Marketplace Population NMEC M&V Plan

[**Summary**](#_q7xz3rn61pts) **2**

[**Population NMEC M&V Plan Compliance**](#_g9qyihe3hwoo) **3**

[Analytical Methods and Calculation Software Selection](#_88wa1bmj9xkv) 3

[Payable Savings](#_crr2kihxr24q) 3

[Claimable Savings](#_b5n1wut3pwh1) 4

[Calculation of Gross and Net Savings](#_qv8bth7rhji4) 5

[Gross Savings](#_lrl0nrrekofo) 5

[Baseline Calculation](#_dmo27ffmygm1) 5

[Normalization for weather and other factors](#_w45ilvb63wjn) 5

[Adjusted Gross and Net Savings](#_1p3200dappb) 6

[Outlier Site & Non-Routine Event Identification](#_n94fozorwhzx) 8

[Eligibility Criteria and Screening](#_j3tqzy9jzbdd) 9

[Non-Routine Events and Treatment](#_iqgnv0jaly9c) 9

[Hourly load shape and peak impact calculations](#_usb3mz6gvam5) 10

[Data Collection](#_65kgec8kglh2) 11

[Data Security](#_aiq7nmmk0883) 11

[Data Collection](#_ifie9q99fkoe) 11

[Monitoring and documentation QA/QC over reporting period](#_ukykhyilvczk) 12

[M&V related plans for project types, design, payments, measures and cost effectiveness](#_7uoyfurx6ob9) 12

[Permissible project types](#_xxnlhifi97o9) 12

[Program design criteria and fractional savings uncertainty (FSU)](#_ch71ua5dfr9o) 13

[Program Design Criteria](#_ml92qbsd2x9n) 13

[Fractional Savings Uncertainty](#_4dq1fuy2zbuc) 13

[Payments and incentives](#_o6fo4b2yzyrc) 15

[Qualifying measures](#_294u8njwbety) 16

[Cost effectiveness](#_xmto1pgc348n) 16

[Eligibility Criteria](#_irco27xvc3r6) 16

[Effective Useful Life (EUL)](#_6cm8wxwz1lnj) 17

[Methods, Payment Terms, and Risk](#_6zntjs5bzk2) 18

[Methods for Payable and Claimable Savings](#_qm9xrt4opvqp) 18

[Payment Terms](#_7kdno44m4v0b) 18

[Risk Mitigation](#_iie092sufsfg) 18

[To Code Savings Compliance](#_sy2jn3x17u9r) 19

[Bid M&V Plan](#_j8f9v6ml8jdg) 20

[**ATTACHMENT A. Tools, Methods, Analytical Approaches and Software Criteria**](#_l71pzvih7nk3) **21**

Population NMEC M&V Plan

Program Name: MCE Commercial Efficiency Marketplace

Market Implementer: Recurve

Program Administrator: MCE

# Summary

This is a Program-Level Measurement and Verification (M&V) Plan for the MCE Commercial Efficiency Marketplace (Commercial Marketplace). The program is eligible for and complies with the population-level NMEC requirements defined in the CPUC NMEC Rulebook v.2.[[1]](#footnote-1) Based on the definitions provided by the CPUC, population-level NMEC is used when savings claims are made for a portfolio of projects using fixed, standardized, verifiable measurement methods established before the program starts and that are uniformly applied to all sites in the group.[[2]](#footnote-2) All NMEC approaches are based on pre- and post-intervention energy usage data observed at the meter.

The program implementation plan[[3]](#footnote-3) for the Commercial Marketplace provides the details for how the program shall be implemented. The population-level NMEC M&V approach is appropriate for this program because it meets the program design criteria related to expected savings and permissible project types related to building-type similarity.

The Commercial Marketplace implemented by Recurve will utilize independent, transparent measurement and continual tracking of changes in pre- and post-intervention energy usage observed at the meter. Standardized, open-source CalTRACK and OpenEEmeter executed on the Recurve Platform are the foundation of this M&V plan. The remainder of this document details compliance with the CPUC NMEC Rulebook 2.0 requirements for the program-level M&V Plan for Population NMEC which must be included in any implementation plan.

# Population NMEC M&V Plan Compliance

## Analytical Methods and Calculation Software Selection

This Commercial Marketplace is designed for the commercial sector within MCE’s service territory. Targeted building types, including consumption trends, existing equipment and likely impact of the interventions, will be reasonably consistent for each aggregator within the program and therefore Population NMEC M&V is an appropriate fit. Qualified bidders will mostly focus on installing a primary technology across a similar sub-section of the commercial market, but the implementation plan does not pre-define the measures nor the targeted sub-set of the market. These decisions will be part of the initial qualification process (see Program Implementation Plan).

Initial savings estimates will be reviewed and validated by Recurve for as reasonable. Since they are not foundational to the Aggregator payments review is focused on ensuring customers are getting reliable internal estimates of savings potential and that MCE can have confidence in forecasted impacts and manage performance payment budgets.

Table 1. Pre-Installation Verification of Savings Estimation Options

|  |  |
| --- | --- |
| **Approach** | **Project Documentation from Aggregator** |
| **Actuarial***Meter-based past performance* | Past evaluation report, third party evaluation or engineering assessment of a similar project's past performance utilizing whole building IPMVP Option C methods; e.g. CalTRACK/OpenEEmeter or ECam |
| **Modeled***Building simulation projection* | Results of a building simulation model like Energy Plus, EQuest, or other similar IPMVP Option D modeling tool. Models calibrated with actual usage data are preferred. |
| **Deemed***Pre-approved standardized measure-specific savings* | Citation of a CPUC approved or archived work paper, or other DEER value. Measure-specific savings estimates from CalTF via the eTRM may also be appropriate but should be calibrated for to-code performance. |
| **Bottom-Up***Multiple approved and standardized measure-specific savings* | Citation of a suite of deemed values (see above) combined to estimate the whole impacts of a project. Interactions between measures should be considered in the estimate. |

### Payable Savings

Payable savings constitute the basis of payments between the Program Administrator and Aggregator(s). The public, open source CalTRACK methods and OpenEEmeter have been chosen as the analytical method(s) and calculation software for payable savings for this program. A wide range of commercial building types may be part of the program and a threshold baseline model fit will be a precursor for project acceptance. The CalTRACK 2.0 hourly methods will be used to determine electric savings and CalTRACK 2.0 daily methods for gas savings. These methods provide the foundation for payable savings. The CalTRACK methods will be implemented using the open-source [OpenEEmeter](https://www.lfenergy.org/projects/openeemeter/) (curated within Linux Foundation Energy). Background on development of CalTRACK and the OpenEEmeter can be accessed through [www.caltrack.org](http://www.caltrack.org). References to technical specifics are provided throughout this M&V plan.

