White Paper: Savings Analysis Methods Guidance for the California Statewide Deemed Energy Efficiency Measures

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INTRODUCTION

Purpose

This white paper proposes guidelines for measure developers to determine the most appropriate method to estimate energy and demand impacts of the statewide deemed energy efficiency measures approved for the California portfolios. Ultimately, this guidance is intended to:

- Facilitate the consistency of methods to estimate impacts for measures with similar attributes (i.e., same end use, technology group, etc.)
- Provide greater transparency into how measure impacts are estimated
- Provide measure developers with trade-offs associated with each method to ensure accuracy and cost efficiency in measure development.

The need for cost-effective energy efficiency programs only continues to grow in California as the state strives for meeting statewide energy and carbon reduction targets. The California energy efficiency deemed portfolios have undergone dramatic changes over the last few years, which are not yet complete. The decreasing savings from lighting, the shifting peak periods from added solar generation, and the transition to third-party (3P) programs, for example, require significant changes but also offer great opportunities.

The California Technical Forum (Cal TF) has led three important foundational steps to support this transition.

- The Cal TF consolidated investor-owned utility (IOU) specific workpapers and the publicly-owned utility (POU) technical reference manual (TRM) into a set of statewide deemed measures. This has simplified the deemed portfolio.
- The Cal TF has developed the California electronic TRM (eTRM). As a centralized repository, the eTRM offers all statewide deemed measures (all values and associated documentation) in a transparent, structured, and accessible format.
- The Cal TF has coordinated the development of a new measure development and review process that offers a streamlined path for new measures from the private sector (3Ps) into the portfolios.

As the eTRM transitions as the data source of record for standardized statewide measures and the new measure submission process ramps up, Cal TF is expecting an influx of new measure proposals from IOUs, POUs, and 3P measure developers.

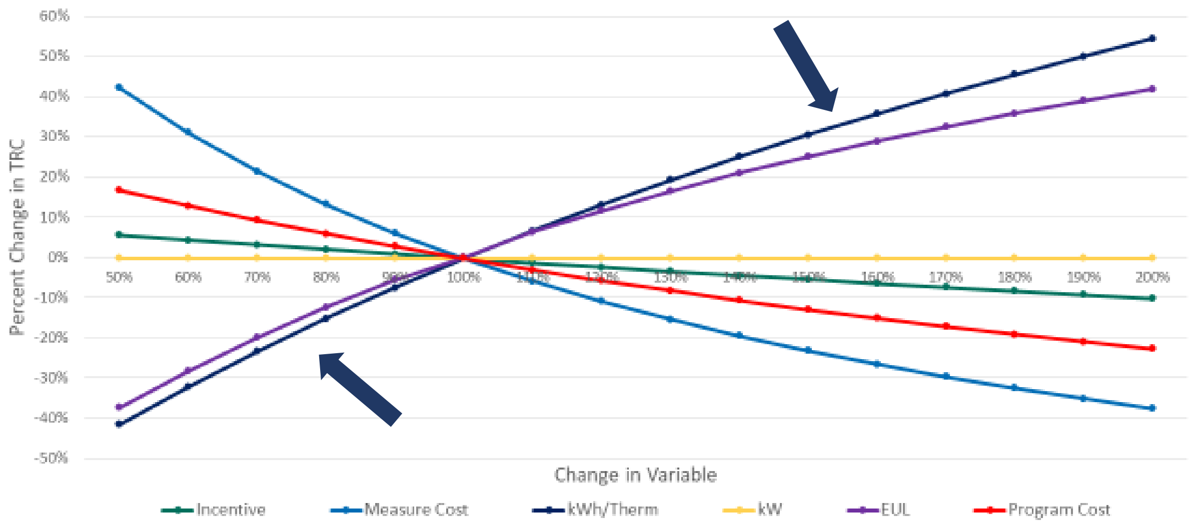
Maintaining a high level of documentation for the deemed measures remains a primary goal that must be balanced with the need to increase market adoption rates and manage costs. As a result, there is a need to develop a framework to estimate measure impacts to guide the measure developers in producing a quality deemed measure in a cost and time efficient manner.

Without established guidelines for statewide measures, diverging from best practices may become too easy since reviews are performed one measure at a time. This framework ensures a reasonable standard of estimating measure savings that will satisfy the Cal TF goals of accuracy, transparency, and cost reduction.

Background

Energy Savings is a Key Driver of Measure Cost-effectiveness

For context, it is important to understand that energy savings (kWh or therms) is the top driver of measure cost-effectiveness.[1] The relative effect of various terms of measure cost effectiveness (represented by the total resource cost value, TRC) is indicated in an analysis completed by the IOUs in 2019. As shown in the figure below, the TRC value is most sensitive to measure savings (followed by measure life and measure cost).



Source: "Cost-Effectiveness Training" (1/7/2019)

Regulatory Underpinnings and Measure Savings Requirements

The requirements for the estimation of measure impacts are rooted in a handful of decisions and guidance documents set forth by the California Public Utilities Commission (CPUC).[2] Notably, the *California Standard Practice Manual* establishes requirements for required benefits and costs inputs for cost effectiveness tests.[3] While the *California Standard Practice Manual* does not explicitly stipulate the type

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[1] The net-to-gross ratio has a significant effect but was not included in this test.

[2] The *Statewide Deemed Workpaper Rulebook, Version 3.0* compiles all CPUC rules and guidance the IOUs must follow for developing a deemed measure. See:

Pacific Gas and Electric (PG&E), San Diego Gas & Electric (SDG&E), Southern California Gas Company (SCG), and Southern California Edison (SCE). 2020. *Statewide Deemed Workpaper Rulebook. Version 3.0.* January 1.

[3] California Public Utilities Commission (CPUC). 2001. California Standard Practice Manual. Economic Analysis of Demand-Side Programs and Projects. October.

of data or methods to calculate the required benefits and costs, the CPUC has provided the "guard rails" that DEER assumptions, methods, and data shall be utilized for all non-DEER measures. Specifically, D.12-05-015 instructed the IOUs to use DEER values as a "starting point" and, when appropriate, that the utilities cannot replace DEER assumptions and values without approval from CPUC Staff.[4] The *Energy Efficiency Policy Manual* (version 6) further states that if "DEER values and methods are not available, new values may be proposed for CPUC Staff review and approval";[5] the *Policy Manual* further states that program administrators (PAs) "must utilize the latest information available, including the CPUC's most recently available evaluation results, when updating or developing new workpapers … All ex ante values are to be updated or developed in consideration of the latest information available, including Unit Energy Savings (UES), Effective Useful Life (EUL), Installation Rate (IR), NTG and Cost."[6] This direction was rooted in the fact that the DEER measures, which are created, updated, and under the purview of the CPUC ED ex ante review team include high-impact measures (HIMs) and others that account for the largest portion of portfolio savings.

