

Total System Benefit Technical Guidance

VERSION 1.1

August 16, 2021

This CPUC staff-level guidance introduces and describes the calculation steps for the Total System Benefit (TSB) metric implemented by D.21-05-031. Starting in 2024, the TSB metric will replace kWh, kW, and Therm as the primary goal for the energy efficiency portfolios administered by the California investor-owned utilities and other program administrators.



**California Public
Utilities Commission**

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Disclaimer

This staff-level guidance was written as a reference for program administrators and stakeholders on implementing the TSB metric, and does not supersede any CPUC decision. The currency of the information in this document is not guaranteed, as there may be a lag between the adoption of a CPUC decision and update to this document.

Section 1: Introduction

Purpose

This California Public Utilities Commission (CPUC) staff-level guidance introduces and describes the calculation steps for the Total System Benefit (TSB) metric implemented by D.21-05-031. Starting in 2024, the TSB metric will replace kWh, kW, and Therm savings as the primary goal for the energy efficiency portfolios administered by the California investor-owned utilities and other program administrators. Rather than setting fuel specific savings goals for the portfolios, D.21-05-031 ordered the program administrators to achieve a single goal expressed in dollars, which represents the value of the energy efficiency resources to the grid. By transitioning to the TSB metric, the CPUC encourages program administrators to optimize portfolios to save energy during high value hours. Previously, energy savings in any day or hour counted equally towards goals.

D.21-05-031 allowed CPUC staff to convene a workshop, working group, or to propose additional clarifications to the TSB metric, if necessary. This document further describes the TSB metric and proposes calculations and an implementation process within the Cost Effectiveness Tool (CET) for display in the California Energy Data and Reporting System (CEDARS). Furthermore, this document provides stakeholders with a step-by-step guide for calculating TSB and using the CET.

Policy Background

On March 12, 2020, the CPUC issued a ruling titled “Administrative Law Judge’s Ruling Inviting Responses to Potential and Goals Policy Questions (Potential and Goals Policy Ruling). Stakeholders responded to questions on energy efficiency goals and cost effectiveness assessments. The Natural Resources Defense Council (NRDC) submitted a proposed goals metric called “Total Economic Benefit” which the CPUC adapted into the Total System Benefit metric. The TSB metric was adopted in D.21-05-031 as the official metric for energy efficiency portfolio planning starting in 2024, but PAs should start informally reporting on the metric in program years 2022 and 2023.

Total System Benefit Definition

TSB is an expression, in dollars, of the lifecycle energy, ancillary services, generation capacity, transmission and distribution capacity, and GHG benefits of energy efficiency activities, on an annual basis.ⁱ The 2021 Energy Efficiency Potential and Goals study states that TSB represents the total benefits, or “avoided costs,” that a measure provides to the electric and natural gas systems.ⁱⁱ The factors included in avoided costs are defined through the CPUC Integrated Distributed Energy Resources (IDER) proceeding.ⁱⁱⁱ

It is important to note that changes to avoided costs and other benefits included in TSB may be adopted either via updates to the Avoided Cost Calculator (ACC) through the IDER proceeding, energy resource assessments, or other CPUC actions. This paper reflects only the benefits and supply costs considered as of the publication date or revision date. Appendix B: Versions & Updates provides information about when this paper was last updated.

CPUC Cost Effectiveness Assessments

The TSB metric relies on the ACC and other cost effectiveness policies set by the CPUC. The ACC determines the generic costs which can be avoided by not using traditional energy generation and distribution technologies. The avoided costs produced by the ACC are not specific to any distributed energy resource technology, and are simply the costs associated with the construction, operation, management, and maintenance of the traditional, fossil-fuel based electricity generation, energy markets, and the transmission and distribution grid. The output of the ACC consists of hourly avoided costs, in six categories, for a 30-year period. The six types of avoided costs are: energy, ancillary services, generation capacity, transmission and distribution capacity, and GHG benefits. The GHG benefits include both carbon (expressed through the GHG adder) and high global-warming potential gasses, such as methane and refrigerants.^{iv}

The ACC does not calculate the costs avoided by specific distributed energy resource activities. The costs avoided by energy efficiency resources are calculated by the CET. CET users provide annual energy savings associated with a measure and choose an approved end-use shape. The end-use shapes indicate when a measure saves energy and condenses the ACC values into quarterly profiles, based on the end use, climate zone, and building vintage.^v This process is depicted graphically in Figure 1.

