year 1	61	61	3,440,440	3%	120,887	6%
SEM Continuation	107	107	6,366,269	5%	360,884	17%
Server closet mini-split AC units	1	1	1,123	0%	-	-
Showerhead	9	9	10,032	0%	9,824	0%
Steam traps	3	3	-	-	9,072	0%
Tanked water heater	22	22	-	-	10,148	0%
Tankless water heater	14	14	-	-	7,782	0%
Virtualization	11	11	884,257	1%	-	-
Wall insulation	12	10	596	0%	7,335	0%
Total	**10,285**	**4,106**	**131,700,017**	**100%**	**2,071,267**	**100%**

APPENDIX C: ENERGY TRUST'S UTILITY CUSTOMER INFORMATION CONFIDENTIALITY AGREEMENTS FOR CONTRACTORS

UTILITY CUSTOMER INFORMATION CONFIDENTIALITY AGREEMENT (Contractor Version)

(A separate agreement to be signed by any contractor who may be granted access to confidential utility customer information provided to Energy Trust by its funding utilities.)

Energy Trust's funding utilities (collectively, the "Utilities") provide Energy Trust with certain Confidential Information consisting of identification and usage information about their respective customers ("Confidential Utility Customer Information") for the sole purpose of implementing, administering, and evaluating Energy Trust's energy programs. In the course of providing services to Energy Trust ("the Services"), [INSERT CONTRACTOR LEGAL BUSINESS NAME HERE]_______________("Contractor") may be provided with Confidential Utility Customer Information.

Contractor understands that the Confidential Utility Customer Information is made available by Energy Trust to Contractor on a "need to know" basis and only after Contractor is advised of the confidential nature of the information and its agreement to all obligations of confidentiality herein. In addition to any and all other obligations of confidentiality as set forth in this Agreement, Contractor specifically agrees as follows:

1. **Nondisclosure.** Contractor agrees that (a) it will not disclose, during the Term or thereafter, Confidential Utility Customer Information, directly or indirectly, under any circumstances or by any means, to any third person, other than Energy Trust its contractors, their subcontractors, or its employees who have authorized access to the Confidential Utility Customer Information confirmed in writing by Energy Trust and (b) it will comply with all Energy Trust policies and procedures for the protection of the Confidential Utility Customer Information.
2. **Nonuse.** Contractor agrees to not copy, transmit, reproduce, summarize, quote or make any commercial or other use whatsoever of Confidential Utility Customer Information, except as may be necessary to perform the Services for Energy Trust; <u>provided, however,</u> Contractor agrees not to use the Confidential Utility Customer Information for telemarketing to customers under any circumstance.
3. **Protection**. Contractor agrees to exercise the highest degree of care in safeguarding the Confidential Utility Customer Information against loss, theft, or other inadvertent disclosure and to take all reasonable precautions to protect the confidentiality of Confidential Customer Information.
4. **Return of Confidential Utility Customer Information.** Contractor agrees that, upon request by Energy Trust, it will return to Energy Trust any documents, materials, or other information in any form that contain, reflect, or constitute any Confidential Customer Information, within forty-eight (48) hours after receipt of such request. Upon termination of the Agreement, Contractor will deliver to Energy Trust all documents, materials or other information in whatever form, which may contain, reflect, or constitute any Confidential Utility Customer Information in its possession or under its control, within twenty-four hours after receipt of a termination notice.
5. **Expiration**. Contractor understands that its obligations of confidentiality shall survive termination or expiration of its engagement as an independent contractor in connection with the Programs.
6. **No Grant of License.** Contractor understands that it is not being granted a license or any other right to use any Confidential Utility Customer Information except for the purpose of performing the Services. Contractor also understands that all Confidential Utility Customer Information disclosed or otherwise acquired by it and all work product, materials, and

information arising out of, related to, or derived from Confidential Utility Customer Information including, but not limited to, studies, analyses, reports, documents, inventions, formulations, methodologies, processes, procedures, designs, and know-how, shall remain the property of Energy Trust.

7. **Retention of Records.** Contractor agrees to keep a record of the documentary Confidential Utility Customer Information furnished by Energy Trust and the location of such Confidential Utility Customer Information.
8. **Disclosure to Employees and Others.** Contractor agrees to disclose Confidential Utility Customer Information within its organization only after having notified such persons of the confidential nature of the information and after having placed them under covenants of nondisclosure and nonuse similar to those contained in this Agreement. Contractor shall maintain documentation of such covenants of nondisclosure.
9. **Remedies.** Disclosure of Confidential Utility Customer Information in violation of this Agreement will cause irreparable harm to Energy Trust and the Utilities. In case of such disclosure, Energy Trust and the Utilities will be entitled to specific performance, including immediate issuance of a temporary restraining order or a preliminary injunction enforcing this Agreement, and to a judgment against Contractor for damages, and to any other remedies provided by applicable law. If Energy Trust or the Utilities brings an action to enforce the terms of this Agreement and prevails, the prevailing party will be entitled to recover reasonable attorney fees, costs, and expenses from Contractor in the trial court and on appeal.
10. **Indemnification**. Contractor will indemnify and hold harmless Energy Trust and the Utilities, their directors, officers, employees, agents, representatives, and affiliates, from any third party claims against those indemnified parties that result from the negligent or wrongful acts or omissions of Contractor or its Employees including, but not limited to, the misuse or unauthorized disclosure of Confidential Utility Customer Information or any other breach of this Agreement.
11. **Notice of Security Breach.** If Contractor believes that a security breach involving Energy Trust's data may have occurred, Contractor shall provide immediate notice to Energy Trust, in no case later than within 24 hours, and consult with Energy Trust regarding appropriate next steps.

Contractor has read this **Contractor Confidentiality and Nondisclosure Agreement** and understands, acknowledges and agrees to the terms and conditions herein effective as of the date set forth below.

ON BEHALF OF CONTRACTOR:

AUTHORIZED REPRESENTATIVE SIGNATURE: ______________________________

PRINT NAME AND TITLE: ______________________________

DATE __________ PHONE: ______________ EMAIL: ______________

UTILITY CUSTOMER INFORMATION CONFIDENTIALITY AGREEMENT (Individual Version)

(A stand-alone agreement to be signed by any Energy Trust employee or employee of a company contracted with Energy Trust who may be granted access to confidential utility customer information provided to Energy Trust by its funding utilities.)

Your role as an Energy Trust employee, or the employee of a company contracted with Energy Trust creates a relationship of trust and confidence with respect to Energy Trust's information. You will likely have access to confidential and proprietary business information relating to the Energy Trust, the utilities it works with, and the participants in its programs. As a result of this relationship of trust and confidence, and the sensitive and confidential nature of information to which you may have access, Energy Trust requires that you read and sign this Individual Confidentiality and Nondisclosure Agreement.

I understand, acknowledge and agree that:

1. **Definition of Confidential Information**. Utilities provide Energy Trust with information about their energy customers pursuant to rules of the Oregon Public Utility Commission. Energy Trust and its contractors also acquire information directly from individuals and firms that participate in Energy Trust programs. Insofar as information from either source refers to utility customers or program participants by name, address, meter number, or other individually identifiable characteristics, it is "Confidential Information" and governed by the terms of this Individual Confidentiality and Nondisclosure Agreement. Confidential Information does not have to be in writing nor does it have to be labeled as "confidential" or "proprietary" or otherwise in order to be considered as Confidential Information.

2. **Obligation of Nondisclosure**. I will use all of Energy Trust's Confidential Information solely for the purpose of performing the services Energy Trust has retained me to perform. I will not disclose any Confidential Information, directly or indirectly, under any circumstances or by any means, to any person who does not meet the criteria described in the "Permitted Disclosure" paragraph, below.