The CalTRACK methods[[4]](#footnote-4), which describe how to quantify the weather normalized change in energy use for each hour compared to past usage, and the OpenEEmeter[[5]](#footnote-5), which is the Python codebase for savings calculation implementation, are publically available for download and inspection. The CalTRACK methods are based on industry guidelines established by The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE Guideline 14)[[6]](#footnote-6) and the Uniform Methods Project (Chapter 8 - Whole Building Methods)[[7]](#footnote-7) and meet all International Performance Measurement and Verification Protocol (IPMVP Option C[[8]](#footnote-8)) requirements. These methods are an appropriate match for this program given it is targeting a range of commercial buildings and combination of interventions. Hourly methods have demonstrated appropriate fit based on historic applications and technical review, and discrete project baseline fit review. Additionally, recent tests conducted by the Efficiency Valuation Organization’s (EVO) demonstrate that the OpenEEmeter 2.6.0 CalTRACK hourly methods, performs on par with the LBNL Time of Week Temperature (TOWT) model, and better than all other models tested as of July 2019, including more complex machine learning models that are based on decision trees and genetic programming.[[9]](#footnote-9)

Payable savings will be adjusted via a comparison group adhering to the protocols and recommendations described in the report *Comparison Groups for the COVID Era and Beyond.*[[10]](#footnote-10) These methods were developed in partnership with the United States Department of Energy and in consultation with a working group of industry experts. Comparison groups are described further below.

The CPUC has specified criteria for “Tools, Methods, Analytical Approaches, and Calculation Software” in the NMEC 2.0 rulebook. Compliance with each of the criteria is provided in Attachment A in table format.

### Claimable Savings

Commercial Marketplace claimable savings will be based on the payable savings (calculated with CalTRACK and the OpenEEmeter) and adjusted for free ridership using the deemed net to gross ratio approved for Commercial NMEC of 0.95. The October 12, 2019 DEER Resolution allows for alternative approaches for net adjustment, but for this program the traditional application of the net to gross ratio will be combined with the comparison group adjustment to gross savings impacts.[[11]](#footnote-11)

Other fields required for claimed savings include the estimated useful life (EUL), load shape, and costs. These parameters of claimed savings will be handled in accordance with CPUC reporting requirements. Aggregator portfolios of reasonably consistent measures will utilize an EUL matching the primary measure or technology installed. Savings will be claimed using the actual load shape.[[12]](#footnote-12) Actual project costs, including participant contributions and information on the key value drivers, will be collected during program implementation to support savings claims to the CPUC.

## Calculation of Gross and Net Savings

### Gross Savings

The basic calculation process for gross savings is conducted in four parts using the CalTRACK calculation methods after data collection and sufficiency checks (see Data Plan section D. for more detail). The first is establishing the baseline calculation or model fit (see CalTRACK Section 3(b): Modeling - Hourly Methods). The second is normalization of weather and occupancy (section 3.8 and 3.9). The third is computing the results of the avoided energy use (sections 3.10-3.12) and the fourth is the formation of comparison groups and adjustment to savings via the difference of differences calculation (Chapters 3 and 4 of *Comparison Groups for the COVID Era and Beyond*).

#### Baseline Calculation

The CalTRACK Hourly model draws from 365 days of pre-intervention data in order to deliver a fully specified baseline model for a weather-normalized savings calculation.

Customer AMI data for a full year prior to program enrollment, customer location (address or latitude/longitude coordinates), initial project intervention date, and blackout period that encompasses the duration of project installation are minimal requirements to fully specify the CalTRACK model and assess savings. Aggregators will report project installation and completion dates in addition to various project metadata, which will enable Recurve to assign baseline, blackout, and reporting periods and to create project cohorts that can be tracked separately.

#### Normalization for weather and other factors

The CalTRACK Hourly methods normalize for weather and occupancy, as described in detail in section 3.8 and 3.9 of CalTRACK technical documentation.

For occupancy, the sensitivity of building energy use to temperature may vary depending on the “occupancy” status. This is handled by segmenting the hours-of-week into periods of high load and low load (also referred to as occupied/unoccupied, although the states may not necessarily correspond to specific occupancy changes). The segmentation is accomplished using the residuals of a linear HDD-CDD model fit at an earlier stage.

For weather normalization, for each data point (hour) in the baseline dataset, the outdoor dry bulb air temperature is used to calculate up to 7 temperature bins (<30, 30-45, 45-55, 55-65, 65-75, 75-90, >90). These bin endpoints are validated for each model by counting the number of hours with temperatures within these bins. Bins with fewer than 20 hours are combined with the next closest bin by dropping the larger bin endpoint, except for the largest bin, where the lower endpoint is dropped. The 𝑁 valid bin endpoints are then used to develop the binned temperature features.

For the purpose of calculating claimable savings, the same modeling approach is applied to the reporting period using the same rules as for the baseline period. For claimable savings, the coefficients of both the baseline and reporting period are fit to the weather conditions of a Typical Weather Year using CZ 2010 weather data. Savings are calculated as a difference in difference between the energy consumption forecasted in a typical weather year under the baseline energy use conditions and under the reporting period energy use conditions.

These methods have been tested and demonstrate that they yield appropriate model fit for most commercial building types in California (as measured by the coefficient of variation of the root-mean-squared error, CVRMSE).[[13]](#footnote-13)

### Adjusted Gross and Net Savings

For the Commercial Marketplace the site-specific gross savings will be adjusted to quantify the relative grid impacts of the program interventions using a comparison group and adjusted for free ridership using a fixed net to gross value. Both adjustments will be reflected in the payable savings to aggregators and in the claimable savings to the CPUC.