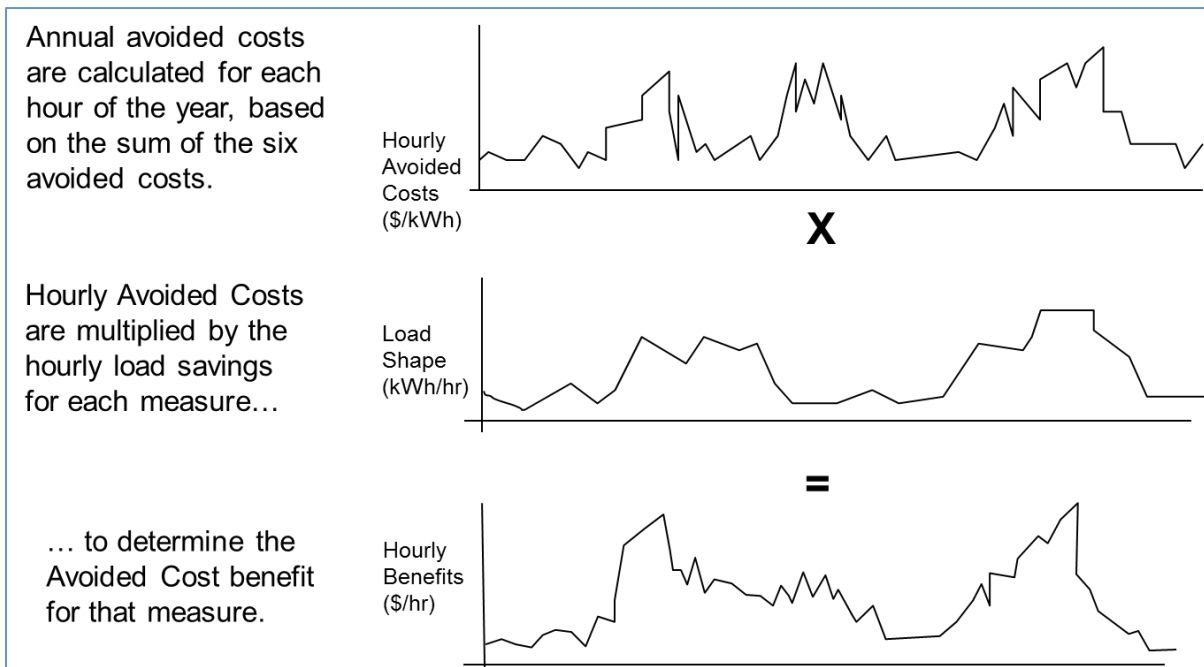


Figure 1: Calculation of Energy Efficiency Avoided Costs

This combined process produces most of the benefits and increased supply costs included in the TSB metric. Some benefits and increased supply costs are calculated separately, such as the benefit or cost of refrigerant leakage. For more information on the CPUC ACC and cost effectiveness policies, visit the CPUC cost effectiveness website: [Cost Effectiveness Website](#).

Audience

The audience for this document includes stakeholders involved with energy efficiency resources supported under the CPUC-authorized energy efficiency portfolios such as investor-owned utilities, regional energy networks (RENs), community choice aggregation (CCAs), program implementers, end users, product manufacturers, CPUC, and other indirectly affected stakeholders including ratepayer advocates and other interest groups.

