MEMORANDUM

CALIFORNIA TECHNICAL FORUM

Date: December 19, 2019

To: Cal TF Members

From: Ayad Al-Shaikh and Roger Baker, Cal TF Staff

Subject: Statewide Measure Savings Methodology Overview

I. Overview and Objectives

Through the statewide measure consolidation process, Cal TF Staff reviewed and catalogued the savings calculation methodologies used for each deemed statewide measure (see Attachment A). Cal TF Staff would next like to work with Cal TF to review trends in energy savings calculation methodologies across measures and end-uses, then develop a recommended framework for how savings for different measure types should be calculated. Having a clear framework for developing deemed savings will help:

- Create more consistency in energy savings calculation approaches
- Provide greater transparency into measure energy savings calculations. Transparency is diminished because of several factors that occur in the modeling approaches described:
    - We do not know how robust weighting factors are (ie, source or age of this data or whether they account for the full population of buildings rather than the population of actual/prospective participants.
    - For DEER measures we do not always know the differences between the base case and the measure case.
    - Results are difficult to reproduce or validate because they come from the combination of so many modeled results.
- Ensure modeling is used only when using modeling is truly cost-beneficial, as modeled measures are less transparent and more expensive to create and maintain than calculated measures

II. Approach

Statewide consolidated measures have been uploaded into the eTRM so their methodologies are available in a structured and readily accessible form. Cal TF Staff identified six different savings calculation method categories that range from building simulation approaches to fully calculated approaches.

1. DEER Modeled

- Whole building simulations that are run in eQUEST/DOE2.3. Typically, these are modeled with a batch[1] processor (MASControl3) and post-processed with SQL scripts because the savings value represents a weighted average savings across several parameters that could include Building Type, Climate Zone, Vintage, and HVAC Type.
- Modeling Approach for a Single Permutation: A single measure permutation described as: "Commercial Building Type, Existing Vintage, and Climate Zone 1" involves the following:
    i. Model Creation: Usage Determination: User enters into MASControl3 the desired measure and desired combinations of building types, vintages and climate zones. MASControl3 creates ~1,500 models (24 individual commercial building types, 4 vintages, ~6-10 HVAC types, 1 climate zone, baseline/proposed models)[2]; MASControl3 then runs the models in DOE2.3 and generates 1,500 building level usage results representing different combinations of pre-defined building types, building vintages, HVAC types and a single climate zone[3].
    ii. Post Processing: Extract Savings: Post processing is performed to extract the usage from each model then savings from each model pair (base case and measure case) through a series of SQL scripts outside of MASControl3[4].
    iii. Post Processing: Weighting Savings Based on Square Footage of Each Commercial Building Type/Vintage/HVAC Type/Climate Zone: The scripts outside of MASControl3 then weights the savings based upon the appropriate building area (square footage) for each combination of building type/vintage/HVAC type/climate zone. Weighting includes building type, building vintage, climate zone and HVAC type.[5] The weighting is done though a script outside of MASControl3.
- Modeling Multiple Permutations for a Single Measure: The steps above would need to be repeated for each additional permutation, which would include: 4 total grouped vintages (Old, Existing, Recent, New) and 16 total climate zones. Each additional permutation would require creation of roughly 1,500 additional simulation models, and performing the other steps described; fewer permutations

[1] Batch Processor – Stand-program that can create the matrix of building simulation models associated with one or more varying parameters. A parameter like building type will influence which prototype is chosen, while other parameters like vintage and climate zone my further refine that prototype. Existing, standard and proposed case models are typically created that are based upon the keywords that change for a given measure. Additional parameters could include HVAC Type and Thermostat Setting. MASControl3 is the batch processor that is used to run models using the DOE2 engine for CA modeled measures.

[2] MASControl3 limits user to specific climate zones, building types, HVAC combinations.

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

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

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

are needed for the New vintage since this vintage is define by only one vintage prototype. The additional permutations can be run as a batch through MASControl3.