Key excerpts from the *Policy Manual* are included below: [7]

> *Workpapers must use DEER assumptions, methods, and data in the development of non-DEER values when available/appropriate and shall follow Commission Staff direction relating to the appropriate application of DEER to non-DEER values. Any proposed workpaper measure definitions that are different from DEER definitions should be calculated using DEER reference impacts. … DEER is updated on an annual basis. Workpapers must use the appropriate DEER version based on their program implementation year.*
>
> *If DEER values and methods are not available, new values may be proposed for Commission Staff review and approval. For non-DEER measures, DEER values should be used as the starting point. In cases where any of the installation parameters differ from the assumptions for the DEER measure, the Implementer should apply DEER methodologies for estimating the non-DEER parameter value. Non-DEER values may not be used without Commission Staff approval. Direct replacement of DEER measures is not allowed in workpapers.*

D.92-02-075 (1992) articulated the CPUC requirement that PAs should analyze the cost effectiveness of demand-side management programs in a manner consistent with the Standard Practice Manual. D.92-02-075 also established the TRC test as the primary test for determining cost effectiveness and that portfolios were also required to meet the PAC test.

[4] California Public Utilities Commission (CPUC). 2012. *Decision 12-05-015 in the Order Instituting Rulemaking to Examine the Commission's Post-2008 Energy Efficiency Policies, Programs, Evaluation, Measurement, and Verification, and Related Issues (R.09-11-014).* Issued May 18. Pp. 331, 338.

[5] California Public Utilities Commission (CPUC), Energy Division. 2020. *Energy Efficiency Policy Manual Version 6.* April. Section IV.

The *Energy Efficiency Policy Manual* documents policy rules related to the administration, oversight, and evaluation of the energy efficiency programs funded by California ratepayers. The Policy Manual is not formally adopted by the CPUC, rather serves as a comprehensive but not exhaustive reference for the more significant rules set forth by the CPUC in various decisions and resolutions. (p. 2)

[6] Ibid. Section V.

[7] Ibid. Section IV.

CURRENT STATE

The current practices for estimating the energy and demand impacts of statewide deemed measures is summarized with respect to the following:[8]

- Categorization of methods to develop (ex ante) impacts for statewide deemed measures
- The number of permutations generated from the analysis

Categorization of Methods to Develop Ex Ante Impacts for Statewide Deemed Measures

Cal TF Staff leveraged knowledge from the consolidation process and analyzed measure documentation for 138 statewide deemed measures that have been affirmed by the Cal TF.[9] The analysis began in the summer of 2019 and concluded in May 2020.

Prior to 2019, all deemed measures in the IOU portfolios were developed by each IOU separately; as a result, the deemed measures lacked consistency. Beginning in mid-2017, Cal TF Staff worked with subcommittees focused on specific end-uses that were comprised of IOU and POU staff who lead and develop deemed measure workpapers, as well as stakeholders with end-use specific experience. Each subcommittee reviewed utility specific workpapers and "consolidated" the utility-specific measures into statewide measures. This "consolidation process" entailed a detailed review and comparison of parameters, inputs, assumptions, energy/demand analysis, and costs analysis methods of all utility-specific workpapers pertaining to the same measure to reach consensus on how to develop one single statewide measure.

As a result of the documentation review, Cal TF Staff identified four primary categories of methods used to estimate energy and demand impacts that vary according to data requirements, level of uncertainty associated with the resultant estimates, cost and time to implement, cost to update in the future, and required technical expertise.[10] The four categories are summarized below. See Appendix A for additional details and examples.

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[8] Cal TF also analyzed claims data to identify trends, particularly measures that accounted for the largest share of impacts. The preliminary analysis did not reveal notable results and thus is not included. Additional valuable research would include analysis of ex post realization rates associated with different methods used to develop ex ante values.

[9] The 138 measures in the analysis include measures currently approved for the IOU portfolios as well as others that were affirmed by the Cal TF but were dropped or have been put on hold. Including the non-approved measures does not skew the results and were therefore retained in the analysis.

[10] Note that the impacts for a limited number of measures Cal TF Staff reviewed were derived using a combination of approaches, such as DEER + Adoption of Values from Another Source. In particular, the Refrigerator or Freezer, Residential measure (SWAP001-01) includes measure offerings for which impacts were derived using the DEER Modeled method and also offerings for which impacts were derived from DOE and ENERGY STAR studies. This situation is not typical and generally

Modeled Energy Use ("Modeled")

The modeled approach uses whole-building energy modeling (BEM) to simulate energy use and energy/demand impacts. This approach incorporates whole-building energy use, mass and heat transfer, weather data, and multiple interactive effects that are too complex to represent with traditional engineering calculations.

The modeled method involves whole-building simulations that are primarily run in eQUEST/DOE-2.3 with a batch processor[11] and post-processing that is completed with SQL scripts. Database for Energy Efficient Resources (DEER) building prototypes or their equivalent in another simulation software are used in the post-processing described further below. Final unit energy savings (UES) values represent the weighted average of savings across several parameters, such as building type, climate zone, vintage, and HVAC type.

A *measure permutation* is a unique combination of parameters for which energy consumption, demand, and/or impacts are calculated. The permutations of a measure are defined by a combination of selected shared and measure-specific parameter labels. For example, a permutation is the savings associated with the following parameter combination: commercial building type (Com), existing vintage (Ex), and climate zone 1 (CZ01). The modeling approach for this single permutation would involve the following:

- *Model Creation & Usage Determination:* The user enters the desired measure and desired combinations of building types, vintages, and climate zones into a batch processor (such as MASControl3), which then creates ~1,500 models (24 individual commercial building types, 4 vintages, ~6-10 HVAC types, 1 climate zone, baseline/proposed models). MASControl3 then runs the models in DOE-2.3 and generates 1,500 building-level usage results that represent different combinations of pre-defined building types, building vintages, HVAC types, and a single climate zone.[12]
- *Post Processing & Savings Calculation:* During post processing, the UES values are calculated as the difference between the simulated base case and measure case energy use through a series of SQL scripts outside of MASControl3.[13] Additionally, the SQL scripts will weight the savings

avoided. Thus, a separate "combination" method has not been defined. Instead, these types of measure have been added to all applicable methodologies.

