

M e m o r a n d u m

FROM: Jeff Sage-Lauck and Sepideh Shahinfard, SBW Consulting
TO: Ayad Al Shaik, FutEE
DATE: February 17, 2022
RE: Proof of concept study for integration of two custom measures into eTRM, interim memo
CC:

This memo summarizes the SBW team’s effort for exploring how the eTRM engine can be used to include two Los Angeles Department of Water and Power (LADWP) custom measures in the eTRM. The next step is for SBW to share these findings with OMBU. OMBU will build on this effort to create a list of software enhancements.

Background and Objectives

The eTRM is currently the system of record for California’s deemed energy efficiency measures. FutEE engaged SBW to explore how custom measures might be incorporated into the eTRM. Given complexities involved in the custom project development and review processes, the SBW team started this integration process with a proof-of-concept approach to identify enhancements required for integrating two LADWP custom projects in the eTRM. The goal of this effort was to demonstrate the viability and practicability of this initiative and identify enhancements required to accommodate these two custom measures in the eTRM architecture.

Research Questions and Approach

For this work, we focused on the following research questions:

1. Are the current calculation abilities of the eTRM sufficient to handle custom measure calculations?
2. What enhancements would be needed to improve the usability of eTRM calculations for custom measures?

We used two approved spreadsheet calculators from LADWP as the basis for this work. These two approved calculators include the CLIP lighting calculator and the TRM401 VFD Savings Calculator. The CLIP calculator is a lighting calculator that estimates savings for lighting upgrade measures by estimating the energy consumption difference between existing condition

baseline and installed lighting. The TRM401 VFD Savings Calculator estimate energy savings for motor control upgrades for various control strategies.

We explored three alternatives for incorporating these two custom calculators into the eTRM:

- **Alternative 1.** The eTRM serves as a repository for external calculators.
- **Alternative 2.** The eTRM serves as a repository for external calculators and storage of completed calculator files.
- **Alternative 3.** The eTRM contains prototypical models using eTRM calculations that can be used by measure developers to create custom measures.

Alternative 1. Calculators Repository and Version Controls

Description

Alternative 1 represents the simplest option to incorporate custom measures into the eTRM and requires only a few modifications. In this alternative, the eTRM would serve as a repository for approved calculators, allowing project implementers to access and download spreadsheet calculators for specific projects. This alternative utilizes the existing eTRM infrastructure and all calculations occur outside of eTRM.

Implementation

Below, we provide an overview of how this alternative would work in the eTRM.

- Measure Characterization section will be used to describe the calculator history, scope, methodology, eligibility, and M&V requirements.
- Excel-based calculators are stored as References and inserted into the characterization as embedded reference links.
- Users can download the calculator by clicking on the link as shown in Figure 1.

Technology Summary

The CLIP workbook can be downloaded for use by clicking the following link:

LADWP CLIP workbook  [Download](#) (XLSX, 1.8 MB)

Figure 1. Calculator file download link

Dependencies and Supporting data are used to clarify certain measure characteristics.

- A new version of the measure is created and approved whenever the calculator is updated.

Note that the Calculations and Permutations sections are not applicable to this alternative since all calculations occur outside of the eTRM.

Recommended Modifications

It is possible to implement this alternative without any modifications, however, SBW recommends the following updates:

- Characterization section titles could be updated and standardized so that the sections are meaningful for custom measure calculators.
- Instead of considering the calculators as references, it may be useful to have a separate library just for calculators. The Assets manager allows for upload of images and videos so perhaps an additional group for calculators could be added.
- Allow measure developers or system admins to remove Calculations and Permutations sections from a measure if they are not needed.

Alternative 2. Alternative 1 with Storage of Calculator Files

Description

Alternative 2 is an enhanced version of Alternative 1 and would allow implementers to upload and store completed calculator files.

Implementation

The basic mechanics of this alternative are likely easy to implement but it would require major changes to the eTRM for accessibility and security purposes. Specifically, controls would need to be implemented to ensure appropriate access to project-specific files and protect personally identifying information (PII).

Recommended Modifications

We recommend the following modifications for this alternative:

- This alternative would require the same modifications as Alternative 1 plus the inclusion of an upload button for project specific calculators.
- Additional modifications are needed for security enhancements, PII protection, and file access, but these are considered workflow related items and are outside the scope of this project.

Alternative 3. Prototypical Models

Description

This alternative explored the possibility of leveraging the eTRM's calculation abilities to perform all savings calculations in the eTRM. We used two approved spreadsheet calculators from LADWP as the basis for calculation comparison: the CLIP lighting calculator and the TRM401 VFD Savings Calculator.

Implementation

We created calculations for two examples of projects (one lighting upgrade and one motor control upgrade) in the eTRM and compared the results with two spreadsheet calculators. All examples were developed in the Stage eTRM site and explained below for each calculator.