2. **DEER Scaled**
    - Modeling Approach for "Base Measure" Used to Create "Scaled" Savings for a Related Measure: Energy usage is modeled with a whole building simulation tool, eQUEST/DOE 2.3, to develop savings for a measure as described above.
    - Scaling: The savings from the original measure are scaled arithmetically to determine savings for a related measure.
        i. Example 1: Condenser coil cleaning savings are scaled from refrigerant charge adjustment savings.
3. **IOU Modeled**
    - The difference between IOU modeled and Case #1 above is:
        i. The IOU creates a new measure in DOE 2.3 that could be a derivative of an existing DEER measure, but may not be.
        ii. In addition, the IOUs may not choose to cover the full range of building vintages, building types, climate zones and HVAC types used for a DEER measure because the IOU is designing the measure such that it is adequately representative of the market.
        Example 1: Commercial HVAC measures (new IOU developed HVAC measures) are combined using a weighted average approach, based upon Building Type, Climate Zone, Vintage, and HVAC Type.
            For many measures, Climate Zone and Building Type are kept as independent parameters when savings can vary dramatically with these variables and when the Building Type can be determined with certainty from the claims data. In these cases, a greater number of specific permutations will be generated rather than a smaller number of averaged permutations. In other words, use same weighting factors to better reflect the market.
        Example 2: Residential HVAC measures (new IOU developed HVAC measures) are weighted based upon Vintage, HVAC Type and thermostat setting.
        Example 3: Commercial Refrigeration measures are weighted based upon Vintage since they are only modeled in one Building Type and Climate Zone is kept as an independent parameter.
            - To note: Depending on the sector and end use, more or less models will be created to generate savings.
4. **ET Result / Study / Tool Result**
    - The energy savings is presented through a body of work that is available for review or accepted by the industry. These measures fall into a few categories:
        i. ET Studies - Typically, study results are used to form direct savings values or regression models[6]. The results of this study form the basis for understand the sensitive parameters associated with this measure. As a result, Offerings within the measure can be established.

[6] Regression models are formulas developed from a set of data to create a result based upon the most sensitive variable(s) for that particular measure. For example, the Circulating Block Heater measure collected data from an ET Study to relate average daily temperature to daily electric energy usage; the Gas Dryer Modulating Valve measure collected data from multiple studies to estimate therms/load based upon dryer load capacity (lbs); and the Commercial Reach-in Refrigerator/Freezer measure references an Energy Star specification to relate refrigerated volume (ft^3) to daily electric energy usage.

   ii. Study - Other studies could be referenced to form direct savings values or regression models. These values could be from an EM&V study, but there are no measures that use savings directly from evaluation results currently. Other jurisdictions do follow this approach.
   iii. Tool Results - Industry accepted tools like AirMaster+ (for compressed air projects) and RSPEC (for commercial pools) are used to present results with a varying level of modeling tool inputs. These tools could also be considered "Complex Calculations" but because the savings are difficult to follow within the shell of the tool for an individual, they have been included in this category that is more related to a study result.

5. **Complex Excel**
   - Excel is used to calculate the savings values through a physics or engineering calculation. Currently, these measures were not entered as calculated measures into the eTRM. These tools take several forms that include:
      i. The Water Heater Calculator (v3.3) is an 8,760 calculation that takes inputs for water heating load from a building simulation tool, as well as many standard equipment inputs to calculate the resulting energy savings. Because of the nature of the inputs, some inputs are more transparent than others.
      ii. Physics-based calculators are used with standard engineering equations and inputs that range in source from EM&V values to study results to engineering assumptions based upon best available data or engineering judgement. These calculation methods use capabilities not currently available within the eTRM math engine.
6. **Fully Calculated**
   - Excel is used to calculate the savings values through a physics or engineering calculation. These measures were entered as calculated measures into the eTRM.
      i. Completely comprised of engineering calculations that are supported by a combination of data used as input, which may include: empirical data, equipment specifications and basic inputs from engineering judgment.

In addition, one mixed category was needed since, in some cases, a single measure included two different approaches for two different offerings within the same measure.

1. **Mixed: DEER and Calc**
   a. These measures have offerings that fall into the "DEER Modeled" category.
   b. Separate offerings are "Fully Calculated".

III. Questions

We are asking for Cal TF Members to provide feedback to help develop guidelines for when a building simulation approach should be used to estimate energy savings and demand reduction. The questions below are intended to guide responses so that they can be more easily tabulated, but please feel free to provide additional feedback on any item.