Section 2: Maximizing Total System Benefit

This section discusses the objectives the CPUC anticipates the TSB metric will achieve. D.21-05-031 states that a purpose of the TSB metric is to tie the goals for program administrators directly to the avoided cost value of energy efficiency savings, which should encourage program administrators to pursue energy savings that deliver high value in some or all of the avoided cost categories: energy, generation capacity, ancillary services, transmission and distribution capacity, high global warming potential (GWP) gases, and GHGs.^{vi}

To illustrate this point, Figure 2 shows avoided cost values for saving 1 MWh of energy during each month in 2021 based on the 2021 ACC Electric Model version v1b.^{vii} This graph does not show the avoided cost of high global warming potential gas leak reduction, as that avoided cost is not calculated per kWh saved.^{viii} The largest contributor to the total avoided cost value is energy (dark green). The second largest contributor to avoided costs is the GHG adder (light blue). In September, capacity costs (yellow) are highly valued, so energy efficiency resources which reduce peak load will produce high TSB benefits.

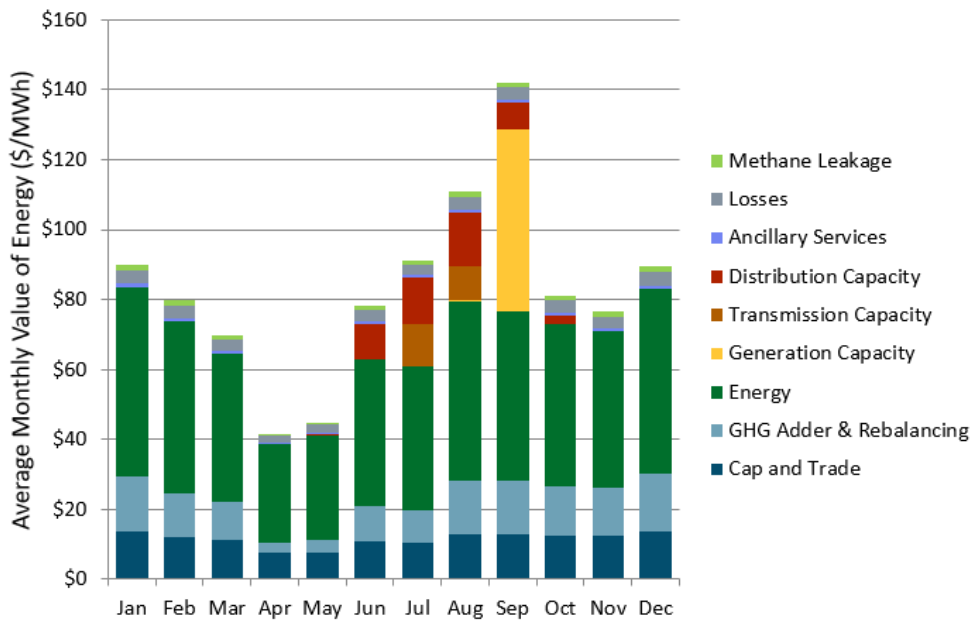


Figure 2: 2021 Avoided Cost Calculator, v 1a

Commenting on the Potential and Goals ruling, NRDC stated that setting goals based on total benefits would “guide program administrators and implementors to target and acquire the type and amount of energy efficiency most needed by the energy system.”^{ix} The type and amount of energy efficiency most needed by the energy system trends along hours which are the most highly valued in the 2021 ACC. Figure 3 shows the average value of 1 MWh in each hour of the day starting in 2024 and levelized over four years

(the length of the portfolio cycle). This graph averages the avoided cost values throughout the year. It demonstrates the daily variability in avoided cost values. For example, in hour 11, the total avoided cost value of saving 1 MWh is below \$25. In hour 19, 1MWh is valued at around \$225.