[11] A *batch processor* is a stand-program that can create the matrix of building simulation models associated with one or more varying parameters. A parameter like building type will influence which prototype is chosen, while other parameters like vintage and climate zone may further refine that prototype. Existing, standard, and proposed case models are typically created that are based upon the keywords that change for a given measure. Additional parameters could include HVAC Type and Thermostat Setting. MASControl3 is the batch processor that is used to run models using the DOE-2 engine for California modeled measures.

[12] For most HVAC measures, MASControl3 also performs "sizing runs", which are additional simulations used to establish uniform equipment sizing for subsequent simulations for a given combination of building parameters. These sizing runs further increase the total number of simulations needed.

[13] The scripts that extract the savings also performs the weighting, as well as derivation of the DEER peak demand reduction. These scripts run on PostgreSQL, and they can be downloaded from http://www.deeresources.com/files/DEER2020/download/MC3_training_July_2019/DEER_Tools_2019_07_26.zip.

values based upon the appropriate normalizing unit for each combination of building type/vintage/HVAC type/climate zone.[14]

The modeling stage is the same for all modeled measures, whether it is a DEER measure or not. The model may produce all the possible permutations of sensitive parameters, such as building type, vintage, climate zones, and HVAC type. The measure developer can choose to include only a subset of the total permutations that fits their designed measure offerings. *However, statewide measures should always include savings that could be applicable to any of the 16 climate zones.*

The original modeled results are always PA independent, but savings sometimes become PA-specific through the weighting process. Resolution E-5009 provides guidance on how to select one PA if multiple values exist within a single climate zone.[15]

There are three subcategories of the modeled approach that are distinguished by the source of the model and the level of post-modeling data analysis required of the measure developers:

DEER Modeled Approach. The model prototype is created and updated only by the California Public Utility Commission (CPUC) Ex Ante Review (EAR) team. A measure developer adopts the DEER modeled savings values *without modification*. The proposed measure parameters should match with the DEER measure parameters (e.g., Asm measure building should pull savings from Asm DEER building).

DEER Modified Approach. The model prototype is created and updated only by the California Public CPUC EAR team. A measure developer uses the DEER modeled results as an input to calculate measure impacts instead of adopting the DEER modeled savings values directly. Common types and reasons for DEER Modified measures include:

- The measure could be implemented so that savings are claimed with a different normalizing unit. Typically, residential HVAC measures are claimed per “each”, while commercial HVAC measures are claimed per capacity unit.
- The measure savings of a DEER measure could be scaled to reflect recent EM&V results or some other stated methodology.
- A weighted average building type may be used to represent a market average. Typically, if the building type is not known through an upstream program, then savings are claimed using a weighted average building type, called “com” or “res”, rather than using the building type that corresponds to the customer NAICS code.

Measure Developer Modeled Approach. This approach refers to measures for which the energy use simulations and all post-processing are done by an IOU, POU, or independent 3P measure developer. The model could be a modification of an existing DEER prototype or a completely new prototype. Any deviations from the original DEER prototypes should be well documented and explained. The measure developer modeled approach should only be pursued when a valid DEER measure does not already exist.

For many measures, climate zone and building type are kept as independent parameters when savings can vary dramatically with these variables and when the building type can be determined with certainty

[14] Note that source of weighting factors for building vintage, building type and climate zone is unclear. We do not know year or source. We also do not know source of HVAC type weighting factors that are specified for each building type.

[15] California Public Utilities Commission (CPUC). 2019. *Resolution E-5009.* September 12. Pp A-6 and A-7.

during the claims process. In these cases, a greater number of specific permutations will be generated rather than a smaller number of averaged permutations. In other words, this approach could use the same weighting factors as the DEER measures to reflect the market average.

Engineering Calculations ("Calculated")

The engineering calculations method refers to the use of widely accepted and relatively simple calculations based upon sound engineering principles to calculate energy and demand impacts (examples include heat transfer for water heating and the conversion of power wattage to energy for lighting equipment). The engineering calculations are supported by a combination of inputs that may include empirical data, equipment specifications, or assumptions based upon professional engineering judgment.

The calculated approach is a relatively simple approach to estimate UES values if engineering calculations have been established for the technology. Engineering calculations provide full transparency of the method as well as the inputs and assumptions to derive the UES values. Moreover, this approach enables the calculation of both base and measure case energy use and can easily incorporate interactive effects multipliers (if applicable). Finally, measure updates are straightforward; once the calculations are determined to be appropriate, updating the calculations with revised input values requires minimal effort to update or perform quality checks.

For each equation in the calculation series, the measure developer should define its purpose, the required inputs variables, and the underlying physical principles. Care should be taken by the measure developer to understand the sensitivity of the calculated result to each input so that risk can be understood and balanced with the level of effort to document inputs.

Calculation Tool

The calculation tool approach refers to the use of an industry-accepted software to calculate measure impacts. Such tools require user-selected inputs to calculate impacts through embedded (protected) macros or formulae. Such calculators use standard engineering equations and inputs that range in source from EM&V values to engineering assumptions based upon best available data or engineering judgement. Calculation tools can be in an open format, such as Excel, such that the methodology is transparent, or in a closed format in which the methodology cannot be examined directly.

Calculation tools are applicable for measures for which a calculator has been developed and fully vetted. These tools are developed most often to simulate a specific end use, that does not have system interactions beyond what is simulated in the tool. Other cases exist where an explicit analytical solution is not available but instead requires a numerical approximation or iterative solution.

This method is relatively inexpensive, readily accessible, and results are accepted by industry experts if the calculator, itself, has been vetted and is industry accepted. Although many calculators are well documented, full transparency is more difficult to demonstrate because all computations are processed internally. Tools are limited by the availability of required inputs, and calibration to represent the market is typically not provided.

Adoption of Values from Another Source

This method refers to the adoption of energy and demand impact values from another source *without modification*. Typically, this method pertains to the adoption of estimated impacts from an M&V study (such as an emerging technology study or a lab test report), custom project collections, or a study conducted for another purpose. (If values reported in another source are modified and/or used as an input for engineering calculations, the method would be categorized as one of the others defined above.)