CLIP calculator. The CLIP spreadsheet compares existing conditions to proposed equipment to estimate energy savings for lighting upgrade projects. The existing fixture wattage is based on Standard Fixture Wattage in Appendix B while the proposed fixture wattage is based on user input. Annual hours of use are input by the user inputs.

For this example, we entered three fixture replacements into the CLIP spreadsheet. We then developed the measure in the eTRM to recreate the outputs of the CLIP spreadsheet. Figure 2 shows measure parameters and value tables that we entered into the eTRM.

Measure Parameters

Parameters are used to characterize individual measure permutations that qualify energy savings and (in some cases) costs.

	MEASURE APPLICATION TYPE NR
	EXISTING LUMINAIRE TYPE 2-Lamp 4' LF T8 32W, 50W, 2-Lamp Halogen, CFL 50W Lamp
	MEASURE EQUIPMENT TYPE Model 1, Model 2, Model 3
	MEASURE DESCRIPTION LED Interior Wall/Ceiling Fixture
	MECHANICAL COOLING No, Yes
	BASELINE LIGHTING CONTROL ECC, ECN, ECO, EDC, EOS, None, VEXT
	MEASURE LIGHTING CONTROL NCC, NCO, NDD, NDS, NFI, NIT, NOS, VEXT
	NEW EQUIPMENT STATUS Conforming Lamp or Fixture, Non-Conforming Fixture or Lamp, Non-Qualified Lamp or Fixture or Retrofit Kit

Value tables

Value tables are used to assign specific numeric values to equations as well as to define values relevant to measure tracking and reporting.

	Offering ID
	Measure Offerings
	Existing Fixture Characteristics
	Constants
	Measure Fixture Characteristics
	Baseline Controls Adjustment Factors
	Measure Controls Adjustment Factors
	New Equipment Status Values
	Lighting Measure Incentive Rates
	Lighting Controls Incentive Rate
	Interactive Effects Incentive Rate

Figure 2. CLIP measure parameters and value tables

This configuration resulted in a total of 3024 permutations. We then used exclusion tables to select only the parameters of interest, resulting in only the desired 3 permutations. Alternatively, the parameter labels could have been activated for each parameter. Note, however, that the Existing Luminaire Type parameter could have hundreds of labels if all the Appendix B fixtures were included. Creating exclusions or activating only certain labels could be extremely cumbersome if all fixtures were included.

A total of 14 calculations were developed to match the calculations in the CLIP spreadsheet in a nearly one-to-one fashion. Figure 3 shows an example of these calculations.

Projected Lighting Measure Savings in kWh

VALIDITY	EQUATION (KWH)
✓	<i>ProjLightingLoadSavings • AdjustedAnnualHours • NewEquipStatusValues__ConformingValue</i>

Figure 3. Example of lighting calculatins created in eTRM

Finally, we built the permutations table and compared the resulting values to the results in the spreadsheet calculator. Note that for the purpose of saving time, we did not map all fields to the permutations table.

The eTRM calculation results closely matched the results in the CLIP calculator. However, there are small differences due to how the eTRM handles significant figures. Table 1 compares the projected savings in the eTRM to the projected savings in CLIP spreadsheet. Note that the projected savings for Measure 3 appear to be 4 kWh less in the eTRM than in the CLIP spreadsheet.

Table 1: Results comparison between eTRM equations and CLIP spreadsheet

	eTRM Projected Savings (kWh)	CLIP Projected Savings (kWh)
Measure 1	524	524.400
Measure 2	684	684.000
Measure 3	2390	2394.000

TRM401 VFD Savings Calculator. The VFD calculator compares usage of the motor using the baseline and installed control strategy to estimate energy savings. The user selects the existing motor control and proposed motor control, enters annual hours of use, and selects a load profile. The user may also create a custom load profile for cases where logger or trend data is available. The calculator uses percent-flow bins for the load profile and a table that relates percent full load power to percent flow is used to estimate the energy for each bin.

The calculator includes options for fans, pumps, and throttling valves. We created an eTRM measure for only the fan option, but the other two are very similar and could easily be developed. Figure 4 shows measure parameters and value tables that we developed in the eTRM.

Measure Parameters

Parameters are used to characterize individual measure permutations that qualify energy savings and (in some cases) costs.

MEASURE APPLICATION TYPE	AOE
EXISTING CONTROL TYPE	Constant Volume, Eddy Current Drives, Inlet Damper Box, Inlet Guide Vane, BI & Airfoil Fans, Inlet Guide Vane, FC Fans, Outlet Damper, BI & Airfoil Fans, Outlet Damper, FC Fans, VSD
MEASURE CONTROL TYPE	Constant Volume, Eddy Current Drives, Inlet Damper Box, Inlet Guide Vane, BI & Airfoil Fans, Inlet Guide Vane, FC Fans, Outlet Damper, BI & Airfoil Fans, Outlet Damper, FC Fans, VSD
LOAD CURVE PROFILE	CO Garage Fan, Custom or Metered, HVAC fan, Low Load, Medium Load

Value tables

Value tables are used to assign specific numeric values to equations as well as to define values relevant to measure tracking and reporting.