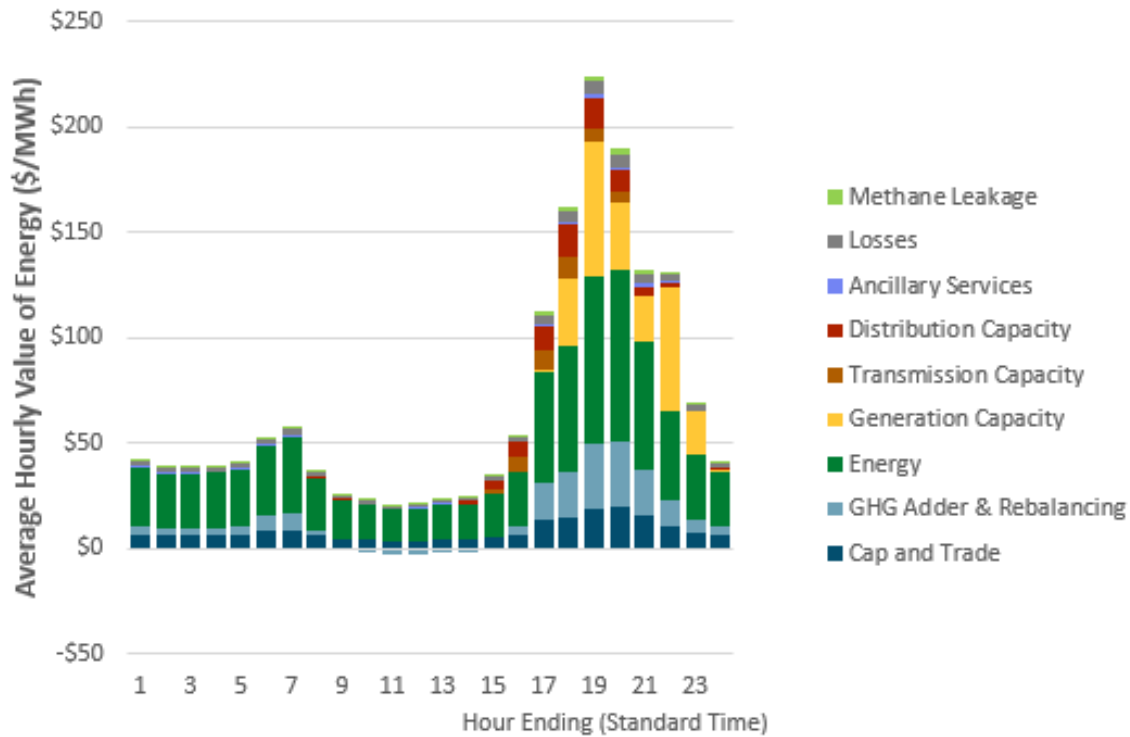


Figure 3: 2021 Avoided Cost Calculator, v.1a

As illustrated in Figure 3, the TSB metric encourages program administrators to orient their program offerings to resources that will reduce energy during hours 17 through 21 in order to deliver the highest value. Previously, energy saving attainment in any day or hour counted equally towards goals. Prior to adopting the TSB metric, the energy goals metrics equally incentivized savings in hour 13 and hour 19, despite dramatically different avoided costs.

Figure 4 shows a selection of measures from Southern California Edison’s 2020 filing. The plotted measures (non-codes and standards) save between .09 and 19000 lifecycle kWh per unit. With benefits per unit plotted on the x-axis and kWh per unit on the y-axis, it is evident that higher kWh saving measures generally deliver more benefits. However, Figure 4 also illustrates that some measures with similar kWh savings produce very different benefits (i.e., points in the figure with similar y-axis values that have very different x-axis values).