3. **Permitted Disclosure.** Confidential Information may be disclosed only to (1) a party bound by a confidentiality and nondisclosure agreement with Energy Trust; (2) on a "need to know" basis; (3) who are authorized by Energy Trust's Legal Department. Persons satisfying these criteria are known as "authorized persons". If I disclose any Confidential Information to an authorized person, I understand, acknowledge and agree that it will be my sole responsibility to (1) clearly direct such person to treat such information as confidential in accordance with the person's confidentiality agreement with Energy Trust, (2) document the disclosure in a writing that identifies the information disclosed and the person to whom it was disclosed, and (3) provide such writing to Energy Trust's Legal Department.

4. **Protection and Nonuse.** I will exercise the highest degree of care in safeguarding and protecting the Confidential Information against loss, theft, or other inadvertent disclosure and will take all reasonable precautions to protect the confidentiality of Confidential Information. I will not copy, transmit, reproduce, summarize, quote or make any commercial or other use whatsoever of the Confidential Information, except as may be necessary to perform the services for Energy Trust.

5. **Retention of Records.** If I am an employee of Energy Trust, I will maintain the Confidential Information in a manner consistent with Energy Trust's document retention requirements. If I am an Energy Trust contractor or employee of an Energy Trust contractor, I will ensure that I

retain any Confidential Information obtained from or furnished by Energy Trust in such a manner that I can locate all Confidential Information provided to me and respond to Energy Trust's request to return or destroy all such information as required by the paragraph below.

6. **Return or Destroy the Confidential Information.** If I am an employee of Energy Trust, upon termination of my employment, I must locate and return to Energy Trust any and all documents, materials, or other information in any form that contain, reflect, or constitute any Confidential Information in accordance with Energy Trust's employment policies. If I am an Energy Trust contractor or employee of an Energy Trust contractor, I will return or destroy all Confidential Information obtained from or provided by Energy Trust promptly upon the termination of my work for Energy Trust, typically within 24-48 hours.

7. **Obligation of Confidentiality Survives Termination or Expiration.** My obligations of confidentiality shall survive termination or expiration of my employment or consultant relationship, or my employer's engagement as an independent contractor in connection with Energy Trust.

8. **Energy Trust Owns the Confidential Information.** I am not being granted a license or any other right to use any Confidential Information that may be disclosed to me except for the purpose of assisting Energy Trust. All Confidential Information disclosed or otherwise acquired by me and all work product, materials, and information arising out of, related to, or derived from Confidential Information including, but not limited to, studies, analyses, reports, documents, inventions, formulations, methodologies, processes, procedures, designs, and know-how, shall remain the property of Energy Trust.

9. **Remedies.** Disclosure of Confidential Information in violation of this Confidentiality and Nondisclosure Agreement will cause irreparable harm to Energy Trust. If I fail to abide by the Individual Confidentiality and Nondisclosure Agreement, Energy Trust will be entitled to specific performance, including immediate issuance of a temporary restraining order or a preliminary injunction enforcing this agreement, and to a judgment against me for damages caused by my breach, and to any other remedies provided by applicable law.

10. **Notice of Breach.** I shall notify Energy Trust within 24 hours of any suspected security breach of the Confidential Information, and will consult with Energy Trust regarding next steps.

I, the undersigned, have read this **Individual Confidentiality and Nondisclosure Agreement** and understand, acknowledge and agree to the terms and conditions herein effective as of the date set forth below.

Print Name: ______________________________

Signature: ______________________________

Name of Employer: ______________________________

Date: ______________________________

Phone Number: ______________________________

Email: ______________________________

Commercial O&M Measurement and Verification Guideline

For Energy Trust of Oregon's Commercial Strategic Energy Management (SEM) and Pay for Performance (PfP) offerings

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Introduction

Energy Trust of Oregon (Energy Trust) deploys programs that drive energy efficiency, resulting in reliable energy savings. To estimate energy savings, these programs utilize approaches that vary based on the type of energy efficiency measure, ranging from very simplified estimates, to system-focused measurements, up to facility-wide savings estimates. Two Energy Trust Commercial sector Operations and Maintenance (O&M) offerings, Strategic Energy Management (SEM) and Pay for Performance (PfP), address multiple energy efficiency measures across entire buildings or facilities using facility-wide savings estimates. This document is a guideline for those programs.

This Energy Trust “Commercial O&M Measurement and Verification Guideline” (Guideline) describes approaches that balance the reliability of energy savings estimates with the cost/effort required to estimate these savings. In addition, this document aims to provide clear guidance on steps to follow while also providing flexibility to the modeler, as appropriate.

This Energy Trust Guideline focuses primarily on top-down, statistical regression models at the meter level, as described by the International Performance Measurement and Verification Protocol (IPMVP) under their “Option C”. In addition, this Energy Trust guideline aligns to and/or refers to other guidelines, including the American Society for Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Guideline 14-2014 and those from several demand side management (DSM) programs.

The goals of this Guideline document are:

- To verify energy savings from energy management activities with a high degree of confidence and precision
- To balance cost-effectiveness with technical confidence when creating energy models
- To balance cost of creating energy models with energy savings
- To define consistently applied approaches that are open, clear and defensible
- To serve as a guideline for program implementers, program administrators and evaluators

Table of Contents

Part 1 – **Model Approach**

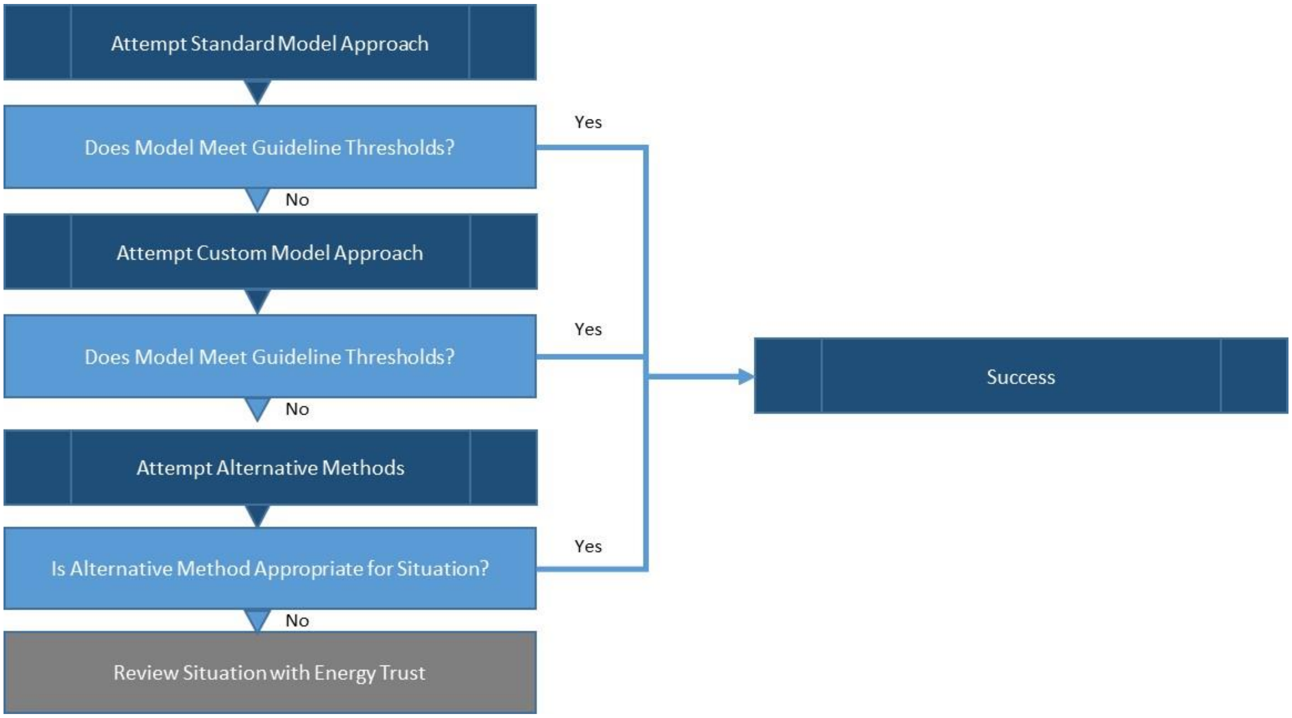
The Commercial O&M Measurement and Verification Guideline (“the Guideline”) adheres to the International Performance Measurement and Verification Protocol (IPMVP) Option C – Whole Building. It also refers to ASHRAE Guideline 14-2014.