Offering ID
Constants
Measure Offerings
Fan Motor Characteristics
Percent Design Fan Power - Existing
Percent Design Fan Power - Measure
Load Profile Bins - Percent Hours

Figure 4. VFD measure parameters and value tables

This configuration yielded 320 permutations. We created exclusion tables to limit the permutations to only one. We developed a total of 26 calculations in the eTRM to recreate the calculations in the VFD Savings Calculator spreadsheet as shown in Figure 5.

CALCULATIONS	PERMUTATIONS	SUBSCRIPTIONS
Top	Annual Baseline Fan Energy - 70% Flow	Annual Measure Fan Energy - 40% Flow
Full Load Motor Power	Annual Baseline Fan Energy - 80% Flow	Annual Measure Fan Energy - 50% Flow
Annual Baseline Fan Energy - 0% Flow	Annual Baseline Fan Energy - 90% Flow	Annual Measure Fan Energy - 60% Flow
Annual Baseline Fan Energy - 10% Flow	Annual Baseline Fan Energy - 100% Flow	Annual Measure Fan Energy - 70% Flow
Annual Baseline Fan Energy - 20% Flow	Total Baseline Fan Energy	Annual Measure Fan Energy - 80% Flow
Annual Baseline Fan Energy - 30% Flow	Annual Measure Fan Energy - 0% Flow	Annual Measure Fan Energy - 90% Flow
Annual Baseline Fan Energy - 40% Flow	Annual Measure Fan Energy - 10% Flow	Annual Measure Fan Energy - 100% Flow
Annual Baseline Fan Energy - 50% Flow	Annual Measure Fan Energy - 20% Flow	Total Measure Fan Energy
Annual Baseline Fan Energy - 60% Flow	Annual Measure Fan Energy - 30% Flow	Annual Energy Savings

Figure 5. Example of VFD calculations created in eTRM

Note that a separate calculation was required for each percent-flow bin for both the baseline and measure cases.

We found that the eTRM was able to perform the calculations, however, it was rather cumbersome to develop. Several calculations were required since they were needed for each % Flow bin. Like the CLIP example, calculated values differed slightly due to the way eTRM handles significant figures. For our example, the eTRM projected total annual savings of 35,600 kWh and the spreadsheet calculator projected total annual savings of 35,685 kWh.

Challenges and Limitations

Here we present challenges that we countered while implementing this alternative:

- Developing these examples of custom measures in the eTRM presented many challenges and limitations. Prototype models for lighting are challenging to develop given the number of options available for existing and proposed equipment. Including all the possible options creates too many permutations. Exclusion tables or label selection must be used to reduce the permutations, which can be time consuming and prone to error. This process is also fundamentally different than the spreadsheet calculators, where a user only enters data that is needed.
- Additionally, the eTRM does not allow the use of if-then statements in the calculations, which presents a challenge when a threshold is required. For example, if a minimum of 10% savings is required for a measure to be eligible, the eTRM does not have a way to incorporate this into the calculations. Also, the eTRM does not offer a way to sum the values in a column, so total project savings must be calculated outside of the eTRM.
- In the lighting example, there may be spaces that use the same baseline and proposed fixtures, but the hours of use are different. This can only be modeled in eTRM if the hours of use are specified as a parameter.
- Currently, all user inputs must be performed by a measure developer and stored in a value table. Once the measure is published, only a measure developer or system administrator can activate parameter labels and make changes to the values. This process is not feasible for custom measures that are dynamic by nature.
- Many parts of the measure development process were quite cumbersome. For example, in the VFD measure, creating calculations for each percent-flow bin was time consuming. While this issue would likely only affect the measure developers, it is important to consider how much effort would be needed to convert existing calculators into eTRM measures.

Recommended Modifications

Following are our recommended modifications to allow the eTRM to incorporate this alternative.

- Allow multiple variations of a permutation for custom measures. For example, lighting projects may have spaces that use the same baseline and measure fixtures but have different hours of use.

- Calculations should support the use of “if-then” statements. This impacts calculations where there are savings thresholds for eligibility (e.g., a measure must have an energy savings of at least 10% to be eligible). This also impacts the ability to use overrides.
- Allow users to upload trend data in a specified format and automatically bin the data to create a load profile.
- Allow the ability to sum values in a column (e.g., total project savings).
- Allow dynamic (user-defined) inputs for some fields. Measure developers would need the ability to create dynamic variables for use in calculations.
- Allow a user to only input needed data needed instead of having all parameters and values included and using exclusion tables to limit outputs. Measure developers could develop the measure with all the available parameters and values and users could select the needed parameters and values.
- Allow users to dynamically create permutations and update calculations. Similar to the above recommendation, measure developers could create templates that include dynamic variables. Users would select specific parameters and enter values for dynamic variables, then build the permutations to update calculations.