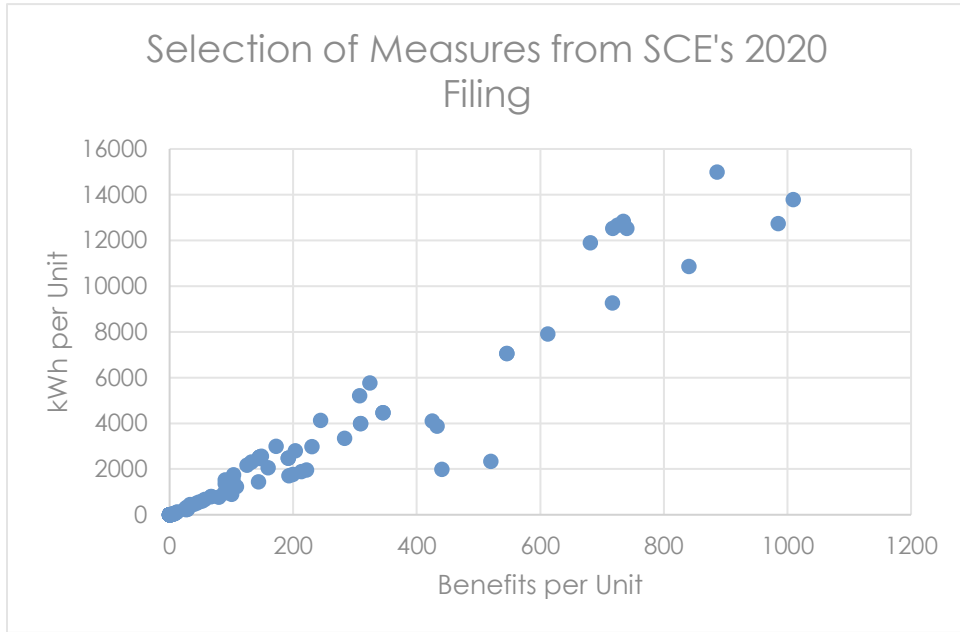


Figure 4: Benefits and kWh of SCE 2020 Filing Measures

In Table 1, the fan controller measure delivers the least lifecycle kWh savings of the three measures (2448 kWh). However, it produces the highest dollar benefit (\$520). Per kWh saved, the fan controller measure delivers \$0.22 in benefits. Comparatively, the agricultural clean water pump saves the highest kWh (2526 kWh) but produces the lowest dollar benefit (\$145). Per kWh saved, the agricultural pump produces only \$0.06 in benefits.

Measure	Lifecycle kWh	\$ Benefit	\$ Benefit per kWh
Fan Controller for Res. Air Conditioner	2448	\$520	\$0.22
Commercial Ice Machine	2484	\$192	\$0.08
Agricultural Clean Water Pump	2526	\$145	\$0.06

Table 1: Measure kWh and \$ Benefit

Section 3: Calculating Total System Benefit

Conceptually, calculating TSB is a two-step process which includes calculating benefits then subtracting the value of increased supply costs resulting from the energy efficiency activities. This section outlines the benefits and increased supply cost calculations. The high-level formula for TSB is outlined here, and in the Draft 2021 Potential and Goals study.^x A more detailed formula outlining the CET / CEDARs calculation is included in Section 4 and Appendix A.

$$\text{Total System Benefit} = \text{NTG Ratio} (\text{Sum of All Benefits}^{\text{xi}} - \text{Sum of All Increased Supply Costs}^{\text{xii}})$$

Benefit Calculation

The benefits portion of the TSB calculation includes the sum of all measure avoided costs reduced by the measure's net to gross ratio. The TSB calculation does not include non-avoided cost benefits, such as customer rebates, bill savings, or non-energy benefits unless specified by CPUC decision.

Most avoided costs are applied per kWh or Therm saved. These benefits are automatically applied by the CET to measures which saving kWh or Therms during hours when the cost is avoided. The benefits embedded in the CET calculations include the avoided cost of energy, capacity, transmission and distribution capacity, ancillary services, and some GHG benefits. The process for calculating these benefits is described at a high level in Section 1.

Accounting for Refrigerants

The avoided cost of refrigerant leakage is not applied per kWh saved and therefore must be calculated differently. Refrigerant benefits which are not applied on a kWh or therm basis must be calculated externally and applied to the TSB calculations through the CET input files. The refrigerant calculator produces the dollar benefit of avoided refrigerant leakage, which is inputted into the CET calculations using the process described in Section 4 and Appendix A. The avoided cost of refrigerant leakage applies only to measures which change the type of and/or quantity of refrigerant compared to the baseline. The refrigerant calculator is linked here: [Refrigerant Calculator](#).

Accounting for Avoided Gas Infrastructure Costs

CPUC staff adopted interim values for the avoided cost of gas infrastructure for use in energy efficiency cost effectiveness assessments.^{xiii} D.18-01-004 assigned the administration of the statewide new construction program to Pacific Gas and Electric (PG&E). In AL 4386-G/6094-E, PG&E requested that the California Energy-Smart Homes Program, All Electric Residential program claim applicable avoided gas infrastructure cost benefits.^{xiv} Energy Division approved the use of interim values in its non-standard

disposition letter approving this advice letter and directed PG&E to work with the other investor-owned utilities prior to the filing of program accomplishments for the all-electric new construction program.^{xv}

The dollar value associated with the avoided gas infrastructure cost is inputted into the CET calculations using the process described in Section 4 and Appendix A. The full benefits portion of the TSB value is calculated by adding together the avoided costs applied on a kWh or therm basis, the avoided cost of refrigerant leakage, and the avoided gas infrastructure costs. The avoided gas infrastructure cost values were approved through Advice Letters 4386-G/6094-E and 4387-G/6095-E.