The Guideline aims to guide modelers toward creating models that are both accurate and useful for the participants, program staff and evaluators. In the impact evaluation conducted in 2016 of Energy Trust’s 2012-2014 Commercial SEM offering, DNV GL described how modelers must consider the strength of a model and whether it can tell a concise, consistent, and compelling story, as follows:

- **Concise.** Concise models can explain the appropriate amount of variation in the dependent variable under conditions experienced most frequently. There can be a large amount of variation in factors outside of weather that drive energy consumption. The intent of the energy consumption model is to best explain energy consumption as a function of weather and other predictor variables.
- **Consistent.** Consistent models have coefficient values with logical relationships. For example, a model should typically yield higher estimates of energy consumption as weather conditions become extreme or building occupancy or activity levels increase.
- **Compelling.** Compelling models have a strong statistical fit. The probability that the coefficients are different than zero should generally be greater than 90%. Further, the overall model should account for a large amount of the observed variation in energy consumption. The adjusted R^2 statistic should note a very strong statistical fit. Models that have an adjusted R^2 less than 0.5 are not able to explain half the variation in energy consumption. [1]

The Guideline describes a series of approaches that balance flexibility with simplicity. These approaches begin with a straightforward and standardized approach for most facility models; this approach is described as the Standard Modeling Approach. If this approach does not meet this Guideline’s minimum thresholds, then the modeler is guided to apply a greater level of professional expertise to develop models; this approach is titled the Custom Modeling Approach. And for those situations where this approach does not meet the Guideline’s minimum thresholds, the modeler is guided to apply Alternative Methods, techniques to enable savings estimation without the level of data quality, sufficiency and other attributes necessary in the prior approaches. These steps are outlined in the following diagram:

[1] Please refer to the Energy Trust of Oregon “Impact Evaluation of Commercial Strategic Energy Management” Report



Additional detail on the approaches can be found in Part 3. The Standard and Custom modeling approaches are diagrammed in Part 6.3.

At a high level, the Standard Modeling Approach utilizes a model form that does not vary from one facility to the next. This model appears as follows:

$$Y = b_1 + b_2X_1 + b_3X_2 + b_4X_3$$

X_1, X_2 and X_3 represent cooling degree days (CDD), heating degree days (HDD), and an occupancy variable. b_2, b_3 and b_4 represent the coefficients for these independent variables. b_1 represents the portion of the model unexplained by the model. If appropriate, the modeler may use fewer variables than these, but they may use no more than these. The modeler should use no other variables in place of CDD, HDD and an occupancy variable; e.g. the modeler cannot use outside air temperature in place of CDD, HDD, or the occupancy variable.

Part 2 – **Statistical Criteria for Model Fitness**

Model fitness is determined using a set of statistical metrics as indicated in IPMVP and ASHRAE Guideline 14-2014. This Guideline will align with the aforementioned, and consider the suggested ranges summarized below (R^2 [2], adjusted R^2 [3], Coefficient of Variation (CV)/Root Mean Squared Estimate (RMSE) [4], and individual variable P-values [5] and individual T-Statistics [6]. Individual models may not meet all of these criteria; in those cases, the modeler should document the result of statistical tests for these criteria and describe whether any of these missed criteria are significant or not and why.

Statistic	Suggested Threshold Value
Number of Observations	>= 24 for monthly data for sub-monthly data, observations should be sufficient to address seasonality
R^2	> 0.75
Adjusted R^2	> 0.75
Standard Error	NA
CV(RMSE)	< 0.2
F-Statistic	NA
P-Value	< 0.1
T-Statistic	>2.0

[2] R^2 is the coefficient of determination or the proportion of variability in a data set that is accounted for by a statistical model. In this definition, the term "variability" is defined as the sum of squares.

[3] Adjusted R^2: is a modification of R^2 that adjusts for the number of terms in a model. R^2 always increases when a new term is added to a model, but adjusted R^2 increases only if the new term improves the model more than would be expected by chance

[4] CV(RMSE): An indicator of the precision of a model. When the RMSE is normalized by the mean measured value, it is usually called coefficient of variation of the RMSE, CV(RMSE). It is analogous to the coefficient of variation with the RMSE taking the place of the standard deviation.

[5] P-Value: a measurement of how extreme the value of a given variable is.

[6] T-Statistic: a measurement of the likelihood that the actual value of a given variable’s coefficient will not be zero.

Part 3 – **Statistical Regression Model Methodology**

This section provides an overview of the modeling methodology. Specific step-by-step procedures for model creation can be found in Part 7.

Statistical regression models are used to determine the relationship between dependent variables and one or more independent variables. In the case of this Guideline, the modeler is trying to predict how energy consumption is related to one or more independent variables such as weather, occupancy, or other drivers.

3.1 – Dependent Variables

The dependent variable is the measurement of electricity or natural gas that the model is trying to predict.

The specific units of the dependent variables will vary depending on the data source, data interval, metering equipment, etc. Some examples of units include: kilowatt hours (kWh), kWh/day, kWh/month, therms, therms/day, British Thermal Units (BTU), BTU/hour, million BTU (MMBTU), MMBTU/day, cubic feet (ft^3).

3.2 – Independent Variables

The independent variables are the known data that the model uses to predict the dependent variable. The independent variables are typically placed on the right side of the equation with the regression coefficients. As the independent variables are used to predict the expected dependent variable (energy consumption), the independent variables are key to the success or failure of the model.

When deciding what independent variables to include in the model, one's approach should be guided by the real-world operation of the building being modelled. Prior to modeling, the modeler should have a discussion with the participant and/or conduct a walkthrough of the building to identify the main energy driving variables. The following table includes some examples of potential independent variables.

Variable Types	Specific Independent Variables
Weather Variables	Heating Degree Days (HDD), Cooling Degree Days (CDD), Outside Air Temperature (OAT), Outside Air Humidity, Solar Irradiance
Occupancy Variables	Workdays, Headcount, Total Hours Worked, Customers Served, Operating Schedule

Independent variables should be tested statistically and only those independent variables which significantly drive energy-use should be included in the energy model. A simple way to evaluate a potential independent variable is to ask:

> *"If this variable increased or decreased, would I expect energy usage to increase or decrease*?"

Typically, one to three independent variables provide an acceptable model for monthly data. For models with sub-monthly data, the modeler may consider adding additional variables such as days of the week or weekend operations.

Sometimes an independent variable only appears to influence energy use above or below a certain threshold. For example, when the temperature is above 65°F, temperature may likely not influence natural gas use. Similarly, natural ventilation may be sufficient for an office only when less than 10 employees are present; while above 10 employees air conditioning must be run. Both of these scenarios include a threshold variable (65°F, 10 employees) to be included with the independent variable (outside air temperature, number of employees).

In certain situations, a relationship may exist between an independent variable and a dependent variable wherein the value is zero when the result is below a threshold and unchanged or linear when it is above the threshold. This function is referred to as a step function. The variable is often referred to as an indicator or change-point variable.

Heating degree days (HDD) and cooling degree days (CDD) are metrics designed to capture the amount of heating or cooling required for a building. HDD and CDD sum the degrees that the average daily temperature for a given time period is above or below a base temperature. The following equations use the step function to define HDD and CDD, where T_{CP} is the change-point or base temperature.

$$HDD(T_{CP}) = \sum_{i=1}^{n} (T_{CP} - OAT_i)^+$$

$$CDD(T_{CP}) = \sum_{i=1}^{n} (OAT_i - T_{CP})^+$$

The previous examples can be represented by the following step functions: $(65 – OAT)^+$ and $(employees – 10)^+$.

