

Section 2:

Estimating Energy Savings and Incentives

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2.1 Estimating Energy Savings and Incentives

This section of the *2012 Statewide Customized Offering Procedures Manual* describes the customized approach utilized to estimate the expected energy savings and incentives for your proposed Customized energy efficiency project(s).

Under this approach you will need to estimate the kWh savings and the permanent DEER peak demand reduction achieved as a result of your high efficiency upgrade. This can be done using either the estimation software or using engineering calculations.

- **Estimating software.** Downloaded from the Utility website or on-line (SCE Only), the estimating software provides methodologies for specific measures that calculate energy savings based on site-specific information for the project (a list of the measures included on the software is included in Section 2.2).
- **Engineering calculations.** If your proposed energy efficiency measures are not addressed by the estimation software, you can calculate the energy savings by using accepted engineering procedures. This option should **ONLY** be used if the estimating software does not address the specific measure you are installing or if the software does not accurately calculate your achievable savings. This is the more difficult approach for estimating the savings but is acceptable with supporting documentation and substantiation of your savings claims and is subject to review by third party reviewers.

2.2 Customized Measures - Estimation Software

The Statewide Customized Offering Estimation Software provides savings calculations for a variety of the most common energy-saving measures. These savings calculations incorporate assumptions and stipulations that provide reasonable savings estimates under most conditions. The estimation software asks for detailed input from your facility, providing a good approximation of the energy savings. In some cases spot measurements may be necessary.

Each of these tools require input of specific project information through a combination of direct data entry and pull-down menus. The input fields are generally self-explanatory, and if you position your cursor at the very beginning (left edge) of the white input field, a “balloon” prompt will pop up to explain the type of data that should be entered into that field.

The estimating tools can be accessed by one of the two following links depending on the Utility:

SCE (Online Tool) – <https://www.sceonlineapp.com/>

Direct Access to the tools is available by selecting “Solutions Tool” from the menu on the left side of the webpage. The user also has the option of logging in, creating an application, and using the tools from within the application.

PG&E and SDG&E (Downloadable Tool) - <http://www.aesc-inc.com/download/SPC/>

Direct access to the tools is available by selecting the “Energy Savings Calculator” button in the 2011 or 2012 CCT main screen. The user also has the option of choosing the “Create or Edit Applications” button, creating an application, and using the tools from within the application.

Specific considerations for each of these tools are discussed below.

2.2.1 AC&R I - High Efficiency Chiller

2.2.1.1 Description

This tool is designed to compute the energy and demand savings for high efficiency chiller upgrade measures. It is intended for the direct replacement of water-cooled chillers (SCE) or for direct replacement of air-cooled and water-cooled chillers (PG&E and SDG&E). Generally, baseline equipment efficiency is current Title 24 standards.

Chiller systems include a chiller (which produces chilled water), an air handler unit(s) (which contains a supply air fan and chilled water coil), and a heat rejection unit(s) (cooling tower for water-cooled or condenser for air-/evaporatively-cooled).

The 2012 CCT calculates the energy savings for this measure by passing all required user inputs through Engage, which is a modified version of the Quick Energy Simulation Tool (eQUEST). eQUEST is a whole-building performance model that incorporates graphics and wizards with the DOE2.2 computation engine to simulate building energy performance based on user-defined inputs. These inputs describe building attributes such as (but not limited to) building envelope characteristics, internal loads, and HVAC system components. eQUEST, through the DOE2.2 computation engine, performs hourly calculations of the electrical and/or gas demand of building system end uses (HVAC, lighting, misc equipment, etc) based on normalized annual weather data. (Please note that to create a more generic model, assumptions are incorporated into eQUEST to create the Engage model, thereby reducing the amount of inputs and detail required by the user. However, the DOE2.2 computation methodology remains the same across both platforms.)

2.2.1.2 Appropriate Use of the Tool – Program Policy

The CCT is utilized for the following High Efficiency Chiller measures:

- ☐ Replacement of a chiller unit
- ☐ Compressor-only upgrades

The estimate of savings from the High Efficiency Chiller Tool is applicable for the following building types and area ranges:

- ☐ Education – Secondary School – defaults to 150,000 ft² but must be between 100,000 and 400,000 ft²
- ☐ Education – Community College – defaults to 300,000 ft² but must be between 100,000 and 600,000 ft²
- ☐ Education – University – defaults to 800,000 ft² but must be between 640,000 and 2,500,000 ft²
- ☐ Health/Medical – Hospital – defaults to 250,000 ft² but must be between 100,000 and 500,000 ft²
- ☐ Lodging - Hotel – defaults to 200,000 ft²
- ☐ Office – Large – defaults to 175,000 ft²
- ☐ Office – Small – defaults to 10,000 ft²
- ☐ Retail – Multistory Large – defaults to 120,000 ft²

The CCT allows implementation of these measures as a retrofit, for early retirement or replacement on burnout. Early retirement chiller retrofits are covered only in situations where the entire chiller is upgraded. The tool also allows for calculating early retirement, either for a recently overhauled unit or a less efficient piece of equipment that is replaced before the end of its useful life.

Please note that the CCT is limited to uniform chiller plant projects only. That is, the tool will only allow the user to select existing and proposed chiller and compressor arrangements in multiples if the equipment is identical in size and type. The tool is not suited for the following situations:

- ❑ Multiple different existing or proposed chiller types
- ❑ Partial chiller plant replacements

If the project falls under any of these scenarios, a more detailed analysis method may be necessary.

2.2.1.3 Applicable Types of Equipment

This tool is utilized for replacement or early retirement of chillers of all sizes. However, the user should be aware of eligibility requirements for incentives that are in place by the local utility of the proposed project site. For additional information, see Section 1 of this manual.

2.2.1.4 Equipment Sizes or Capacities Covered by the tool

The High Efficiency Chiller tool allows the user to select the equipment and capacity specified in Table 1-1 and the equipment and description in Table 1.2.

Table 1-1: Chiller Types and Capacities

Equipment	Capacity
Electric Centrifugal Hermetic	All sizes are covered except for chillers which operate with frictionless (Turbocor) compressors. If the frictionless Turbocor option is selected, the compressors must be less than 150 Tons.
Electric Reciprocating Hermetic	All sizes
Electric Centrifugal Open	All sizes
Electric Reciprocating Open	All sizes
Screw	All sizes

Table 1-2: Condenser Types

Equipment	Description
Water-Cooled Condenser	A water-cooled chiller will be used
Packaged Air-Cooled Condenser	A self-contained air-cooled condenser will be used. All energy consumption associated with the condenser fans is included in the chiller's rated efficiency
Remote Air-Cooled Condenser	A remotely located, air-cooled condenser will be used. The chiller's rated efficiency does not include the energy used by the condensing unit.

Remote Evaporative-Cooled Condenser	A remotely located, evaporative-cooled condenser will be used. The chiller's rated efficiency does not include the energy used by the evaporative-cooled condensing unit
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2.2.1.5 Measure Tool Use

2.2.1.5.1 Inputs

Once the High Efficiency Chillers measure is selected, the user is then directed to enter the various inputs as described in the following tables.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 1-3: Tool Inputs Sheet 1 of 4, Building Specifications

Tool Input	Description / Purpose
Location	Choose site location based on zip code or CTZ (California Thermal Zone - CEC climate zone). In the adjacent menu select the appropriate Zip Code or CTZ. (refer to Appendix D in the Customized Offering Procedures Manual for detailed CTZ descriptions).
Building Type	Choose the building type most appropriate for the project site. Select a "predefined" building configuration from the list of "DEER prototypical" buildings (refer to Appendix D in the Customized Offering Procedures Manual for detailed building descriptions).
Vintage	Choose the year range in which the building was constructed.
HVAC System(s)	Choose the system type that best fits the type found on the project site. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the total conditioned and unconditioned primary building area in square feet. The conditioned area is defined on screen 4 in the "Area Served" input.
Secondary Building Area	Enter the secondary building area in square feet (if applicable). The conditioned area is defined on screen 4.applicable to your Building Type.

Number of Floors	Enter the number of floors of primary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Secondary Number of Floors	Enter the number of floors of secondary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Sheet 2 (Table 1-3) allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 1-4 Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 1-5: Tool Inputs Sheet 3 of 4 Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the chiller upgrade to be implemented. Inputs are described in the following table.

Table 1-6: Tool Inputs Sheet 4 of 4 Building Measure Specifications

Name	Description / Purpose
Area Served	Enter the total area served by the HVAC system.
Year Manufactured	Enter the year in which the existing chiller was manufactured. This is important if the user is seeking an 'Early Retirement' analysis.
Year Overhauled	If the 'Overhauled' checkbox is selected, enter the year in which the existing chiller was overhauled. This is important if the user is seeking an 'Early Retirement' analysis.
Chiller Type(s)	Select the appropriate chiller type for the baseline and measure case equipment
Condenser Type(s)	Select the appropriate condenser type for the baseline and measure case equipment.
Compressor(s)	If applicable, enter the compressor type used by the chiller(s) for the baseline and measure case equipment.
Chiller Counts & Sizes	Enter the appropriate number of chillers and the tonnage range the chiller(s) falls under for the baseline and measure case equipment.
Chiller Efficiency	Enter the efficiency and appropriate units of the chiller(s) for the baseline and measure case equipment.
Program Baseline Efficiency	This is the efficiency of the chiller to be used as the baseline for the analysis. If the baseline equipment qualifies for early retirement, this will be equal to the baseline efficiency. If the equipment is not qualified for early retirement, the appropriate minimum efficiency standard will be used.

2.2.1.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 1-7: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.1.5.3 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 1-8: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the existing equipment and estimated annual energy use (kWh) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the baseline equipment and estimated annual energy use (kWh) of the baseline equipment.
Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment and estimated annual energy use (kWh) of the proposed equipment.
Savings	Estimated on-peak demand (kW) and energy savings for measure (kWh) For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.1.6 Calculating Early Retirement

If there is at least one year of Effective Useful Life (EUL) left then a retrofit will be eligible for Early Retirement and two baselines will need to be determined. If there is less than one year left on the EUL it is treated as a replace on burnout measure. In 2012, the software will be updated to determine measure early retirement eligibility and estimate savings using dual baselines.

The EUL is an estimate of median number of years for equipment life and thus, at a project-specific level, equipment is expected to function longer than the EUL in 50% of the population. Additionally, some industry practices like routine maintenance can extend equipment life beyond the estimated EUL values.

For early retirement measures, there are two periods to consider, the Remaining Useful Life (RUL) period and the Effective Useful Life minus the Remaining Useful Life (EUL – RUL) period. RUL is relevant for early replacement measures that are designed to retire equipment before the end of their useful life. Early replacement measures capture additional energy savings that result from the replacement of older, less efficient equipment with newer, higher efficiency equipment. For replace on burnout, new installation, and retrofit add-ons the new equipment is either not replacing existing equipment or replacing equipment that has been assumed to have failed so there is no RUL period of existing equipment.

2.2.2 AC&R I - Split/Packaged AC Retrofit (PG&E and SDG&E only)

2.2.2.1 Description

This tool is designed to compute the incentive for a High Efficiency Air Cooled Split or Packaged Air Conditioning system, which includes a compressor, and an air handler unit(s) (which contains a supply air fan and chilled water coil).

The 2012 CCT calculates the energy savings for this measure by passing all required user inputs through Engage, which is a modified version of the Quick Energy Simulation Tool (eQUEST). eQUEST is a whole-building performance model that incorporates graphics and wizards with the DOE2.2 computation engine to simulate building energy performance based on user-defined inputs. These inputs describe building attributes such as (but not limited to) building envelope characteristics, internal loads, and HVAC system components. eQUEST, through the DOE2.2 computation engine, performs hourly calculations of the electrical and/or gas demand of building system end uses (HVAC, lighting, misc equipment, etc) based on normalized annual weather data. (Please note that to create a more generic model, assumptions are incorporated into eQUEST to create the Engage model, thereby reducing the amount of inputs and detail required by the user. However, the DOE2.2 computation methodology remains the same across both platforms.)

2.2.2.2 Appropriate Use of the Tool –Program Policy

The CCT is utilized for the following High Efficiency Air Cooled Split/Packaged AC measures:

- ☐ Replacement of an air cooled split or packaged air compressor.

The CCT allows implementation of these measures as a retrofit, new installation, or for early retirement. The tool allows for calculating early retirement for a less efficient piece of equipment that is replaced before the end of its useful life.

The estimate of savings from the Split/Packaged AC Retrofit Tool can be calculated for the following building types and the building area must be between:

- ☐ Assembly – defaults to 34,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Primary School – defaults to 50,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Secondary School – defaults to 150,000 ft2 but must be between 100,000 and 400,000 ft2
- ☐ Education – Community College – defaults to 300,000 ft2 but must be between 100,000 and 600,000 ft2
- ☐ Health/Medical – Hospital – defaults to 250,000 ft2 but must be between 100,000 and 500,000 ft2
- ☐ Lodging - Hotel – defaults to 200,000 ft2
- ☐ Manufacturing – Bio/Tech – defaults to 200,000 ft2
- ☐ Manufacturing – Light Industrial – defaults to 100,000 ft2
- ☐ Office – Large – defaults to 175,000 ft2
- ☐ Office – Small – defaults to 10,000 ft2
- ☐ Restaurant – Sit Down – defaults to 4,000 ft2
- ☐ Restaurant – Fast Food – defaults to 2,000 ft2
- ☐ Retail – Multistory Large – defaults to 120,000 ft2
- ☐ Retail – Single -Story Large – defaults to 130,500 ft2
- ☐ Retail – Small – defaults to 8,000 ft2
- ☐ Storage – Conditioned - defaults to 500,000 ft2

2.2.2.3 Applicable Types of Equipment

This tool is utilized for early retirement, replacement, or new installation for split or packaged air conditioning replacements greater than 63.3 Tons. However, the user should be aware of eligibility requirements for incentives that are in place by the local utility of the proposed project site. For additional information, see section 1 of the 2012 Statewide Customized Offering Procedures Manual.

2.2.2.4 Equipment Sizes or Capacities Covered by the Tool

The High Efficiency Air Cooled Split/Packaged AC tool allows the user to select the equipment and capacities specified in Table 2-1.

Table 2-1: Equipment Sizes and Capacities

Equipment	Capacity
Split or Packaged Air Compressor Unit	> 63.3 Tons

While the CCT will allow the user to enter any existing site equipment capacity, this information will not be used in the baseline under the following conditions:

- ☐ Existing equipment capacity is less than or equal to 63.3 Tons per unit
- ☐ Existing equipment efficiency is less than Title 24 minimum and equipment does not qualify for early retirement.

2.2.2.5 Measure Tool Use

2.2.2.5.1 Inputs

Prior to selecting the High Efficiency Air Cooled Split/Packaged AC measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. This CCT allows projects that fall under any of the three above referenced measure types. The user should make the appropriate selection based on the proposed equipment and project scope.

Once the High Efficiency Air Cooled Split/Packaged AC measure is selected, the user is then directed to enter the various inputs as described in the following tables. The data in the tables appear in the same order as the CCT.

Sheet 1 (Table 2-2) allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 2-2: Tool Inputs Sheet 1 of 4, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.

Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
Secondary Building Area	Enter the secondary building area (if applicable). The conditioned area is defined on screen 4.
Secondary Number of Floors	Enter the total number of floors of the secondary building (if applicable). The tool will automatically assign an equal amount of square feet per floor.

Sheet 2 (Table 2-3) allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 2-3: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.

Observed Holidays	Click this button and insert check marks next to the observed holidays.
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Sheet 3 (Table 2-4) will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 2-4: Tool Inputs Sheet 3 of 4, Operations

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the packaged upgrade to be implemented. Inputs are described in the following table.

Table 2-5: Tool Inputs Sheet 4 of 4, Building Measure Specification

Name	Description / Purpose
Area Served	Enter the total area served by the HVAC system.
Economizer	Choose the economizer option that best fits the project equipment.
Existing AC Equipment	Define the appropriate details for the existing equipment.
Replacement AC Equipment	Define the appropriate details for the replacement equipment. Please note, as of March 31, 2011 all replacement units must be a minimum of 63.3 Tons to qualify for an incentive.
Code Baseline AC Equipment	This section does not require any input from the user. The text boxes will provide the efficiency and capacity of the AC equipment to be used as the baseline for the analysis. If the existing equipment qualifies for early retirement, this will be equal to the baseline efficiency. If the existing equipment is not qualified for early retirement, the appropriate minimum efficiency standard will be used.

2.2.2.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 2-6: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.2.5.3 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 2-7: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the baseline equipment.

Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the proposed equipment.
Savings	Estimated on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms). For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.2.6 Calculating Early Retirement

If there is at least one year of Effective Useful Life (EUL) left then a retrofit will be eligible for Early Retirement and two baselines will need to be determined. If there is less than one year left on the EUL it is treated as a replace on burnout measure. In 2012, the software will be updated to determine measure early retirement eligibility and estimate savings using dual baselines.

The EUL is an estimate of median number of years for equipment life and thus, at a project-specific level, equipment is expected to function longer than the EUL in 50% of the population. Additionally, some industry practices like routine maintenance can extend equipment life beyond the estimated EUL values.

For early retirement measures, there are two periods to consider, the Remaining Useful Life (RUL) period and the Effective Useful Life minus the Remaining Useful Life (EUL – RUL) period. RUL is relevant for early replacement measures that are designed to retire equipment before the end of their useful life. Early replacement measures capture additional energy savings that result from the replacement of older, less efficient equipment with newer, higher efficiency equipment. For replace on burnout, new installation, and retrofit add-ons the new equipment is either not replacing existing equipment or replacing equipment that has been assumed to have failed so there is no RUL period of existing equipment.

2.2.3 AC&R I - Split/Packaged HP Retrofit (PG&E and SDG&E only)

2.2.3.1 Description

This tool is designed to compute the incentive for a High Efficiency Air Cooled Split or Packaged Heat Pump system, which includes a compressor, an air handler unit(s) (which contains a supply air fan and chilled water coil).

The 2012 CCT calculates the energy savings for this measure by passing all required user inputs through Engage, which is a modified version of the Quick Energy Simulation Tool (eQUEST). eQUEST is a whole-building performance model that incorporates graphics and wizards with the DOE2.2 computation engine to simulate building energy performance based on user-defined inputs. These inputs describe building attributes such as (but not limited to) building envelope characteristics, internal loads, and HVAC system components. eQUEST, through the DOE2.2 computation engine, performs hourly calculations of the electrical and/or gas demand of building system end uses (HVAC, lighting, misc equipment, etc) based on normalized annual weather data. (Please note that to create a more generic model, assumptions are incorporated into eQUEST to create the Engage model, thereby reducing the amount of inputs and detail required by the user. However, the DOE2.2 computation methodology remains the same across both platforms.)

2.2.3.2 Appropriate Use of the Tool –Program Policy

The CCT is utilized for the following High Efficiency Air Cooled Split/Packaged HP measures:

- ☐ Replacement of an air cooled split or packaged heat pump

The CCT allows implementation of these measures as a retrofit, new installation, or for early retirement. The tool allows for calculating early retirement for a less efficient piece of equipment that is replaced before the end of its useful life.

The estimate of savings from the Split/Packaged HP Retrofit Tool can be calculated for the following building types and the building area must be between:

- ☐ Assembly – defaults to 34,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Primary School – defaults to 50,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Secondary School – defaults to 150,000 ft2 but must be between 100,000 and 400,000 ft2
- ☐ Education – Community College – defaults to 300,000 ft2 but must be between 100,000 and 600,000 ft2
- ☐ Health/Medical – Hospital – defaults to 250,000 ft2 but must be between 100,000 and 500,000 ft2
- ☐ Lodging - Hotel – defaults to 200,000 ft2
- ☐ Manufacturing – Bio/Tech – defaults to 200,000 ft2
- ☐ Manufacturing – Light Industrial – defaults to 100,000 ft2
- ☐ Office – Large – defaults to 175,000 ft2
- ☐ Office – Small – defaults to 10,000 ft2
- ☐ Restaurant – Sit Down – defaults to 4,000 ft2
- ☐ Restaurant – Fast Food – defaults to 2,000 ft2
- ☐ Retail – Multistory Large – defaults to 120,000 ft2
- ☐ Retail – Single -Story Large – defaults to 130,500 ft2
- ☐ Retail – Small – defaults to 8,000 ft2
- ☐ Storage – Conditioned - defaults to 500,000 ft2

2.2.3.3 Applicable Types of Equipment

This tool is utilized for early retirement, replacement, or new installation for split or packaged heat pump replacements greater than 63.3 Tons. However, the user should be aware of eligibility requirements for incentives that are in place by the local utility of the proposed project site. For additional information, see section 1 of the 2012 Statewide Customized Offering Procedures Manual.