Adjustment for Free Ridership

The TSB of energy efficiency resources may be calculated either gross or net of free riders. Per D.16-08-019, energy efficiency goals are set net of free ridership therefore TSB must be adjusted by the measure unique net-to-gross ratio.^{xvi} More information on measure-specific net-to-gross calculations can be found on the eTRM website: <https://www.caetrm.com/login/?next=/>.

As noted in Section 1, the TSB calculation may include additional avoided costs adopted by the CPUC in the energy efficiency or IDER proceedings in the future. These updated avoided costs may be embedded in the CET calculations, like the energy and capacity avoided costs, or inputted into the CET through external calculators, like the avoided cost of refrigerants.

Increased Supply Costs

In some instances, ratepayer funded energy efficiency activities can result in increased costs to supply energy. The Draft 2021 Potential and Goals Study calculated TSB net of supply costs.^{xvii} The three types of supply cost increases that are subtracted in the TSB metric in this version of the guidance include: interactive effects, load increases resulting from fuel substitution, and costs related to increased high GWP gases emissions. As with the measure benefits, increased supply costs are reduced by the net-to-gross ratio. These costs are described below:

Lighting Interactive Effects

Interactive effects are defined as increased heating load needs due to a decrease in heat gain from efficient lighting.^{xviii} As efficient lighting can result in a higher heating load, the CET subtracts the value of that load from the measure energy efficiency benefits when calculating TSB.

Fuel Substitution Load Increases

The increases resulting from fuel substitution occur when a technology utilizing one regulated fuel is replaced by a technology utilizing a different regulated fuel. Load from the original fuel decreases, but load from the new fuel increases.^{xix} For example, if a customer replaces their gas water heater with an electric heat pump water heater, their gas consumption will decrease but their electric consumption increases.

High GWP Refrigerant Leakage

Costs occur when energy efficiency measures utilize more refrigerants, or a different type of refrigerant compared to the measure baseline. For example, when substituting a gas furnace for a heat pump, the heat pump includes refrigerants to meet the cooling needs. According to 2020 ACC, those refrigerants leak into the atmosphere and result in increased mitigation costs for utilities.^{xx} Information on the high GWP benefits and costs will be tracked through the DEER update process. Measure specific information are available for review on the eTRM website: <https://www.caetrm.com/login/?next=/>.

Section 4: TSB in the CET

This section provides a high-level overview of how to calculate TSB using the CET. A detailed step-by-step guide for performing these calculations is included in Appendix A. Users can calculate TSB for energy efficiency portfolios and measures using the CPUC CEDARS website: <https://cedars.sound-data.com/>. To access the cost effectiveness tab on the website, users will need to make a free account. Once the account is confirmed, users can access the CET through the Cost Effectiveness Tool tab. For more complete directions on how to utilize the CET, access the user guide and review the provided training documentation.

The first step in calculating TSB is to provide critical inputs which describe the energy efficiency measure. Users need to state which program administrator offers the measure and in what building type and climate zone the measure will be installed. Then, users specify the fuel type and choose an approved load shape.

Next, users specify how much energy the measure saves annually. For deemed measures, these values are approved through workpapers or saved in the DEER database. Normal replacement measures have a single annual energy savings value, while accelerated replacement measures have one annual savings value assuming an existing conditions baseline and a second energy savings value assuming a code / standard practice baseline.

Then, users provide information about the measure performance. The CET has input fields for measure effective useful life, remaining useful life, installation rates, realization rates, and net-to-gross ratios. These values are reviewed and approved through the workpaper process or DEER.