Examples of other sources from which measure impacts could be directly opted include:

- *Emerging technology (ET) study.* Typically, ET study results are directly adopted or used in regression models to derive the measure UES values.[16] The results of an ET study help developers understand the parameters and inputs that are the key drivers of savings for a measure. As a result, offerings can be established to make sure that the most influential parameters can still be used to influence savings claims.
- *National study.* National studies are conducted by a federal agency and typically support the development of a federal standard or qualification for ENERGY STAR that are utilized for establishing measure case specifications. For example, U.S. Department of Energy (DOE) rulemakings include technical support documents used to establish federal standards for energy usage that can be adopted as baseline, and has created standards for minimum energy usage based upon empirical testing of equipment for ENERGY STAR® qualifying criteria.
- *EM&V or other study.* Results of impact evaluations could be adopted directly or used in regression models to establish measure impacts. (There are currently no measures in the portfolio for which EM&V results were directly adopted as measure impacts, but other jurisdictions do follow this approach.) Alternatively, a collection of custom project results can be used to document a repeatable methodology.

Adopting measure impacts directly from another source is cost efficient compared to other approaches described herein. This approach is particularly advantageous if the study has been independently reviewed and vetted by industry experts. In the spirit of transparency, the measure developer should provide an explanation of the applicability of the study and savings values that are adopted for the proposed measure.

There are several drawbacks and limitations, however, that will limit the use of this approach. Since all calculations, modeling, and/or data analysis are done by external sources, the transparency of the methodology will depend upon how thoroughly the study is documented. The analysis might utilize different assumptions and key inputs than what is assumed for the proposed measure, and any data utilized for the study may not be available and could be proprietary, which will inhibit reproducibility and validation of results. Finally, many studies report only the measure impacts rather than the baseline and measure case energy use.

Finally, it is important to note that this approach does not include studies conducted by equipment manufacturers, which are not considered to be valid references for measure impacts. Deemed savings

[16] Regression models are formulas developed from a set of data to create a result based upon the most sensitive variable(s) for that particular measure. For example, the Circulating Block Heater measure collected data from an ET Study to relate average daily temperature to daily electric energy usage; the Gas Dryer Modulating Valve measure collected data from multiple studies to estimate therms/load based upon dryer load capacity (lbs); and the Commercial Reach-in Refrigerator/Freezer measure references an ENERGY STAR specification to relate refrigerated volume (ft3) to daily electric energy usage.

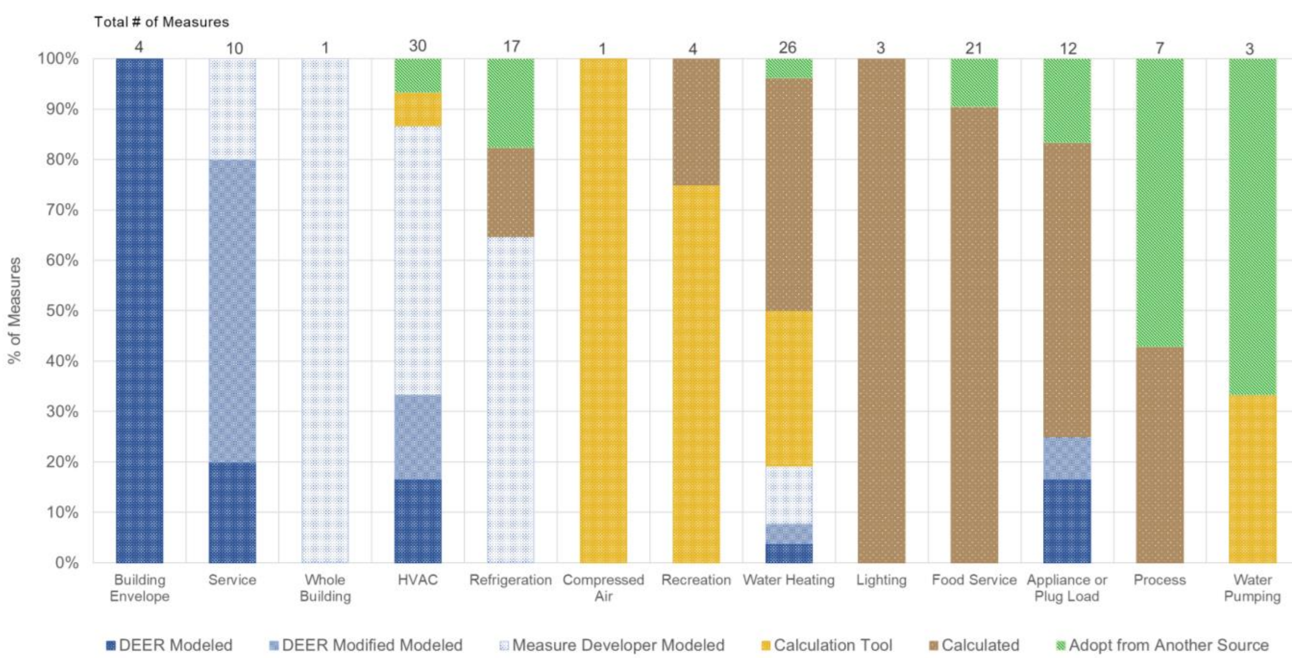
should be agnostic to the manufacturer/vendor[17] even if an ET study, for example, might represent equipment of a single manufacturer.

Summary of Methods of California Deemed Measures

There is not a single correct method to estimate the impacts for a specific measure; rather, there are key considerations and tradeoffs that will inform the decision on which method to use. The figure below summarizes the methods used to develop impacts for the 138 measures included in this analysis. The following trends are observed:

- The color variation of the vertical bars is an indication of consistency of methods across measures within the same end use. Logically, there is greater variation in use categories that include more measures – HVAC, water heating, and appliance or plug load.
- The modeling approach was used to estimate impacts for measures in the building envelope, service, whole building, HVAC, and refrigeration use categories.
- Calculation tools were used to determine impacts for measures in the compressed air, water heating (equipment), and recreation (pools) end uses.
- Engineering calculations were used to derive impacts for measures in the appliance & plug load, food service, lighting, water heating (water fixture), process and water pumping use categories.

Measure Impacts Estimation Methods, by Use Category



[17] Biermayer, Peter (CPUC, Energy Division). 2019. "Informational Memo on Allowing a Sole Source measure in a Workpaper." Memorandum submitted to Cassie Cuaresma (SCE), Henry Liu (PG&E), Ed Reynoso (SDG&E), and Chan Paek (SCG). April 23.