2.2.3.4 Equipment Sizes or Capacities Covered by the Tool

The High Efficiency Air Cooled Split/Packaged HP tool allows the user to select the equipment and capacities specified in Table 3-1.

Table 3-1: Equipment Sizes and Capacities

Equipment	Capacity
Split or Packaged Heat Pump Unit	> 63.3 Tons

While the CCT will allow the user to enter any existing site equipment capacity, this information will not be used in the baseline under the following conditions:

- ☐ Existing equipment capacity is less than or equal to 63.3 Tons per unit
- ☐ Existing equipment efficiency is less than Title 24 minimum and equipment does not qualify for early retirement.

2.2.3.5 Measure Tool Use

2.2.3.5.1 Inputs

Prior to selecting the High Efficiency Air Cooled Split/Packaged HP measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. This CCT allows projects that fall under any of the three above referenced measure types. The user should make the appropriate selection based on the proposed equipment and project scope.

Once the High Efficiency Air Cooled Split/Packaged HP measure is selected, the user is then directed to enter the various inputs as described in the following tables. The data in the tables appear in the same order as the CCT.

Sheet 1 (Table 3-2) allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 3-2: Tool Inputs Sheet 1 of 4, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.

Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
Secondary Building Area	Enter the secondary building area (if applicable). The conditioned area is defined on screen 4.
Secondary Number of Floors	Enter the total number of floors of the secondary building (if applicable). The tool will automatically assign an equal amount of square feet per floor.

Sheet 2 (Table 3-3) allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 3-3: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.

Observed Holidays	Click this button and insert check marks next to the observed holidays.
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Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 3-4: Tool Inputs Sheet 3 of 4, Operations

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the packaged upgrade to be implemented. Inputs are described in the following table.

Table 3-5: Sheet 4 of 4, Building Measure Specification

Name	Description / Purpose
Area Served	Enter the total area served by the HVAC system.
Economizer	Choose the economizer option that best fits the project equipment.
Existing HP Equipment	Define the appropriate details for the existing equipment.
Replacement HP Equipment	Define the appropriate details for the replacement equipment. Please note, as of March 31, 2011 all replacement units must be a minimum of 63.3 Tons to qualify for an incentive.
Code Baseline HP Equipment	This section does not require any input from the user. The text boxes will provide the efficiency and capacity of the HP equipment to be used as the baseline for the analysis. If the existing equipment qualifies for early retirement, this will be equal to the baseline efficiency. If the existing equipment is not qualified for early retirement, the appropriate minimum efficiency standard will be used.

2.2.3.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 3-6: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.3.5.3 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 3-7: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the baseline equipment.

Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms) of the proposed equipment.
Savings	Estimated on-peak demand (kW) of the proposed equipment, estimated annual energy use (kWh), estimated annual gas usage (Therms). For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.3.6 Calculating Early Retirement

If there is at least one year of Effective Useful Life (EUL) left then a retrofit will be eligible for Early Retirement and two baselines will need to be determined. If there is less than one year left on the EUL it is treated as a replace on burnout measure. In 2012, the software will be updated to determine measure early retirement eligibility and estimate savings using dual baselines.

The EUL is an estimate of median number of years for equipment life and thus, at a project-specific level, equipment is expected to function longer than the EUL in 50% of the population. Additionally, some industry practices like routine maintenance can extend equipment life beyond the estimated EUL values.

For early retirement measures, there are two periods to consider, the Remaining Useful Life (RUL) period and the Effective Useful Life minus the Remaining Useful Life (EUL – RUL) period. RUL is relevant for early replacement measures that are designed to retire equipment before the end of their useful life. Early replacement measures capture additional energy savings that result from the replacement of older, less efficient equipment with newer, higher efficiency equipment. For replace on burnout, new installation, and retrofit add-ons the new equipment is either not replacing existing equipment or replacing equipment that has been assumed to have failed so there is no RUL period of existing equipment.

2.2.4 AC&R I - VAV Retrofit or VSD on Supply Fan Motors

2.2.4.1 Description

The CCT can be used to predict the savings achievable by installing a variable speed drive (VSD) or other control device on the supply fan(s) in a building or group of buildings. A VSD or other control device on the supply air fan(s), along with variable air volume (VAV) boxes at the zone level, allows for air flow to be varied depending on the overall building cooling load.

2.2.4.2 Appropriate Use of the Tool –Program Policy

The CCT allows implementation of this measure as a retrofit or for early retirement. For calculating early retirement the tool allows for a less efficient piece of equipment that is replaced before the end of its useful life.

This tool shall be used exclusively in buildings that utilize supply air fan(s) to provide space-cooling in the building and applies to any supply fan motors. There is no restriction on the size of the fan motors. The user may input up to 20 different fans.

The estimate of savings from the VAV or VSD on Supply Fan Motors Tool can be calculated for the following building types and the building area must be between:

- ☐ Education – Secondary School – defaults to 150,000 ft2 but must be between 100,000 and 400,000 ft2
- ☐ Education – Community College – defaults to 300,000 ft2 but must be between 100,000 and 600,000 ft2
- ☐ Education – University – defaults to 800,000 ft2 but must be between 640,000 and 2,500,000 ft2
- ☐ Health/Medical – Hospital – defaults to 250,000 ft2 but must be between 100,000 and 500,000 ft2
- ☐ Lodging - Hotel – defaults to 200,000 ft2
- ☐ Office – Large – defaults to 175,000 ft2
- ☐ Office – Small – defaults to 10,000 ft2
- ☐ Retail – Multistory Large – defaults to 120,000 ft2

2.2.4.3 Measure Tool Use

2.2.4.4 Inputs

Prior to selecting the VAV or VSD of HVAC Supply Fans measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. The CCT only allows projects that are retrofits (same load). Once the VAV or VSD of HVAC Supply Fans measure is selected, the user is then directed to enter the various inputs as described in the following tables.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 4-1: Tool Inputs Sheet 1 of 4, Building Specifications

Input Name	Description / Purpose
Location	Location can be selected by either Zip Code or climate zone (CTZ). The appropriate Zip Code or CTZ is then selected from the adjacent pull-down menu.

Building Type	A “predefined” building configuration can be selected. (See Appendix D in the Customized Offering Manual for detailed descriptions). Multiple Building Types are available for this measure.
Vintage	Select a Building Vintage from the list of available vintages that best matches the age of the building and main systems.
HVAC System(s)	Select the appropriate cooling equipment type from the pull-down menu. Please note that the available HVAC systems for selection are dependent on the selected building type.
Allow HVAC System Downsizing	This checkbox allows <i>Engage</i> to downsize HVAC systems in the measure runs if the selected measure results in reduced cooling loads. This checkbox is only enabled if the building vintage is after 2005.
Total Building Area	Enter the square-feet of conditioned space.
Number of Floors	Enter the number of floors of conditioned space.
Secondary Building Area/Total Dormitory Area	This field may or may not be disabled for this measure, depending on the building type selected. Building types such as Universities and Colleges allow for input to this field, while Large/Small offices do not.
Secondary Number of Floors	This field may or may not be disabled for this measure, depending on the building type selected.

Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the ‘Observed Holidays’ button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 4-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.

Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 4-3: Tool Inputs Sheet 3 of 4, Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the fan upgrade to be implemented. Inputs are described in the following table.

Table 4-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Input Name	Description / Purpose
Fan Motors	Enter motor count and motor horsepower for up to twenty (20) different motor horse power sizes.
Baseline Supply Fan Type	Select the Supply Fan Type for the baseline case. The available options include Forward curved or air foil centrifugal fans that can by inlet vanes or discharge dampers. A vane-axial option is available as well. Note: Variable Speed Drive can also be selected; however this baseline selection is unlikely to yield energy savings.

Baseline VAV Minimum Flow (Perimeter & Core Zones)	Use these inputs to describe the Minimum Flow entering Perimeter Zones and Core Zones throughout the building. The defaults are based on Title 24. If a Baseline case is constant volume, VAV Minimum Flow should be 100%.
Replacement Supply Fan Type	Select the Supply Fan Type for the measure case. The default value is Variable Speed Drive (VSD).
Replacement VAV Minimum Flow (Perimeter & Core Zones)	Use these inputs to describe the Minimum Flow entering Perimeter Zones and Core Zones throughout the building. The defaults are based on Title 24.

2.2.4.4.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 4-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.4.4.2 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 4-6: Building Measure Results

Output Label	Description/Purpose
Existing Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Baseline Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 minimum efficient equipment is displayed.
Proposed Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
Savings	The difference between the Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.4.5 Energy Savings Explanation

Since supply fan(s) are designed and sized to serve the maximum cooling load in a building, they are supplying excess capacity during part-load conditions. Fan capacity and corresponding power requirement can be reduced during these periods through the use of control devices such as inlet guide vanes, discharge dampers, or variable speed drives (VSDs). The amount of power reduction depends on the control strategy as some are more efficient than others. The 2012 CCT can estimate the energy savings achieved when the supply fan(s) in a building or group of buildings is fitted with a VSD or other control devices. It should be noted that the CCT assumes the control measure is applied to any and all fans that serve the building or site.

The 2012 CCT calculates the energy savings for this measure by passing all required user inputs through Engage, which is a modified version of the Quick Energy Simulation Tool (eQUEST). eQUEST is a whole-building performance model that incorporates graphics and wizards with the DOE2.2 computation engine to simulate building energy performance based on user-defined inputs. These inputs describe building attributes such as (but not limited to) building envelope characteristics, internal loads, and HVAC system components. eQUEST, through the DOE2.2 computation engine, performs hourly calculations of the electrical and/or gas demand of building system end uses (HVAC, lighting, misc equipment, etc) based on normalized annual weather data. (Please note that to create a more generic model, assumptions are incorporated into eQUEST to create the Engage model, thereby reducing the amount of inputs and detail required by the user. However, the DOE2.2 computation methodology remains the same across both platforms.)

If you believe the simulation does not fairly represent the project's savings, use the engineering calculations approach to estimate the energy savings.

2.2.5 AC&R I - VSD for Centrifugal Chillers

2.2.5.1 Description

This tool is designed to compute the incentive achieved from a Centrifugal Chiller Variable Speed Drive (VSD) retrofit. Chillers are generally oversized in order to accommodate loads potentially experienced during the hottest day of the year. As a result, chillers will run at part loads for the majority of the cooling season. However, the efficiency (kW/ton) of a constant-speed centrifugal chiller drops off significantly during low part-load operation (under 50% of full cooling capacity). A Variable Speed Drive retrofit to the chiller efficiently reduces the speed of the compressor during part-load conditions. This allows the chiller to run during part-load conditions without any decrease in overall efficiency (kW/ton).

The CCT is utilized for measures involving the retrofit of a chiller with a VSD drive controller.

2.2.5.2 Appropriate Use of the Tool –Program Policy

The CCT is utilized for the following VSD for Centrifugal Chillers HP measures:

- ☐ Installation of VSD on an existing centrifugal chiller

The estimate of savings from the VSD for Centrifugal Chillers Tool can be calculated for the following building types and the building area must be between:

- ☐ Education – Primary School – defaults to 50,000 ft² but must be between 40,000 and 200,000 ft²
- ☐ Education – Secondary School – defaults to 150,000 ft² but must be between 100,000 and 400,000 ft²
- ☐ Education – Community College – defaults to 300,000 ft² but must be between 100,000 and 600,000 ft²
- ☐ Health/Medical – Hospital – defaults to 250,000 ft² but must be between 100,000 and 500,000 ft²
- ☐ Lodging - Hotel – defaults to 200,000 ft²
- ☐ Office – Large – defaults to 175,000 ft²
- ☐ Office – Small – defaults to 10,000 ft²
- ☐ Retail – Multistory Large – defaults to 120,000 ft²

2.2.5.3 Measure Tool Use

2.2.5.3.1 Inputs

Prior to selecting the VSD for Centrifugal Chillers measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. This CCT only allows projects that are retrofits (same load). Once the VSD for Centrifugal Chillers measure is selected, the user is then directed to enter the various inputs as described in the following tables. The data in the tables appear in the same order as the CCT.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 5-1: Tool Inputs Sheet 1 of 4, Building Specifications

Tool Input	Description / Purpose
Location	Select the appropriate city
Building Type	From the pull-down menu, select a “predefined” building configuration from the list of “prototypical” buildings (see Appendix D in the Statewide Customized Offering Procedures Manual).
Vintage	From the pull-down menu, select the year the building was constructed.
HVAC System(s)	From the pull-down menu, select a cooling equipment type. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type.
Secondary Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Secondary Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the ‘Observed Holidays’ button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 5-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Pattern	From the pull-down menu, select a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	From the pull-down menu, select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 5-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	From the pull-down menu, choose the appropriate shell. One or more typical usage pattern will be available based on the previously chosen Building Type.
Season	From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the chiller upgrade to be implemented. Inputs are described in the following table.

Table 5-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Tool Input	Description / Purpose
Area Served	Enter the square-feet of conditioned space.
Year Manufactured	Insert the year the chiller was constructed.
Overhauled	Check the box if the chiller has been overhaul since its manufactured date.
Year Overhauled	Insert the year the chiller was constructed.
Chiller Type(s)	From the pull-down menu, choose the appropriate chiller type. The Baseline selection will be applied to the Measure.
Condenser Type(s)	From the pull-down menu, the only appropriate chiller type is Water-Cooled.
Compressor(s)	From the pull-down menu, the only appropriate chiller type is Constant Speed for the Baseline and Variable Speed for the Measure.
Chiller Counts & Sizes	Insert the number of chillers. From the pull-down menu, choose Specify if you know the actual chiller size or Auto-size if you know the size range.
Chiller Efficiency	Insert the chiller's full load efficiency in either kW/ton or COP.

2.2.5.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 5-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.5.3.3 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 5-6: Building Measure Results

Tool Output	Description/Purpose
Existing Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Baseline Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 minimum efficient equipment is displayed.
Proposed Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
Savings	The difference between the Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.5.4 Energy Savings Explanation

The applicant inputs information in the CCT. All the user inputs are passed on to Engage. Engage is a software program developed by James J. Hirsch and Associates that incorporates a DOE2.2 computation engine, which runs on a PC computer. The DOE2.2 engine is a building energy simulation tool that incorporates hourly weather data for specific cities throughout California. This engine utilizes this weather data (along with user inputs describing the building envelope characteristics, internal loads, and HVAC system components) to calculate the peak electrical demand and energy usage for all the building components (HVAC equipment, lighting, etc.). Engage then passes the above values back to the CCT. The software then displays the savings estimates and incentive amount.

2.2.6 AC&R I - Water Source Heat Pump with or without Variable Flow

2.2.6.1 Description

The CCT estimates the energy savings achieved when an existing water source heat pump is replaced with a unit with a higher efficiency rating (EER). Energy savings can also be achieved where the replacement equipment utilizes a variable flow controls over a baseline unit with constant controls.

2.2.6.2 Appropriate Use of the Tool –Program Policy

The CCT can be utilized for the replacement of a water-source heat pump system. No fuel switching is allowed and only savings associated with cooling are calculated when using the tool for a heat pump. All heat pump sizes and capacities are applicable.

The tool allows implementation of this measure as a retrofit or for early retirement. For calculating early retirement, the tool allows for either for a recently overhauled unit or a less efficient piece of equipment that is replaced before the end of its useful life.

The estimate of savings from the Water Source Heat Pump with or without Variable Flow Tool can be calculated for the following building types and the building area must be between:

- ☐ Office – Large – defaults to 175,000 ft²
- ☐ Office – Small – defaults to 10,000 ft²

2.2.6.3 Measure Tool Use

2.2.6.3.1 Inputs

Prior to selecting the HE WSHP w or w/o Variable Flow (Engage) measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load) or New Installation. The CCT allows projects that fall under either Retrofit (same load) or Retrofit (increased load). The user should make the appropriate selection based on the proposed equipment and project scope.

Once the measure for HE WSHP w or w/o Variable Flow (Engage) is selected, the user is then directed to enter the various inputs as described in the following tables.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 6-1: Tool Inputs Sheet 1 of 4, Building Specifications

Input Name	Type	Description / Purpose
Location	Pull-down	Location can be selected by either Zip Code or climate zone (CTZ). The appropriate Zip Code or CTZ is then selected from the adjacent pull-down menu.
Building Type	Pull-down	A “predefined” building configuration can be selected. (See Appendix D in the Customized Offering Manual for detailed descriptions). Multiple Building Types are available for this measure.

Vintage	Pull-down	Select a Building Vintage from the list of available vintages that best matches the age of the building and main systems.
HVAC System(s)	Pull-down	Select the appropriate cooling equipment type from the pull-down menu. Please note that the available HVAC systems for selection are dependent on the selected building type.
Allow HVAC System Downsizing	Pull-down	This checkbox allows <i>engage</i> to downsize HVAC systems in the measure runs if the selected measure results in reduced cooling loads. This checkbox is only enabled if the building vintage is after 2005.
Total Building Area	Fill In	Enter the square-feet of conditioned space.
Number of Floors	Pull-down	Enter the number of floors of conditioned space.
Secondary Building Area/Total Dormitory Area	Pull-down	This field may or may not be disabled for this measure, depending on the building type selected. Building types such as Universities and colleges allow for input to this field, while Large/Small offices do not.
Secondary Number of Floors	Pull-down	This field may or may not be disabled for this measure, depending on the building type selected.

Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 6-2: Tool Inputs Sheet 2 of 4, Building Seasons

Input Name	Type	Description / Purpose
Seasonal Usage - Pattern	Pull-down	Select the appropriate usage type from the pull-down menu. Only "Typical Use Throughout the Year" is available for selection for this measure.
Seasonal Usage - Number of Seasons	Pull-down	Select the number of seasons during which the building systems operate from the pull-down menu. User can select up to three seasons
Season #1	Pull-down	User can modify the default entry for this field which is "Typical Use"
Observed Holidays	Pull-down	When clicked, this button displays a checkbox list of holidays available to be exempt from scheduling.
Season #2: (With Label & No of Periods)	Pull-down	This field is enabled if the number of seasons selected is >1. Insert an appropriate label for the seasons. Choose an appropriate number of periods when the season occurs from the pull-down menu and the pop up calendar.

Season #3: (With Label & No of Periods)	Pull-down	This field is enabled if the number of seasons selected is >2. Insert an appropriate label for the seasons. Choose an appropriate number of periods when the season occurs from the pull-down menu and the pop up calendar.
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Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 6-3: Tool Inputs Sheet 3 of 4, Building Operations

Input Name	Type	Description / Purpose
Select Active Building Shell	Pull-down	From the pull-down menu, choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Pull-down	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the heat pump upgrade to be implemented. Inputs are described in the following table.

Table 6-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Input Name	Type	Description / Purpose
Area Served	Fill In	Enter the total area served by the HVAC system.
Economizer	Pull-down	Choose the economizer option that best fits the project equipment.
Existing Loop Flow	Pull-down	The user may select either 'Constant' or 'Variable' from the drop down. The default value is 'constant.'
Existing Pump Control	Pull-down	The user can define the existing pump control with this input. Please note that the user can only edit this field when 'Variable' loop flow is selected. Otherwise the value is fixed at 'Single Speed'.
Existing WSHP Equipment Data	Button	Press the command button to open up the screen and define the appropriate details for the existing equipment.
Replacement Loop Flow	Pull	The user may select either 'Constant' or 'Variable' from the drop down. The default value is 'Variable.'
Replacement Pump Control	Pull-down	The user can define the replacement pump control with this input.

Replacement WSHP Equipment Data	Pull-down	Press the command button to open up the screen and define the appropriate details for the replacement equipment.
Code Baseline HP Equipment	Display	This section does not require any input from the user. The text boxes will provide the efficiency and capacity of the WSHP equipment to be used as the baseline for the analysis. If the existing equipment qualifies for early retirement, this will be equal to the baseline efficiency. If the existing equipment is not qualified for early retirement, the appropriate minimum efficiency standard will be used.

2.2.6.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 6-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.6.3.3 Output

Once all the necessary input information has been gathered, the CCT utilizes these inputs to compute the annual energy demand and usage for two scenarios: the baseline water source heat pump equipment compared to the replacement equipment (the calculation methodology is explained below). Finally, the energy savings and incentive is computed and the results are presented to the user as found in the Table below.