A comparison group for each aggregator portfolio will be maintained for a gross savings adjustment. The same savings calculation as described in the "gross savings" section including method and software will be applied to understand participant and comparison group changes in energy consumption. The calculated incremental impact of the program over the non-participant population will adjust both payable and claimable savings for the portfolio. The adjusted gross[[14]](#footnote-14) will be the difference of differences on a percentage basis applied to the counterfactual baseline to determine the value of the savings.

Comparison groups used in meter-based programs have the unique challenge of needing to quantify impacts in the midst of implementation as well as address dissimilar responses to exogenous factors, unpredictable exogenous events, and limited data for assigning buildings to cohorts. As such, the comparison group selection process in meter-based programs needs to utilize a more standardized and consistent methodology than what might be found in traditional impact evaluations.

The methodological approach used for establishing comparison groups in the Commercial Marketplace was developed in an intensive, collaborative research project led by Recurve and funded by DOE in the summer of 2020. More detail on the research informing this method is described in a comprehensive working group report funded by the Department of Energy and peer reviewed by industry leaders.[[15]](#footnote-15) The comparison group analytic approach comports with best practices in the Department of Energy Uniform Methods Project on Estimating Net Savings[[16]](#footnote-16), and is an evolution of standardized approaches for developing matched comparison groups documented by the Energy Trust of Oregon.[[17]](#footnote-17)

**Comparison Group Method Synopsis - Adapted to MCE Commercial Marketplace**

Recurve will execute the comparison group construction according to the methods summarized below which were modified to incorporate the specific elements of the Commercial Marketplace from the DOE report. Because the Commercial Marketplace will serve commercial customers, the primary comparison group selection strategy will be to weight the number of meters by business type (determined by NAICS codes) such that the comparison group has the same proportionality as the treatment group.

1. **Identify program-eligible participants**
	1. The eligibility rules for this program are included in the implementation plan. These classifications will guide the classification of comparable customers.
2. **Limit comparison group to eligible customers that meet program requirements. Identifying eligibility is also the first step to defining a relevant comparison pool from which a comparison group will ultimately be formed.**
	1. Fit a CalTRACK 2.0 model on all eligible program participants prior to program launch. This model will uncover incomplete or missing data, erratic energy consumption patterns, and potential for higher savings. Where program optimization techniques are applied, such as selecting targeted customers based on energy consumption profiles, customers who fit these criteria can be proportionally sampled as described in [Chapter 3](https://grid.recurve.com/sampling-methods.html) in order to more specifically anticipate the likely program enrollees.
	2. Remove outlier customers from the comparison group sampling pool.
	3. Array all eligible customers by annualized consumption by fitting the baseline CalTRACK model to weather conditions of the baseline year.
	4. Remove customers with daily baseline CVRMSE values in excess of 1.0.
	5. Remove any remaining customers failing to meet program eligibility criteria
3. **Selection of Comparison Group from within Stratified Sample of Sub-Population**
	1. If a treated group is substantially different from the comparison group selected, the sub-population may be resampled to select a comparison group more similar to the treatment group.
	2. Resampling should only occur once enrollment in the program has reached a sufficient level to support stratified sampling from the broader population of eligible non-participants. [Chapter 3](https://grid.recurve.com/sampling-methods.html) provides a detailed procedure for conducting and optimizing stratified sampling.
	3. Sample proportionally according to business type as determined by NAICS Groups (see Appendix A for NAICS code mapping to NAICS Groups).
4. **Creation of Comparison Group Vintages and Difference of Differences**
	1. Once a comparison group has been created, the baseline period of the comparison group must be aligned temporally with the baseline period of the participating customers.
	2. Where programs enroll customers over a period of time longer than 30 days, the comparison group must be rebaselined for each month of enrollment and a new vintage created that is assigned to a monthly cohort of enrolled participants.
	3. For each monthly cohort of participants, calculate a difference of differences of percentage savings between the treated customers and the associated vintage of the comparison group.
	4. The difference of differences in percentage terms can be multiplied by the raw total for the purposes of aggregation of multiple treated cohorts.
	5. The difference of differences calculation should be applied to the model counterfactual for the determination of savings. More detail is provided in [Chapter 4](https://grid.recurve.com/difference-of-differences.html) on conducting the difference of differences savings calculations.

For payable and claimable net savings, Recurve will apply the 0.95 approved net to gross ratio adopted for Commercial NMEC programs in the October 12, 2019 DEER Resolution[[18]](#footnote-18) to account for free ridership.

### Outlier Site & Non-Routine Event Identification

In addition to targeting Commercial customers, this section of the M&V plan augments generic qualification criteria for participants with specific considerations regarding project eligibility criteria, screening, and handling of non-routine events to ensure that the savings from the program are reflective of the impacts of the program intervention. The process includes pre-screening, event detection and handling adjustments as described in the sections below. The following diagram illustrates the 4 step process:



#### Eligibility Criteria and Screening

**STEP 1.** Recurve will utilize CalTRACK modeling to pre-screen the population to identify qualifying customers that have data sufficiency and baseline model fit that will allow for tracking in the performance period. Customers must have 12 months of data and a CVRMSE (pre intervention) that is under 1.0. Customers who experience a temporary non-routine event or erratic energy consumption that exceeds the prescribed threshold during the baseline period will be excluded from program participation unless:

(i) the impacted metered consumption can be excluded from the analysis without violating minimum data sufficiency standards; or

(ii) the NRE can be adequately controlled by comparing customer energy consumption to a matched nonparticipant comparison group. Aggregators will be able to check potential projects against this pre-screened list.

In the process of customer acquisition, aggregators will verify with customers that they have not nor do they plan to install major new load additions or subtractions, solar PV, or EV charging in the reporting year (post-program implementation). In addition, aggregators will work with Recurve and MCE to ensure that customers are not participating in another energy efficiency program, have not installed an EV charging system, or solar PV or battery storage within the baseline year. Finally, Recurve will work with MCE to ensure that savings claims will not be duplicated for deemed measures by cross-referencing known participants in other programs.