Outside Air Temperature (OAT) versus Degree Days (DD)
When working at the daily to monthly level, modelers typically use heating degree days (HDD) and cooling degree days (CDD) in order to represent the amount of cooling and/or heating load of a building, illustrating the accumulation of heating/cooling loads across a period using a single number. Degree days show this load in a way not clearly visible with Outside Air Temperature (OAT). For example, if half of the days in a month were 45 degrees and the other half were 55, then this would appear as the same average OAT as a month in which every day was 50 degrees. HDD and CDD capture the actual load, and can be used together to indicate days in which a building both heats and cools. The HDD base temperature is the temperature below which energy increases as the temperature decreases and above which the temperature has no influence on energy. The CDD base temperature is the temperature above which energy increases as the temperature increases and below which the temperature has no influence on energy. The change-point or base temperature with which HDD and CDD are calculated can be the same or different, and can be thought of as an additional variable to optimize in

the model creation process. HDD and CDD coefficients represent the portion of the building's energy which is used to heat and cool the building, respectively.

All Standard models should use HDD and/or CDD. Modelers may consider OAT for Custom models.

3.3 – Model Types

The most recommended and common model type is the linear regression. It is flexible enough to successfully model most buildings, given the proper independent variable selection, yet simple enough to intuitively understand the underlying relationships. It may make sense to select an additional variable, such as an indicator variable designating a step function.

The following equation defines a generic linear regression equation with two independent variables.

$$Y = b_1 + b_2X_1 + b_3X_2$$

Here Y is the dependent variable, X_1 and X_2 are the independent variables, and b_2, and b_3 are the coefficients of the independent variables. b_1 is the value that is unexplained by the independent variables. This number is not the same as "base load", as it could include some variable elements that cannot be directly expressed by the model as well as consistent energy loads or drivers. The model is referred to as linear, but the independent variables may exhibit non-linear relationships, such as when a cooling or heating load changes exponentially with temperature. Regression software should be used to determine the coefficients given a dataset of the dependent and independent variables. Standard Least Squares regression should be used to determine the coefficients which minimizes the error between the dataset of known dependent variables, Y, and the dataset of predicted dependent variables, $\hat{Y}$.

Techniques for Custom Models
Custom models can be used when the modeler questions the Standard Model's predictive reliability. More information on this decision can be found in Part 6 of this Guideline. For Custom models, the modeler may consider non-linear terms for independent variables. This can appear in the form of higher-order polynomial terms and/or terms with multiple independent variables multiplied together. Non-linear models should only be used when the physical system (e.g. HVAC) shows a non-linear relationship (e.g. cooling load power use vs. outside air temperature [OAT]). The OAT^2 term is sometimes beneficial in representing the cooling energy use of chillers and cooling towers as their energy use is non-linear with respect to OAT. Non-linear variables have been shown to over-fit the data, lose the intuitive nature of the model, and do a poor job predicting future energy use, so the modeler should use these approaches carefully.

The modeler should use statistical modeling software. Many different types of statistical modeling software are available. The underlying statistics for all modeling, regression, and statistical software is consistent. Different software packages may offer differing degrees of flexibility, speed, computational power, data visualization, troubleshooting, and automation. Commonly used modeling software include R, SASS/JMP, STATA and RETScreen.

Part 4 – **M&V Boundaries – applicable to SEM only**

SEM efforts typically address numerous changes by multiple employees across multiple facilities. The basic approach is to think of the entire facility rather than individual systems. However, within a facility many energy using systems may be outside or inside the facility. With that, the modeler should work with the participant to designate what is included in the scope of the engagement alongside of what is physically within the facility; the area of what is included in the analysis is within the M&V boundary. To develop a reliably predictive model within this boundary, the modeler should understand several facility attributes, including what the facility's systems are, the system's energy drivers, and other relevant factors.

The boundary can be more complicated in several situations, including:

- Energy projects may be conducted on systems within a whole facility boundary where a system level baseline is appropriate. For example, to measure the efficiency improvements on an HVAC system, an organization may use isolation approaches with data loggers on that system alone. As those measured values are often seen as more precise than a facility-wide approach, the modeler may consider subtracting these savings from their baseline model, and later from the resulting energy results during the reporting period.
- Energy using systems consume their energy within one boundary that is being targeted, but the utility of the system is used across the boundary in a different area. For example, a customer is participating in SEM, and they specifically focus on Building 1. A boiler may be in Building 1, which is the building that is being modeled, but it may provide steam to Building 2, which is not only not in the SEM program, but they may also vary their steam consumption based on their own needs. The modeler would ideally account for this energy consumption affected by factors outside of the boundary. They may consider modeling both Building 1 and Building 2 together within a single model; the modeler should balance this approach with the loss of resolution that may result from that combination. The modeler should understand whether interaction occurs, that is, if there is no sharing of activity between systems, the modeler should avoid combining building models.
- Multiple organizations or discrete occupants are located within a boundary, with subset groups participating in SEM efforts. In this case the modeler may seek a solution to subtract the non-participant consumption data from the baseline modeling process and subsequent measurement.

Part 5 – **Baseline Dataset**

5.1 – Baseline Period

The baseline period should capture the relationship between independent variables and energy usage under standard operating procedures before implementing SEM or PfP. IPMVP requires baseline data to be representative of the range of operations of the building – e.g., including both hot and cold temperatures.

5.1.1 Baseline requirements for Pay for Performance only

- At least 12 monthly data points immediately before installation of measures
- If more than 24 months of data are available, the modeler should add additional data in 12 month increments to ensure that no time period is overrepresented.

5.1.2 Baseline requirements for SEM only

The baseline period should capture and include the following:

- Timeframe as close to the start of the engagement as possible
- Two or more cycles of operation; for example: two or more school years, busy shopping seasons, summer seasons of warm weather, etc.
- At least 24 monthly data points immediately before participation
    - If a baseline period is selected other than immediately before participation, the reasons should be thoroughly documented
    - If more than 24 months of data are available, the modeler should add additional data in 12 month increments to ensure that no time period is overrepresented.
    - If less than 24 months of data are available, then the modeler should use 12 months of data.
    - If sub-monthly data is used, the modeler should have enough data points to capture seasonality.

If the modeler deems it appropriate to vary from the above guidelines, then they must thoroughly document their rationale.

If a regression using the 12 months prior to participation yields inferior results to those for an alternate baseline period, both sets of results should be presented; e.g., the 12 months prior to participation could not be made to yield better than an R^2 of 0.65, while an alternate baseline ending 6 months earlier yielded a regression with an R^2 of 0.9. Simply stating that the alternate baseline provides a "better" fit is not sufficient. If the 12 months immediately before participation are not representative of typical operations or if there are major data gaps during those 12 months, then the modeler should document the reasons why they made the change as well as why they selected the chosen baseline time period.

Deviation from the consistent operation can indicate changes to variables not included in the analysis that need to be added, in order to increase accuracy; e.g., A building at 50% occupancy may have very predictable energy usage based on HDD and CDD only. However, if the occupancy level increases or decreases, the energy consumption predicted by the original analysis will no longer be correct. The modeler should only add variables when there are sufficient data points in the baseline period; as a rule of thumb, there should be six baseline data points for every independent variable. E.g. with 24 months of monthly data, the modeler should only use up to four independent variables. The adjusted R^2 as well as the T-statistics for the individual variables should be reviewed to account for overfitting. In an overfitting situation, the adjusted R^2 value may begin to go down. The modeler should monitor the model's performance over time for increased deviation.

5.2 – Data Intervals

Short interval data can illustrate the effects of O&M activities faster and more reliably than the use of just monthly data. Greater numbers of data points can enable the modeler to increase the number of unique variables used in the model which can improve the model's predictive power.

Meter data can often be captured in 15 minute intervals and summed into daily kilowatt-hours but if daily data is not available, weekly or monthly model intervals can be used.

It should be noted that using short interval data can increase the time taken for model analysis and thus increase the work required to collect the data which in the case of SEM could result in participants less likely to consistently update the model variables. In addition, non-weather related variables may not be available on such a granular level resulting in the need for estimation. This again, would add uncertainty to the analysis.