Table 6-6: Building Measure Results

Output Label	Description/Purpose
Existing Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Baseline Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 minimum efficient equipment is displayed.
Proposed Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
Savings	The difference between the Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.6.4 Energy Savings Explanation

The CCT calculates the energy savings for this measure by passing all required user inputs through Engage, which is a modified version of the Quick Energy Simulation Tool (eQUEST). Developed by James J. Hirsch and Associates, eQUEST is a whole-building performance model that incorporates graphics and wizards with the DOE2.2 computation engine to simulate building energy performance based on user-defined inputs. These inputs describe building attributes such as (but not limited to) building envelope characteristics, internal loads, and HVAC system components. eQUEST, through the DOE2.2 computation engine, performs hourly calculations of the electrical and/or gas demand of building system end uses (HVAC, lighting, misc equipment, etc) based on normalized annual weather data.

(Please note that to create a more generic model, assumptions are incorporated into eQUEST to create the Engage model, thereby reducing the amount of inputs and detail required by the user. However, the DOE2.2 computation methodology remains the same across both platforms.)

If you believe the simulation does not fairly represent the project's savings, use the engineering calculations approach to estimate the energy savings.

2.2.7 AC&R II - Air-Side Economizers

2.2.7.1 Description

This tool is designed to compute the savings and incentive achieved from the installation of an Air-Side Economizer. Many commercial buildings have large internal loads due to lights, computers, and other electrical equipment. As a result, even in cold climates buildings may still need cooling. This constant need to provide cooling can lead to large amounts of energy consumption throughout the year. One alternative, however, is using an economizer. When outdoor air is cool enough, the building's HVAC system can cycle in outdoor air to cool the building. This can result in energy savings by reducing, or eliminating the need to operate a package unit and chiller. Economizers operate most effectively by comparing the outdoor enthalpy conditions to indoor enthalpy requirements. However, due to the lack of reliable, rugged and low cost enthalpy sensors, a dry bulb sensor is often used to determine when the economizer can be utilized. Economizers can be installed on many, but not all, HVAC systems.

2.2.7.2 Appropriate Use of Tool – Program Policy

This CCT is utilized for the following economizer measures:

- ☐ The addition of an economy cycle onto existing HVAC equipment.
- ☐ The addition of actuator controls to automate an existing manually operated economizer.

The estimate of savings from the Air Side Economizers Tool can be calculated for the following building types and the building area must be between:

- ☐ Assembly – defaults to 34,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Primary School – defaults to 50,000 ft2 but must be between 40,000 and 200,000 ft2
- ☐ Education – Secondary School – defaults to 150,000 ft2 but must be between 100,000 and 400,000 ft2
- ☐ Education – Community College – defaults to 300,000 ft2 but must be between 100,000 and 600,000 ft2
- ☐ Education – University – defaults to 800,000 ft2 but must be between 640,000 and 2,500,000 ft2
- ☐ Health/Medical – Hospital – defaults to 250,000 ft2 but must be between 100,000 and 500,000 ft2
- ☐ Lodging - Hotel – defaults to 200,000 ft2
- ☐ Manufacturing – Bio/Tech – defaults to 200,000 ft2
- ☐ Manufacturing – Light Industrial – defaults to 100,000 ft2
- ☐ Office – Large – defaults to 175,000 ft2
- ☐ Office – Small – defaults to 10,000 ft2
- ☐ Restaurant – Sit Down – defaults to 4,000 ft2
- ☐ Restaurant – Fast Food – defaults to 2,000 ft2
- ☐ Retail – Multistory Large – defaults to 120,000 ft2
- ☐ Retail – Single -Story Large – defaults to 130,500 ft2
- ☐ Retail – Small – defaults to 8,000 ft2
- ☐ Storage – Conditioned - defaults to 500,000 ft2

2.2.7.3 Equipment Sizes or Capacities Covered by this Tool

All HVAC equipment sizes and capacities are applicable. The proposed operating hours for an economizer is based on the amount of cooling required and the amount of cooling that can be achieved from using only outside air, as determined by the building's load and location respectively.

The CCT calculates savings using the Engage Software for a measure of this type. The Engage software is a stand-alone, DOE2 based modeling program. If you believe the simulation does not fairly represent the project's savings, use the engineering calculations approach to estimate the energy savings.

2.2.7.4 Measure Tool Use

2.2.7.4.1 Inputs

Once the measure for Air-Side Economizers (Engage) is selected, the user is then directed to enter the various inputs as described in the following tables. The data in the tables appear in the same order as a user experiences while using the CCT.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 7-1: Tool Inputs Sheet 1 of 4, Building Specifications

Tool Input	Description / Purpose
Location	From the pull-down menu, select by Zip Code or by CTZ. (CTZ stands for Climate Zone) In the adjacent pull-down menu select the appropriate Zip Code or CTZ.
Building Type	From the pull-down menu, select a “predefined” building configuration from the list of “prototypical” buildings (see Appendix D in the Customized Offering Program Manual for detailed descriptions).
Vintage	From the pull-down menu, select the year the building was constructed.
HVAC System(s)	From the pull-down menu, select a cooling equipment type. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type.
Secondary Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Secondary Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
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Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 7-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Pattern	From the pull-down menu, select a seasonal usage pattern. One or more typical usage pattern will be available based on the previously chosen Building Type.
Number of Seasons	From the pull-down menu, select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 7-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	From the pull-down menu, choose the appropriate shell. One or more typical usage pattern will be available based on the previously chosen Building Type.
Season	From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Sheet 4 allows users to define the economizer upgrade to be implemented. Inputs are described in the following table.

Table 7-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Tool Input	Description / Purpose
Cooling Equipment Served	Total capacity of cooling equipment served by economizers. Input should be in tons of total (sensible + latent) cooling capacity, where the tons input here represents the sum of the rated nominal capacity of all systems for which economizers are being added or repaired.
Baseline Economizer Type	From the pull-down menu, choose –none-, Drybulb Temperature or Enthalpy.
High Limit	Enter the current set point. The economizer is enabled whenever the outside air drybulb temperature is below the set point.
Measure Economizer Type	From the pull-down menu, choose –none-, Drybulb Temperature or Enthalpy.
High Limit	Enter the proposed set point. The economizer is enabled whenever the outside air enthalpy is below the set point.

2.2.7.4.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 7-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.7.4.3 Outputs

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 7-6: Building Measure Results

Tool Output	Description/Purpose
Existing Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Baseline Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 minimum efficient equipment is displayed.

Proposed Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
Savings	The difference between the Baseline Equipment values and Proposed Equipment values are displayed.
Incentive (@ \$0.09 kWh/yr)	Estimated incentive amount based on 2012 program rates.

2.2.7.5 Energy Savings Explanation

The applicant inputs information in the CCT. All the user inputs are passed on to Engage. Engage is a software program developed by James J. Hirsch and Associates that incorporates a DOE2.2 computation engine, which runs on a PC computer. The DOE2.2 engine is a building energy simulation tool that incorporates hourly weather data for specific cities throughout California. The Engage software program utilizes the user's inputs (along with DEER prescribed equipment specifications, operating schedules, and building envelope characteristics) to estimate the energy demand and usage of the cooling equipment. Specifically, it computes baseline peak demand [kW] and energy use [kWh/yr] of the existing cooling equipment without an outside air economizer. It also computes proposed peak demand [kW] and proposed annual energy usage [kWh/yr] of the proposed cooling equipment, with an outside air economizer. Engage then transfers the above values to the CCT. The CCT then performs the necessary calculations and displays the Annual Demand Savings [kW], Annual Energy Savings [kWh] and the Incentive amount.

2.2.8 AC&R II - Chilled Water/Hot Water Reset (SCE Only)

2.2.8.1 Description

This tool is designed to compute the incentive for implementing Chilled Water and/or Hot Water Reset Controls. The dependency many buildings have on air conditioning for day to day comfort offers many opportunities for energy savings. The SCE Online Application Tool provides incentives to encourage upgrades that would provide such savings. The SCE Online Application Tool 2012 software tool calculates energy savings by calculating cooling and heating loads on a building using the engage program. Engage is created as a replacement to the MARS software and is primarily used to aid account representatives analyze energy efficiency measures similar to the SCE Online Application Tool. Engage is built on the Quick Energy Simulation Tool (eQUEST) which calculates cooling loads and system energy requirements based on hourly weather data.

2.2.8.2 Appropriate Use of Tool

The SCE Online Application Tool is utilized for the following control system measures:

- ☐ Implementation of CHW system controls including OA Reset and Load Reset
- ☐ Implementation of HW system controls including OA Reset and Load Reset

The online tool currently has a limited number of system types available, which are based on the selected building type. If the system and building type combination are unavailable, a more detailed analysis method may be necessary.

2.2.8.3 Applicable Types of Equipment

This tool is utilized for calculating savings associated with the installation of CHW and HW reset controls for all available system types that can be selected on the Online Application Tool. However, the user should be aware of eligibility requirements for incentives that are in place by the local utility of the proposed project site. For additional information, see the 2012 Statewide Customized Offering Procedures Manual.

2.2.8.4 Equipment Sizes or Capacities Covered by the tool

The SCE Online Application Tool CHW and HW reset are limited to the system types available based on the selected building type. For customized and specialized systems, a more detailed tool and detailed simulation model, such as eQUEST, will be required to appropriately calculate savings associated with CHW and HW reset measures.

2.2.8.5 Measure Tool Use

2.2.8.5.1 Inputs

Prior to selecting the CHW and HW reset measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load) or New Installation. This SCE Online Application Tool allows projects that fall under any of the three above referenced measure types. The user should make the appropriate selection based on the proposed equipment and project scope.

Once the CHW and HW reset measure is selected, the user is then directed to enter the various inputs as described in the following tables. The input screens appear in the same order as a user experiences while using the SCE Online Application Tool.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction and climate zone to be used in the analysis.

Table 8-1: Tool Inputs Sheet 1 of 4, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
Secondary Building Area	Enter the secondary building area (if applicable). The conditioned area is defined on screen 4.
Secondary Number of Floors	Enter the total number of floors of the secondary building (if applicable). The tool will automatically assign an equal amount of square feet per floor.

The program then allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen. If multiple seasons are needed to more accurately reflect the operation of the project site the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 8-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Pattern	From the pull-down menu, select a seasonal usage pattern. One or more typical usage pattern will be available based on the previously chosen Building Type.
Number of Seasons	From the pull-down menu, select one, two or three.
Season #1	Insert an appropriate label for the season.

Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 8-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	From the pull-down menu, choose the appropriate shell. One or more typical usage pattern will be available based on the previously chosen Building Type.
Season	From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

The next sheet, allows users to define the equipment and chiller upgrade to be implemented. Inputs are described in the following table.

Table 8-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Name	Description / Purpose
CHW SysControl	Select the baseline and proposed chilled water control type
Setpoint	Enter the existing fixed CHW temperature setpoint
CHW Min Temp	Select the proposed minimum CHW temperature
CHW Max Temp	Select the proposed maximum CHW temperature
HW SysControl	Select the baseline and proposed Hot Water control type
Setpoint	Enter the existing fixed HW temperature setpoint

CHW Min Temp	Select the proposed minimum HW temperature
CHW Max Temp	Select the proposed maximum HW temperature

2.2.8.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 8-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.8.5.3 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 8-6: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the existing equipment and estimated annual energy use (kWh) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the baseline equipment and estimated annual energy use (kWh) of the baseline equipment.
Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment and estimated annual energy use (kWh) of the proposed equipment.
Savings	Estimated on-peak demand (kW) and energy savings for measure (kWh) For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.9 AC&R II - Cold Storage Rapid Close Doors

2.2.9.1 Description

Rapid close doors save energy at cold storage facilities by reducing the refrigeration system load due to infiltration. This can be achieved by improving the seal of the doorway, increasing the door speed and/or reducing the amount of time the door simply stands open. The methodology for estimating energy savings for this measure is well documented (2002 ASHRAE Refrigeration Handbook, Refrigeration Load, Page 12.3).

2.2.9.2 Appropriate Use of the Tool – Program Policy

The software allows the user to specify multiple retrofit types. Retrofit types must share similar operating schedules, doorway specifications, traffic flow, etc. In addition to cold storage facilities, walk-in freezer/coolers can also be modeled with this tool.

2.2.9.3 Measure Tool Use

2.2.9.3.1 Inputs

Model assumptions should be based on the last twelve months of operation. Indeterminate variables that significantly impact estimated savings are space temperatures, doorway usage and control strategies, and hours of operation. Therefore, as with any estimating tool, model outputs should be compared to annual billing data to verify the reasonableness of the results. Where discrepancies are observed, documentation supporting the project assumptions should be requested.

The model advances through 5 sheets. To get from the first sheet to the second press the “Edit Existing” button, to get from the first sheet to the third press the “Edit Proposed” button, to get from the first sheet to the fourth press the “Edit Operation” button. To get to the result press the “Next” button from the first sheet.

Table 9-1: Site Information

Input Name	Description / Purpose
Number of Doorway Types	Enter the number of doorway retrofit types. Recall each type must have similar characteristics and usage patterns
City	Select the site location.

Table 9-2: Existing/Proposed Doorway Characteristics

Input Name	Description / Purpose
Building Identification	Enter the building identification.
Number of Doorways	Enter the number of like doorway retrofits.
Doorway Width (ft)	Enter doorway width
Doorway Height (ft)	Enter doorway height

Opens to	Select from the following door opening type: Outside from Loading Dock, Outside from Cooler, Outside from Freezer, Unconditioned Loading Dock from Cooler, Unconditioned Loading Dock from Freezer, Conditioned Loading Dock from Cooler, Conditioned Loading Dock from Freezer, Cooler from Freezer
Refrigeration System Efficiency	Enter the rated efficiency of the refrigeration system and select the appropriate units. The rated efficiency should be based on design conditions at entering ambient air temperatures of 95°F dry-bulb for air-cooled condensers and 75°F wet-bulb for evaporative-cooled condensers, and 85°F entering water temperature for water-cooled condensers. If the door opens to a conditioned space, the exterior cooling efficiency needs to be input.
Condenser Type	Select the refrigeration system condenser type: air-cooled, water-cooled, or evaporative-cooled.
Controls	Select the refrigeration controls: fixed or floating head.

Table 9-3: Existing/Proposed Doorway Protective Device Inputs

Input Name	Description / Purpose
Doorway Protective Device	The doorway protective device is the main device that restricts infiltration into the conditioned area. If the doorway protective device is left open during business hours, losses are still accounted for during non-business hours, therefore it is necessary to represent this device in the model. Select from the following doorway protective devices: none, strip curtains, dual strip curtain with air-lock vestibule, dual impact (or push-through) doors with air-lock vestibule, vertical non-recirculating air curtain, dual horizontal recirculating air curtain, dual horizontal recirculating air curtain with outer strip curtain, standard-folding doors, standing-sliding curtains, standard-sliding doors, rapid-folding doors, rapid-sliding curtains and rapid-sliding doors.
Door Insulation	Enter the door insulation type. This information is for review purposes only; it does not impact the savings calculation.
Insulation Thickness (in.)	Enter the door insulation thickness. This information is for review purposes only; it does not impact the savings calculation.

U-Factor (Btu/hr•ft •°F)	Enter the overall coefficient of heat transfer (U-Factor). The U-Factor accounts for inside surface conductance, total door thermal conductance and outside surface conductance. Please provide manufacturer's specification for the existing, if available, and proposed doors. For a summary of the principles of heat transfer, refer to the 2001 ASHRAE Fundamentals Handbook, Pages 3.2-3.3. Other variables that may impact the thermal conductivity are wind and solar exposure. For a detailed discussion of their effects, refer to the 2001 ASHRAE Fundamentals Handbook, Pages 25.12 and 30.11, and 2002 ASHRAE Refrigeration Handbook, Page 12.2.
Open Doorway Protective Device	The open-doorway device is a secondary device that restricts infiltration when the main door is open. Select from the following open doorway protective devices: none, strip curtains, dual strip curtain with air-lock vestibule, dual impact (or push-through) doors with air-lock vestibule, vertical non-recirculating air curtain, dual horizontal recirculating air curtain, dual horizontal recirculating air curtain with outer strip curtain, rapid-folding doors, rapid-sliding curtains and rapid-sliding doors.
Open-Close Time (sec)	Enter the doorway protective device open-close time. This is the time it takes for the doorway protective device to open and close. For conventional pull-cord operated doors, this value typically ranges from 15 to 25 seconds per passage; for high speed doors, it can range from 5 to 10 seconds depending on the means of control and the control setpoint.

Table 9-4: Operating Characteristics

Input Name	Description / Purpose
Operation Varies by Month?	The user may input annual or monthly values for the variables listed below. To input monthly values select the check box.
Loading Dock / Cooler Temperature (°F)	If the doorway does not open to the outside or to an unconditioned space, the user needs to specify the annual or monthly temperatures and relative humidity of the loading dock or cooler.
Inside Temperature (°F)	Enter storage temperature setpoint.
Weekday Hours	Enter the average work hours per weekday.
Saturday Hours	Enter the average work hours on Saturday.
Sunday Hours	Enter the average work hours on Sunday.

Averages Openings per Hour	Enter the average openings (passages) per hour for this doorway protective device type. This is how many times the doorway protective device opens and closes as a result of foot or forklift traffic.
Average Open Time, Pre and Post (minutes)	Enter average doorway protective device open time, before and after installation. This is the time the doorway protective device simply stands open. This could be the result of multiple forklift traffic or manually keeping the door open. If the doorway protective device is left open during business hours, enter a value of 60 min/hour.

2.2.9.3.2 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Table 9-5: Measure Energy Savings, Operating Hours & Incentive

Name	Description / Purpose
Doorway Type	Doorway retrofit type. Recall each type must have similar characteristics and usage patterns.
Annual Op Hours	Annual operating hours of Doorway Type
Existing, kW	Estimated maximum on-peak demand of the existing doorway type.
Proposed, kW	Estimated maximum on-peak demand of the proposed doorway type.
Existing, kWh/yr	Estimated annual energy use of the existing doorway type.
Proposed, kWh/yr	Estimated annual energy use of the proposed doorway type.
Savings, kW	Estimated on-peak demand savings for measure (difference between baseline and proposed)
Savings, kWh/yr	Estimated annual energy savings for measure (difference between baseline and proposed)
Incentive (\$)	Estimated incentive amount based on 2012 program rates.

2.2.9.4 Energy Savings Explanation

Infiltration from one space to another is primarily caused by the air density difference between them. The expression for heat gain through an opening due to infiltration is as follows:

$$q_{to} = qD_tD_f(1 - E)$$

Where,

q_{to} = Average heat gain for the 24-h or other period, Btu/h

q = Sensible and latent refrigeration load for fully established flow, Btu/h

D_t = Doorway open-time factor.

D_f = Doorway flow factor

E = Effectiveness of doorway protective device

This model looks at the heat gain and effectiveness of both a doorway protective device and an open-doorway protective device. The open-doorway protective device is a secondary device, typically strip or air curtains that provide some level of protection even when the primary door is left open or opened temporally to allow passage.

The original model did not account for equipment-related loads associated with latent heat in freezer spaces. Based on heat balance calculations and a general cooler-to-freezer doorway scenario, the following equation was developed to account for equipment-related loads in freezer applications.

$$q_{to} = qD_tD_f(1 - E)(1.05R_s + (0.0034T_{sc} + 2.224)(1 - R_s))$$

Where,

T_{sc} = The amount of “subcool” = 32 °F – Inside Temperature

R_s = sensible heat ratio of the infiltration air heat gain, tons/ft²

This approach uses the following equation and sensible heat gain and sensible heat ratio data.

$$q = 3790WH^{1.5} \left(\frac{Q_s}{A} \right) \left(\frac{1}{R_s} \right)$$

Where,

q = sensible and latent heat load, Btu/h

W = door width, ft

H = door height, ft

Q_s/A = sensible heat load of infiltration air per square foot of doorway opening, tons/ft²

A = door area, ft²

The doorway open-time factor is calculated using the following equation.

$$D_t = \left(\frac{P \times \Theta_p + 60 \times \Theta_o}{3600} \right)$$

Where,

P = Number of doorway passages

Θ_p = Doorway protective device open-close time, seconds per passage

Θ_o = Time doorway protective device simply stands open, minutes

Determination of the D_t is automated in the software. The logic is

- If $\Delta T > 20^\circ$, DF = 0.80.
- If $\Delta T < 20^\circ$, DF = 1.10.