Additional fields are required for measures which have avoided costs or supply costs not embedded into the CET calculations. Examples of these measures are included in Section 3. For measures which impact refrigerants, users take the output from the refrigerant calculator and enter it into the CET. For measures which avoid gas infrastructure costs, users enter approved advice letter values into the CET.

The fields listed in this document directly contribute to the calculation of TSB. However, all the CET fields are required to be accurately completed for the CET to process the input files. Complete all other measure fields according to the CET guidelines outlined in the [CET User Guide](#).

Once users complete the input files and enter them into the CET, the CET will process the results. The CET output files will display the following fields related to TSB:

TotalSystemBenefits: The measure TSB, calculated using the formula in step six, inclusive of the subtracted supply costs.

ElecSupplyCost & GasSupplyCost: The measure supply costs, which include the value of interactive effects, fuel substitution supply costs, and refrigerant supply costs as applicable.

Appendix A: Step-by-Step Guide for Calculating TSB in the CET

This step-by-step guide outlines the proposed process for integrating the TSB calculations into the CET and displayed in CEDARS. This guide is a proposal for the CET calculations, and may be adapted further based on implementation and additional CPUC direction. Please note that input name fields may change.

Step 1: For each measure, choose the appropriate Program Administrator, Electric and Gas Target Sectors, Measure End-Use Shape, Gas Savings Profile, and Building Climate Zone. Measure End-Use Shapes are specified in CPUC-approved workpapers or DEER, available on [eTRM](#). Input the values into the corresponding fields: *PA*, *E3TargetSector*, *E3GasSector*, *E3MeaElecEndUseShape*, *E3GasSavProfile*, and *E3ClimateZone*.

Note: In order to make the calculation, each measure must use an approved avoided cost combination which includes the program administrator, target sector, end use shape, climate zone, and start year. All approved avoided cost combinations are linked here:

https://cedars.sound-data.com/cet_ui/spec/avoidedcostcombo/

Step 2: Enter appropriate *UnitkW1stBaseline*, *UnitkWh1stBaseline*, and *UnitTherm1stBaseline* values based on approved workpapers or DEER. For normal replacement values, the first baseline represents the difference between standard / code baseline equipment and replacement equipment. For accelerated replacement measures, the first baseline field represents the difference between existing conditions equipment and replacement equipment.

Note: For fuel substitution measures, negative values entered into these fields will be calculated as “supply costs”, moved to the denominator of the cost effectiveness ratios, and subtracted from TSB benefits as supply costs.

Step 3: Enter appropriate *UnitkW2ndBaseline*, *UnitkWh2ndBaseline*, and *UnitTherm2ndBaseline* values based on approved workpapers or DEER. For normal replacement values, each value is zero. For accelerated replacement measures, the second baseline field represents the difference between standard / code baseline equipment and replacement equipment.

Note: For fuel substitution measures, negative values entered into these fields will be calculated as “supply costs”, moved to the denominator of the cost effectiveness ratios, and subtracted from TSB benefits as supply costs.

Step 4: Enter the appropriate Installation Rates (*InstallationRatekW*, *InstallationRatekWh*, *InstallationRateTherm*), Realization Rate (*RealizationRatekW*, *RealizationRatekWh*, *RealizationRateTherm*), Net-to-Gross Ratio (*NTGRkW*, *NTGRkWh*, *NTGRTherm*, *NTGRCost*), and

Expected and Remaining Useful Life (*EUL_ID*, *EULYrs*, *RUL_ID*, *RUL_Yrs*) values based on approved workpapers or DEER.

Step 5: Next, users enter the *UnitRefrigBens* and *UnitRefrigCost* fields. Positive values outputted from the refrigerant calculator represent avoided cost benefits of refrigerant leak reduction. Negative values outputted from the refrigerant calculator represent supply costs from refrigerant quantity increase or change of type. The link to the refrigerant calculator is here: <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm>

Step 6: Enter the *GasInfraBens* field, as applicable to the measure. The inputted values are the dollar benefits associated with the project or measure, calculated through the methodology proposed by PG&E in Advice Letters 4386-G/6094-E and 4387-G/6095-E. The advice letter is available for review [here](#).