Interval data should not be used for the model unless the participant/modeler:

- Has access to the relevant data
- Is willing to update the model on a regular basis
- Understands the analysis thoroughly

5.3 – Accounting for Energy Projects during Baseline Period

To create a model that accurately reflects energy use, the modeler should work with Energy Trust Existing Buildings PMC to collect reports with incentivized energy projects that occurred during the baseline period. If there are projects, the modeler should capture relevant data for the energy project including verified energy savings and the M&V start date and duration of the project implementation.

For their analysis, the modeler should use the project's reported M&V start date. If the modeler observes an inflection in the energy data or a change in the rate of energy savings occurring on a different date, then they may use an alternate date. The modeler should document their decision and the reason behind the decision.

To account for energy projects during the baseline period, the modeler should use one of the following techniques:

- Baseline period shift – the modeler would shift the baseline period to end before the energy project's M&V start date. The modeler would then subtract the energy project's annual energy savings from the reporting period's annual savings. If this technique requires shifting by more than a month or two, the customer's energy savings may be unduly penalized. Thus, the modeler should then consider other options.

- Reporting period data modification – the modeler would use a baseline period up to the start of the reporting period including the energy project, and then would subtract the energy project savings from the SEM savings during the reporting period. This technique would only work when the energy project was one-two years before the baseline period.
- Pre-energy project baseline normalization – the modeler would subtract the energy project savings from the baseline period data. For HVAC or natural gas projects whose savings will be greater in the summer, the modeler should consider interactive effects. This may require more or less effort depending on the magnitude and type of the energy project.
- Baseline normalization by indicator variable – the modeler applies an indicator variable to the baseline data set representing the energy project implementation. This is the preferred technique if the modeler does not know the M&V savings of the energy project. This technique can be used for incentivized and non-incentivized energy projects. When using an indicator variable in this way, the modeler should account for the project's seasonality, and potentially adjust how they select or use the indicator variable. For example, with a chiller retrofit, the indicator variable may need to be cooling degree days (CDD).

5.4 – Data Collection

It is important to collect energy and energy driver data very early on in the engagement to account for models that require greater development time. The following section will help modelers understand the data collection process. Energy data should be obtained from Energy Trust, the participant, and it is the responsibility of the modeler to capture weather station data[7].

5.5 – Quantitative Data Collection

The following table lists the quantitative data requirements and the frequency of collection required by the modeler. Modelers will review participant data to determine if any additional data or refinements are necessary.

Data Description	Optional/Optimal Frequency	Minimum Frequency
Energy consumption data (kWh, therms, and actual read-dates)	Daily/monthly (based on availability)	Monthly
Actual weather data (HDD & CDD)	Hourly/daily	Monthly
Occupancy (headcount, hospital beds, etc.)	Daily/monthly	Monthly

[7] Acceptable sources of weather data include local airport weather stations and the National Climate Data Center (NCDC) database. A change in the weather data source during the reporting period should trigger an update to the original model.

Data collected from building control systems, which are often on an hourly or more granular basis, should be analyzed very closely for inaccurate data values and inconsistent operations.

5.6 – Treatment of gaps and outliers

When analyzing the baseline data set, it is important to track any changes made, such as the treatment of gaps in the data and removal of outliers.

The modeler should review the data set for erroneous data, looking for gaps. Then the modeler should review the data for outliers, as follows:

- Scatterplot Review – plot each independent variable in a scatterplot with energy, to visibly identify and flag outliers for review
- Standard Deviation Review – determine values for upper and lower standard deviations from residuals, and then identify and flag outliers for review. The threshold for outliers would be 3 standard deviations.

Observations that appear to be anomalies should be reviewed with the participant to better understand the operation of the system.

Any data point within the observation that is inaccurate or inconsistent should be handled as follows:

- For daily data, the data should be removed from the analysis and documentation should be provided that supports the removal. When a data point is removed, the related energy data for that period and independent variable for that same period should be removed, closing the gap for that removed data so that data is still aligned by period and outliers are not replaced by zero values but instead are removed entirely. To preserve model integrity, the modeler should not fill gaps or replace outliers with estimated values.
- For monthly data, removal of data points can significantly impact model development. The modeler should consider adjusting data points to account for inaccuracy. For example, if some energy meter data is obviously too high in one month and then too low the next, the modeler may consider averaging the two months and replacing these two data points with that average.

For any such adjustment, the modeler should document the change and rationale.

Data periods should be aligned between independent variables and energy. The modeler should review the source of these data sets and understand the nature of data collection as well as how this data is aggregated. If the modeler is not confident in the data source and/or in how aggregation is potentially applied to align data periods, then they should recommend to not use a given independent variable.

To check for gaps and outliers in the baseline data set, the modeler should plot each variable independently in a time series format. If any are identified they should be investigated and corrected by the participant. It is possible that the participant may need to contact the utility to address missing or incorrect data; if that is the case, the modeler should first engage Energy Trust to potentially leverage utility relationships and to monitor repetitive data challenges.

The modeler should work to understand events that would only happen once, where an indicator variable would not be a useful ongoing solution. Also, when there are only 12 months of data, the modeler should not remove any data points from the analysis.

5.7 – Model variables

The modeler should utilize the fewest number of variables necessary to support an accurate model with solid predictive capabilities. Models with fewer variables are less likely to suffer from data errors and/or outliers during the reporting period and will be easier for the participant to maintain in the long run. The most commonly used variables are:

- HDD
- CDD
- Occupancy

These above variables are those used in models following the Standard approach.

Variables should be clearly defined so that the relationship between the independent (weather and other) variables and energy usage is clear to the participant and can be used to calculate energy savings in the future. The variables should be readily available to individual customers and their sources (e.g. National Climate Data Center (NCDC) database) should be identified in the model documentation provided to customers and Energy Trust.

Part 6 – **Model Creation**

This section provides best practices and specific step-by-step procedures for model creation.

6.1 – Model Creation Best Practices

The two basic components of the model creation process, data and models, are discussed further in the following section.

6.1.A – Data

As discussed in previous sections, the dataset used to create the energy model is the key to a successful model. Care should be taken when aggregating data from multiple meters or sources. When data are of different intervals or are reported on different days, the data will need to be aligned into a common interval. Although some data resolution is lost, the most accurate method is to aggregate up to the large interval dataset. Thus, if electricity is metered with a monthly interval, while occupancy and HDD are both daily, these two independent variables should be summed up to the same monthly interval as the electricity data.

If multiple meters or datasets share the same interval, but not the same start and end dates, when following the Custom Modeling Approach, the modeler must align the data set into common start and end dates. It is important to note that the modeler must exercise care when shifting data and should be mindful of the amount of data that is being consistently realigned on a period basis. Data should not be shifted when following the Standard Modeling Approach.

Applicable to SEM only:

When possible, the modeler should avoid shifting data from the energy bills; rather, they should shift other data (e.g. weather, occupancy) to match the start/end dates from the energy bills. This will lessen customer confusion and help customers more easily enter energy bill data into the performance tracking tool on an ongoing basis.

Sometimes the energy utility is able to change their meter read dates if requested. The modeler may recommend that the customer request this realignment of read dates. If this cannot happen, then a set of common start and end dates must be chosen and the data must be shifted accordingly.

> Example 1: a facility has electricity data that is read on the 5th of each month. To preserve the utility bill information in its original format, the modeler determines the heating and cooling degree days for these shifted months rather than true calendar months.
>
> Example 2: a building has multiple meters, so the modeler uses the dates of the largest meter to offset the least amount of data, minimizing the shifting of data. This should only done for multiple meters of one building at the same location and the modeler should evaluate the value of realigned data with the potential issues of maintaining/updating this data over time.

Applicable to SEM and PfP:

The quality of all datasets should be assessed prior to their inclusion in the model creation process. The datasets must be complete for the entire baseline period. Furthermore, the data should be readily available for the foreseeable future, for use in the savings analysis. A review of the data quality should ensure the correct units, dates, and times for all datasets. When the modeler is troubleshooting potential outliers or questionable models, they may cross verify datasets against similar datasets or historical data. For example, the natural gas meter data could be verified against the hot water output of the water heater, last year's annual gas usage, and the typical gas usage for a similar building size and type in the same geographic region.