Number of Permutations Generated From the Analysis

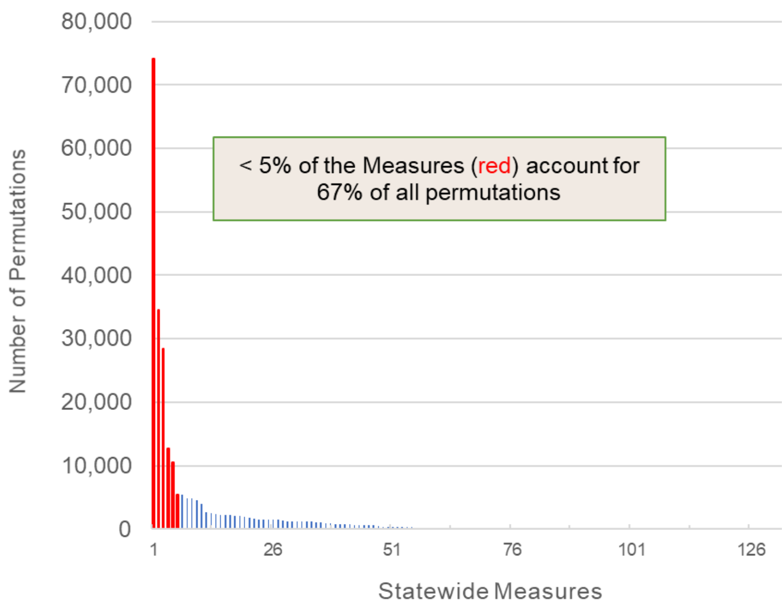
A permutation is defined within a measure as having distinct descriptive parameters that could include common elements such as building type, building vintage, building location, and delivery type, but could also include measure-specific parameters such as fuel type, efficiency tier, or lumen range. Permutations are defined to connect parameters with impacts that affect cost effectiveness such as savings, cost, effective useful life (EUL) and net-to-gross (NTG). Any measure can be defined down to the lowest level by specifying every parameter, but this approach would lead to an overly complex measure that would be: cumbersome to manage for planning and claims purposes, expensive to maintain, difficult to control quality, and prone to claiming false precision.

For example, a commercial food service measure could be offered in any building type (24 options), in any vintage (4 options), in any climate zone (16 options), in any delivery type (3 options), and with many tiers of savings (10 options). This measure would then have at least 46,080 permutations (= 24 x 4 x 16 x 3 x 10). However, if hours of operation are established as a weighted average of values across building type options and vintage or weather effects are not determined to be significant drivers of measure energy/demand impacts, then the permutations could be reduced to 30 options (= 1 x 1 x 1 x 3 x 10).

The number of permutations generated to describe measure impacts depends upon the parameters that are required to estimate impacts. The parameters that are the strongest drivers of the number of permutations are:

- Offering (influenced by tiers of performance but also by product options and measure application type)
- Building Type (up to 24 commercial building types)
- Climate Zone (typical 16 zone for a weather sensitive measure)
- Delivery Type (3 types available)

A histogram of the number of permutations generated for each measure in this analysis illustrates how different the number of permutations can vary across the portfolio of deemed measures. There are approximately 250,000 permutations associated with the 138 measures analyzed for this white paper. Less than 5% of the measures (red bars) account for over two-thirds of the permutations.



The importance in managing the number of permutations becomes apparent when one considers the added complexity associated with implementation/planning and measure maintenance. Notably, during implementation and planning, the ability to quickly distinguish the permutations that have greater value to the portfolio can enhance program planning. As the number of permutations increases, planners must simplify groups of permutations to aid in the manipulation of the data, which can cloud variations that have positive and negative impacts on portfolio savings. For example, the use of the Com building type, which is calculated as a weighted average by building stock square footage of all building types, can hide true variation that exists between building types due to differing hours of operation. Additionally, during measure maintenance, if the number of permutations skyrockets, the measure developer will experience challenges to update the measure and provide a thorough quality control check on the measure permutations; the update process will become more time consuming and difficult.

PROPOSED GUIDELINES TO ESTIMATE MEASURE IMPACTS

By analyzing the large library of California statewide deemed energy efficiency measures, guidance on best-practices begins to emerge. These best-practice guidelines are intended to provide a path that will:

- Document energy savings and demand reduction in the most transparent and accurate manner
- Balance the need for accuracy with a cost-efficient approach so that risk can be managed within budget
- Maintain consistency in quality throughout the portfolio and across an end-use.

The overarching *fundamental principles* that serve as a framework for the proposed guidelines are as follows:

Comply with regulatory requirements. Measure savings should conform to the cost-effectiveness calculation and claims requirements as well as the baseline assumptions for each measure application type. The savings analysis and resultant per-unit savings values must be reviewed and approved by the CPUC to be implemented in the IOU portfolios.

Represent average savings actually achieved by customers. Because deemed impacts are intended to represent market averages, an understanding of the implementing market will align savings with the claims that are achieved by customers.

Represent current market conditions. Estimated measure energy savings and demand reduction should reflect impacts that would be saved during the period in which the measure is approved to be implemented.

Represent an "apples-to-apples" comparison between base and measure case usage. The baseline and measure case usage should be based on data collected from similar sources of the same vintage and computed using the same methodology.

Represent manufacturer agnostics savings. Energy savings and demand reduction should be defined through equipment specifications.

Investment in measure savings development should be commensurate with the measure contribution of impacts to the portfolio. Both the precision of inputs and the frequency of updates should be considered with respect to the measure impact upon the portfolio.

Be transparent and well documented to foster consistency and reproducibility. Use of "best available data", [18] accessibility to the data, and clarity in documentation is necessary to complete measure development.

The proposed guidelines for measure savings development are summarized below. These guidelines draw from a variety of resources including: Cal TF Staff experience from reviewing IOU-specific workpapers during the consolidation process to develop statewide measures, familiarity of CPUC regulatory requirements and CPUC Staff/ex ante review consultant requirements for workpapers submitted for review, insights from consultants that have conducted measure savings analysis, Cal TF Staff experience with cost-effectiveness analyses, and input from the Cal TF measure savings guidance subcommittee.

Building from a Technical Position Paper to reduce measure complexity,[19] the following definitions have been adopted to describe the impact of a measure to the portfolio:

Normal impact measure: A measure predicted to be normal impact, or that has demonstrated normal portfolio impact through the course of implementation.

Low impact measure: A measure that is predicted to have a lower impact on the portfolio than average.

Demonstrated high impact measure: A measure predicted to immediately be high impact or has demonstrated high portfolio impact through the course of implementation.