Questions:

1. Are there specific, recommended corrections to the attached spreadsheet: (*This question is specifically intended for users with already-existing, deep knowledge of particular measures; it is not intended to request everyone to become an expert of every measure.)*
   - Moving measures between columns
   - Creating/deleting columns and/or separating/combining workpapers

2. To get closer to consensus on general principles for guiding the selection of methodology, please rate the following from:
   (1 = Always Building Simulation to 10 = Always Fully Calculated)
   - Highly weather-dependent measures (many HVAC measures fall in this category; >20% difference between summer and winter months)
   - “Questionably” weather-dependent measures (commercial refrigeration measures; <10% difference between summer and winter months)
   - “Questionably” weather-dependent measures (plug load measures in conditioned spaces)
   - “Questionably” weather-dependent measures (appliance measures such as refrigerators, dishwashers and clothes dryers in conditioned spaces)
   - “Questionably” weather-dependent measures (lighting in conditioned spaces)
   - Weather independent measures (any outdoor lighting)
   - GROUP EXERCISE: Come up with guidelines that prescribe when certain approaches should be used.

     These guidelines could be framed using any categorization the group feels would be most applicable, such as:

     1. By end-use,
     2. By weather-dependency,
     3. By size of savings, or
     4. By some combination of categories.

3. Where do you see measures that can be made more transparent by pushing toward the “fully calculated” approach? To provide some context, some examples that may be good candidates include:
   - Measures that use both modeled and calculated approaches (ie, “Mixed: DEER and Calc category”).
     - Refrigerator or Freezer
     - Clothes Dryer, Residential
     - Clothes Washer, Residential

- Measures that use calculated approaches in most other jurisdictions (ie, many of the Appliance or Plug Load end-use measures fall into this category).
- Measures where a heating or cooling load could be modeled.

4. How should the amount of energy savings relative to the prototype energy consumption play into the decision to create a building simulation, rely on a study result, or calculate a result?
   - For example, does it make sense to compare the energy consumption of a whole supermarket to estimate the savings from one display case fan motor upgrade (electronically commutated motor, ECM) that may contribute a fraction of 1% to the building energy consumption?

5. Is there value in trying to quantify transparency? Please provide thought on how this could be done.
   - For example, should we show number of models created to produce a single result?
   - Should the most sensitive parameters be documented with error estimations?

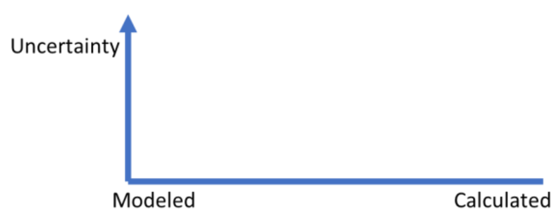
IV. Attachment A

Savings Methodology Spreadsheet: 

To supplement the methodology spreadsheet, savings claims data for 2018 was aligned with these measures to also show which ones produced the most savings. This information was incorporated visually into the attached spreadsheet:

- Blue Font (2% or greater of electric portfolio; **bold** if significantly higher within this group)
- Green Font (2% or greater of gas portfolio; **bold** if significantly higher within this group)
- Only three measures fell into both the blue and green categories:
  - Clothes Washer, Residential
  - Smart Thermostat, Residential
  - Medium or Low-Temperature Display Case

While uncertainty is not calculated for each measure today, this information would be valuable so that another dimension could be added to our continuum of methodologies. The goal would be to optimize the balance between uncertainty and measure cost:



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

Modeled ↔ Calculated

	DEER Modeled	DEER Scaled	IOU Modeled	Mixed: DEER and Calc	ET Result / Study / Tool Result	Complex Excel	Fully Calculated
HVAC	**Space Heating Boiler, Commercial** Furnace, Commercial Unitary Air-Cooled Air Conditioner, Over 65 kBtu/h, Commercial Unitary Air Cooled Air Conditioner or Heat Pump, Under 65 kBtu/h, Commercial Air Cooled Chiller Whole House Fan, Residential Furnace, Residential	Water-Cooled Chiller Package Terminal Air Conditioner or Heat Pump, Under 24 kBtu/h	Space Heating Boiler, Multifamily Demand Control Ventilation for Single Zone HVAC Variable Speed Drive for a Central Plant System Supply Fan Controls, Commercial HVAC Occupancy Sensor, Classroom VSD for HVAC Fan Controls, Commercial Enhanced Ventilation for Packaged HVAC Cogged V-Belt for HVAC Fan, Commercial Fan Controller for Air Conditioner, Residential Brushless Fan Motor Replacement, Residential Software-Controlled Switch Reluctance Motor, Commercial		**Smart Thermostat, Residential**	Intermittent Pilot Light, Residential	Gravity Wall Furnace, Residential
Building Envelope	Greenhouse Heat Curtain Greenhouse Infrared Film Ceiling Insulation, Residential Wall Insulation, Residential						
Service	Refrigerant Charge, Commercial Refrigerant Charge Adjustment, Residential	Duct Seal, Residential Evaporator Coil Cleaning, Commercial Condenser Coil Cleaning, Commercial Condenser Coil Cleaning, Residential Evaporator Coil Cleaning, Residential Air Flow Adjustment, Residential	Economizer Repair, Commercial Economizer Controls, Commercial				
Appliance or Plug Load		Refrigerator or Freezer Recycling Dishwasher, Residential		Refrigerator Clothes Dryer, Residential Clothes Washer, Residential	Room Air Conditioner, Residential Room Air Cleaner, Residential Vending and Beverage Merchandise Controller		Ozone Laundry, Commercial Smart Power Strips Gas Dryer Modulating Valve, Commercial and MFm
Whole Building			Conditioned Crawlspace, Residential				
Water Heating			Demand Control for Centralized Water Heater Recirculation Pump - MFm Domestic Hot Water Loop Temperature Controller, MFm Central Boiler Dual Setpoint Temperature Controller, MFm		Boiler, Process	Boiler, Commercial Tankless Water Heater, Commercial Storage Water Heater, Commercial Central Storage Water Heater, MFm Storage Water Heater, Residential Tankless Water Heater, Residential Heat Pump Water Heater **Hot Water Pipe Insulation**	Faucet Aerator, Residential **Low-Flow Showerhead - Residential** TSV w/ & w/o an Integrated Low-Flow Showerhead, Res Laminar Flow Restrictor Boiler, MFm Hot Water Tank Insulation, Nonresidential Faucet Aerator, Commercial Low-flow Showerhead - Commercial Recirculation Pump Timer, Commercial Smart Pump, Residential Diverting Tub Spout with TSV
Refrigeration			**Anti-Sweat Heater Controls** Low-Temp Display Case Doors With No Anti-Sweat Heaters ECM Motor Retrofit For Display Case Cooler Or Freezer Walk-In Cooler/Freezer with ECM Motor Retrofit Auto Closer for Refrigerated Storage Door Floating Head Pressure Controls, Multiplex Floating Suction Controls, Multiplex Compressor Retrofit, Multiplex Medium-Temperature Case Doors Medium or Low-Temperature Display Case With Doors			Medium or Low-Temperature Display Case Ultra-Low Temperature Freezer Low-Temperature Coffin To Reach-In Display Case Conversion Medium-Temperature Open Display Case Retrofit	Bare Suction Line Insulation Reach-In Refrigerator or Freezer, Commercial
Process					Circulating Block Heater	Steam Trap, Commercial	Ventilation Fan, Agriculture VFD for Glycol Pump Motor VFD for Dust Collection Fan VFD for Ag Ventilation Fan
Compressed Air					VFD Retrofit for Air Compressor		
Recreation					Heater for Pool or Spa, Commercial	Pool Cover, Commercial	VSD for Pool & Spa Pump
Food Service					Commercial Hand-Wrap Machine, Electric Exhaust Hood Demand Controlled Ventilation, Commercial Refrigerated Chef Base		Convection Oven, Commercial Door-Type Dishwasher, Commercial Combination Oven, Commercial Griddle, Commercial Steamer, Commercial Ice Machine, Commercial Insulated Hot Food Holding Cabinet Commercial Conveyor Oven Deck Oven, Electric, Commercial **Fryer, Commercial** Low-Flow Pre-rinse Spray Valve Rack Oven, Gas, Commercial Conveyor Broiler, Commercial Undercounter Dishwasher, Commercial Underfired Broiler, Commercial
Lighting							**LED, Tube** LED, High or Low Bay **LED, Ambient Commercial Fixtures & Retrofit Kits**
Water Pumping							VFD on Well Pump, <=300 hp Water Pump Upgrade Enhanced VFD on Irrigation Pump