Finally, all datasets should be screened for outliers, time-series offsets, and any readily apparent seasonality, as follows:

- Time Series Plots of Energy and Independent Variables – to visibly identify time series offsets or readily apparent seasonality as well as outliers
- Scatterplots of Variables – plot each independent variable with energy, to visibly identify and flag outliers for review; data points that are more than 3 standard deviations from the residual values should be considered outliers

6.1.B – Models

Models should strive to be as standardized as possible, while explaining the key underlying relationships driving energy use. Model creation can be an iterative process of adding and removing variables, adjusting the timeframe of the baseline period, and adjusting the model form. While these iterations can reveal unique variables or relationships, a pragmatic approach should be taken to limit the number of iterations and resources spent to create the model.

The preferred model type is a standard linear regression model of the following form.

$$Y = b_1 + b_2X_1 + b_3X_2 + b_4X_3$$

As discussed in previous sections, care should be taken when determining the independent variables, and limit the complexity of the model so that it remains intuitive.

The following sections describe the Standard and Custom model creation process in more detail. The first attempt at model creation should always use the Standard approach. Only when the Standard approach fails, should the Custom model approach be used. Large/complex buildings or campuses will likely require a Custom Model approach, but the Standard Model approach should still be checked first.

6.2 – Standard Model Creation

The model methodology, described previously, should be used throughout the Standard model creation process. First the energy data should be collected, processed, and validated as described in the 'Baseline Dataset' section of this guideline. Then the significant independent variables should be determined using regression analysis. As described in the 'Model Methodology' section, the selection of independent variables should be guided by the real-world operation of the building and the factors that influence its energy use. Thorough discussions with participants or walkthroughs of the building are commonly used to identify the main energy driving independent variables. In addition, the analysis can often lead to insights for the participants about the true nature of their facility operation.

For the Standard model, the possible energy driving variables are limited to the following: HDD, CDD, and a single site-specific occupancy metric. The modeler may not use variables beyond these for the Standard model. In addition, HDD and/or CDD are the only weather related variables that can be used in the Standard model. Once the energy drivers have been determined for the building, the energy driver (independent variables) dataset should be collected, processed, and validated in the same manner as the energy dataset.

The combination of the energy and independent variable datasets makes up the baseline dataset. This dataset can be analyzed prior to the regression modelling to attempt to better understand the relationships between the dependent and independent data, often shown with X-Y scatter plots, and seasonality, often shown with time series. Once the modeler is confident that the baseline dataset captures all of the energy drivers, the baseline model form is established. For the Standard model, the model form will be limited to the following generic equation.

$$Y = b_1 + b_2X_1 + b_3X_2 + b_4X_3$$

Here Y is the dependent variable (energy use); X_1, X_2, and X_3 are three possible independent variables (energy drivers); and b_2, b_3, and b_4 are the linear regression coefficients. b_1 is the value that is unexplained by the independent variables. The Standard model is limited to a maximum of three independent variables, and the model must be linear. This is the maximum complexity of the Standard model; many Standard models may only include one or two independent variables. Once the model form is established, the linear regression is run on the baseline dataset and the outputs are analyzed.

The regression output statistics must meet the requirements set in the 'Model Approach' section of the guideline. If the statistical thresholds are met, then the residuals of the model should be analyzed in a manner typical of general model creation. The residuals should be randomly distributed throughout time and with respect to each variable. If the residuals show a pattern, this information should be used to inform the next iteration of the baseline model. If the residuals are randomly distributed, then the regression generated coefficients and model form should be evaluated on an intuitive level. For example, if the model coefficient for CDD is negative, the model is dictating that as the CDDs increases, the energy use decreases, which may not make intuitive sense for a commercial building.

The modeler will follow the flow diagram outlined in section 6.4, which includes three tests:

1. Do the Regression Output Statistics Meet Requirements?
2. Are the Residuals Randomly Distributed? (e.g. visibly being random and not showing extreme trends in a given direction; also could be determined by testing to see if residuals fit a normal distribution, or if they do not exhibit homoscedasticity),
3. Do the Coefficients and Model make Intuitive Sense?

If the regression outputs pass all three of the tests, then the model can be considered a success, and the model creation process ends. If any of these tests fail, then a new iteration of the model should be created, informed by the outputs of the current model.

The Standard model creation process should be iterated several times before attempting the Custom model creation process. The Standard model can be improved by revisiting the energy driving variables that were originally determined to be significant drivers of energy use. The CDD and HDD base temperature can be modified, which will modify the baseline dataset, which will then produce different model coefficients. The model form can include variables that were previously excluded, or exclude variables that were previously included. Finally, the residuals of the previous regression model often provide valuable information which can be incorporated into subsequent baseline models, e.g. the modeler may look for extended periods of residuals above or below zero. The modeler can also use CUSUM charts to watch for trends; the charts can also demonstrate the range of demonstrable savings possible from a model.

The modeler may try combinations of CDD, HDD and occupancy, resulting in a few potential iterations. Once the Standard model creation process has been attempted without success, or if the Standard model creation process appears to point to a more complex model for the baseline dataset, the modeler should notify their Energy Trust program manager via email. After this notification, the modeler may initiate the Custom model creation process.

A final reason to move from the Standard model approach to the Custom model approach would be if there is sufficient data to justify additional independent variables in the model. The modeler should notify their Energy Trust program manager via email about this intended direction and gain their approval.

6.3 – Complex Model Creation

As indicated above, the Custom model creation process should only be used after several failures with a Standard model form. Custom models often are difficult to conceptually understand, may include complex equations or data processing, and run the risk of overfitting the model to the data, thus reducing the predictive qualities of the model.

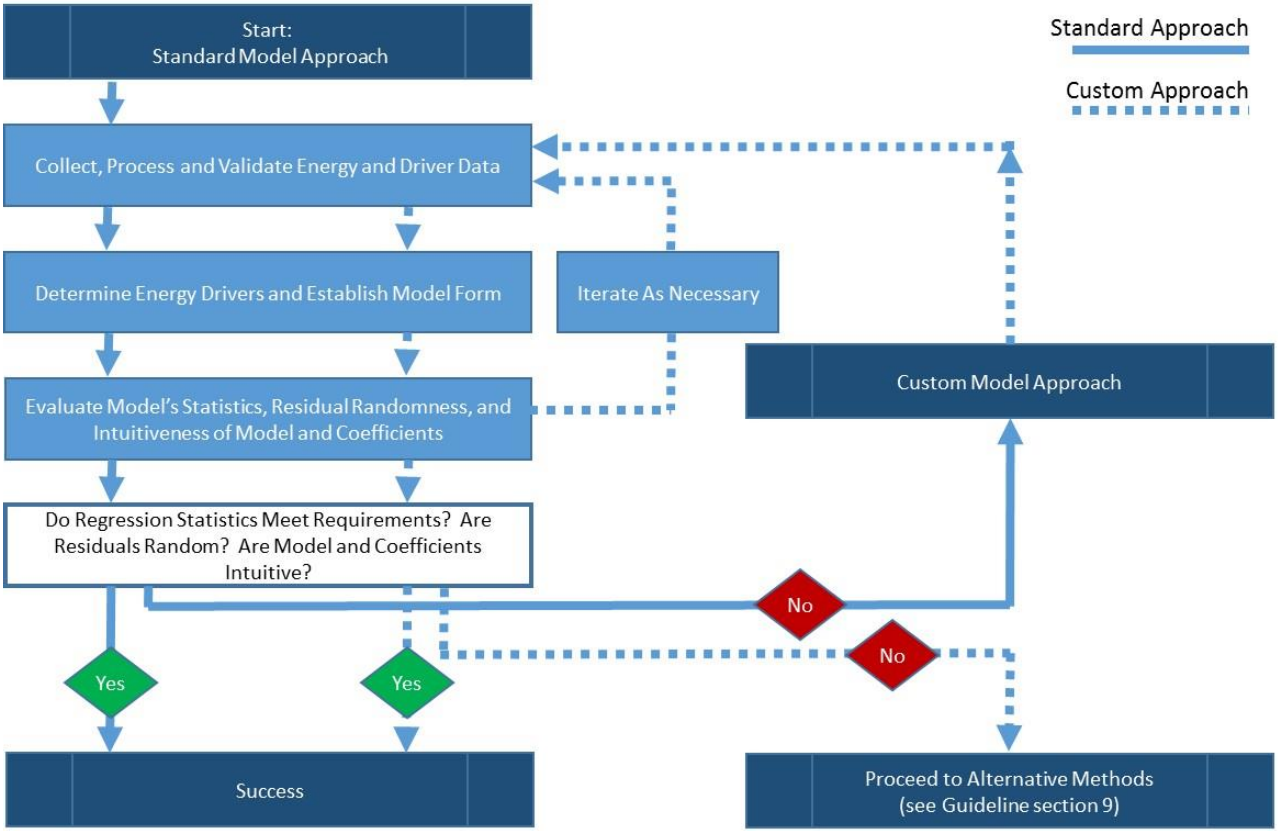
Custom models still face the same limits on the number of independent variables as those seen in Standard models; for 24 periods of data points, the modeler can use up to 4 independent variables.