Interim measure: A measure for which sufficient information is anticipated but not yet available that would satisfy the level of rigor for a measure predicted to be normal or high impact. Interim measures must be re-examined after 1 year or another duration determined by the Cal TF.

[18] Documentation of best available data is provided in the *TPP No. 4: Using Best Available Data to Determine Deemed Savings*. The current version can be downloaded from the Cal TF website (http://www.caltf.org/tools).

[19] Documentation of measure impact is provided in the *TPP No. 5: Reducing Measure Complexity*. The current version can be downloaded from the Cal TF website (http://www.caltf.org/tools).

Guideline 1: Choose an Impact Estimation Method that Aligns with the Measure Use Category

It is not a requirement to use the calculation method recommended within the table below that is based upon use category. Instead, this guideline shows the methodology that most other measures in this use category utilize. To promote consistency of ex ante impact estimates and rigor throughout the portfolio, the methodology listed below is the one that is expected to move towards over the life of the measure.

Interim measures may use a less rigorous technique. Relying upon an ET study alone is a good example.

High impact measures (HIMs) should be treated differently. Utilizing multiple categories of calculation methodologies may be appropriate. For example, results that are Adopted from Another Source could be used as the input to a Calculated approach.

Impact Estimation Methods, by Use Category

<table>
<tr><th>Use Category – Technology Group</th><th>Modeled</th><th>Calculation Tool</th><th>Calculated</th><th>Adoption of Values from Another Source</th></tr>
<tr><td>Building Envelope</td><td rowspan="5">Whole-Building Energy Modeling (BEM) tools provide accepted packages to evaluate complex, interacting building systems.</td><td colspan="2"></td><td rowspan="14">RCT, ET Studies, custom projects, EM&V, or regression models constitute a large portion of this category.</td></tr>
<tr><td>Service (RCx)</td><td colspan="2"></td></tr>
<tr><td>Whole Building</td><td colspan="2"></td></tr>
<tr><td>HVAC</td><td colspan="2"></td></tr>
<tr><td>Refrigeration</td><td colspan="2"></td></tr>
<tr><td colspan="2">Compressed Air</td><td rowspan="3">Simulation tools for specialized end-use categories used when interactions with other systems is not required.</td><td></td></tr>
<tr><td colspan="2">Recreation (Pools)</td><td></td></tr>
<tr><td colspan="2">Water Heating – Equipment</td><td></td></tr>
<tr><td colspan="3">Water Heating – Water Fixture</td><td rowspan="6">These measures involved relatively simple physics models or engineering calculations that are widely accepted.</td></tr>
<tr><td colspan="3">Lighting</td></tr>
<tr><td colspan="3">Water Pumping</td></tr>
<tr><td colspan="3">Food Service</td></tr>
<tr><td colspan="3">Appliance or Plug Load</td></tr>
<tr><td colspan="3">Process</td></tr>
</table>

Modeled Approaches. Whole building energy modeling (BEM) tools that meet industry quality standards provide an accepted package to evaluate the energy usage between complex, interacting building systems.

Because building prototype models are only developed within DOE-2/eQUEST, working outside of this platform would benefit from early discussions with the EAR team to ensure that the measure can be approved for use by IOUs.

Measures that fall into the Building Envelope, Service, Whole Building, HVAC, and Commercial Refrigeration use categories most commonly use this approach. The Service use category can be further defined as a category of Behavioral-RetroCommissioning-Operational (BRO) measures that are related to HVAC measures.

Calculated. Simple physics models or engineering calculations remain the most transparent and cost-efficient ways to document energy savings.

Measures that fall into the Water Heating/Water Fixture, Lighting, Water Pumping, Food Service, Appliance or Plug Load, and Process use categories most commonly use this approach.

Calculation Tool. Simulation tools for specialized use categories have been developed that are industry accepted. These tools are most appropriate when interactions with other building systems are not required.

Measures that fall into these categories should be linked to the tool that is recommended.

- Compressed Air – AIRMaster+[20]
- Recreation/Pools – RSPEC[21] (pool simulation software) or SCG calculator
- Water Heating / Equipment – Water Heater Calculator[22] (CPUC's water heating equipment software)

Adoption of Values from Another Source. Independent evaluations can be used to form the basis of savings for a measure. Often, these values or the equations to generate the savings are adopted from another source without making any changes.

Alternatively, this approach can also be used to supplement the Modeled, Calculation Tool, or Calculated approach to better support an input.

[20] AIRMaster+ is a tool created by the DOE and is available through this link: https://www.energy.gov/eere/amo/articles/airmaster

[21] RSPEC (Reduce Swimming Pool Energy Cost) is a tool created by the DOE in 1993.

[22] Water Heater Calculator is maintained by the CPUC and version 4.1 was released as part of the DEER2021 Update: http://www.deeresources.com/index.php/deer-versions/deer2021.

Guideline 2: Develop Measure Savings that Align with Cost-Effectiveness and Claims Requirements

The savings used in the cost effectiveness calculation depends upon the measure application type (MAT). MAT impacts the baseline and the period over which impacts are claimed. The requirements for each measure application type are summarized in the table below.

Measure Savings Requirements, by Measure Application Type

Measure Application Type	Description	1st Baseline	2nd Baseline
Accelerated Replacement (AR)	Measure is installed when the existing equipment is still operational. This type includes Repair Eligible and Repair Indefinitely measures.	Existing conditions	Code / Standard Practice
Normal Replacement (NR)	Measure is installed when the existing equipment fails, or maintenance requires replacement.	Code / Standard Practice	N/A
New Construction (NC)	Measure is installed during construction instead of code/standard equipment.	Code / Standard Practice	N/A
Add-on Equipment (AOE)	Measure is installed to pre-existing "host" equipment that is still operational.	Existing conditions	N/A
Building Weatherization (BW)	Measure includes improvements to nonmechanical building structures or existing equipment that is essential to building function without maintenance.	Existing conditions	N/A
Behavioral (BRO-Bhv)	Measure includes informational or educational programs that influence energy-related practices.	Existing conditions	N/A
Retrocommissioning (BRO-RCx)	Measure is installed/applied as part of retro-commissioning.	Existing conditions	N/A
Operational (BRO-Op)	Measures that improve the efficient operation of installed equipment.	Existing conditions	N/A

Source: Statewide Deemed Workpaper Rulebook, Table 3 (version 3.0, 1/1/2020)

Measure energy/demand impacts should be documented in a manner that makes it easy for measure users to use the data for related tasks. The two tasks of calculating cost-effectiveness through the cost effectiveness tool (CET) and submitting claims to the California Energy Data and Reporting System (CEDARS) both require impacts to be reported in the same format. Documenting impacts with respect to first and second baselines will facilitate this need. The table above shows how impacts vary with measure application type and the first and second baselines.