Table 9-6: Protective Doorway Device Effectiveness, Static and w/ Traffic

Doorway Device Description	Effectiveness (Static)	Effectiveness (Traffic)
None	0	0
Strip curtains	0.9	0.8
Dual strip curtain with air-lock vestibule	0.97	0.95
Dual impact (or push-through) doors with air-lock	0.99	0.97
Vertical non-recirculating air curtain	0.65	0.65
Dual horizontal recirculating air curtain	0.76	0.76
Dual horizontal recirculating air curtain with outer strip	0.88	0.86
Standard-folding doors	0.93	0.82
Standard-sliding curtains	0.93	0.63
Standard-sliding doors	0.98	0.79
Rapid-folding doors	0.93	0.82
Rapid-sliding curtains	0.93	0.63
Rapid-sliding doors	1	0.79

Losses during operating hours (q_i) are the sum of the loss when the doors is open (q_{to}) and closed (q_{tc}) during normal operation.

$$q_i = q_{to} + q_{tc}$$

Therefore, the baseline and post-installation energy consumption are estimated using the following equations:

$$kWh = \frac{(kW / ton) \times ((q_{to} + q_{tc}) \times hr_{op} + (q_{tc}) \times hr_{non-op})}{12,000 Btuh / ton}$$

Where,

kW/ton = Refrigeration efficiency

hr_{op} = Hours of operation

hr_{non-op} = Hours of non-operation.

2.2.10 AC&R II - Demand Control Ventilation (DCV)

2.2.10.1 Description

Outside air is typically introduced at a fixed rate into buildings for the peak design occupancy level. Demand Control Ventilation (DCV) varies the amount of outside air introduced in the building based on occupancy level. The energy conserving attribute of DCV is heavily dependent on the variability of the occupancy level and climate zone. Reducing the amount of outside air can reduce the amount of energy to heat or cool the outside air in certain climate zones. Reducing outside air in certain climate zones (cool and dry) can increase energy consumption because the cooling effect of the outside air is reduced (no economy cycle scenario).

Carbon Dioxide is used as an indicator of occupancy level. With the use of CO₂ sensors and a prescribed (the program's default set-point for CO₂ of 1000 ppm was accepted) CO₂ concentration set point for the space, the amount of outside air can be varied. In all cases DCV is overridden by economy cycle controls. When outside air (economy cycle) can be beneficial for cooling, DCV is not allowed to reduce the amount of outside air introduced. DCV saves cooling energy by reducing the amount of outside air, to the minimum required by a CO₂ measurement as a proxy for occupancy during periods of non-economy cycle operation.. This measure does not calculate heating energy savings.

2.2.10.2 Appropriate Use of the Tool –Program Policy

2.2.10.2.1 Appropriate use of the tool

The Demand Control Ventilation Tool estimates the highest probability of cooling energy savings for buildings with high occupancies and in “hot & dry” weather zones.

2.2.10.2.2 Types for equipment for which the tool is applicable

The Demand Control Ventilation Tool is applicable for electric cooling equipment with and without an economy cycle.

2.2.10.2.3 Size or capacities which are covered by the tool

The estimate of savings from the Demand Control Ventilation Tool can be calculated for the following building types and sizes. This tool is primarily for smaller buildings. The accuracy is degraded when the area is larger than the following area because the *Honeywell* “Saving Estimator” program Version 3.30 does not recommend using values more the four times the software defaults:

- ☐ Restaurant – 21,000 ft²
- ☐ Retail – 300,000 ft²
- ☐ School (Class Room Wing) – 38,000 ft²
- ☐ Small Office – 25,000 ft²

2.2.10.3 Measure Tool Use

2.2.10.3.1 Inputs

Prior to selecting the Demand Control Ventilation measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. Once the Demand Control Ventilation measure is selected, the user is then directed to enter the various inputs as described below.

Table 10-1: Inputs

Input Name	Type	Sheet	Description / Purpose
Manufacturer	Fill in	1	Enter manufacturer of DCV controls
Model Number	Fill in	1	Enter model number of DCV controls
City	Pull-Down	1	Select the location of the building
Economy Cycle	Button	1	Yes or No
Cooling Equipment Efficiency	Button	1	Specify the EER of the cooling equipment, either "Low (EER=8)", "Medium (EER=10)", "High (EER=12)"
Building Type	Pull-Down	1	Select either Restaurant, School, or Small Office
Building Area	Fill in		Enter area of the building (Square feet)

2.2.10.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 10-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.10.3.3 Output

Once all necessary input information has been gathered, the Demand Control Ventilation Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user. The Demand Control Ventilation Tool outputs are described below.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 10-3: Output

Output Name	Type	Sheet	Description / Purpose
Existing Equipment, kW	Result	2	Estimated DEER Peak Demand
Proposed Equipment, kW	Result	2	Estimated DEER Peak Demand
Existing Equipment, kWh/yr	Result	2	Estimated existing annual energy
Proposed Equipment, kWh/yr	Result	2	Estimated proposed annual energy
Savings, kW	Result	2	Estimated DEER Peak demand savings for measure (difference between existing and proposed)
Savings, kWh/yr	Result	2	Estimated annual energy savings for measure (difference between existing and proposed)
Total Incentive, \$	Result	2	Estimated incentive amount based on 2012 program rates.

2.2.10.4 Energy Savings Explanation

Description of calculation procedures

Honeywell has developed a software program that was used to develop the savings for the Customized Offerings. This *Honeywell* program is “Saving Estimator” Version 3.30 (8/8/2003) by J. E. Braun & M. J. Brandemuhl. This program was used to develop 1536 savings estimates. There were 16 California Weather Zones, 2 conditions of the economy cycle (yes or no), 3 levels of equipment efficiency (low, medium, and high), 4 building types, and 4 building areas. From these estimates trend lines were developed and used in the Customized Calculation Tool.

2.2.11 AC&R II - High Performance Skylights with Daylighting (SCE Only)

2.2.11.1 Description

Lighting systems are found throughout various facilities both internally and externally and are used for illumination purposes of all types. Skylights can provide significant savings by replacing electrical lights with daylight. High performance skylights offer an attractive option by providing the option for day lighting with reduced solar heat gain, which provides cooling savings over standard skylights.

The CCT provides for the following lighting retrofit measures:

- ❑ Installation of high performance skylights. Specifically skylights with a performance index (Visible Transmittance/Solar Heat Gain Coefficient) > 0.81

2.2.11.2 Appropriate Use of the Tool

The Engage tool is appropriate for calculating estimated savings for lighting and HVAC usage. Lighting savings are calculated as a result of reduced operating hours for interior lights affected by day lighting controls, and HVAC savings are calculated based on reduction in heat load compared to skylights with lower efficiency skylights.

2.2.11.3 Applicable Types of Equipment

Program requirements for baseline skylights are subject to National Fenestration Rating Council values preferred by Title 24 for use of NFRC rated glass. The user should note that eligible program incentives are calculated using standard NFRC values which vary based on climate zone.

The proposed skylights must meet a minimum performance index of 0.81, which is calculated by dividing the visible transmittance and solar heat gain coefficient $\left[\frac{Vis.Trans.}{SHGC}\right]$.

2.2.11.4 Measure Tool Use

2.2.11.4.1 Inputs

Prior to selecting the actual High Performance Skylights with Day lighting measure, the user is required to specify site information which is used to define the building for savings calculations on Sheet 1, Basic Specifications.

Table 11-1: Tool Inputs Sheet 1 of 4, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.

Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
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Screen 2, Describes the “Season Definitions. Select the appropriate number of seasons and appropriate date ranges under which they apply. Season’s #2 and #3 will allow the user to select up to three periods during which the defined schedule for those seasons will apply. Any remaining dates will automatically be set to Season #1. If multiple seasons are described then the user should switch back to the Building Operations topic and define the schedule for each season.

Table 11-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 11-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must define the appropriate values for the existing and proposed skylights and daylighting control system. Topic 1: High Performance Skylights (1 of 2) allows the user to input appropriate values for the baseline and proposed skylights.

2.2.11.4.2 Existing Skylights and Proposed Skylights

The Existing and Proposed Skylight types can be selected as NFRC rated or Glass Manufacturer Data. The NFRC rated selection automatically defines Ufactor, SHGC and Visible Transmittance per the National Fenestration Rating Council (NFRC) which are consistent with Title 24 requirements for use of NFRC rated glass. Glass Manufacturer Data allows the user to define customized values which may be obtained from the glass manufacturer. The user may also define if the existing and proposed skylights are “Diffusing” and/or “Domed”. The “Diffusing” selection is appropriate if the skylight glazing transmits sunlight and daylight with significant scattering; this should not be selected if the skylight is specular and will transmit light with minimum scattering. The “Domed” selection is appropriate if the skylight is curved and projects above the skylight frame, this should not be selected if the skylight is planar and is in-line with the skylight frame.

2.2.11.4.3 Program Baseline Skylights

The user should note that the eligible program incentive is calculated using the “Program Baseline Skylights” definition. The types available for selection contain pre-defined values for the all pertinent factors and coefficients for the baseline skylights. The user should select the type that matches most closely to the existing skylights.

2.2.11.4.4 Existing and Proposed Skylights and Coverage

The lighted area controlled should define the area below the skylights that are controlled by daylight sensors which can be either dimming or on/off controllers. The day lit area is sometimes defined as the interior floor area served by the lighting fixtures in that space. Figure 11-1 below gives an example of this calculation.

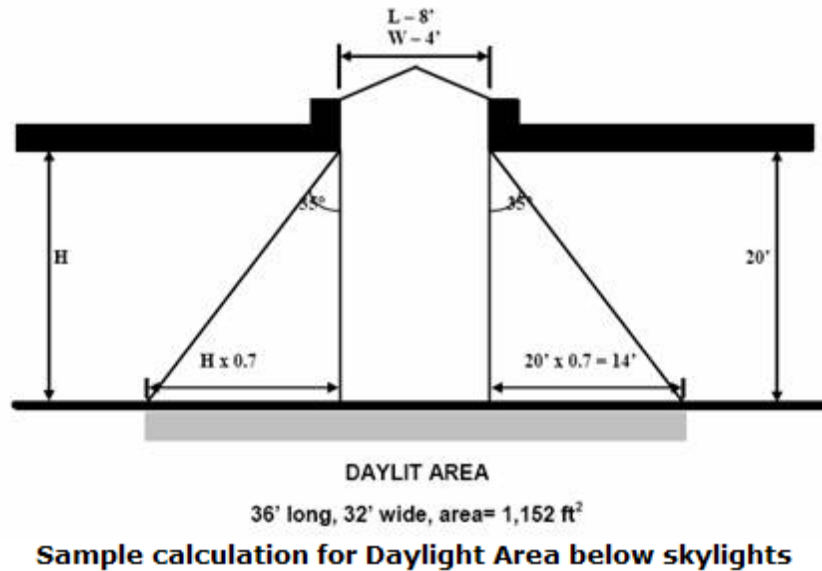


Figure 11-1: Daylit Area Calculation

The total number of skylights should only include skylights which are serving areas with acceptable controllers which will reduce or turn off any interior electrical lights during daylight hours.

The skylights can be defined by either the dimensions or the total skylight area. Defining the lights by dimensions assumes the lights to be square or rectangular. If the lights do not fit these criteria, the user may elect to define the area by the total skylight area in square feet by selecting the appropriate selection and entering the appropriate value.

2.2.11.4.5 Lighting Control Type

The user may also need to enter appropriate lighting control definitions found in the second topic selection "Daylighting for High Perf. Skylights (2 of 2)." As this measure only covers High performance skylights with Daylighting, only the "Toplighting" selection is available for the Daylighting Method. The control type should be selected based on actual site conditions.

2.2.11.4.5.1 Continuous Control Type

"Continuous" is appropriate for a dimming control system which is capable of dimming from 100% ON to a pre-set minimum which is defined under the "Min Power Frac" parameter. The "Light Setpoint" will define the required light for the facility. If daylighting exceeds this value, electrical fixtures should remain at the "Min Power Frac". "Min Light Frac" defines the minimum amount of light output by the electrical fixtures. As seen in the right graph of Figure 11-2, the electrical illuminance starts at 50 fc (Light Setpoint), when no daylight is available, and gradually decreases to 5 fc (Min Light Frac), when the daylight alone would meet the lighting requirements of the area served.

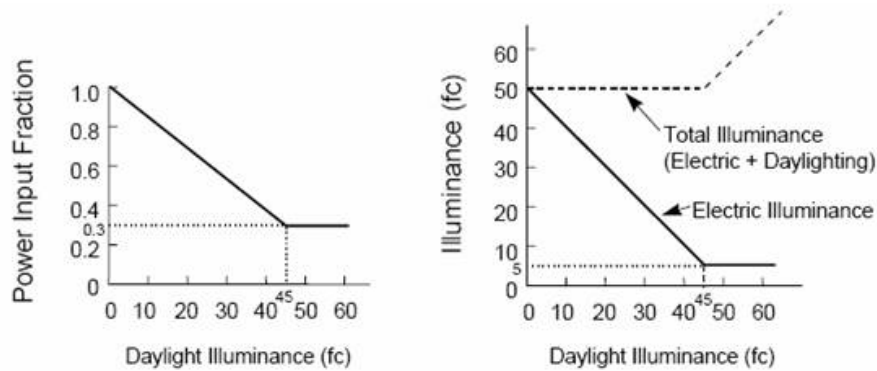


Figure 11-2: Continuous Lighting Control Type

2.2.11.4.5.2 Continuous/Off Control Type

The Continuous/Off control type works in a similar fashion to the continuous control type with one difference. When daylight alone is capable of meeting the minimum light requirements of the area served, the electrical lights will turn off completely, rather than operate at a minimum. See Figure 11-3.

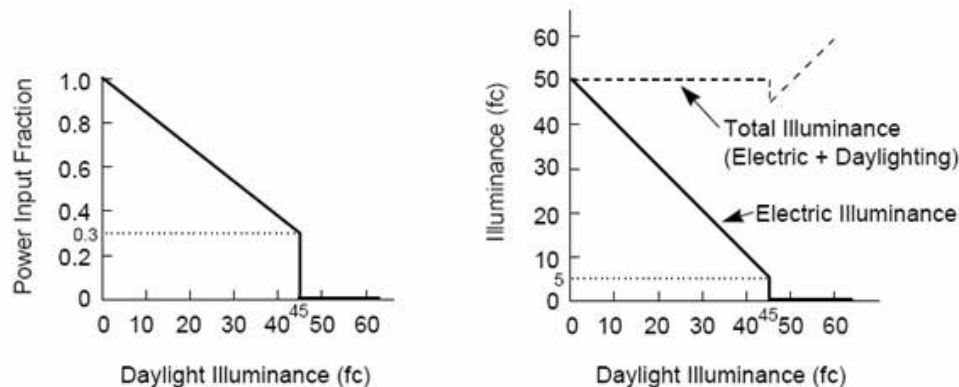


Figure 11-3: Continuous/Off Lighting Control Type

2.2.11.4.5.3 Stepped Control Type

The step control type is an appropriate selection if the lighting control system operates in discrete steps. If Control Steps = 1, then this represents a simple on/off control system in which the lights will remain on at 100% if the daylighting is incapable of providing enough to meet the defined lighting setpoint. If Control Steps = 2, then this represents a controller where the lights will step from 100% to 50% to 0% (off). The total electrical and daylight provided must meet the minimum light setpoint defined. Under this control type, the simulation will not operate between any discrete control steps. That is, if the daylighting only provides 40% of the required light, the control step will be 100%, as the 50% option will not be able to meet the required amounts. If Control steps ≥ 3 , then the system will automatically define an equivalent sized set of control points up to 20.

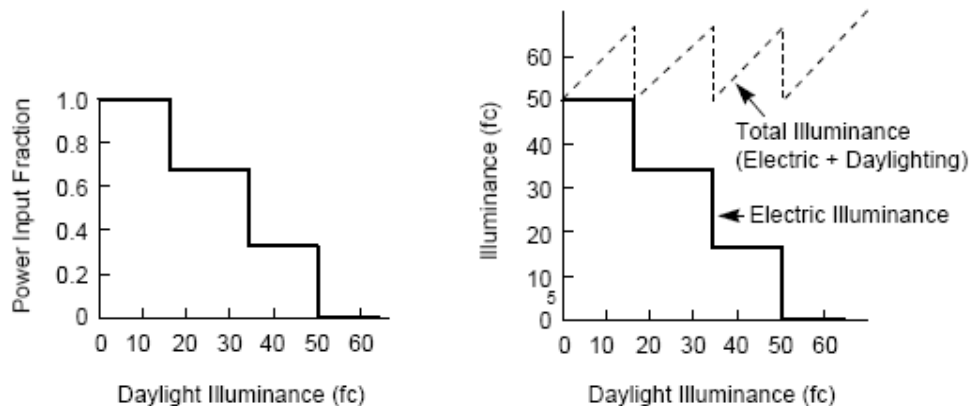


Figure 11-4 - Stepped Lighting Control Type

Once all inputs have been entered, the user may proceed by selecting “Save & Continue”. The software will then run a DOE2 simulation to estimate the measure’s impact on energy usage for the HVAC and lighting system.

2.2.11.4.6 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 11-4: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.11.4.7 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 11-5: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.12 AC&R II - High Performance Windows with Daylighting (SCE Only)

2.2.12.1 Description

Lighting systems are found throughout various facilities both internally and externally and are used for illumination purposes of all types. Windows can provide significant savings by replacing electrical lights with daylight. High Performance Windows offer an attractive option by providing the option for day lighting with reduced solar heat gain, which provides cooling savings over standard Windows.

The CCT provides for the following lighting retrofit measures:

- ❑ Installation of high performance windows. Specifically, windows with a performance index (Visible Transmittance/Solar Heat Gain Coefficient) > 1.15

2.2.12.2 Appropriate Use of the Tool

The Engage tool is appropriate for calculating estimated savings for lighting and HVAC usage. Lighting savings are calculated as a result of reduced operating hours for interior lights affected by day lighting controls and HVAC savings are calculated based on reduction in heat load compared to Windows with lower efficiency Windows.

2.2.12.3 Applicable Types of Equipment

Program requirements for baseline windows are subject to National Fenestration Rating Council values preferred by Title 24 for use of NFRC rated glass. The user should note that eligible program incentives are calculated using standard NFRC values which vary based on climate zone.

The proposed window must meet a minimum performance index of 1.15, which is calculated by dividing the visible transmittance and solar heat gain coefficient $\left[\frac{Vis.Trans.}{SHGC}\right]$.

2.2.12.4 Measure Tool Use

2.2.12.4.1 Inputs

Prior to selecting the actual High Performance Windows with Daylighting measure, the user is required to specify site information which is used to define the building for savings calculations on Sheet 1, Basic Specifications. The critical inputs are defined in Table below.

Table 12-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Bldg. Area	Enter the building area. The conditioned area is defined on screen 4.

Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
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Screen 2, Describes the “Season Definitions. Select the appropriate number of seasons and appropriate date ranges under which they apply. Season’s #2 and #3 will allow the user to select up to three periods during which the defined schedule for those seasons will apply. Any remaining dates will automatically be set to Season #1. If multiple seasons are described then the user should switch back to the Building Operations topic and define the schedule for each season.

Table 12-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 12- 3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must define the appropriate values for the existing and proposed Windows and daylighting control system. Topic 1: High Performance Windows (1 of 2) allows the user to input appropriate values for the baseline and proposed Windows.

2.2.12.4.2 Existing Windows and Proposed Windows

The Existing and Proposed Window types can be selected as NFRC rated or Glass Manufacturer Data. The NFRC rated selection automatically defines Ufactor, SHGC and Visible Transmittance per the National Fenestration Rating Council (NFRC) which are consistent with Title 24 requirements for use of NFRC rated glass. Glass Manufacturer Data allows the user to define customized values which may be obtained from the glass manufacturer. The appropriate boxes may also be checked or unchecked to define the appropriate window orientation. Title 24 permits higher solar transmission glass on north facing windows.

2.2.12.4.3 Program Baseline Windows

The user should note that the eligible program incentive is calculated using the “Program Baseline Windows” definition. The types available for selection contain pre-defined values for all pertinent factors and coefficients for the baseline windows. Window orientation for “Program Baseline Windows” is automatically defined based on “Existing Window” inputs. The user should note that changing orientation may result in the change of baseline SHGC and Visible Transmittance in the case that a window does not meet Title 24 requirements of NFRC ratings.

2.2.12.4.4 Total Window Area

The user must first select an input method which can be either % Gross Wall Area (floor to floor) or Total Facility Window Area (SqFt). If the % Gross Wall area is selected, the user can specify the % glass, which will be based on the total wall area. The total wall area is defined by the building type selection in Screen 1 – Basic Specifications. Engage will then automatically calculate the appropriate glass area based on the provided inputs. Total Facility Window Area (SqFt) indicates that the total glass area will be specified by the user. Engage will then use this information to automatically specify the appropriate area on the respective building orientations.