The Custom model creation process is similar to the Standard model creation process in that it is iterative and should be informed by past failed models. The first step is to determine the Custom model form. In addition to elements from Standard Models, the Custom Model may include polynomial terms, indicator variables, or other non-linear terms in addition to any of the Standard model terms. Again, the model form should be informed by the building's systems and actual operations as much as possible, such that the model reflects the building energy drivers. Once the model form is determined, if any additional data are required, they should be collected, processed, and validated. The model form should be validated and the regression should be run on the Custom model baseline dataset.

After the regression is run on the baseline dataset, a similar validation process should be completed on the regression outputs. The statistics should meet the Guideline requirements, the residuals should not show a pattern, and the coefficients and model should be somewhat intuitive for the Custom model. If the Custom model passes these tests, then the Custom model creation is successful and the model creation process is complete. If any of the tests fail, the Custom model creation process should be iterated several times, varying and verifying the baseline dataset and the model form. Within the Custom model creation process, the modeler should exhaust all reasonable options based on the size of the building and the magnitude of potential savings. At that point, the modeler should review the situation with Energy Trust, and potentially stop the model creation process, document the best-fit model, consider alternative M&V methods described in Part 9, or wait for a period to acquire additional customer data.

6.4 – Model Creation Flow Diagram

The following flow chart shows the Standard and Custom model creation process described in the previous sections.



Part 7 – **Validating the Model**

To ensure that the model is an ongoing reliable tool to predict energy savings, the customer as well as the modeler should regularly review the source data as well as the building's operating characteristics.

The modeler should review energy data (electricity and gas) to monitor for anomalies such as gaps and outliers. This can prompt more qualitative reviews of the building's operations. The modeler may consider removing intervals of energy and independent variable data where independent variable data is +/- 10% of the average baseline period levels.

The modeler should also query the participant regarding building changes during the reporting period that are substantively different than during the baseline period. Such changes may include changes to independent variables as well as static factors. The modeler should document the rationale behind removal of data intervals, including a supporting explanation based on the participant's insights. If appropriate, the modeler may consider revising the baseline model (Part 8-applicable to SEM only).

Part 8 – **Revisions to the Baseline Model – applicable to SEM only**

Revisions to the baseline model may be necessary due to changes in building operation or equipment that could invalidate the baseline model.

The model is considered valid for the range of the independent variables observed during the baseline period, provided the general operation and qualitative factors of the facility or system remain constant. Scenarios that would trigger a reassessment of the baseline model include:

- A sustained increase or decrease in the observed level of an independent variable, outside the range for which the baseline model was established.
- A change in business operations (e.g., change in tenants).
- Other changes in static factors, such as facility size, occupancy, or equipment design.

8.1 – Options for Non-Routine Adjustments to the Baseline

For non-routine baseline adjustments, pursue the following, in order of preference:

1. **If the change involves new equipment or facility space, subtract the new load.** The modeler would estimate electrical or gas load from dedicated sub-meter or engineering calculations, and then subtract this from the gross savings. Alternatively, the modeler may add the savings to the prediction on a monthly basis. This basic technique would also apply for sites which have deployed onsite generation such as an onsite PV array; in this case, the modeler can add the PV load into the sites usage.
2. **If the energy drivers have remained the same, but have significantly increased or decreased relative to the baseline period, the modeler should review the model's performance.** If the model appears unreliable based on the modeling guidelines, the modeler may need to consider alternative M&V approaches, including backcasting and intervention step approaches.
3. **Utilize the existing baseline model, with the addition of an "indicator variable" placed in the dataset at the time of the change.** The impact of the change is thereby quantified by solving for the indicator variable coefficient using regression, following a suitable data collection time period. The modeler may consider non-binary variables If the change was gradual or in other cases where too simplistic of a variable would be inappropriate.

When it is determined that a baseline adjustment is necessary, the modeler must provide consistent and clear documentation substantiating the reason baseline adjustments were made and provide all relevant data.

Part 9 – **Energy Savings Calculations**

This section describes the methodology to calculate and validate energy savings using traditional and alternative approaches.

9.1 – Adjustments

The modeler should work with the PMC and the participant to obtain a report detailing Energy Trust incentivized energy projects (not including PfP identified measures) that occurred during the reporting period. The modeler should capture relevant project data including reported energy savings and the project's completion or installed date. Any Energy Trust incentivized energy project savings installed at the site during the enrollment period should be pro-rated from the project's installation date to the end of the reporting period, and then subtracted from the top-down savings estimate obtained from the regression model. The modeler should confirm with PMC that the reported energy savings includes an evaluation factor as to not underestimate the SEM or PfP savings. The energy savings calculation with adjustments is demonstrated in the following equation:

$$Energy\ Savings = (Predicted\ Use\ from\ Baseline\ Model - Actual\ Energy\ Use) + \\ \mp\ Adjustments$$

Applicable for SEM ONLY:

Occasionally, adjustments to the baseline model or claimed energy savings will be required. Part 8 describes conditions which would warrant changes to the baseline model. The claimed energy savings may require adjustments if energy-impacting projects occur during the reporting period.

If the energy project's savings are greater than the top-down savings estimate obtained from the regression model, then the modeler should work with the Energy Trust Program Manager to determine whether to adjust the energy project's savings claim or to find another solution. Typically, the modeler should not report negative savings from the model's performance.

9.2 – Savings Claim Process

This section will define the energy savings claim process for sites participating in SEM and PfP programs and describe the change in process from the predicted and annualized savings method to the current measured savings claim process. The following should be used:

> ***Avoided energy use (Energy Savings) = Measured reduction in energy use during the engagement (starting with the program initiation date and ending 12 months following)***

9.3 – Calculating Savings using Standard Models and the Forecasting Approach

The recommended approach to calculating energy savings is with the forecasting approach. The forecasting approach uses the baseline model form and coefficients to calculate the predicted energy use, Ŷ, during the reporting period given the independent variables during the reporting period. As the model form and coefficient remain the same during the savings period as the baseline period, the predicted energy use equals the energy use of the building had no intervention occurred. The energy savings is the difference between the predicted energy use, Ŷ, and the actual energy use, Y, during the reporting period. The following equation defines the energy savings using the forecasting approach, where n is the number of reporting period data points.

$$Energy\ Savings = \sum_{i=1}^{n} (\hat{Y}_i - Y_i) \pm adjustments$$

9.4 – Calculating Savings using Alternative Models or Approaches- **Applicable for SEM only**

As described in Part 7 'Validating the Baseline Model' section, there may be cases where the baseline model cannot be validated using the standard approach, and an alternative approach is required. The following sections briefly describe the methods of calculating energy savings for these alternative approaches; however, these descriptions are not exhaustive, as these are not the primary energy savings calculation approach. The following approaches must justified by the modeler in a written request to Energy Trust before moving forward.