Guideline 3: Document Influential Parameters for Sensitivity Analysis

While uncertainty is not calculated for each measure today, documenting the influential parameters allows a measure developer to focus resources on the right level of documentation. Measures that produce savings with greater bands of uncertainty / less precision will subject the utilities to a higher risk of underperforming or overperforming. The ultimate goal is to optimize the balance between uncertainty and measure development cost:

- Minimize uncertainly that may be a function of risk to the portfolio
- Minimize the development and maintenance cost of a measure.

To establish this balance, the guidance must focus on the influential parameters but also consider the importance of the measure's impact to the portfolio.

Determination of Influential Parameters

Approval Type	Low Impact	Normal Impact	High Impact	Interim
Short Term (expires after 1 year)				Sensitivity analysis for highest impact parameters 80% confidence level TF judgement for precision
Long Term	TF judgment	Sensitivity analysis for highest impact parameters 80% confidence level TF judgement for precision	Sensitivity analysis for highest impact parameters 90% confidence level 10% precision	

Guideline 4: Document Base Case and Measure Case Energy Usage

Energy savings and demand reduction should be documented by providing both the base case and measure case energy usage values so that the normalization process is clear and transparent. Considerations with respect to each method are noted below:

Modeled. Results should be reported as whole building base and measure case usage so that normalization can remain transparent. In many cases, the weighting process has been automated through scripts. When this process occurs, the weighted average base case and measure case usage values may be lost and no longer available. Efforts should be made to avoid this situation.

Key modeling parameters should be documented and explained as described in the Statewide Modeled Savings Methodology Template.[23]

[23] Documentation requirements are also provided in the *SW Modeled Savings Methodology Template*. The current version can be downloaded from the Cal TF website (http://www.caltf.org/tools).

Calculated. Results should be reported as base and measure case usage to preserve some of the most important elements of this approach. Depending upon whether interactive effects are required, savings should be reported at the end-use or whole building level. Key modeling parameters should be documented and explained.[24]

Calculation Tool. Since these tools focus on providing savings at the end-use level, results should be reported at that level for base and measure case usage so that normalization can remain transparent. Key modeling parameters should be documented and explained.[25]

Adoption of Values from Another Source. Results should be reported for base and measure case usage when available so that normalization can remain transparent.

Guideline 5: Include Interactive Effects Consistently

Interactive effects arise when a more efficient measure is installed that consequently reduces waste heat. This waste heat reduction could increase heating requirements and decrease cooling requirements. The table below provides guidance on how to consider this effect consistently with the rest of the portfolio.

To determine which savings to document, the following guidance is provided:

- Modeled measures should report whole-building simulated usage.
- Calculated measures should calculate end-use savings and then apply approved interactive effect values to simulate the whole-building savings. Whole-building savings should always be reported when interactive effects are significant. A general rule for deciding whether to include interactive effects is to examine whether the savings vary by more than +/-10% for low and normal impact measures.

> ***High impact measures (HIMs)*** *should be treated differently. Rather than considering whether the impact has an effect of +/-10% within the measures, it is more important to consider the effect of the permutation on the portfolio.*

[24] Ibid.

[25] Documentation requirements are also provided in the *Measure Development and QA/QC Guidelines*. The current version can be downloaded from the Cal TF website (http://www.caltf.org/tools).

Interactive Effects Guidelines by Use Category

Use Category – Technology Group	Apply Interactive Effects?	Recommended Approach
Building Envelope	Yes	Building Energy Model
Service (RCx)	Yes	Building Energy Model
Whole Building	Yes	Building Energy Model
HVAC	Yes	Building Energy Model
Refrigeration	Yes	Building Energy Model
Compressed Air	No	
Recreation (Pools)	No	
Water Heating – Equipment	No	
Water Heating – Water Fixture	No	
Lighting	Yes	Commercial and Residential Interactive Effect Table
Water Pumping	No	
Food Service	No	
Appliance or Plug Load	Yes	Commercial and Residential Interactive Effect Table
Process	No	

Guideline 6: Reduce Measure Complexity

The parameters that define the permutations within a measure are critical to document how impacts such as savings, cost and life can change with those parameters. However, the measure developer should be wary of over-defining a measure, which can lead to documenting false precision. The general guidance when determining whether a parameter should be included to further segment measure impacts is shown in the table below.

Criteria to Include a Parameter to Segment Impacts

Low Impact	Normal Impact	High Impact	Interim
Savings vary by >10% due to variation by influential parameter	Savings vary by >10% due to variation by influential parameter	Consider the effect on the portfolio; include parameters as appropriate	Savings vary by >10% due to variation by influential parameter

The most common parameters to consider are explained below.

Shared-Data Parameters that Impact Savings or Cost: Energy savings and demand reduction are the impacts that typically vary across these permutations. Cost should be considered, but it is not typically an influence. In this case, validating that a savings variation of >10% does exist is typically sufficient to understand if a parameter should be distinguished.

- *Building type* – Building type designation carries with it all of the characteristics of that particular building type such as schedules, equipment type, and building construction. Several standard building types exist across the range of sectors.

- *Climate zone* – Climate zone describes differences due to weather variations across the state using 16 climatic zones. Depending upon the situation, this parameter can be a critical differentiator for impacts or can influence the number of permutations by variations that are far less significant. The two prominent examples where variation due to weather effects is small include: interactive effects for lighting and commercial refrigeration measures.
- *Vintage* – Vintage does not currently impact the number of permutations, but it could become a significant driver with the new policy considerations for existing conditions.

Measure-Specific Parameters that Impact Savings or Cost: These parameters are typically used to distinguish Offerings. Offerings are used to group a set of parameters to describe this more efficient choice to the customer. Typical Offerings could include:

- Efficiency tiers
- Subcategories of a product (for example, fuel type, product size or capacity, or use cases)
- Measure application type

Normally, the number of Offerings remains small to make it easy for the customer to understand and make a choice, but periodically the number of Offerings can increase dramatically. Careful consideration should be given when incrementally add an Offering such that savings and/or cost do vary by more than 10%.