2.2.12.4.5 Replacement Window Areas

Under either option, the user can manually override the calculated replacement window areas specified. The software will automatically assume the “Total Window Area” described will be replaced in the proposed measure. If these areas are not equivalent, the user should manually input the total window area to be replaced per window orientation. The Windows can be defined by either the dimensions or the total Window area. Defining the lights by dimensions assumes the lights to be square or rectangular. If the lights do not fit these criteria, the user may elect to define the area by the total Window area in square feet by selecting the appropriate selection and entering the appropriate value.

2.2.12.4.6 Lighting Control Type

The user may also need to enter appropriate lighting control definitions found in the second topic selection “Daylighting for High Performance Windows (2 of 2).” As this measure only covers High performance Windows with Daylighting, only the “Toplighting” selection is available for the Daylighting Method. The control type should be selected based on actual site conditions.

2.2.12.4.6.1 Continuous Control Type

“Continuous” is appropriate for a dimming control system which is capable of dimming from 100% ON to a pre-set minimum which is defined under the “Min Power Frac” parameter. The “Light Setpoint” will define the required light for the facility. If daylighting exceeds this value, electrical fixtures should remain at the “Min Power Frac”. “Min Light Frac” defines the minimum amount of light output by the electrical fixtures. As seen in the right graph of Figure 12-1, the electrical illuminance starts at 50 fc (Light Setpoint), when no daylight is available, and gradually decreases to 5 fc (Min Light Frac), when the daylight alone would meet the lighting requirements of the area served.

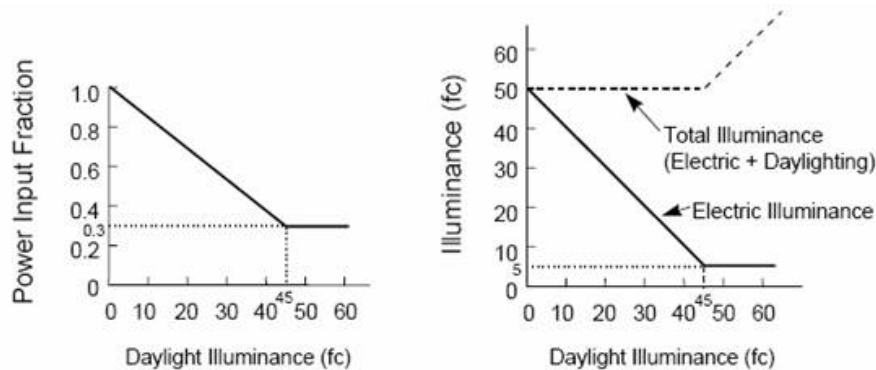


Figure 12-1: Continuous Lighting Control Type

2.2.12.4.6.2 Continuous/Off Control Type

The Continuous/Off control type works in a similar fashion to the continuous control type with one difference. When daylight alone is capable of meeting the minimum light requirements of the area served, the electrical lights will turn off completely, rather than operate at a minimum.

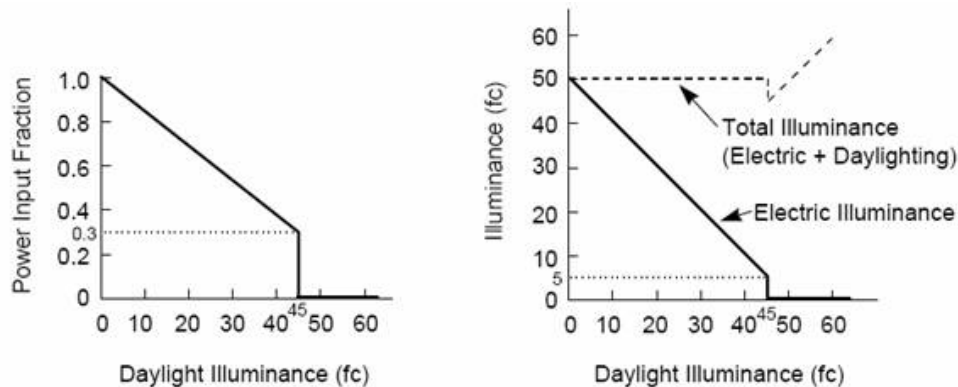


Figure 12-2: Continuous/Off Lighting Control Type

2.2.12.4.6.3 Stepped Control Type

The step control type is an appropriate selection if the lighting control system operates in discrete steps. If Control Steps = 1, then this represents a simple on/off control system in which the lights will remain on at 100% if the daylighting is incapable of providing enough to meet the defined lighting setpoint. If Control Steps = 2, then this represents a controller where the lights will step from 100% to 50% to 0% (off). The total electrical and daylight provided must meet the minimum light setpoint defined. Under this control type, the simulation will not operate between any discrete control steps. That is, if the daylighting only provides 40% of the required light, the control step will be 100%, as the 50% option will not be able to meet the required amounts. If Control steps ≥ 3 , then the system will automatically define an equivalent sized set of control points up to 20.

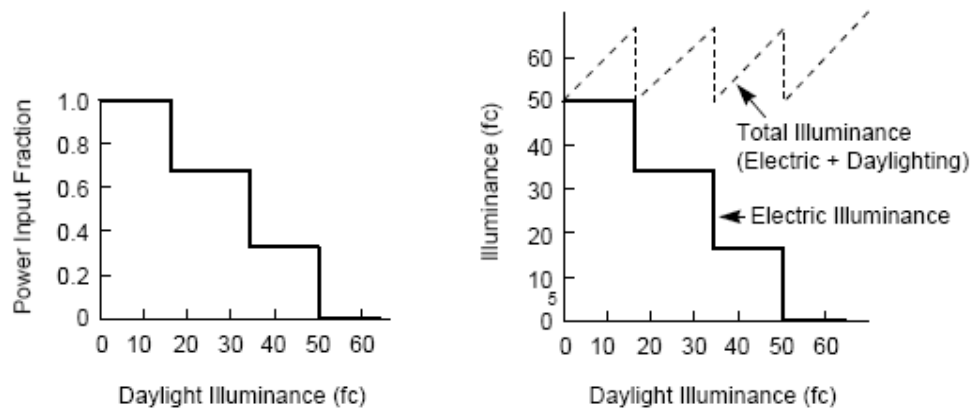


Figure 12-3: Stepped Lighting Control Type

Once all inputs have been entered, the user may proceed to screen 4 and select “Calculate Results”. The software will then run a DOE2 simulation to estimate the measure’s impact on energy usage for the HVAC and lighting system.

2.2.12.4.7 Outputs

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 12-4: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.

Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.13 AC&R II – Roof and Ceiling Insulation (SCE Only)

2.2.13.1 Description

Roof/ ceiling insulation reduces the transfer of heat across the roof or ceiling surface. By limiting this uncontrolled heat transfer, the building's heat load is less affected by external conditions and the energy consumed by the HVAC system is reduced.

2.2.13.2 Appropriate Use of the Tool

The Engage tool is appropriate for calculating estimated savings for HVAC usage, which are based on reduced cooling and heating energy usage.

2.2.13.3 Applicable Types of Equipment

Program requirements for Roof/ Ceiling Insulation are subject to the requirements of Title 24, Section 143(a)1. The requirements for exterior roofs are as follows:

- ☐ Exterior roofs shall have insulation placed in direct contact with a continuous roof or drywall ceiling that is sealed to limit infiltration and exfiltration.
- ☐ Fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed and the space between the ceiling and the roof shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements.
- ☐ Insulation placed on top of a suspended ceiling with removable ceiling panels shall be deemed to have no effect on envelope heat loss.
- ☐ Insulation shall be installed below the roofing membrane or layer used to seal the roof from water penetration unless the insulation has a maximum water absorption of 0.3 percent by volume.
- ☐ An exterior roof shall have an overall assembly U-factor no greater than the applicable value in Table 143-A, Table 143-B, or Table 143-C of the Title 24 manual.

2.2.13.4 Measure Tool Inputs

Prior to selecting the actual Roof/ Ceiling Insulation measure, the user is required to specify site information which is used to define the building for savings calculations on Screen 1, Basic Specifications. The critical inputs for Screen 1 are defined in Table 13-1, below.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 13-1: Tool Inputs Sheet 1 of 4, Building Specifications

Tool Input	Description / Purpose
Location	Choose site location based on zip code or CTZ (California Thermal Zone - CEC climate zone). In the adjacent menu select the appropriate Zip Code or CTZ. (refer to Appendix D in the Customized Offering Procedures Manual for detailed CTZ descriptions).
Building Type	Choose the building type most appropriate for the project site. Select a “predefined” building configuration from the list of “DEER prototypical” buildings (refer to Appendix D in the Customized Offering Procedures Manual for detailed building descriptions).
Vintage	Choose the year range in which the building was constructed.
HVAC System(s)	Choose the system type that best fits the type found on the project site. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the total conditioned and unconditioned primary building area in square feet. The conditioned area is defined on screen 4 in the “Area Served” input.
Secondary Building Area	Enter the secondary building area in square feet (if applicable). The conditioned area is defined on screen 4. applicable to your Building Type.
Number of Floors	Enter the number of floors of primary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Secondary Number of Floors	Enter the number of floors of secondary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Sheet 2 (Table 13-2) allows users to define seasons and observed holidays for the project site. By clicking the ‘Observed Holidays’ button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple

chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 13-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 13-3: Tool Inputs Sheet 3 of 4 Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must input the Affected Roof Area. The default is for the Affected Roof Area to be 100% of the total building area, but this may be changed by the user.

The user must then enter the Overall Roof R-values for the existing and proposed insulation. The Program Baseline R-value is shown as reference, and will be used to calculate Above Code Savings. Sheet 4 allows users to define the roof/ceiling measure to be implemented. Inputs are described in the following table.

Table 13-4: Tool Inputs Sheet 4 of 4 Building Measure Specifications

Name	Description / Purpose
Affected Roof Area, ft ²	Enter the total area that will be insulated.
Overall Roof R-Value, h-ft ² -degF/ Btu	Enter the Overall (combined) R-values of the Existing, Code/ISP Baseline, and Proposed Insulation.

2.2.13.4.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 13-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.13.4.2 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 13-6: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the existing equipment and estimated annual energy use (kWh) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the baseline equipment and estimated annual energy use (kWh) of the baseline equipment.
Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment and estimated annual energy use (kWh) of the proposed equipment.
Savings	Estimated on-peak demand (kW) and energy savings for measure (kWh) For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.14 AC&R II – Thermostat Set Back and Set Point Adjustment (SCE Only)

2.2.14.1 Description

The dependency many buildings have on air conditioning for day to day comfort offers opportunities for energy savings. Thermostats are often set at a lower cooling point and higher heating point than is required, especially for unoccupied hours. The savings from simple setbacks through EMS can be an economical and financially rewarding implementation. The SCE Online Application Tool provides savings estimates for incentives to encourage upgrades that would provide such savings. The SCE Online Application Tool 2011 software tool calculates energy savings by calculating cooling and heating loads on a building using the Engage program. Engage is created as a replacement to the MARS software and is primarily used to aid account representatives analyze energy efficiency measures similar to the SCE Online Application Tool. Engage is built on the Quick Energy Simulation Tool (eQUEST) which calculates cooling loads and system energy requirements based on hourly weather data.

2.2.14.1.1 Appropriate Use of Tool

The SCE Online Application Tool is utilized for the following control system measures:

- ☐ Thermostat set back and set point adjustment

The online tool currently has a limited number of system types available, which are based on the selected building type. If the system and building type combination are unavailable, a more detailed analysis method may be necessary.

2.2.14.1.2 Applicable Types of Equipment

This tool is utilized for calculating savings associated with resetting of cooling and heating set points for all available system types that can be selected on the Online Application Tool. However, the user should be aware of eligibility requirements for incentives that are in place by the local utility of the proposed project site. For additional information, see the Statewide Customized Offering Manual 2012.

2.2.14.1.3 Equipment Sizes or Capacities Covered by the tool

The SCE Online Application Tool Thermostat Set Back is limited to the system types available based on the selected building type. For customized and specialized systems, a more detailed tool and detailed simulation model, such as eQUEST, will be required to appropriately calculate savings associated with CHW and HW reset measures.

2.2.14.2 Measure Tool Use

2.2.14.2.1 Tool Inputs

Once the Thermostat SB and SP measure is selected under the HVAC category, the user is then directed to enter the various inputs as described in the following tables and associated figures. The input screens appear in the same order as the SCE Online Application Tool.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction and climate zone to be used in the analysis.

Table 14-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
Secondary Building Area	Enter the secondary building area (if applicable). The conditioned area is defined on screen 4.
Secondary Number of Floors	Enter the total number of floors of the secondary building (if applicable). The tool will automatically assign an equal amount of square feet per floor.

The program then allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen. If multiple seasons are needed to more accurately reflect the operation of the project site the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 14-2: Tool Inputs Sheet 2 of 4, Building Seasons

Name	Description / Purpose
Seasonality	Typical use throughout year (non-editable)
Number of Seasons	User may choose up to 3 distinct operating seasons
Season #2 and Season #3	The user may specify the date ranges through which the season is applicable. The next screen will ask the user to define operating hours for these seasons.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 14-3: Tool Inputs Sheet 3 of 4, Building Operations

Name	Description / Purpose
Select Active Building Shell	For certain building types the area operating hours must be defined on a shell by shell basis. Alternatively, using the Copy button will ascribe the defined operating hours to all shells.
Seasons	Enter the operating hours per the season that was defined on the previous screen

The next sheet, allows users to define the square footages for which the solution is applicable. It also allows the user to input the values for the temperature resets. Inputs are described in the following table.

Table 14-4: Tool Inputs Sheet 4 of 4, Equipment Description

Name	Description / Purpose
Area Served by Thermostats	Defaults to the building size input on sheet one. If the measure is zone specific, change this value to the zone size.
Typical Use	Enter the heating and cooling set points for both occupied and unoccupied hours. Also enter the proposed set points in the adjoining columns.
Season #2 and #3 (if applicable)	Enter the season specific set points for the previously defined operating seasons.

2.2.14.2.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 14-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.14.2.3 Tool Outputs

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 14-6: Tool Outputs

Tool Output	Description
Existing Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the existing equipment and estimated annual energy use (kWh) of the existing equipment.
Baseline Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the baseline equipment and estimated annual energy use (kWh) of the baseline equipment.
Proposed Equipment: Demand and Energy	Estimated maximum on-peak demand (kW) of the proposed equipment and estimated annual energy use (kWh) of the proposed equipment.
Savings	Estimated on-peak demand (kW) and energy savings for measure (kWh) For units that qualify for early retirement this will be the difference between existing and proposed. For units that do not qualify for early retirement this will be the difference between the baseline and proposed.
Incentive	Estimated incentive amount based on 2012 program rates.

2.2.14.3 Measure tool Calculation Methodology

The calculation methodology followed by this SCE Online Application Tool is described below:

2.2.14.4 Tool Inputs

The applicant inputs information in the SCE Online Application Tool as described in Section 2.2.14.1 above. The inputs are summarized as:

Building Specifications	These inputs describe the location, building type (i.e. large office), size, vintage, number of floors, and existing HVAC System.
Building Seasons	These inputs define the number of seasons and the periods of each.
Building Operations	These inputs describe the building operating hours for each defined season.
Measure	These inputs describe the type, efficiency, capacity, and year manufactured, of the existing and proposed HVAC system. Additionally, the inputs concerning Early Retirement are included in this screen (see Sect 1.4 for Details)

All the user inputs are passed on to Engage. Engage is a software program that incorporates a DOE2.2 computation engine, which runs on a PC computer. The DOE2.2 engine is a building energy simulation tool that incorporates hourly weather data for specific cities throughout California. This engine utilizes the weather data (along with user inputs describing the building envelope characteristics, internal loads, and HVAC system components) to calculate the peak electrical demand and energy usage for all the building components (HVAC equipment, lighting, etc.).

2.2.14.5 Engage computation

The Engage software program described above utilizes the user's inputs (along with DEER prescribed equipment specifications, operating schedules, and building envelope characteristics) to estimate the energy demand and usage of the cooling equipment. Specifically, it computes:

- ☐ Baseline peak demand [kW] of the existing cooling equipment.
- ☐ Baseline annual energy usage [kWh/yr] of the existing cooling equipment.
- ☐ Proposed peak demand [kW] of the proposed cooling equipment.
- ☐ Proposed annual energy usage [kWh/yr] of the proposed cooling equipment.

Engage then transfers the above values to the SCE Online Application Tool.

2.2.14.6 Baseline Annual Energy Use and Peak Demand

The SCE Online Application Tool receives the baseline and proposed demand and energy usage estimation values from Engage. The actual energy usage amounts taken from Engage are those that are considered an HVAC end use.

An HVAC end use is defined as equipment required for normal operation of the air conditioning system of the building. The energy usage for this measure is calculated with the consumption calculated from the following end uses:

- ☐ Space Heating
- ☐ Space Cooling
- ☐ Heat Rejection
- ☐ Pumping & Auxiliaries
- ☐ Ventilation
- ☐ Heat Pump Supplemental

The software then performs the following calculations on these HVAC end uses: Annual Demand Savings [kW] = Baseline demand [kW] – Proposed demand [kW]

Annual Energy Savings [kWh] = Baseline annual energy usage [kWh/year] – Proposed annual energy usage [kWh/year]

Please note that the Baseline is the greater value between the Existing and Code baseline (title 24) values that are produced by Engage. This applies to both replacement and early retirement equipment. See the equation below:

Baseline = Minimum(\sum Existing kWh/yr or \sum Codebase kWh/yr)

The results are totaled and the SCE Online Application Tool then displays the savings estimates and incentive amount, as shown in Section 2.2 above.

2.2.15 AC&R II - Timeclocks for Heating/Cooling (SCE Only)

2.2.15.1 Description

This tool is designed to compute the incentive for a timeclock measures that will control heating and cooling schedules for a building to be less than 24 hours/day

The dependency many buildings have on air conditioning for day to day comfort offers many opportunities for energy savings. This tool provides incentives to encourage upgrades that would provide such savings. The software calculates energy savings by calculating cooling and heating loads on a building using the engage program. Engage is created as a replacement to the MARS software and is primarily used to aid account representatives analyze energy efficiency measures similar to the SCE Online Application Tool. Engage is built on the Quick Energy Simulation Tool (eQUEST) which calculates cooling loads and system energy requirements based on hourly weather data.

The CCT provides for the following lighting retrofit measures:

- ❑ Controls upgrades that will allow for scheduling of building cooling and heating systems.

2.2.15.2 Appropriate Use of the Tool

The Engage tool is appropriate for calculating estimated savings as a result of reduced HVAC usage due to the implementation of HVAC scheduling controls. Savings are estimates based on areas served and not served by timeclocks. All areas not served by timeclocks are assumed to maintain 24-hour operation. For more detailed systems, a comprehensive energy simulation model, such as eQUEST, must be used to calculate savings.

2.2.15.3 Applicable Types of Equipment

Program requirements are limited to standard efficiencies based on current Title 24 standards. Should the system desired in the model be unavailable, a more comprehensive model should be used in order to get a more accurate representation of savings. The software does not currently allow for equipment side edits, and will use standard assumptions based on the HVAC System selected on screen 1 of the project inputs.

2.2.15.4 Measure Tool Use

2.2.15.4.1 Inputs

Prior to selecting the measure, the user is required to specify site information which is used to define the building for savings calculations on Screen 1, Basic Specifications. The critical inputs are defined in the table below.

Table 15-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.

HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.

The program then allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen. If multiple seasons are needed to more accurately reflect the operation of the project site the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur.

Table 15-2: Tool Inputs Sheet 2 of 4, Building Seasons

Name	Description / Purpose
Seasonality	Typical use throughout year (non-editable)
Number of Seasons	User may choose up to 3 distinct operating seasons
Season #2 and Season #3	The user may specify the date ranges through which the season is applicable. The next screen will ask the user to define operating hours for these seasons.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 14-3: Tool Inputs Sheet 3 of 4, Building Operations

Name	Description / Purpose
Select Active Building Shell	For certain building types the area operating hours must be defined on a shell by shell basis. Alternatively, using the Copy button will ascribe the defined operating hours to all shells.
Seasons	Enter the operating hours per the season that was defined on the previous screen

Once the appropriate selections are made, the user must define the appropriate values for the measure. For the purposes of the time clock measure, the only valid input is the *conditioned* area that will *not* be served by the new time clocks. The area input is relative to the area specified on screen 1 and should not exceed that amount. The Time clock-served Area Default value provided is based on Title-24 amounts and incentive qualified savings will only be present if the default area is less than the total area specified on screen 1. That is, if the default area = building area, there can be no incentive qualified savings as a result of the time clock measure as it is already a prescribed requirement for the building & HVAC system type and vintage specified.