#### Non-Routine Events and Treatment

**STEP 2.** Once projects have been initiated, Recurve shall regularly conduct screening of all projects in the aggregators’ portfolios for possible non-routine events in three dimensions:

* **Savings relative to baseline consumption.** Recalculate savings as a percentage of baseline consumption for all participating projects on a quarterly basis. Flag the highest and lowest one percent (1%) of projects, plus any projects with savings exceeding ±75 percent of baseline (after adjustment by comparison group).
* **Deterioration in normalization model goodness of fit.** Fit CalTRACK model to the Year 1 post-retrofit consumption data and recalculate CVRMSE at the end of Year 1, prior to a savings claim. If the Year 1 model has a CVRMSE of greater than 0.5, then the Project will be flagged as a non-routine event.

**STEP 3 & 4.** If it has been determined that metered savings results are invalid, the project savings will be estimated using a consistent transparent adjustment that will be applied uniformly to all disqualified projects. This value is based on the realization rate for the other projects (without non-routine events) in the aggregators’ portfolio and calculated for electric and gas savings separately.

Estimated Savings = Realization Rate \* Predicted Annual Project Savings

Where:

Estimated Savings = Annual non-routine-adjusted savings to calculate performance payments

Realization Rate = Aggregators total portfolio actual savings divided by total predicted portfolio savings;

∑ S /∑ P

Where:

S = Actual annual project savings in kWh or therms as calculated in Recurve platform

P = Predicted annual project savings in kWh or therms as reported by the Aggregator during Project submission to Recurve

Each project in the sub-portfolio designated for approved non-routine adjustments will be adjusted by the appropriate amount relative to its "home" portfolio. Recurve will calculate non-routine adjustments, review with the aggregator and apply to annual performance payments in the place of measured savings.

Aggregators will review and adopt this standard approach for the identification and treatment of non-routine events as part of their contract with Recurve. Systematic and predictable treatment of non-routine events tied to overall portfolio performance to manage risk comports with the Population-NMEC expectation of consistent calculations and treatment of projects across the portfolio. No custom calculations of non-routine adjustments will be conducted for this program.

## Hourly load shape and peak impact calculations

CalTRACK V.2.0 hourly methods, which quantify the change in energy use for each hour in the reporting period compared to baseline usage at the same hour of the year, will be used to assess electric savings including load shape impacts, to ensure an accurate valuation of savings and marginal greenhouse gas (GHG) impacts.[[19]](#footnote-19),[[20]](#footnote-20) Measurement of metered savings on an hourly basis will give MCE and CPUC essential information to accurately gauge the GHG and avoided cost impacts of the Demand Flexibility Marketplace program. For gas savings the CalTRACK V.2.0 daily methods will be used.[[21]](#footnote-21)

At this time, actual load shape impacts cannot be reported to the CPUC via CEDARS - Cost-Effectiveness Tool.[[22]](#footnote-22) Deemed load shapes or proportional deemed load shapes are used to mirror the impacts of meter-based programs (see Home Energy Reports Filing). For the Demand Flexibility Marketplace program, actual load shapes will be submitted. If actual load shapes are not accepted, a proportional multi-deemed load shape that is the closest reflection of the actual load shape achieved by the program will be used.

Peak impact calculations will leverage the hourly data to estimate the peak impacts achieved by the program during the peak periods defined in the October 11, 2019, DEER Resolution.[[23]](#footnote-23) Timing of peak load is 4:00 p.m. to 9:00 p.m over a three consecutive weekday “heatwave” that occurs between June 1st and September 30th, does not include weekends or holidays, has the highest value for the sum of the average temperature over the three-day period, plus the average temperature from noon to 6 p.m. over the three day period, plus the peak temperature over the three-day period.

## Data Collection

### Data Security

Data security and customer privacy are paramount for effective, trustworthy customer programs. Recurve has implemented rigorous data security procedures and protocols at every step of data transfer, analysis, and reporting for handling AMI data and customer information. Recurve data tools and systems are built on modern industry standards. Security agreements with MCE and aggregators are available upon request.

### Data Collection

The availability and quality of AMI consumption data for proper baselines is fundamental to identifying NMEC program participants. CalTRACK details necessary data and sufficiency requirements for the establishment of appropriate baselines in [Section 2. Data Management](http://docs.caltrack.org/en/latest/methods.html#section-2-data-management).

Aggregators will collect the site and meter information required for proper weather station matching project start and end dates needed for identification of baseline, blackout, and reporting periods to meet the CalTRACK with the specification. Aggregators will collect relevant project and site metadata as specified in the aggregator’s Flexibility Purchase Agreement. These data will include participant, location, meter id, date of installation, technology installed, and project costs. Any or all of these data will be utilized for more granular cohort (program subgroup) tracking and management and could be used to facilitate future EM&V studies.

For developing a comparison group, a sample of non-participant customers will be identified to perform accurate matching and comprise a reliable comparison group. Recurve has access to the full population of MCE's commercial customer base to define a robust comparison group.

## Monitoring and documentation QA/QC over reporting period

The CalTRACK modeling process specifies quality assurance and quality control procedures. Recurve will maintain quality data management and monitoring throughout the program life to ensure the reporting period results generate an accurate representation of the savings impacts. As part of this M&V plan Recurve will provide a fully auditable and verifiable record to track each meter that is modeled and its fate over the course of the program. MCE will oversee the QA/QC process to verify measure installation through a separate agreement.

## M&V related plans for project types, design, payments, measures and cost effectiveness

### Permissible project types

As noted in the implementation plan, the Commercial Marketplace will be made up of several aggregators targeting a range of building types. For any given aggregator, the targeted customers are reasonably expected to have similar types of equipment and drivers in energy consumption. During the aggregator qualification process Recurve will ensure that factors that impact consumption and energy savings will be relatively similar across the population.

In addition, the Commercial Marketplace will leverage insights from multiple recent studies[[24]](#footnote-24),[[25]](#footnote-25),[[26]](#footnote-26) and PG&E’s Energy Efficiency Business Plan[[27]](#footnote-27) which have shown that recruiting customers based on insights from AMI data analytics can effectively identify stranded potential and substantially enhance the metered savings and cost-effectiveness of energy efficiency programs. These analyses will be conducted by Recurve in partnership with qualified aggregators to find populations that may have similar characteristics of usage prior to intervention and that will be predictive of impacts of the intervention.