Step 7: In the event that new avoided costs not applied on a kWh or therm basis are adopted through the IDER proceeding, they will be added into the TSBs calculations utilizing a similar process described in Step 5.

Step 8: Steps 1 – 7 outline the fields which directly contribute to calculating TSB. However, all the CET fields are required to be accurately completed for the CET to process the input files. Complete all other measure fields according to the CET guidelines outlined in the [CET User Guide](#).

Step 9: The CEDARS CET interface accepts zip archives as input files. The zip archive must contain two pipe-delimited .csv files: Measure.csv and ProgramCost.csv. A sample file is provided on the CEDARS website: https://cedars.sound-data.com/cet_ui/spec/source_of_truth/current/cet_good.zip. TSB is calculated in the backend of the CET using the following formula:

$$\text{TotalSystemBenefit} = (\text{ElecBen} + \text{GasBen} + \text{Qty} * (\text{NTGRkWh} + @\text{MEBens}) * \text{RefrigBens} + \text{Qty} * (\text{NTGRkWh} + @\text{MEBens}) * \text{GasInfraBens}) - (\text{ElecSupplyCost} + \text{GasSupplyCost} + \text{Qty} * (\text{NTGRkWh} + @\text{MECost}) * \text{UnitRefrigCosts})$$

Step 10: Once the specification update is completed on the CET, the CET output files will display the following fields related to TSB:

TotalSystemBenefits: The measure TSB, calculated using the formula in step six, inclusive of the subtracted supply costs.

ElecSupplyCost & GasSupplyCost: The measure supply costs, which include the value of interactive effects, fuel substitution supply costs, and refrigerant supply costs as applicable.

Appendices B: Versions and Updates

Draft Version 1.0: Released on August 6, 2021

Draft Version 1.1 Released on August 16, 2021 – Updated / repaired broken URLs. No other changes.

Final Version 1.0: Released **XXXX**.

ⁱ Assessment of Energy Efficiency Potential and Goals and Modification of Portfolio Approval and Oversight Process (2021) Decision (D.) 21-05-031, p. 9.

ⁱⁱ 2021 Potential and Goals Study, p. 3

ⁱⁱⁱ Integrated Distributed Energy Resources Proceeding, Rulemaking (R.) 14-10-003.

^{iv} 2020 Policy Updates to the Avoided Cost Calculator (2020) Decision (D.) 20-04-010.

^v DEER Load Shapes, <http://www.deeresources.com/index.php/deer-load-shape>.

^{vi} D.21-05-031, p.9.

^{vii} Cost Effectiveness, <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm>.

^{viii} Cost Effectiveness, <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/idsm>.

^{ix} Natural Resources Defense Council. *Opening Comments on Administrative Law Judge's Ruling Inviting Comments on Draft Potential and Goals Study, Appendix A*. p 5.

^x Energy Efficiency Potential and Goals Studies, 2021 Potential and Goals. <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies>

^{xi} In Version 1.0 of the Total System Benefit Guidance document, the benefits included in the TSB metric are the per kWh / Therm benefits adopted through IDER, refrigerant benefits, and avoided gas infrastructure benefits.

^{xii} In Version 1.0 of the Total System Benefit Guidance document, the increased supply costs included in the TSB metric are the lighting interactive effects, fuel substitution load increases, and high GWP refrigerant leakage.

^{xiii} Advice Letters 4386-G/6094-E and 4387-G/6095-E.

^{xiv} Advice Letters 4386-G/6094-E and 4387-G/6095-E, p. 7.

^{xv} ED Non-Standard Disposition of 4386-G/6094-E and 4387-G/6095-E, p. 6

^{xvi} D.21-05-031, p. 10

^{xvii} 2021 Draft PG Study

^{xviii} California Public Utilities Commission, *Draft 2021 Potential and Goals Study*, p.3.

<https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/demand-side-management/energy-efficiency/energy-efficiency-potential-and-goals-studies/2021-potential-and-goals-study>

^{xix} Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution (2019) Decision (D.) 19-08-009.

^{xx} D.20-04-010.