Table 15-4: Tool Inputs Sheet 4 of 4, Equipment Description

Name	Description / Purpose
Area Served by Timeclock(s)	Defaults to the building size input on sheet one. If the measure is zone specific, change this value to the zone size.

2.2.15.4.2 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 15-5: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.16 AC&R II - Variable Flow CHW and HW Systems w or w/o VSD (SCE Only)

2.2.16.1 Description

Variable Flow Chilled Water (CHW) and Hot Water (HW) Systems allow facilities to reduce HVAC-related pumping energy consumption. This can be achieved through various methods, which include Variable Speed Drives (VSD) and modulation of control valves. Varying the system flow also reduces the energy required to cool and heat the water.

2.2.16.2 Appropriate Use of the Tool

The tool is appropriate for calculating estimated savings for HVAC usage, which are based on reduced pumping, chiller and water heating energy usage

2.2.16.3 Applicable Types of Equipment

Program requirements for Variable Flow CHW and HW Systems w or w/o VSD are subject to the requirements of Title 24, Section 144(j). The requirements are as follows:

HVAC pumping system must be capable of reducing fluid flow rates to 50% or less of the design flow rate, or the minimum flow rate required by the manufacturer for proper equipment operation, whichever is greater. The exceptions to this rule are for systems with no more than (3) control valves, and systems with total pump power less than or equal to 1-1/2 HP.

Pumps with motors exceeding 5 HP shall be controlled such that no more than 30 percent of motor design wattage is consumed at 50 percent design water flow rate. Pumps shall be controlled as a function of required differential pressure. Exceptions are for heating hot water systems and condenser water systems serving only water-cooled chillers.

2.2.16.4 Measure Tool Use

2.2.16.4.1 Inputs

Prior to selecting the actual Variable Flow CHW and HW Systems w or w/o VSD measure, the user is required to specify site information which is used to define the building for savings calculations on Sheet 1, Basic Specifications.

Table 16-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.

Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
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Screen 2, Describes the “Season Definitions. Select the appropriate number of seasons and appropriate date ranges under which they apply. Season’s #2 and #3 will allow the user to select up to three periods during which the defined schedule for those seasons will apply. Any remaining dates will automatically be set to Season #1. If multiple seasons are described then the user should switch back to the Building Operations topic and define the schedule for each season.

Table 16-2: Tool Inputs Sheet 2 of 4, Building Seasons

Name	Description / Purpose
Seasonality	Typical use throughout year (non-editable)
Number of Seasons	User may choose up to 3 distinct operating seasons
Season #2 and Season #3	The user may specify the date ranges through which the season is applicable. The next screen will ask the user to define operating hours for these seasons.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 16-3: Tool Inputs Sheet 3 of 4, Building Operations

Name	Description / Purpose
Select Active Building Shell	For certain building types the area operating hours must be defined on a shell by shell basis. Alternatively, using the Copy button will ascribe the defined operating hours to all shells.
Seasons	Enter the operating hours per the season that was defined on the previous screen

Once the appropriate selections are made, the user must select whether the measure will involve the CHW System Variable Flow and/or VSD, the HW System Variable Flow and/or VSD, or both, by selecting the appropriate choice. The user must then enter the pump motor horsepower and pump quantity.

Once the motor information has been entered, the user then selects the Baseline, Code, and Measure CHW and/ or HW Loop Flow and Pump Control types. Sheet 4 allows users to define the pump upgrade to be implemented. Inputs are described in the following table.

Table 16-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Input Name	Description / Purpose
CHW Pump(s)	Enter pump count and motor horsepower for up to twenty (20) different motor horse power sizes. Total Pump Count and Power is displayed.
CHW Loop Flow	Select the Loop Control Type for the existing, code, and installed case. The available options include constant or variable
CHW Pump Control	Select the Pump Control Type for the existing, code, and installed case. The available options include single speed, two speed, or VSD.
HW Pump(s)	Enter pump count and motor horsepower for up to twenty (20) different motor horse power sizes. Total Pump Count and Power is displayed.
HW Loop Flow	Select the Loop Control Type for the existing, code, and installed case. The available options include constant or variable
HW Pump Control	Select the Pump Control Type for the existing, code, and installed case. The available options include single speed, two speed, or VSD.

2.2.16.4.2 Output

Once all necessary input information has been gathered, the SCE Online Application Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 16-5: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.

Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.17 AC&R II - Variable-Speed Drives for Cooling Tower Fan Motors

2.2.17.1 Description

Background

Cooling towers reject heat in an HVAC system that contains water-cooled chillers or water-cooled package AC units / heat pumps. There are fans integrated into the towers which force ambient air over the condenser water coming from the chiller, which lowers the condenser water temperature. Typically, the cooling tower fans are controlled to satisfy a tower outlet water temperature setpoint (typically 85 degrees). There are typically three types of cooling tower fan motor control options:

1) One-speed fan motor:

The least efficient fan control method for a cooling tower is a one-speed fan motor. This fan motor will operate at 100% speed until the tower water outlet temperature is lowered to the outlet water setpoint. The fan motor will then cycle on and off as needed to satisfy the setpoint temperature with the least amount of fan power.

2) Two-speed fan motor:

The two-speed fan motor is a more efficient control method than the one-speed fan. The fan motor is designed to operate at two distinct speeds, full speed (typically 1800 RPM) and low-speed (typically 40% - 60% of full speed). When the tower outlet water temperature setpoint is not satisfied, the cooling tower will initially operate in low-speed mode. If the low-speed fan mode is unable to lower the condenser water to the setpoint, the fan will switch to high-speed mode. The fan will then alternate between low-speed, high-speed, and fan-off modes in order to adequately satisfy the outlet water temperature setpoint with the least amount of fan power.

3) VSD fan motor control:

The third, and most-efficient, method to operate a cooling tower fan is with variable speed drives (VSDs). These motor VSDs continuously speed up or slow down the cooling tower fans in order to exactly match the tower outlet condenser water setpoint. A cooling tower fan motor with VSD will utilize significantly less annual energy running at several fractional speed points than a one-speed fan motor, which must cycle on and off to maintain the outlet condenser water temperature.

Purpose of the VSD or Two-Speed Cooling Tower Fans Tool

This Customized Calculation Tool software tool is designed to determine the energy savings achieved by installing a VSD on one-speed and two-speed cooling tower fan motors. Both the energy demand and energy usage savings is calculated with this tool.

Specifically, the tool provides for the following cooling tower fan measures

- ☐ Installation of a VSD(s) to a one-speed cooling fan motor(s).
- ☐ Installation of a VSD(s) to a two-speed cooling fan motor(s)

2.2.17.2 Appropriate Use of the Tool – Program Policy

The VSD or Two-Speed Cooling Tower Fans tool is to be used to add VSD control to fan motor(s) in a cooling tower. The existing fan motor(s) shall be a one-speed or two-speed motor(s). This tool shall be used exclusively in buildings that utilize cooling towers to reject heat for HVAC equipment that is used for typical space cooling. Therefore, it is not applicable suitable for cooling towers used in cooling or refrigeration systems where the building indoor air setpoint is 45 degrees or lower. It is also not applicable to cooling towers that serve process cooling applications.

2.2.17.3 Applicable Types of Equipment

The VSD or Two-Speed Cooling Tower Fans tool applies to existing one-speed or two-speed cooling tower fan motor(s).

2.2.17.4 Equipment Sizes or Capacities Covered by the Tool

The VSD or Two-Speed Cooling Tower Fans tool applies to all manufactured sizes and capacities of cooling tower fan motor(s).

2.2.17.5 Measure Tool Use

2.2.17.5.1 Inputs

Once the “VSD or Two-Speed Cooling Tower Fans (Engage)” measure is selected, the user is then directed to enter the various inputs as described in the following tables. The input screens appear in the same order as a user experiences while using the CCT.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 17-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Tool Input	Description / Purpose
Location	From the pull-down menu, select by Zip Code or by CTZ. (CTZ stands for Climate Zone) In the adjacent pull-down menu select the appropriate Zip Code or CTZ.
Building Type	From the pull-down menu, select a “predefined” building configuration from the list of “prototypical” buildings (see Appendix D in the Statewide Customized Offering Procedures Manual for detailed descriptions).
Vintage	From the pull-down menu, select the year the building was constructed.
HVAC System(s)	From the pull-down menu, select a cooling equipment type. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type.

Secondary Building Area	Enter the square-feet of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Secondary Number of Floors	Enter the number of floors of conditioned space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Screen 2, Describes the “Season Definitions. Select the appropriate number of seasons and appropriate date ranges under which they apply. Season’s #2 and #3 will allow the user to select up to three periods during which the defined schedule for those seasons will apply. Any remaining dates will automatically be set to Season #1. If multiple seasons are described then the user should switch back to the Building Operations topic and define the schedule for each season.

Table 17-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Pattern	From the pull-down menu, select a seasonal usage pattern. One or more typical usage pattern will be available based on the previously chosen Building Type.
Number of Seasons	From the pull-down menu, choose one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Screen 3 is where the user defines the desired efficiency measure. The appropriate selection for this measure is found under the following selections: Category > HVAC - Miscellaneous followed by Measure > Variable Flow CHW and HW Systems w or w/o VSD.

Table 17-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	From the pull-down menu, choose the appropriate shell. One or more typical usage pattern will be available based on the previously chosen Building Type.
Season	From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once all necessary input information has been gathered, the SCE Online Application Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Table 17-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Name	Description/Purpose
Motor	From the pull-down menu, select a motor designation number. This allows you to enter multiple tower fans of various sizes.
Motor HP	Enter the motor HP.
Motor Count	Enter the total number of motors at the entered HP.
Baseline Temperature Control	From the pull-down menu, select fixed or reset.
Baseline Set point	Enter the condenser water return temperature setpoint.
Baseline Capacity Control	From the pull-down menu, select One-Speed Fan, Two-Speed Fan, Variable Speed Fan, Fluid Bypass or Discharge Dampers.
Code Baseline Temperature Control	Returns the temperature control type for minimum efficiency code requirement
Code Setpoint	Returns the minimum efficiency set point requirements
Code Capacity Control	Returns the code requirements for minimum efficiency capacity control.
Measure Temperature Control	From the pull-down menu, select fixed or reset.
Measure Set point	Enter the condenser water return temperature setpoint.
Measure Capacity Control	From the pull-down menu, select One-Speed Fan, Two-Speed Fan, Variable Speed Fan, Fluid Bypass or Discharge Dampers.

2.2.17.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 17-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.17.5.3 Output

Once all necessary input information has been gathered, the SCE Online Application Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table17-6: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.18 AC&R II - Water-Side Economizer (SCE Only)

2.2.18.1 Description

Water-side economizers allow facilities with water-cooled chillers to reduce energy consumption through the use of free cooling. Water-side free cooling is possible when the outside wet bulb temperature is low enough to offset all, or part of the mechanical cooling load. The most common method of water-side economizing is through the use of a heat exchanger, which allows for heat to be rejected from the space load to the cooling tower, via the chilled and condenser water lines.

2.2.18.2 Appropriate Use of Tool

The Engage tool is appropriate for calculating estimated savings for HVAC usage, which are based on reduced chiller energy usage

2.2.18.3 Applicable Types of Equipment

Program requirements for water-side economizers are subject to the requirements of Title 24, Section 144(e), which states that for systems with a supply air flow design capacity over 2,500 cfm and a total cooling capacity over 75,000 Btu/h, water-side economizers must be capable to providing 100 percent of the system cooling load when the outside air temperature is 50°F dry-bulb/ 45°F wet-bulb and below. The economizer shall not increase building heating energy use and must be capable of providing partial cooling even when additional mechanical cooling is required.

2.2.18.4 Measure Tool Use

2.2.18.5 Inputs

Prior to selecting the actual Water-Side Economizer measure, the user is required to specify site information which is used to define the building for savings calculations on Screen 1, Basic Specifications.

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 18-1: Tool Inputs Sheet 1 of 4, Basic Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.

Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.
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Screen 2, Describes the “Season Definitions. Select the appropriate number of seasons and appropriate date ranges under which they apply. Season’s #2 and #3 will allow the user to select up to three periods during which the defined schedule for those seasons will apply. Any remaining dates will automatically be set to Season #1. If multiple seasons are described then the user should switch back to the Building Operations topic and define the schedule for each season.

Table 18-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Pattern	From the pull-down menu, select a seasonal usage pattern. One or more typical usage pattern will be available based on the previously chosen Building Type.
Number of Seasons	From the pull-down menu, choose one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Screen 3 is where the user defines the desired efficiency measure. The appropriate selection for the water-side economizer measure is found under the following selections: Category > HVAC - Miscellaneous followed by Measure > Water-Side Economizer.

Table 18-3: Tool Inputs Sheet 3 of 4, Building Operations

Tool Input	Description / Purpose
Select Active Building Shell	From the pull-down menu, choose the appropriate shell. One or more typical usage pattern will be available based on the previously chosen Building Type.
Season	From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must define the area served (ft²) by the Water-Side Economizer. The percent of the total facility square footage served by the Water-Side Economizer will then be displayed in parentheses to the right.

Once the Area Served by Water-Side Economizer has been entered, the software will run a DOE2 simulation to estimate the measure's impact on energy usage for the HVAC system.

Table 18-4: Tool Inputs Sheet 4 of 4, Building Measure Specification

Tool Input	Description / Purpose
Area Served by Water-Side Economizer, ft ²	Defaults to the building size input on sheet one. If the measure is zone specific, change this value to the zone size.

2.2.18.5.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 18-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.18.5.2 Output

Once all necessary input information has been gathered, the CCT sends the required information to Engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table describes the CCT outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 18-6: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.19 Gas - Natural Gas Boiler Measures (PG&E & SDG&E Only)

2.2.19.1 Description

This tool is designed to evaluate three actions for a natural gas boiler measure (accessed from a Pull-down menu):

- ❑ **Replace Process Boiler(s)** – This tool calculates the energy savings and incentive for replacing existing steam or hot water boiler(s) with new boiler(s) of higher efficiency. This method is specific to process/industrial boiler heating loads as opposed to space heating loads. The 2010-2012 program does provide incentives for increased capacity therefore the energy output from the proposed boiler(s) can be larger than the output from the existing boiler(s) (if the increased load option is chosen at the beginning).
- ❑ **Add Boiler Economizer** – This tool is to be used for calculating the energy savings by adding an economizer to an existing boiler. An economizer recovers heat from the flue gas and transfers it to the boiler feed or return water. This tool is not available if the increased load option is chosen at the beginning.
- ❑ **Replace Space Heating Boiler(s)** – This tool is to be used for calculating the energy savings and incentive for replacing space heating steam or hot water boiler(s) with new boiler(s) of higher efficiency. The 2010-2012 program does provide incentives for increased capacity therefore the energy output from the proposed boiler(s) can be larger than the output from the existing boiler(s) (if the increased load option is chosen at the beginning).

2.2.19.2 Appropriate Use of the Tool – Program Policy

This tool covers the replacement of space heating, process, and commercial boilers, and the addition of a boiler economizer. The baseline minimum efficiency and the type of CEC minimum efficiency (AFUE or combustion) are dependent on the size of the boiler, as shown in the table below.

Table 19-1: CEC Minimum Efficiencies for Natural Gas Fired Boilers

Steam & Hot Water Boilers		
Size (Btuh Input)	Steam (min eff.)	Hot Water (min eff.)
<300,000	75%a	80%a
> 300,000	80%c	80%c

a = AFUE c = Combustion Efficiency

Definitions:

- ❑ **AFUE (Annual Fuel Utilization Efficiency)** – AFUE is a measure of the percentage of heat from the combustion of natural gas or oil that is transferred to the space being heated during a year, as determined using the applicable test method in the Appliance Efficiency Regulations of § 112... (CEC-400-2008-004-CMF)
- ❑ **Combustion Efficiency** is a measure of the percentage of heat from the combustion of gas or oil that is transferred to the medium being heated or lost as jacket loss. (CEC-400-2008-004-CMF)
- ❑ **% Combustion Eff** = Energy to HX/Total Fuel Input

Note: "Combustion Efficiency does not include losses from the boiler jacket. It is strictly a measure of the energy transferred from the products of combustion." (CEC-400-2008-017-CMF-Rev I)

2.2.19.3 Measure Tool Use

2.2.19.3.1 Inputs

2.2.19.3.1.1 Inputs for Replace Process Boiler(s)

Prior to selecting “Natural Gas Boiler/Water Heater,” the user is required to specify whether the proposed project is one of the following: Retrofit (same load/production) or Retrofit (increased load/production).

From the Pull-down menu select “Replace Process Boiler(s)” from the three following options:

- ☐ Replace Process Boiler(s),
- ☐ Add Boiler Economizer,
- ☐ Replace Space Heating Boiler(s)

Table 19-2: Input Sheet for “Replace Process Boiler”

Input Name	Description / Purpose
Application	Replace process boiler(s)
Manufacturer	From existing boiler nameplate/proposed boiler spec
Model #	From existing boiler nameplate/proposed boiler spec
Number of Boilers	Enter number of existing and proposed process boilers
Input (Btu/hr)	From existing boiler nameplate/proposed boiler spec
Custom built	Check only if the boiler was custom built for that application
Output (Btu/hr)	From existing boiler nameplate/proposed boiler spec. In some instances the output of a boiler may be rated in “Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor of 33,476 Btu/hr per BHP and inserted in the output box. Output cannot be greater than the input.
Boiler Output or Service Duty	Select steam or hot water
Steam pressure (psig)	Specify the pressure in psig
Design Supply Water Temperature (Deg F)	Specify supply water temperature in °F
Design Return Water Temperature (Deg F)	Specify return water temperature in °F

Boiler efficiency (%) AFUE	Specify boiler efficiency in AFUE from the manufacturer specs or from the boiler nameplate. Minimum efficiencies are required as indicated in Table 19-1.
Average Annual Load (%)	Specify percentage of full load during operating hours. This element should come from load calculations or short term monitoring and regression analysis
Annual Operating hours	Specify the amount of working hours

Tips on the inputs

- ❑ **Boiler Output** – Minimum boiler output is typically 60 to 90% of the boiler input. In some instances the boiler's output may be rated in Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor 33,476 Btu/hr per BHP and inserted in the output field.
- ❑ **Steam Pressure** – Less than 400 psig.
- ❑ **Water Supply and Return Temperatures (°F)** – Typically in the range of 100 to 200 °F. This parameter is for information purposes only.
- ❑ **Boiler Efficiency** – The minimum for the existing boiler might be entered as 50%. The calculations only consider efficiency equal to or greater than Title 24.
- ❑ **Average Annual Load (%)** – The input is % and it might range from 5 to 90%. One hundred percent would be considered unusual. Typically boilers do not operate at full load over their entire operating schedule. The project sponsor shall estimate the "Average Annual Load" on the boiler(s) as a percent of boiler(s) full load. The project sponsor will provide, along with the application, data (e.g. steam flow data, gas meter data, etc.) backing up the estimate made for the Customized Calculation application.
- ❑ **Multiple Boilers Replacing a Single Boiler** – Indicate the number of proposed boilers in the quantity field. The proposed boilers must be identical in energy output and efficiency. Enter the value for one of the multiple boilers in the proposed boiler Input (Btu/hr) and Output (Btu/hr) sections. "Average Annual Load" and "Operating Hours" for multiple boilers should be calculated as the average of all boilers. If the proposed boilers are not identical in output energy and efficiency, separate software runs will have to be performed.
- ❑ **Single Boiler Replacing Multiple Boilers** – Indicate the number of existing boilers in the quantity field. The existing boilers must be identical in energy output and efficiency. Enter the value for a single boiler in the existing boiler Input (Btu/hr) and Output (Btu/hr) sections. If the existing boilers are not identical in output energy and efficiency, separate software runs will have to be performed.
- ❑ **Multiple Boilers Replacing Multiple Boilers** – Indicate the number of proposed and existing boilers in the quantity fields. The proposed boilers must be identical in energy output and efficiency. Enter the value for one of the multiple boilers in the proposed Input (Btu/hr) and Output (Btu/hr) fields. If the existing boilers are not of the same output and efficiency, use the average efficiency, input energy rating, and the output energy rating. This information should be entered as a single unit not the sum of all the units.

2.2.19.3.1.2 Inputs for Add Boiler Economizer

Prior to selecting “Natural Gas Boiler/Water Heater,” the user must specify Retrofit (same load/production). The economizer measure is not available for Retrofit (increased load/production).