### Program design criteria and fractional savings uncertainty (FSU)

#### Program Design Criteria

The Commercial Marketplace has been designed to meet the CPUC criteria for population-level NMEC programs. Recurve is currently forecasting 350 projects that encompass lighting and HVAC. In the third portfolio, Recurve is forecasting 200 heat pump fuel switching projects. Based on analysis of eligible buildings in the MCE service territory that meet program requirements, and forecasted average savings of 10%, we estimate a portfolio fractional savings uncertainty of 8.2% at the 90% confidence level, well within the 25% guideline for Population NMEC.

#### Fractional Savings Uncertainty

Calculation of Fractional Savings Uncertainty used in this plan complies with industry best practice and specifically reflects Section 4.3 of the CalTRACK methods. The two key metrics for uncertainty are the Coefficient of Variation of the Root Mean Square Error (CVRMSE) and Fractional Savings Uncertainty (FSU). The FSU depends on a number of interactive factors, several of which have non-linear dependencies. In general, driving deeper savings, recruiting customers with good model fit, and serving a large number of customers will improve FSU at a given confidence interval. FSU at an individual site level is defined by the following equation:



where

t is the t-statistic and a, b, and d are empirical coefficients described further in the online CalTRACK documentation

M is the number of months in the reporting period

Q is the number of periods in the reporting period (days or billing periods for example)

F is the savings fraction defined as the savings divided by the counterfactual baseline usage

CVRMSE is the coefficient of variation of the root-mean-squared error and provides a measurement of the quality of model fit (lower CVRMSE equates to better model fit) and is defined as follows:



where

UP is the total energy use during period P

Uhat is the predicted energy use during period p

Ubar is the mean energy use during the baseline period

P is the total number of periods

c is the number of explanatory variables in the model

Fractional savings uncertainty at an aggregated (portfolio) level is calculated via the following equation:



For the Commercial Marketplace the CalTRACK methods described above were applied to a sample of buildings that are likely to be targeted as part of the program. Assumptions about the forecasted average savings and savings depth as a percentage of the baseline were derived from past project experience and combinations of DEER technology savings and load shapes (HVAC, Lighting and fuel-substitution) that will be deployed as part of the program. Recurve has estimated the rough number of projects needed to capture savings under projected budgets; and discrete business plans from Aggregators will further refine these estimates..

The CalTRACK methods model each site individually before aggregating to the portfolio level with savings uncertainty reported as a first-class output. Savings uncertainty, as opposed to savings depth, is the ultimate parameter of concern (e.g. savings of 4+/-1% may be acceptable, but savings of 10+/-3% may be unacceptable). Aggregating results to a portfolio mitigates issues related to model noise and increases confidence in savings estimates. An extensive discussion of model uncertainty is included in CalTRACK documentation and was leveraged for this analysis.[[28]](#footnote-28)

Based on assumptions, if the Commercial Marketplace is able to achieve 500 installations of the planned technologies, and achieve the forecasted average savings, FSU will fall well within the bounds of the CPUC requirements. Recurve expects to achieve the CPUC’s stated desired FSU of +/- 25% at the 90% confidence level by recruiting a sufficient number of projects, supporting aggregators in recruiting customers with a reasonable CVRMSE (generally less than 0.75), monitoring savings for a sufficient number of days (FSU will be calculated with the CalTRACK daily model), and delivering a reasonable savings depth measured from existing conditions baseline.

#### Payments and incentives

Aggregators will be eligible for an "efficiency" payment and additional "flexibility" payment depending on the performance of their portfolio. The payment structure is designed to incentivize maximum performance around net benefits, and maintain cost-effective savings. Both payments are dependent on actual savings achieved at the meter, while the Flexibility Payment creates an additional incentive to improve the load shape value over deemed assumptions.

In calculating the net benefits (avoided costs), Recurve will take the full measured 8,760 electric savings resource curve and multiply by the appropriate hourly avoided cost profile of the CPUC’s Electric Avoided Cost Calculator for the duration of the Effective Useful Life of the measure. The gas benefits will be paid based on the lifetime therm savings based on the measured annual savings, effective useful life, and the forecasted value per therm. The forecasted therms value is derived from the CPUC’s Gas Avoided Cost Calculator.

The minimum Efficiency Payment is based on the forecasted fixed rate of the projected value (avoided cost benefit net of customer and administrative costs) of projects in the portfolio divided by the portfolio savings. Aggregators will be paid for their portfolio per kwh or therm achieved in the first year following projects completion based on the metered savings achieved, and the deemed load shape. The Efficiency Payment is net of the upfront customer contribution to the cost of the project and administrative costs to support cost-effectiveness.

A Flexibility Payment is available to aggregators that demonstrate that the actual savings and actual load shape deliver higher net benefits than the deemed forecasted value. The Flexibility Payment is also net of the upfront customer contribution to the cost of the project and administrative costs to support cost-effectiveness.

The Aggregator is not eligible for either the Efficiency or Flexibility payment if the net benefits from their portfolio do not exceed the corresponding costs, which consist of energy-related customer (participant) cost and implementation costs.

MCE payments for this population-level program will be made based on payable savings determinations using NMEC methods described in the gross and net sections of this plan. Payments for the program will be made after the 12-month post-intervention measurement period is complete and final payable savings determinations are made.

Recurve will document in an electronic, revenue-grade, auditable ledger the recommended payments to support aggregator invoices to MCE monthly once the first project has reached 12 month maturity. The electronic ledger will track all stages of a NMEC project in a program, including non-routine adjustments. Invoice payment recommendations will be based on CalTRACK payable savings results. Claimable results to the CPUC will be derived from the ledger with adjustments for normal year, and compliance with reporting requirements.

#### Qualifying measures

The Commercial Marketplace will promote a wide range of measures, as described in the implementation plan. The types of measures that are installed will be documented in the course of program deployment and be included in the metadata (see Data Collection section).

As aggregators will be recruited as part of this plan, Recurve has used the deemed measures as a starting point for forecasting key cost-effectiveness parameters and qualifying measures anticipated to be the focus of the program these include lighting, HVAC, and heat pump fuel substitution measures.