Parameters that do not impact savings or cost: Several parameters are needed to distinguish implementation paths but may not typically vary impacts. In this case, even though the permutations may be important and valid, the numbers of permutations should still be considered. The solution may be more linked to improved automation in permutation creation, such as through the eTRM, and through enhanced viewing capabilities so that these parameters can be easily filtered out. (Delivery type is the most common parameter in this category currently.)

Guideline 7: Identify Inputs That Should Be Collected Through Programs

Program data collection can meet different needs of several types of measures. One benefit of requiring data collection is that some blocked measures might be revived for implementation. The increased administration cost should be considered in this decision, so the data must be useful and regularly evaluated.

Examples of Measure Types That Benefit from Data Collection

Measure Type	Reason to Collect Data	Sunset Period
Interim Measure	New measure with not enough existing implementation data	1 year
Accelerated Replacement	Existing conditions baseline	Judgement
Add-On Equipment / To-Code	Existing conditions baseline	Judgement
Midstream / Upstream Programs	Document customer data (BT, CZ, HTR, etc)	EM&V Feedback

The sunset date can be set for a prescribed period to ensure that data is re-evaluated, and the measure is (potentially) updated. Depending upon the results of the collected data, collection requirements can be removed with the goal of lowering administrative costs for good measures or the measure can be discontinued for poor measures.

APPENDIX A: SUMMARY OF APPROACHES

DEER Modeled Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
The model prototype is created and updated only by the CPUC EAR team. A measure developer adopts the DEER modeled savings values *without modification*.	– DEER measures must be used if available for proposed measure.	– Measure impacts are already approved – Accounts for complex interactions between systems in the building.	– Base and measure case usage are built through MASControl3 and therefore not known. – Differences between base and measure case simulations are not transparent. Furthermore, MASControl3 changes modeling parameters within building prototypes and can change parameters based upon logic that is associated with other characteristics such as climate zone or vintage. – The weighted approach to derive UES values makes it more difficult to understand the modeled results. – Lack of transparency, models are not well documented. – The robustness of weighting factors is questionable	– SWBE001-01 Greenhouse Heat Curtain – SWHC004-01 Space Heating Boiler, Commercial

DEER Modified Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
The model prototype is created and updated EAR team. A measure developer uses the DEER modeled results as an input to calculate measure impacts.	– When the proposed measure shares similar attributes to an existing DEER measure. – Only valid for modifications made to the approved DEER values.	– DEER measure impacts upon which the modifications are based are already approved – Cost effective to develop and document a new measure. – Accounts for complex interactions between systems in the building. – EM&V or field study data typically determine the scaling factor to adjust the DEER values as needed.	– Same as DEER Modeled.	– SWHC031-01 – Furnace, Residential – SWSV004-01 – Condenser Coil Cleaning, Commercial – SWHC005-01 – Water-Cooled Chiller

Measure Developer Created Model Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
The energy use simulations and all post-processing are done by an IOU, POU, or independent 3P measure developer.	– If modifications occurred in the modeling stage (input assumptions, building type prototype, etc.) – If the measure case technology does not exist in DEER	– Incorporates interactive effects between multiple building systems. – Flexibility to modify DEER building prototypes – Allows for a more accurate representation of the base and measure cases. – Both base and measure case energy use can be extracted and documented separately.	– Expensive & time consuming to develop and update. – Less transparent due to the complexity. – The weighted approach to arrive at UES values makes it difficult to understand the modeled results. – Difficult to replicate or verify because represents a market average building, and inputs might not be properly documented. – The robustness of weighting factors is questionable	– SWHC009-01 Supply Fan Controls, Commercial – SWCR005-01 – Auto Closer for Refrigerated Storage Door

Engineering Calculation Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
Impacts are determined from engineering-based calculations.	– Applicable for measures for which impacts can be fully calculated due to the lack of an alternative accepted analytical solution.	– Relatively simple approach – Calculations are industry accepted – Full transparency, all assumptions, calculation inputs, sources, and engineering principles are known and documented. – Results can be easily replicated and verified. – Both base and measure case usage can be calculated. – Interactive effects can be incorporated through approved interactive effects tables. – Inputs can be updated over time to improve the accuracy of the estimated savings.	– The data available to establish the calculation could be inadequate. – For unique measures, deriving the correct equations with calculation inputs can be time-consuming and prone to human error. – The uncertainty level of the savings estimate depends on the simplification of the analytical calculation and the uncertainty level of the calculation inputs. – Calibration might not be included.	– SWFS001-02 Convection Oven, Commercial – SWLG009-01 LED Tube – SWWH001-02 Faucet Aerator, Residential

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Calculation Tool Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
An industry-accepted calculation tool, typically an Excel-based tool that requires user-selected inputs to calculate impacts through embedded (protected) macros or formulae.	– “Black box” solutions are not appropriate.	– Relatively inexpensive – Readily accessible – Approximate typically modeling software. – Results can be fairly accurate to the real-world application – Accepted by industry experts. – Values are replicable assuming universal access to software and proper documentation of inputs. – Most tools are well documented even if the methodology is not completely transparent.	– Some tools require licensing agreement – Not fully transparent because computations are processed internally. – Possible limitations of the calculation inputs. – Calibration might not be provided.	– SWWH005-01 Boiler, Commercial – SWCA001-01 VFD Retrofit for Air Compressor – SWRE003-01 Heat for Pool or Spa, Commercial

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Adoption from Another Source Approach Summary

Definition	Applicability	Strengths	Weaknesses	Examples
Adoption of impact values from another source *without modification*.	– Applicable for measures for which there are field studies or lab experiments conducted on the energy performance of the base or measure case, or both. – A study is not valid if conducted or sponsored by the manufacturer/vendor	– This approach is relatively inexpensive. – Studies leverage tested and trusted sources to document savings. – In many cases, the studies provide calibration to actual projects and test data.	– Potential for lack of transparency since all calculations, modeling, and/or data analysis are done by external source. – Data is not always available and could be proprietary. – There might not be enough data to accurately represent California statewide population or the general market of the measure case technology. – The reported impacts could use a different set of assumptions & key parameters from the proposed measure. – Some studies report only savings, not the baseline and measure case consumption. – An ET study may represent equipment of a single manufacturer and/or there may only be one equipment manufacturer or vendor	– SWWH011-01 Central Storage Water Heater, Multifamily – SWCR018-02 Reach-In Refrigerator or Freezer, Commercial – SWFS010-01 Commercial Hand-Wrap Machine, Electric