From the Pull-down menu select “Add Boiler Economizer” from the three following options:

- ☐ Replace Process Boiler(s),
- ☐ Add Boiler Economizer,
- ☐ Replace Space Heating Boiler(s)

Table 19-3: Input Sheet for “Add Boiler Economizer”

Input Name	Description / Purpose
Application	Add Boiler Economizer
Manufacturer	From existing boiler nameplate/proposed boiler spec
Model #	From existing boiler nameplate/proposed
Input (Btu/hr)	From existing boiler nameplate
Custom built	Check only if the boiler was custom built for that application
Output (Btu/hr)	From existing boiler nameplate. In some instances the output of a boiler may be rated in “Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor of 33,476 Btu/hr per BHP and inserted in the output box. Output cannot be greater than the input.
Boiler Output or Service Duty	Select steam or hot water
Steam pressure (psig)	Specify the pressure in psig
Design Supply Water Temperature (°F)	Specify supply water temperature in °F
Design Return Water Temperature (°F)	Specify return water temperature in °F
Flue Gas Temperature (°F) Entering and Leaving the Economizer	Based on calculation or vendor specifications
Water Temperature (°F) Entering and Leaving the Economizer	Based on calculation or vendor specifications
Flue Gas Flow (lbs/hr)	Based on boiler specs
Water Flow (gpm)	Based on calculation or vendor specifications. This is the flow of make up or returning water that goes through the economizer

Energy Transferred from flue gas to water (Btu/hr)	Based on calculations or vendor specifications
Return Water Temperature (°F)	Specify hot water system return water temperature in °F
Energy Transferred from flue gas to water (Btu/hr)	Based on calculations or vendor specifications
Average Annual Load (%)	Specify percentage of full load during operating hours. This element should come from load calculations or short term monitoring and regression analysis
Annual Operating hours	Specify the amount of working hours

Tips on the inputs

- ❑ **Boiler Output** – Minimum boiler output is typically 60 to 90% of the boiler input. In some instances the boiler's output maybe rated in Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor 33,476 Btu/hr per BHP and inserted in the output field.
- ❑ **Steam Pressure** – Less than 400 psig.
- ❑ **Water Supply and Return Temperatures (°F)** – Typically in the range of 100 to 200 °F. This parameter is for information purposes only.
- ❑ **Boiler Efficiency** – The minimum for the existing boiler might be entered as 50%. The calculations only consider efficiency equal to or greater than Title 24.
- ❑ **Flue Gas Temperature (Deg F) entering and leaving economizer** – Can range from 260 to 2,560 degrees F.
- ❑ **Water Temperature (Deg F) entering and leaving economizer** – Typically in the range of 100 to 200 °F. This parameter is for information purposes only.
- ❑ **Flue Gas Flow (lbs/hr) through economizer** – No range required, as this parameter is for information purposes only.
- ❑ **Water Flow (gpm) through economizer** – No range required, as this parameter is for information purposes only.
- ❑ **Energy Transferred from gas to water (Btu/hr)** – No range required, as this parameter is for information purposes only.
- ❑ **Average Annual Load (%)** – The input is % and it might range from 5 to 90%. One hundred percent would be considered unusual. Typically boilers do not operate at full load over their entire operating schedule. The project sponsor shall estimate the "Average Annual Load" on the boiler(s) as a percent of boiler(s) full load. The project sponsor will provide, along with the application, data (e.g. steam flow data, gas meter data, etc.) backing up the estimate made for the CCT.

2.2.19.3.1.3 Inputs for Replace Space Heating Boiler(s)

Prior to selecting “Natural Gas Boiler/Water Heater,” the user is required to specify whether the proposed project is one of the following: Retrofit (same load/production) or Retrofit (increased load/production).

From the Pull-down menu select “Replace Space Heating Boiler(s)” from the following three options:

- ☐ Replace process boiler(s)
- ☐ Add Boiler Economizer
- ☐ Replace Space Heating Boiler(s)

Table 19-4: Input Sheet for “Replace Space Heating Boiler”

Input Name	Description / Purpose
Application	Replace space heating boiler(s)
Manufacturer	From existing boiler nameplate/proposed boiler spec
Model #	From existing boiler nameplate/proposed boiler spec
Number of Boilers	Enter number of existing and proposed boilers
Input (Btu/hr)	From existing boiler nameplate/proposed boiler spec
Custom built	Check only if the boiler was custom built for that application
Output (Btu/hr)	From existing boiler nameplate/proposed boiler spec. In some instances the output of a boiler may be rated in “Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor of 33,476 Btu/hr per BHP and inserted in the output box. Output cannot be greater than the input.
Boiler Output or Service Duty	Select steam or hot water
Steam pressure (psig)	Specify the pressure in psig
Supply Water Temperature (°F)	Specify supply water temperature in °F
Return Water Temperature (°F)	Specify return water temperature in °F
Boiler efficiency (%) AFUE	Specify boiler efficiency in AFUE from the manufacturer specs or from the boiler nameplate. Minimum efficiencies are required as indicated in Table 19-1.

Boiler efficiency (%) AFUE	Specify boiler efficiency in AFUE from the manufacturer specs or from the boiler nameplate. Minimum efficiencies are required as indicated in Table 19-1.
Building Type	Select 1 of 5 building types: Education, Retail, Office, Health/Medical, and Lodging
Location (City)	Select the city where the building is located. The city selected will determine the CEC climate zone
Year Built	Select year (range) building was built. The choices are: pre-1978, 1978 to 1992, 1993 to 2001, 2002 to 2005, and after 2005.
Conditioned Area (sq. ft.)	Specify the floor area of the heated space in ft ² .
Total Building Area (sq. ft.)	Specify the floor area of the building in ft ²
Number of floors	Specify the number of floors in the building
24 hour operation	Select yes or no
Operating profile type	Select typical or custom
Air conditioning system operating hours	Specify the start and stop time for the heating system on a daily basis.

Tips on the inputs

- ❑ **Boiler Output** – Minimum boiler output is typically 60% to 90% of the boiler input. In some instances the boiler's output maybe rated in Boiler Horsepower (BHP). BHP should be converted to Btu/hr by the factor 33,476 Btu/hr per BHP and inserted in the output field.
- ❑ **Steam Pressure** – No range required, as this parameter is for information purposes only.
- ❑ **Supply and Return Temperatures (°F)** – In the range of 100 to 200 °F. This parameter is for information purposes only.
- ❑ **Boiler Efficiency** – The minimum for the existing boiler might be entered as 50%. The calculations only consider efficiency equal to or greater than Title 24.
- ❑ **Conditioned Area and Total Building Area (sq. ft.)** – The software will handle all sizes of buildings. Recognize extremely small or large buildings energy may deviate from what is considered reasonable answers. No work has been done to set boundaries of reasonableness.
- ❑ **Air conditioning system operating hours** – This is the start and stop time for the heating system and is in the range of 0 to 24 for each day, Monday through Sunday.

2.2.19.3.2 Output**Table 19-5: Output Sheet for Boiler and Economizer Measures**

Output Name	Description / Purpose
Baseline Unit – Therms/yr (input)	Baseline usage
Proposed Unit – Therms/yr (input)	Proposed usage
Savings – Therms/yr (input)	Therms savings
Incentive	Estimated incentive amount based on 2012 program rates.

2.2.19.4 Energy Savings Explanation

Savings are calculated by the software by subtracting the proposed usage Therms from the baseline usage Therms. For the “Replace Process Boiler(s)” application, the main parameters are: boiler output, boiler efficiency, average annual load, and annual operating hours. For the “Add Boiler Economizer” application, the savings are calculated based on the temperatures of the flue gas and the water temperature rise. Industry tables are used to evaluate the efficiency gain based on the temperatures of the two fluids. For the “Replace Space Heating Boiler” application the savings are calculated using the Engage software simulation tool which is based on DOE-2 software.

2.2.20 Gas - Steam Trap Replacement (PG&E and SDG&E Only)

2.2.20.1 Description

Steam traps are automatic valves used to remove air, non-condensable gases and condensate from steam systems. Proper steam trap operation is crucial to efficient plant operation since failure in either an open or closed position can reduce plant efficiency or capacity. Failure in a closed position can result in a buildup of condensate, which can reduce the flow capacity of steam lines and the thermal capacity of heat transfer equipment. Likewise a buildup of non-condensable gases can reduce steam pressure and temperature and may also reduce the thermal capacity of heat transfer equipment. Steam trap failure in an open position results in steam passing directly through the steam trap into the condensate drain. When this occurs the steam provides none of the intended heating service and some or all of the steam energy may be lost. Recovery systems that direct the condensate drains back to the boiler via a feedwater heater, such as a deaerator can help reduce this energy loss.

This CCT is used to estimate the energy savings and associated incentive for replacement of a defective steam trap. To qualify, the steam trap must have previously been identified in a recent vendor steam trap survey as having failed in the open position. Steam trap vendors can survey the steam traps in a facility, cataloging the important data for each trap. These data include the type and size of the trap along with the inlet steam conditions, condensate conditions and the operating status.

2.2.20.2 Appropriate Use of the Tool – Program Policy

The Steam Trap Savings tool may only be used for traps that have previously been confirmed as having failed in the open position and a copy of a recent vendor steam trap must be provided to the Utility Administrator with the Project Application. Only trap replacement with a new trap qualifies: repair or rebuilding of defective traps does not qualify for an incentive under the existing program rules. This measure only applies to retrofit applications (new construction and added load applications are not covered).

2.2.20.3 Applicable Types of Equipment

The estimation tool may be used to estimate savings associated with replacement of any of the four most common types of steam traps: thermodynamic, thermostatic, inverted bucket and float/thermostatic.

2.2.20.4 Measure Tool Use

2.2.20.4.1 Inputs

Estimation tool inputs are entered via two inputs screens, the first of which, the Steam Trap Measures List (Sheet 1), displays the data in tabular form. User entry of the various inputs is accomplished using the “Edit Steam Trap Details” button (located on Sheet 1) and the Steam Trap Details screen. Table 20-1 summarizes the various inputs that are required.

Table 20-1: Estimation Tool Inputs

	Description/Purpose
Line Item	User has the option to define up to 20
Steam Trap Type	The type of steam trap involved (thermodynamic, thermostatic, inverted bucket, float/thermostatic) – for inspection purposes
Edit Steam Trap Details	Button to access Sheet 2, where specific Steam Trap Information is inputted.
Copy Steam Trap	Copies the details of an existing Steam Trap that was inputted by the user.
Location	The physical location of the steam trap for purposes of locating the trap at the time of inspection.
Number of Traps	The number of leaking steam traps of this type with the same steam conditions.
Boiler Effcy (%)	The thermal efficiency of the boiler that replaces the steam lost via the faulty trap.
Makeup Water Temp (°F)	The temperature of the boiler makeup water – used to estimate make up water enthalpy (typically 55 to 65 DegF).
Total Retrofit Cost (\$)	Total replacement cost of all of the steam traps of this type and size.
Steam Press. (psig)	The pressure (gauge) of the steam flowing in the line served by the steam trap.
Steam System Annual Op Hours	The total number of hours that the steam system operates annually – used to estimate annual energy savings.
Steam Temp. (°F), optional	The temperature of the steam flowing in the line served by the steam trap. This field is optional when using the calculated steam properties option. If left blank, the steam properties will be calculated automatically based on the saturation temperature.
Select Steam Property Entry Method	Steam and makeup water properties can be entered manually using steam table values or the estimation tool will calculate* the needed values automatically based on the steam and makeup water parameters entered above.
Steam Enthalpy (btu/lb)	The enthalpy of the steam flowing in the steam line served by the steam trap – optional input that should be entered if the steam conditions do not correspond to saturated conditions. Only applies if 'Manual – Steam Tables' is selected as the 'Steam Property Entry Method'
Makeup Water Enthalpy (btu/lb)	The enthalpy of the makeup water – optional input that is otherwise calculated by software. Only applies if 'Manual – Steam Tables' is selected as the 'Steam Property Entry Method'

Calculate	Macro calculates steam and make-up water enthalpy based on 'Steam Pressure and Makeup Water Temperature' inputted above.
Manufacturer	Manufacturer of the existing steam trap – for inspection purposes
Model	Model of the existing steam trap – for inspection purposes
Line Size (inches)	Steam trap inlet and outlet fitting size - used in steam flow / energy loss calculations
Orifice Size (inches)	Steam trap orifice size from manufacturer's data - used in steam flow calculation
Leakage Rate (lbs/hr)	Estimated steam loss rate in lbs/hr for a specific trap as noted in the vendor survey – used as a comparison check against the calculated value.
Condensate Recovered?	Select YES if the output of the steam trap is collected and returned to the steam system for recovery of thermal energy. Select NO if the trap drain is vented to atmosphere or if the condensate is recovered without recovery of thermal energy.
Source of Steam Trap Survey	Name of vendor or individual/affiliation that performed the steam trap leakage survey
Date of Survey	Date of the steam trap survey that identified the steam trap as having failed in the open position

* -- Using an algorithm based on 1967 ASME steam tables.

2.2.20.4.2 Output

The following table describes the CCT outputs.

Table 20-2: Measure Therm Savings & Incentive

Name	Description / Purpose
Estimated Leakage Rate (lbs/hr)	Estimated leakage rate for each trap included in this line item
Total Leakage Rate (lbs/hr)	Total estimated leakage rate for all traps included in this line item
Annual Therms Savings	Estimated annual energy loss for all traps included in this line item.
Incentive Rate	Estimated incentive amount based on 2012 program rates.
Incentive Units	Applicable incentive units (\$/therm)
Energy Incentive Amount (\$)	Total incentive amount for all traps included in this line item.
Application Totals	
Total Therms Savings	Total project energy savings (all line items)
Total Incentive Amount (\$)	Total project incentive amount (all line items)

2.2.20.5 Energy Savings Explanation

Annual energy savings is calculated by subtracting the proposed energy usage from the baseline usage. Incentive values are then calculated as the product of the incentive rate (\$1.0 / therm) and the estimated energy savings value.

Annual Savings (therms) = Baseline Therms – Proposed Therms

Incentive Amount = Annual Savings (therms) * Incentive Rate (\$/therm)

Unlike other savings measures, for steam traps no attempt is made to estimate the actual baseline or “normal” energy use. Instead, the baseline energy use of the existing trap is assumed equal to the energy loss associated with steam passing directly through the defective trap. Similarly, the proposed energy use of a new trap (no leakage) is assumed to be zero. In other words, the energy savings are equal to the abnormal energy loss associated with the defective trap. No attempt is made to quantify steam trap energy loss for a normally functioning trap under the assumption that this “baseline” energy loss would remain the same for the replacement trap compared to the defective steam trap.

The energy savings calculation is therefore the product of the mass flow of the escaping steam and the equivalent energy of the fuel needed by the central boiler to bring the boiler makeup water to the energy level of the escaping steam. These calculations are based on calculations used in the Department of Energy’s Steam Challenge program.

2.2.21 Gas - Thermal Oxidizer Upgrades (PG&E and SDG&E Only)

2.2.21.1 Description

This tool is designed to compute the CCT incentive for Thermal Oxidizer Upgrades. A thermal oxidizer is a processing unit used to control pollution, by destroying volatile organic compound (VOCs). VOCs are organic compounds that are able to vaporize at atmospheric pressures. In order to reduce the damage done by the release of VOCs, they are often treated at high temperatures in order to decompose them before they are released in the air.

Thermal oxidizers work by converting hydrocarbons into carbon dioxide (CO₂) and water (H₂O). Six combustion methods exist to control VOC emission:

- ☐ Thermal Oxidizers (with no heat recovery)
- ☐ Catalytic Oxidizers
- ☐ Recuperative Thermal Oxidizers
- ☐ Recuperative Catalytic Oxidizers
- ☐ Regenerative Thermal Oxidizers
- ☐ Regenerative Catalytic Oxidizers

This tool covers retrofits involving the replacement of an existing thermal oxidizer with a more efficient oxidizer. It also covers measures involving the addition of a heat exchanger for heat recovery purposes (recuperative) on an existing thermal oxidation system. The tool is intended for oxidization systems that are used to destroy low concentration VOC waste streams (less than 25% Lower Flammable Limit). Examples of processes that create these contaminated airstreams are as follows:

Coating Operations	Printing Lines
Paint Booths	Textile Converters
Textile Finishing	Solvent Cleaning
Packaging	Food Processing and Baking
Pulp and Paper	Ventilation Odors
Drying	Rendering Plants
Certain Chemical Processes	Sewage Treatment Plants
Computer Chip Manufacturing (Semiconductors)	

Significant energy savings can be achieved by replacing an existing thermal oxidizer, catalytic oxidizer, or recuperative oxidizer with a regenerative thermal oxidizer and regenerative catalytic oxidizer. For processes with the appropriate waste gas stream, a regenerative thermal oxidizer retrofit can save significant electric (reduced combustion fan usage) and gas (reduced supplemental fuel requirements) usage. The amount of savings is highly dependent on the characteristics of process, existing equipment type, and proposed equipment type.

Thermal oxidizers differ from catalytic oxidizers in the method in which the VOCs are destroyed. Thermal oxidizers generally heat the waste gas to very high temperatures through direct contact with a flame in order to accomplish destruction. Catalytic oxidizers allow for a comparatively lower operating temperature and decreased in-chamber residence time to achieve the same destruction efficiency as a thermal oxidizer. This is a result of the catalyst accelerating the rate of reaction of the VOCs by lowering the required activation energy.¹

2.2.21.2 Appropriate Use of the Tool –Program Policy

This tool covers retrofits involving the replacement of an existing thermal oxidizer with a more efficient oxidizer. It also covers measures involving the addition of a heat exchanger for heat recovery purposes (recuperative) on an existing thermal oxidation system. The tool is intended for oxidization systems that are used to destroy low concentration VOC waste streams. This tool does not cover oxidizers that are used to destroy contaminated inert gas streams, rich gas streams, or contaminated air streams with greater than 25% Lower Flammable Limit (LFL).

2.2.21.3 Measure Tool Use

2.2.21.3.1 Inputs

The lists below describe the input information necessary to estimate the energy savings and incentives. Because of the nature of the air quality requirements associated with Thermal Oxidizers much of this information is readily available from the permitting processes.

2.2.21.3.1.1 Tool Inputs - General Information

Table 21-1 describes the general inputs for both oxidizer replacement and auxiliary heat exchanger installation.

Table 21-1. General Information

Input Name	Description/Purpose
<i>Waste Gas Stream</i>	
Average VOC Concentration (LFL)	Enter the Average VOC Concentration as expressed in terms of lower flammable limit (LFL) of the VOCs in the waste gas. The LFL (previously referred to as LEL - lower explosive limit) of an organic compound is its minimum concentration in air that will sustain combustion. The Average VOC Concentration is the actual volumetric concentration value divided by the theoretical volume concentration of the combined gases. This input is required if Average VOC Loading and Average VOC Heat of Combustion are not available.
Average VOC Loading (lb/hr)	Enter the Average VOC Loading as the mass (weight) of the waste gas produced per hour. Typically this information can be obtained from the Air Quality permit emission information. This input is required if Average VOC Concentration is not available.

¹ D.A. Lewandowski. "Design of Thermal Oxidation Systems for Volatile Organic Compounds," 2000. pg. 205. Lewis Publishers.

Average VOC Heat of Combustion (Btu/hr)	Enter the average VOC heat of combustion as the heat content of the VOCs in the waste gas. Typically, this information can be obtained from the Air Quality permit emission information. This input is required if Average VOC Concentration is not available.
Average Volumetric Flow Rate (SCFM)	Enter the average volumetric flow rate of the waste gas at standard conditions.
Average Entering Temperature (°F)	Enter the average temperature of the waste gas during VOC destruction. This value should not average the ambient temperature when the oxidizer is operating at idle (unit at operating temperature but no oxidation occurring).
Destruction Efficiency (%)	Enter the required VOC Destruction Efficiency (sometimes referred to as Destruction Removal Efficiency - DRE) in terms of a percentage. This value is mandated by the governing air quality district.
<i>Site</i>	
City	From the pull-down menu, select a city that best represents the site location. Site elevation is determined from ASHRAE weather data. Average ambient temperature is calculated based on the 16 weather zones from California Energy Commission's CTZ weather data.
Annual Operating Hours (VOC Destruction)	Enter the total number of hours in the year that the oxidizer operates during VOC Destruction.
Annual Operating Hours (Idle)	Enter the total number of hours in the year that the oxidizer operates at full temperature but with no waste gas flowing through the system.
Measure Type	Select either Oxidizer Replacement or Auxiliary Heat Exchanger Installation.

2.2.21.3.1.2 Tool Inputs - Oxidizer Replacement

Table 21-2 describes the inputs for oxidizer replacement.