####  Cost effectiveness

The Commercial Marketplace was designed for compliance with all of the Commission's current cost effectiveness rules. All data needed to calculate cost effectiveness for this program are included in this plan. MCE’s 2021 ABAL filed with the Commission illustrates cost-effectiveness.

Recurve has broken out the cost-effectiveness forecast into three line items. The first encompases lighting measures in which we have used the DEER:Indoor\_Non-CFL\_Ltg load shape with a weighted average EUL of 10 years. The second covers HVAC measures with a 7 year weighted average EUL and is represented with the DEER:HVAC\_Chillers load shape. Recurve is currently forecasting a total of 550 projects. Of that total project amount, 350 encompass lighting and HVAC, and 200 heat pump fuel substitution. We have used the DEER:HVAC\_Split-Package\_HP load shape for these projects, and based on our meter-based analysis for SMUD, anticipate a roughly 10% increase in building kWh consumption. This is reflected in a negative kWh savings value. In all cases we have used Climate Zone 3A and a NTG of 1.0. We have removed the 5% market effects using the associated CET option as per direction from MCE. At this point Recurve is forecasting a 1.08 TRC for the 2021 program year.

## Eligibility Criteria

*See Section b. Calculation of Gross and Net Savings/Eligibility Criteria and Screening*

Recurve will utilize CalTRACK modeling to qualify customers based on data sufficiency and baseline model fit in addition to other usage characteristics. Aggregators will verify with customers that they do not plan to install major new load additions or subtractions, solar PV or EV charging in the reporting year (post program implementation). In addition, Recurve will work with MCE to ensure that the customers have not participated in another energy efficiency program, installed an EV charging system, or installed solar PV or battery storage within the baseline year. Finally, Recurve will work with MCE to ensure that savings claims will not be duplicated for deemed measures by cross-referencing known participants in other programs and not allowing them to participate.

## Effective Useful Life (EUL)

The Commercial Marketplace includes the following interventions lighting, HVAC and fuel switching technologies. The DEER or approved workpapers listed in the following table will be utilized to assign EUL values. The program is technology agnostic and a wide array of measures may be installed to meet the savings and demand impact targets. Measures will be identified and appropriate EULs will be applied as part of the final claimable savings calculations. The information provided here is consistent with the MCE 2021 Annual Budget Advice Letter (ABAL).

|  |  |  |
| --- | --- | --- |
| **Technology / Intervention** | **DEER / Workpaper Name** | **Effective Useful Life** |
| LED Ambient Fixtures  | DEER:Indoor\_Non-CFL\_Ltg loadshape | Weighted average EUL of 10 years |
| Retrofit Kits |
|  LED High or Low Bay |
| LED Tube measures. |
| Heat Pump fuel switching measures | DEER:HVAC\_Split-Package\_HP load shape | Historic Average EUL 2019 Savings claims of 10 Years |
| HVAC | DEER:HVAC\_Chillers load shape | Weighted Average EUL of 7 year  |

In preparing savings claims, Recurve and MCE will develop combined measure claims In accordance with the CPUC’s guidance on “Weighted Average Expected Useful Life/Net to Gross Method.[[29]](#footnote-29) Since the outputs of the calculator are dependent on the savings achieved, the projected EUL for this program is not yet known. The forecasted savings in the ABAL are utilizing the EUL's of the primary measures, assuming single measure installations by site.

## Methods, Payment Terms, and Risk

### Methods for Payable and Claimable Savings

*See section a. Analytical Methods and Calculation Software Selection and section b. Calculation of Gross and Net Savings for detail on methods and the expected difference between payable and claimable savings.*

### Payment Terms

Recurve and qualified aggregators will establish the payment terms in their contract based on a pricing formula wherein the base rate is the net avoided cost value of the technology type divided by the kwh and therm savings respectively. The CPUC's deemed parameters determine the payment rate by primary technology installed based on: 1.) primary measure (including EUL) 2.) deemed load shape and 3.) project location. Value is directly related to the net benefit stream in the current Avoided Cost Calculator and a rate sheet for each year is included in the contract with the aggregator. An alternative payment is available to aggregators that demonstrate (via the measured actual load shape) they have exceeded the deemed loadshape value.

This formula is designed in accordance with the NMEC Rulebook 2.0 guidance and all known Commission directives related to terms and conditions. Compliance on payment terms for this M&V plan are described in *Section f. Payments and Incentives.*

### Risk Mitigation

In the Commercial Marketplace, the difference in payable and claimable savings will reflect the future grid impact achieved through the program. If the fixed NTG ratio was used for this NMEC program it will be about 95% of the savings achieved.[[30]](#footnote-30)

100% of the payment to the aggregator is based on the annual savings achieved at the meter. The aggregator takes on the upfront risk, and arranges financing, to deliver impacts. This risk is within their power to mitigate with successful program implementation, innovative financing, insurance, and with targeting support provided by the program administrator. The Commercial Marketplace represents minimal risk for MCE or ratepayers especially when compared to deemed program models given that the program administrator will only pay for savings achieved at the meter and by design will meet minimum cost effectiveness criteria.

The Commercial Marketplace will further mitigate risk of settlement dispute by using a consistent, transparent means of tracking the impacts for settling payable savings as described in this M&V plan. Payment to the implementer is completely based on savings delivered at the meter, and will be made on an annual basis. Recurve will provide targeting support to the qualified aggregators in support of achieving their collective goals.

The Commercial Marketplace is designed to minimize risk to program administrators, moderate risk for project developers with a portfolio pricing scheme, and decouple interest in the savings from the entity calculating the savings. MCE makes incremental payments by project rather than committing to full project or program costs. All payments to external entities are depending on identifying projects and the performance of those projects. In the worst-case scenario: MCE pays its administrative cost (staff); no projects come forward, and no savings are achieved, which would still represent a very small portion of the total allocated budget.