9.4.A – Intervention Step Model

The intervention step model is appropriate in situations where a solid model was created, but halfway through the reporting period a major event occurred which result in unclear savings. The modeler must know exact dates of actions for their sites energy actions. The intervention step model involves creating a new regression model spanning both the baseline and reporting periods. An indicator variable is added to the energy model to differentiate between the baseline and reporting periods. The regression calculated coefficient of this indicator variable can be used to calculate the energy savings, as the coefficient represents the normalized change in energy use between the baseline and reporting periods for each data interval.

9.4.B – Mean Model

The mean model often works well when a reliable regression model cannot be created due to lack of variation in independent variables. The mean model is useful when there is relatively low heating/cooling. The mean model uses the same energy savings calculation methodology as the forecasting approach, except with a much simplified energy model. As the mean model does not include any independent variables, the predicted energy use during the reporting period will be equal to the measured energy use during the baseline period. Thus, the energy savings is the difference between the measured energy use during the baseline period and the measured energy use during the reporting period.

9.4.C – Bin Model

For participants that already have EnergyExpert, the bin model can be a viable path forward. The bin model uses the same energy savings calculation methodology as the forecasting approach, except with the added complexity of multiple bins. Just as the forecasting approach applies the baseline model to the reporting period, so too does the bin model apply the baseline model's multiple KPIs to the corresponding independent variable in the reporting period. The energy savings is the difference between the predicted energy use during the reporting period and the actual energy use during the reporting period.

9.4.D – Backcasting Approach

For the backcasting approach, the modeler must be able to develop a post-baseline model that meets all of the guideline's variable requirements, and they must be able to track interventions back into the baseline period. The backcasting approach is very similar to the forecasting approach, but in reverse. The reporting period dataset (dependent and independent variables) are used to create an energy model for the reporting period. This reporting period model is then applied to the independent variables during the baseline period to predict the baseline energy use. The difference between the actual energy use during the baseline period and the predicted energy use during the baseline period is the energy savings.

9.4.E – Bottom-Up Approach

All of the previous analyses have been top-down approaches. The top-down approach is appropriate for sites that fluctuate too much to develop a reliable model. A top-down approach calculates energy savings by analyzing energy data for the entire site, building, or facility, regardless of the simplicity or complexity of the energy project or program. The bottom-up approach focuses on a specific piece of equipment, system, or sub-system. The energy savings can be calculated, using IPMVP Option D, or sub-metered, using IPMVP Option B.

9.4.F – Dual-Model Approach

The dual-model approach can be thought of as a combination of the forecasting and the backcasting approaches. The main advantage of the dual-model approach is that it completely normalizes energy savings against fluctuations in independent variables (i.e. a warm summer or cold winter) by applying the measured energy savings to a typical or average set of independent variables (i.e. typical meteorological year (TMY) weather data).

The dual-model approach creates two models: one during the baseline period using baseline data and one during the reporting period using reporting period data. A third dataset of typical independent variable data for an entire year is prepared or pulls from reliable sources (i.e. TMY weather data). Both models are applied to the dataset of typical independent variables to calculate the predicted energy use during a typical year. The energy savings are calculated as the difference between the baseline model's typical year predicted energy use and the reporting period model's typical year predicted energy use.

9.5 – Validating Savings

The savings measured by the above methods should be validating using industry best practices. At a minimum the fractional savings uncertainty (FSU)[8] should be calculated for the measured energy savings per ASHRAE Guideline 14-2014. ASHRAE Guideline 14-2014 specifies 50% as the maximum level of uncertainty in the measured energy savings, at the 68% confidence level. If the energy savings uncertainty exceeds 50%, additional data could be collected and incorporated into the reporting period, the model could be adjusted, or an alternative energy savings calculation method could be attempted.

In addition to the statistical thresholds, the energy savings should be compared to the estimated or calculated energy savings for the implemented energy projects or programs. An order of magnitude check should compare this bottom-up summation of expected energy savings to the top-down measured energy savings. Where significant differences occur, further investigation, discussions, and validation of implemented projects should occur.

If negative savings occur, then the modeler should review the situation with the participant to diagnose the cause. The modeler should document the background, solution, and next steps.

[8] FSU: Fractional Savings Uncertainty, also referred to as the relative uncertainty or precision, is the ratio of the standard uncertainty to the measured savings. It is discussed in detail in ASHRAE Guideline 14, and is viewed as a critical statistic for validating energy savings.

Appendix A – Glossary

ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers. This is the society that sets standards for energy efficiency, building systems, indoor air quality, refrigeration and sustainability within the built environment.

Autocorrelation Coefficient: The measure of the correlation of time series with its past and future values, indicating bias from one period to a following period.

Baseline Period: The period before the engagement with the participant, used to compare to the energy consumption during the implementation and reporting period.

British Thermal Units (BTU): unit of work needed to raise the temperature of one pound of water one degree Fahrenheit; expresses the heat content of fuels (e.g. natural gas)

Million BTU (MMBTU): One million BTU

Coefficient of Determination (R^2): The proportion of the independent variable that is explained by the regression equation. Indicated by R^2, a higher R^2 designates that more of the independent variable's variability is explained by the regression equation.

Coefficient of Variation (CV): The ratio of the root mean squared error (RMSE) to the mean of the dependent variable (energy). CV illustrates the closeness of the predictions of actual values (the uncertainty of the model).

Continuation: Participant engagement following Year-1 SEM.

Cooling Degree Days: Measure of demand for energy needed to cool a building. Determined by quantifying the number of degrees above a given base temperature that occurred in a day.

Cumulative Sum (CUSUM): A technique to detect shifts in energy consumption as well as to estimate total energy savings from an engagement. The CUSUM chart shows the cumulative sums of the deviations of each actual energy consumption value from a predicted (status quo) value. Because it is cumulative, even minor drifting in the process mean will lead to steadily increasing or decreasing cumulative deviation values. Therefore, this chart is especially useful in detecting slow shifts away from the predicted value due to small improvements to energy efficiency. The graph has time along the horizontal axis and energy consumption along the vertical axis.

Energy Driver: An independent variable which is an indication of energy consumption

Energy Model: A mathematical model where the dependent variable (energy) is regressed on the independent variables which are said to determine its value. The energy model is the primary method for claiming energy savings from an SEM engagement.

Heating Degree Days: Measure of demand for energy needed to heat a building. Determined by quantifying the number of degrees below a given base temperature that occurred in a day.

Hypothesis Model: An initial model to share with the facility to indicate a basic relationship with weather, a single occupancy indicator or seasonal indicator. This is not the final model used to calculate the energy savings.

Indicator Variables: Variable used to account for discrete levels of a qualitative variable. Generally indicated by a 1 or a 0 for different operating levels.

International Performance Measurement and Verification Protocol (IPMVP): Provides best practices available for verifying the results of energy efficiency, water efficiency and renewable energy projects in commercial and industrial facilities.

Kilowatt hour (kWh): measure of electrical energy, based on one kilowatt of power sustained for one hour

M&V: Measurement and Verification

Net Determination Bias Error: Statistical metric that quantifies the tendency of a model to underestimate or overestimate energy savings. Typically represented as a percentage.

O&M: Operations and Maintenance

Program Management Contractor (PMC): The Energy Trust of Oregon contractor who manages the Existing Buildings Program and is responsible for supporting participant recruitment for the SEM program offerings.

Reporting Period: Time period used to measure energy savings. For Commercial SEM, this begins at the date of the kickoff and continues through the end of Year-1.

Static Factor: identified factor that influences energy performance but does not routinely change

T-Statistic: ratio of departure of an estimated parameter from its notional value and its standard error

Therm: unit of heat energy, equal to 100,000 BTU, equivalent of burning 100 cubic feet of natural gas

Variance Inflation Factor (VIF): metric that quantifies the severity of multicollinearity in a regression analysis