An easy way to visualize the risk is looking at a three point table as has been done in other papers on understanding risk in pay for performance programs:[[31]](#footnote-31)

|  |
| --- |
| MCE / RATEPAYERS**Upfront**: Administrative cost (staff)**If projects materialize:** Portion of the forecasted benefits for monitoring and tracking**If savings materialize:** Payment of base rate per kwh or therm |
| CUSTOMERS / PARTICIPANTS**Upfront**: Contribution to project**If savings materialize**: enough savings to generate value for the customer in addition to other value provided by the project. | PROJECT DEVELOPERS / AGGREGATOR**Upfront:** Forecasting, Business plans, Customer recruitment, project development, financing, etc.**If projects materialize:** Fixed rate needs to be enough to cover costs and generate margin**If savings materialize**: Ineligibility risk will fall on developers (manage risk with portfolio), that installations can exceed minimum deemed load shapes and generate flexibility payment. |

## To Code Savings Compliance

The Commercial Marketplace program is targeting to-code savings as described in the implementation plan. Compliance with [D. 17-11-006 Ordering Paragraph 2](https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M199/K076/199076456.PDF) is met in Section 6 of the implementation plan.

The M&V plan described herein will quantify the savings achieved compared to an existing conditions baseline as authorized in AB802, SB350 and detailed in the methods sections of this M&V plan.

## Bid M&V Plan

The Commercial Marketplace will not conduct a bidding process for this program. It will utilize an aggregator qualification approach that reduces barriers to entry. Bid M&V plans will not exist.

# **ATTACHMENT A. Tools, Methods, Analytical Approaches and Software Criteria**

In the NMEC Rulebook V. 2.0 (p. 17) the CPUC outlines specific criteria for the approaches and calculation software allowable and preferable for NMECpopulation-level M&V. The following table itemizes the criteria in the left hand column and how the proposed tools, methods, analytical approaches and calculation software in this M&V plan meet these criteria.

|  |  |
| --- | --- |
| ***Tools, Methods, Analytical Approaches and Calculation Software - CPUC Criteria*** | **Compliance demonstrated in this M&V plan** |
| ***Savings Calculations:*** *All analytical methods, including tools, algorithms and software used in savings and incentive or compensation payment calculations, must be made available to Commission staff and its consultants upon request.*  | The proposed analytical methods ([CalTRACK](http://docs.caltrack.org/en/latest/methods.html)) and calculation software ([OpenEEmeter](https://www.lfenergy.org/projects/openeemeter/)) are open source and publicly available. Stratified comparison group methods ([GRIDMeter](https://grid.recurve.com/methods.html)) are publicly available.A certificate of [compliance](https://www.caltrack.org/caltrack-compliance.html) with the CalTRACK methods will be provided to the PA, CPUC, and Evaluators. All data will be readily accessible and made available upon request. |
| ***Measurement Period:*** *Savings determinations must be made by comparing at least 12 months of post-intervention energy consumption to at least 12 months of pre-intervention energy consumption.*  | CalTRACK data handling (see [Section 2](http://docs.caltrack.org/en/latest/methods.html#section-2-data-management) of the technical specification) will be followed which screens for pre-intervention baseline data criteria: **“2.2.1.1.** Consumption and temperature data should be sufficient to allow for a 365-day baseline period”Interim savings determinations will be assessed on an ongoing basis but reported annually and based on the Commission guidelines. |
| ***Transparency:*** *Data, methods and calculations must be made available to the PAs well as the Commission and its impact evaluators.*  | The proposed analytical methods ([CalTRACK](http://docs.caltrack.org/en/latest/methods.html)), ([GRIDMeter](https://grid.recurve.com/methods.html)) and calculation software ([OpenEEmeter](https://www.lfenergy.org/projects/openeemeter/)) are open source and publicly available. [Certification](https://www.caltrack.org/caltrack-compliance.html) of compliance will be provided to PAs, the CPUC and impact evaluators in addition to access to all data methods and calculations. |
| ***Documentation and Replicability****: The methods used to calculate savings for NMEC programs must be documented in the program-level M&V Plan sufficiently such that savings calculations are able to be replicated by the PAs well as the Commission and its impact evaluators. Upon request, the underlying participant consumption data and other data inputs must be made available to the PAs well as the Commission and its impact evaluators such that savings calculations can be replicated to reach the same result.*  | The methods used to calculate savings are referenced in the program-level M&V plan and the details for savings calculation, including data handling, and weather station selection are documented in the [CalTRACK 2.0 Technical Specification](http://docs.caltrack.org/en/latest/methods.html). Stratified sample comparison group methods for quantifying net impacts to the grid are documented in [GRIDMeter](https://grid.recurve.com/methods.html). The [OpenEEmeter](https://www.lfenergy.org/projects/openeemeter/) is a Python code base which enables replication of the CalTRACK methods.All data will be made available. In addition, documentation of data handling, and calculations will be documented and provided to PA, CPUC and evaluators to quickly isolate any differences in results using the same data. |
| ***Consistent, Pre-Set Method****: For Population-level NMEC programs, the specific measurement method(s) and calculation software must be determined before the program begins and applied uniformly to all sites in the program.* | The [CalTRACK](http://docs.caltrack.org/en/latest/methods.html) and [GRIDMeter](https://grid.recurve.com/methods.html) methods and [OpenEEmeter](https://www.lfenergy.org/projects/openeemeter/) code base have been pre-determined for this program; and will be applied uniformly to all sites in the program.[Certification](https://www.caltrack.org/caltrack-compliance.html) of compliance and documentation of data handling will validate uniform application to all sites in the program. |

1. Rulebook for Programs and Projects Based on Normalized Metered Energy Consumption, January 7, 2020 <https://www.cpuc.ca.gov/General.aspx?id=6442456320> [↑](#footnote-ref-1)
2. CPUC’s full definition: “*Population-level NMEC is an energy savings calculation approach in which results are based on pre- and post-intervention energy usage data observed at the meter and calculated across a group of sites, rather than a modeled engineering forecast or deemed value (or a Site-level metered savings calculation). For Population-level NMEC, measurement methods are fixed before the program starts and apply to all sites in the group in a uniform fashion, as opposed to Site-level NMEC measurement methods which may differ on a site-by-site basis.*” Rulebook p. 24 [↑](#footnote-ref-2)
3. Templates for implementation plans can be found here: <http://eestats.cpuc.ca.gov/StandardTables/GuidanceDocument.aspx> [↑](#footnote-ref-3)
4. The current v. 2.0 CalTRACK methods documentation and technical appendix are available at <http://docs.caltrack.org/en/latest/methods.html> [↑](#footnote-ref-4)
5. The python code base for the OpenEEmeter (eemeter and eeweather) can be downloaded from Github at: <https://github.com/openeemeter> [↑](#footnote-ref-5)
6. ASHRAE Guideline 14-2014 –Published guideline. Supersedes ASHRAE Guideline 14-2002. Measurement of Energy, Demand and Water Savings <https://www.ashrae.org/technical-resources/standards-and-guidelines/titles-purposes-and-scopes> [↑](#footnote-ref-6)
7. *The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures*, National Renewable Energy Laboratory, <https://www.energy.gov/eere/about-us/ump-protocols> [↑](#footnote-ref-7)
8. International Performance Measurement & Verification Protocol: Concepts and Options for Determining Energy and Water Savings, Volume I, Revised March 2002 DOE/GO-102002-1554, International Performance Measurement & Verification Protocol Committee <https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp> [↑](#footnote-ref-8)
9. EVO’s testing portal <<http://mvportal.evo-world.org/> > allows users to compare Advanced M&V implementations and methods against each other using a single standardized dataset comprised of one year of hourly electricity data and outdoor temperature from 367 buildings from different regions in North America. [↑](#footnote-ref-9)
10. Report available at: https://grid.recurve.com/methods.html [↑](#footnote-ref-10)
11. Resolution E-4952. Approval of the Database for Energy-Efficient Resources updates for 2020 and revised version 2019 in Compliance with D.15-10-028, D.16-08-019, and Resolution E-4818. See p. A-45 for table of NMEC NTG ratios. <http://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf> [↑](#footnote-ref-11)
12. Reporting the actual load shape will be achieved either by weighting the existing load shapes to match the actual, or submit actual load shape pending updates to the CET. [↑](#footnote-ref-12)
13. *Technical Report: Testing and Analysis of Residential and Commercial Billing Data*, Recurve (Prepared for the California Energy Commission) [↑](#footnote-ref-13)
14. "adjusted gross" is, in this context, net of other activity on the grid, whereas the final "net" adjustment is considering free ridership alone. [↑](#footnote-ref-14)
15. *Comparison Groups for the COVID Era and Beyond*, Recurve, 2020 <https://grid.recurve.com/uploads/8/6/5/0/8650231/recurve_comparison_group_methods_final_report_2.pdf> [↑](#footnote-ref-15)
16. *Chapter 21: Estimating Net Savings – Common Practices* <https://www.nrel.gov/docs/fy17osti/68578.pdf> [↑](#footnote-ref-16)
17. *Comparison Group Identification for Impact Evaluation*, OpenEE, for Energy Trust of Oregon, 10/2018 <https://www.energytrust.org/documents/open-ee-technical-report-comparison-group-identification-for-impact-evaluation/openee-technical-report-comparison-group-identification-methods-final-wsr/> [↑](#footnote-ref-17)
18. Resolution E-4952. Approval of the Database for Energy-Efficient Resources updates for 2020 and revised version 2019 in Compliance with D.15-10-028, D.16-08-019, and Resolution E-4818. See p. A-45 for table of NMEC NTG ratios. <http://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf> [↑](#footnote-ref-18)
19. A careful study of the CPUC’s 2019 Avoided Cost Calculator reveals that over-generation and renewables curtailment is forecast for 25% of all hours in 2025 with the majority of these hours occurring during mid-day time periods and mild shoulder months. [↑](#footnote-ref-19)
20. Golden, M., A. Scheer and C. Best. 2019. “*Decarbonization of Electricity Requires Market-Based Demand Flexibility*”. The Electricity Journal. Vol 32. Issue 7 (August-September). [↑](#footnote-ref-20)
21. Gas data is generally available but hourly gas data are only available in part of the state. [↑](#footnote-ref-21)
22. Recurve is hopeful functionality to submit actual load shapes will be available by the time savings can be reported for this program. [↑](#footnote-ref-22)
23. <http://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf> [↑](#footnote-ref-23)
24. *Customer Targeting for Residential Energy Efficiency Programs: Enhancing Electricity Savings at the Meter*, A.M. Scheer, S. Borgeson, K. Rosendo, 2017 [↑](#footnote-ref-24)
25. *Energy Efficiency Program Targeting: Using AMI Data Analysis to Improve At-the-Meter Savings for Small and Medium Businesses*, S. Borgeson, A.M. Scheer, R. Kasman et. al. 2018 [↑](#footnote-ref-25)
26. *Customer Targeting via Usage Data Analytics to Enhance Metered Savings*, 2018 ACEEE Summer Study, A.M. Scheer, S. Borgeson, R. Kasman et al. [↑](#footnote-ref-26)
27. PG&E’s Energy Efficiency Business Plan 2018 – 2025, Residential Appendix D [↑](#footnote-ref-27)
28. See CalTRACK issue: <https://github.com/energy-market-methods/caltrack/issues/71>. [↑](#footnote-ref-28)
29. Rolling Portfolio Program Guidance; Weighted Average Expected Useful Life/Net to Gross Method. Excel Spreadsheet titled “Combining\_Measures\_Claims-DRAFT”. The spreadsheet calculator has not been updated to reflect new DEER values; so can only be used with respect to the proposed method. <https://www.cpuc.ca.gov/General.aspx?id=6442456320> [↑](#footnote-ref-29)
30. From DEER Resolution 2019:NMEC NTG; Non-Residential: 0.95; Residential Single-Family: 0.85; Residential Multi-Family: 0.55 <http://docs.cpuc.ca.gov/publisheddocs/published/g000/m232/k459/232459122.pdf>: or DEER Resources: <http://www.deeresources.com/index.php/23-deer-versions> [↑](#footnote-ref-30)
31. [Where's the Risk with Pay for Performance? Rob Hansen, ACEEE paper 2018](https://www.aceee.org/files/proceedings/2018/node_modules/pdfjs-dist-viewer-min/build/minified/web/viewer.html?file=../../../../../assets/attachments/0194_0286_000184.pdf#search=%22hansen%22) [↑](#footnote-ref-31)