Table 21-2: Oxidizer Replacement Inputs

Input Name	Description/Purpose
<i>Existing/Proposed Oxidizer Characteristics</i>	
Manufacturer	Enter the manufacturer of the Oxidizer.
Model Number	Enter the model number of the Oxidizer.
Serial Number	Enter the Serial number of the Oxidizer.

Oxidizer Type	From the pull-down menu, select the appropriate Oxidizer Type: Thermal Oxidizer (no heat recovery); Recuperative Catalytic Oxidizer (no heat recovery); Recuperative Thermal Oxidizer; Regenerative Thermal Oxidizer (RTO); Regenerative Catalytic Oxidizer (RCO).
Thermal Efficiency (%)	For Oxidizers with heat recovery, enter a thermal efficiency of the integral heat exchanger in terms of a percentage. For Thermal Oxidizer (no heat recovery) this field will not be available.
Combustion Chamber Air Temp (°F)	Enter the set point temperature that the oxidizer maintains in the combustion chamber during operation. This value is mandated by the governing air quality district.
<i>Existing/Proposed Oxidation (System) Fan</i>	
Oxidation Airflow Resistance (Flange to Flange Pressure Drop – Inches W.C.)	Enter the total pressure drop across the oxidation side of the oxidizer in inches of H ₂ O.
Oxidation (System) Fan Motor HP	Enter the rated horsepower of the fan motor on the oxidation side of the oxidizer. Typically this information can be found on the motor nameplate.
Oxidation (System) Fan Motor Efficiency (%)	This entry is automatically entered based on the selected Letter Code (see below) unless N/A is chosen. If N/A is chosen then enter the rated efficiency of the fan motor on the oxidation side of the oxidizer.
Letter Code	The fan motor efficiency as expressed by letter code. Typically, this information can be found on the motor nameplate.
<i>Existing/Proposed Combustion Blower</i>	
Combustion Blower Average Air Flow Rate (SCFM)	Enter the average volumetric flow rate of the combustion air at standard conditions.
Combustion Blower Motor HP	Enter the rated horsepower of the fan motor on the combustion side of the oxidizer. Typically, this information can be found on the motor nameplate.
Combustion Blower Motor Efficiency (%)	This entry is automatically entered based on the selected Letter Code (see below) unless N/A is chosen. If N/A is chosen then enter the rated efficiency of the fan motor on the oxidation side of the oxidizer.
Letter Code	The fan motor efficiency as expressed by letter code. Typically, this information can be found on the motor nameplate.
Combustion blower fan operates during idle	Check this box if the combustion fan runs during Oxidizer idle operation.

Combustion blower fan operates during VOC destruction	Check this box if the combustion fan runs during Oxidizer VOC destruction operation.
Combustion blower fan draws outside air	Check this box if the combustion fan draws fresh outside air. Leave this box unchecked if the combustion fan draws air/fuel mixture directly from the VOC laden waste stream.

2.2.21.3.1.3 Tool Inputs – Auxiliary Heat Exchanger Installation

The following list describes the inputs for auxiliary heat exchanger installations.

Table 21-3. Auxiliary Heat Exchanger Installation Inputs

Input Name	Description/Purpose
<i>Existing Oxidizer Characteristics</i>	
Manufacturer	Enter the manufacturer of the Oxidizer.
Model Number	Enter the model number of the Oxidizer.
Serial Number	Enter the Serial number of the Oxidizer.
Average Combustion Chamber Temperature (°F)	Enter the set point temperature that the oxidizer maintains in the combustion chamber during operation. This value is mandated by the governing air quality district.
Exhaust Gas Temperature During VOC Destruction (°F)	Enter the Average exhaust gas temperature during operation.
Oxidation (System) Fan Motor Efficiency (%)	This entry is automatically entered based on the selected Letter Code (see below) unless N/A is chosen. If N/A is chosen then enter the rated efficiency of the fan motor on the oxidation side of the oxidizer.
Letter Code	The fan motor efficiency as expressed by letter code. Typically, this information can be found on the motor nameplate.
<i>Proposed Heat Exchanger</i>	
Manufacturer	Enter the manufacturer of the heat exchanger.
Model Number	Enter the model number of the heat exchanger.
Effectiveness (%)	Enter the rated effectiveness of the proposed heat exchanger. Typically, this information is found in manufacturer's specifications.
Heat Exchanger Pressure Drop (Inches W.C.)	Enter the rated pressure drop in inches w.c. Typically, this information is found in manufacturer's specifications.

2.2.21.4 Intermediate Calculations

Intermediate Calculations are provided for oxidizer retrofits in order to display the heat balance equations. These values are displayed for the existing and proposed systems during idle and VOC destruction operations. The field elements are described below:

Heat Required – This value represents the estimated heat required to raise the waste gas stream to combustion chamber temperature.

Heat Loss – This value represents the estimated heat radiant loss through the oxidizer walls.

Heat Released – This value represents the estimated heat released through the oxidization of the VOCs in the waste gas stream.

Auxiliary Heat Required - This value represents the estimated auxiliary heat required, beyond that released through VOC oxidation, in order to achieve the total Heat Required. Natural gas usage (therms) required during operation can be derived from this value.

2.2.21.4.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 21-4: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.21.4.2 Output

The thermal and electrical usages and the savings for the existing system and the proposed system are displayed on this screen. The incentive is calculated from these values.

Table 21-5: Output

Output Name	Description/Purpose
<i>Oxidizer Replacement</i>	
Therms/yr (Existing/Proposed/Savings)	This value represents the estimated annual fuel usage.
kW (Existing/Proposed/Savings)	This value represents the estimated average annual electrical demand.
kWh/yr (Existing/Proposed/Savings)	This value represents the annual electrical usage.
Incentive (Therms/yr)	Estimated incentive amount based on 2012 program rates.
Incentive (kWh/yr)	This value represents the electrical incentive based on the annual electric usage savings.
<i>Heat Exchanger Installation</i>	
Therms/yr (Existing/Proposed/Savings)	This value represents the estimated annual fuel usage.
Increased Fan Electrical Consumption (equivalent therms)	This value represents the increased fan usage for the added pressure drop associated with a heat exchanger installation. The value is converted into equivalent therms. The program uses a 10:1 electric to fuel conversion ratio.
Therms/yr (Net Savings)	This value represents the fuel savings minus the increased fan usage (equivalent therms) for heat exchanger installations.
Incentive (Therms/yr)	Estimated incentive amount based on 2012 program rates.

2.2.21.5 Energy Savings Explanation

The energy saving estimating tool for thermal oxidizer retrofits uses simplified calculation procedures that are based on industry standards. These procedures capitalize on the fact that the waste gas stream consists primarily of air. An average density and mean heat capacity of the waste gas stream are determined based on this information. Thermodynamic equations are utilized to calculate the heat required to raise the waste gas to combustion temperature, the heat released from the VOCs, the radiated heat losses, and ultimately the additional heat required from natural gas.

The general heat equations are as follows:

$$Q_{\text{FUEL}} = Q_{\text{WASTEGAS}} + Q_{\text{RADLOSS}} - Q_{\text{VOC}}$$

Where: $Q_{\text{WASTEGAS}} = \text{Flow scfm} * 60 \text{ min/hr} * \text{Density lb/scf} * \text{Heat Capacity BTU/lb}^\circ\text{F} * \Delta^\circ\text{F}$
 $Q_{\text{RADLOSS}} = Q_{\text{WASTEGAS}} * \% \text{ Heat Loss (based on oxidizer type)}$
 $Q_{\text{VOC}} = \text{VOC Loading lb/hr} * \text{VOC Heat of Combustion BTU/lb}$
 -or-
 $Q_{\text{VOC}} = \text{Flow scfm} * 60 \text{ min/hr} * \text{Density lb/scf} * \text{Heat Capacity BTU/lb}^\circ\text{F} * (\text{VOC Concentration LFL} * 25^\circ\text{F})$

Increased electrical usage is calculated using basic fan affinity laws. Pressure differentials, efficiencies and air flow are used as inputs. The general fan energy equation is as follows:

$$\text{kW}_{\text{FAN}} = \text{BHP}_{\text{FAN}} * 0.7457;$$

$$\text{BHP}_{\text{FAN}} = (\text{Flow acfm} * \Delta \text{ Pressure inches w.c.}) / (6,356 * \eta_{\text{FAN}} * \eta_{\text{MOTOR}})$$

The energy savings estimating tool for the heat exchanger installation utilize calculations based on standard heat balance and thermal efficiency equations. Mass flow and average temperature readings are used as inputs. The basic heat equations are as follows:

Heat Exchanger Effectiveness (where mass flow in = mass flow out) -

$$\varepsilon = (T_{\text{CO}} - T_{\text{CI}}) / (T_{\text{HI}} - T_{\text{CI}}) \ \& \ \varepsilon = (T_{\text{HI}} - T_{\text{HO}}) / (T_{\text{HI}} - T_{\text{CI}})$$

Oxidizer Thermal Efficiency (where mass flow in = mass flow out) -

$$\eta = (T_{\text{COMBUSTION}} - T_{\text{EXHAUST}}) / (T_{\text{COMBUSTION}} - T_{\text{WASTEGAS}})$$

2.2.22 Lighting - Dimmable Ballast (SCE Only)

This tool covers retrofits that reduce lumens as the result of fixture tuning and/or daylight harvesting. Additionally it covers these type of retrofits that also include demand response and/or occupancy sensor control. The required illumination is still provided in the post-installation condition, however some (or all) of this load may be supplied by natural light. The input power to lighting fixtures may be reduced or eliminated in these conditions.

2.2.22.1 Measure Tool Use

2.2.22.1.1 Inputs

To run a calculation for the Dimmable Ballast measure, the user must first specify the Solutions Category. The appropriate selections for this measure is Category > Lighting and Type > Dimmable Ballast Tool. Once they are selected, enter a customer reference name and proceed by selecting "Save & Continue".

The user is then required to enter equipment descriptions. The inputs are defined in Table 22-1, below.

Table 22-1: Equipment Descriptions for Savings Estimate

Input Name	Type	Description / Purpose
Savings Reduction Factor Strategy	Pull-down	Select Savings Reduction Factor Strategy. 20% tuning refers to reducing light output by 20% (i.e. the resulting highest light output is 80% of the ballast's capability).
Climate Zone	Pull-down	Select Climate Zone from 10 cities in the drop-down menu. If your city is not listed, refer to the Climate Zone document (located under "Tools & Resources" top right corner). Then select the city that matches with your Climate Zone.
Area Sq. Ft.	Fill in	Enter lighting area in sq. ft.
Number of Fixtures	Fill in	Enter the number of fixtures being controlled
Annual Op Hours	Fill in	Enter the number of annual hours the existing/proposed fixtures operate.
Building Type	Pull-down	Select building type from the drop-down menu.
Area Type	Pull-down	Select area type from the drop-down menu.
Base Case Fixture Type	Pull-down	Select base case fixture type from the drop-down menu. A detailed fixture description can be displayed by holding the pointer on the fixture code in the drop-down menu.

Measure Case Fixture Type	Pull-down	Select measure case fixture type from the drop-down menu. A detailed fixture description can be displayed by holding the pointer on the fixture code in the drop-down menu.
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Once all inputs have been entered, select “Save & Continue”.

2.2.22.1.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 22-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.22.1.2 Output

Once all necessary input information has been gathered, the Indoor Lighting Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 22-3: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.23 Lighting - Indoor Lighting by Fixture Type (SCE Only)

2.2.23.1 Description

Lighting systems are found throughout various facilities and are used for illumination purposes of all types. As such, lighting systems vary in the equipment that is employed. Replacing antiquated lighting systems with higher efficiency equipment provides significant opportunities for energy savings. The tool allows users to calculate direct and indirect energy savings associated with upgrading lighting systems by simply selecting fixture types listed in the Table of Standard Fixture Wattages that is included in Appendix B of the Customized Offering Procedures Manual.

2.2.23.2 Measure Tool Use

2.2.23.2.1 Inputs

After selecting the Indoor Lighting by Fixture type measure, the user is required to specify site information which is used to define the building for savings calculations.. The critical inputs are defined in the table below.

Table 23-1: Tool Inputs Sheet 1 of 4, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.

Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 23-2 Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 23-3: Tool Inputs Sheet 3 of 4 Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must define the values for the existing and proposed fixtures. Sheet 4 allows users to define the lighting upgrade to be implemented. Inputs are described in the following table.

2.2.23.2.1.1 Existing and Proposed Lighting Fixtures

The Existing and Proposed Lighting Fixture types can be selected from the Lighting Fixture Definitions window. Selecting the Lighting Fixture Definitions will open a new window.

Lighting Zones organize the lighting fixtures by grouping them into zones defined by geographical area (i.e., a distinct region of a building such as “the first floor”, etc). When assigning zones, the sum of all zone areas should add up to the **Total Building Area** defined in screen 1. To define the your first zone (Lighting Zone 1) select Edit Zone. An unique name and the Zone Area should be created for each zone for easy identification. To create additional lighting zones, select **Add a New Zone**.

Once all zones are defined, the user can select existing and proposed fixtures for each zone. First, select the zone to add fixtures and click **Add New Fixtures** to open **Fixture Type Information** window. In this window, the user can specify existing and proposed (replacement) fixtures. Below table summarizes the input parameters needed to complete this task.

Table 23-4: Tool Inputs Sheet 4 of 4 Lighting Measure Specifications

Input Name	Description / Purpose
Area Served	Each zone can have multiple fixture replacement line items. Enter the area served by the lighting fixtures of the particular line item. The sum of all areas should match the lighting zone area.
Light Type	Select light type for the existing/proposed fixtures.
Lamp Type	Select lamp type for the existing/proposed fixtures. The available choice for the Lamp Type corresponds to the Light Type selected.
Lamp Size	Select the lamp size. The available choice for the Lamp Size corresponds to the Lamp Type selected. (i.e., wattage for HID, inches for Linear Fluorescent, etc.)
Lamps per Fixture	Select the number of lamps per fixture.
Num Fixtures	Enter the number of proposed/existing fixtures.
Ballast Type	Select the ballast type (i.e. Magnetic, Electronic, etc.).
Ballasts per Fix	Select the number of ballasts per fixture.
Fixture Type	Select a specific combination of Lamp Type, Lamp Size, and Ballast Type (i.e. lamp wattage, light output, ballast start type, etc). The available Fixture Type choices are predetermined by the previous selections.

Once this information is entered for the fixtures, **Number of Fixtures** can then be entered. A new window named **Number of Existing/Proposed Fixtures** will open, which will allow the user to specify the number of fixtures in the area. In addition to simply specifying the number of fixtures in the area, the fixture numbers can be estimated by other methods. Once specified, the fixture count, area per fixture, and total kW will be displayed.

Annual Operating Hours represent the annual equivalent full load operating hours for the lighting system, and they are based on the business hours defined previously in screen 2, Baseline Description. Note that hours reported here account for the lighting operation outside business hours (i.e., store preparation, custodial services, security lights, etc). Editing the **Annual Operating Hours** on this screen WILL affect the lighting savings reported on the Customized application but WILL NOT affect the lighting savings reported on the Facility Energy Savings Estimate.

Description of Area Served is used to determine Title 24 default lighting power allowances when calculating program energy savings. Choose the most appropriate description of the lighting area. Once all inputs have been entered, exit the window by clicking "**Done**". Repeat the same process for all lighting fixtures for all zones. The energy usage information will be displayed..Once all inputs have been entered, the user may proceed by selecting **Save & Continue**.

2.2.23.2.2 Equipment Description for Savings Estimate

After all zones and fixtures have been entered the CCT calculates electric load and lighting power densities (LPD) for the sum existing, program baseline, and installed values. The load for the Defaulted Lighting can be updated on this sheet.

Table 23-5: Equipment Description for Savings Estimate

Input Name	Description / Purpose
Existing Lighting	Returns the Load (kW), Lighting Power Density (W/ft ²), and Area for the entered existing lighting data. Defaulted lighting can be added for lighting areas that are present but not included in the retrofit. This allows for accurate LPDs to be calculated.
Program Baseline	Returns the Load (kW), Lighting Power Density (W/ft ²), and Area for the code baseline lighting data.
Proposed Upgrades	Returns the Load (kW), Lighting Power Density (W/ft ²), and Area for the entered proposed lighting data.

2.2.23.2.3 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 23-6: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.23.2.4 Output

Once all necessary input information has been gathered, the Indoor Lighting Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 23-7: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.24 Lighting - Lighting Controls

2.2.24.1 Description

The CCT estimates the energy savings achieved when the energy consumed by lighting equipment is reduced through the use of an automated system or control devices, such as sensors, time clocks or EMS systems.

2.2.24.2 Appropriate Use of the Tool –Program Policy

The CCT can be used to predict the savings attributed to the installation of occupancy sensors, time clocks, and lighting energy management systems (EMS) for lighting replacements and existing lighting systems. Measures involving day-lighting or daylight harvesting cannot use this tool and it is recommended that the Engineering Calculations approach is used.

2.2.24.3 Measure Tool Use

2.2.24.3.1 Inputs

Once the Lighting Controls measure is selected, the user is then directed to enter the various inputs as described in the following tables. Additional (line items) rows can be created for different usage groups.

Table 24-1: Measure Information

Input Name	Description / Purpose
Line Item	Select a unique line item number for each lighting control retrofit, consisting of identical equipment within the same usage group.
Control Type	Select the control technologies between EMS, occupancy sensors, and time clocks. Day-Light Harvesting or Day-Lighting systems must use the Engineering Calculations approach to estimate energy savings.
Usage Group	Enter an identifying name for a grouping of lighting controls that have similar operating characteristics (i.e. they are turned off and on at the same time).
Area Description	Enter a short description of the area covered by the lighting controls (e.g. Warehouse, Building 123, Conference Room, etc).

After Control Type is selected, click “Edit Equipment” to enter Equipment Specifications information below.

Table 24-2: Equipment Specifications

Input Name	Description / Purpose
Line Item	Select the appropriate line item number for each lighting retrofit.
Num Fixtures	Enter the number of proposed/existing fixtures.
Previous Op Hours*	Enter the number of annual hours the fixtures operate prior to the installation of lighting controls.

New Op Hours*	Enter the number of annual hours the fixtures operate after the installation of lighting controls. This input is automatically calculated for occupancy sensor measures.
Space Type	Select the space type from the pull-down list that most closely describes the primary function/purpose of the illuminated area.
Fixture Type	Select the space type from the pull-down list that most closely describes the primary function/purpose of the illuminated area.
Lamp Type	Choose "Standard" if the fixture is identified in the Standard Table of Fixture Wattages in Appendix B. Choose "Custom" if the fixture is not identified on this table.
Lamp Type	Select the lamp type (i.e. T12 Fluorescent, HPS, Incandescent, etc). Please see Appendix B for a legend of lamp type acronyms.
Tube Length	For tube fixtures select the tube length in inches. For non-tube fixtures select N/A.
Ballast Type	Select the ballast type for fixtures equipped with ballasts (i.e. Magnetic, Electronic, etc.). Select N/A for non-ballast fixtures.
Lamps/Fixture	Select the number of lamps per fixture.
Watts/Lamp	Select the nominal watts per bulb
Watts Fixture	This value is calculated from the inputs above

* The maximum allowable exterior lighting operating hours is 4,100 hours/year per DEER Database.

2.2.24.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 24-3: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.24.3.3 Output

Once all necessary input information has been gathered, Lighting Control Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 24-4: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.24.4 Energy Savings Explanation

The energy savings for this measure is calculated as the difference between the energy usage of the lighting equipment in an uncontrolled (Baseline) and controlled (Proposed) state. The power demand (kW) of a lighting system is calculated based on the specifications ballast and the lamp that comprise the lighting fixture. The Table of Standard Fixture Wattages contains average kW draw for a range of lighting fixtures and is located in the 2012 Program Manual. The user also has the option to input custom equipment specifications to estimate power draw. Since power is assumed to be unchanged from the baseline, the energy savings are determined by the reduction in the number of hours that the fixture is energized;

$$\text{Energy Savings (kWh)} = \text{Power Demand, (kW)} * (\text{Uncontrolled Operating Hours} - \text{Controlled Operating Hours})$$

EMS and time clocks type measures utilize a scheduling capability that reduces the amount of time (hours) that a fixture is energized based on a pre-determined schedule. These hours are input directly into the software tool by the user. Please note that these values must correspond to actual hours the lights are energized prior to the installation of the controls and the proposed hours from the scheduled operation. The programmed schedule in the EMS will be independently verified by the Utility Administrator Inspector. Please also note that for exterior lighting the maximum allowable operating hours is 4,100 hours/year per DEER Database.

Occupancy sensors work in a different fashion than EMS systems in that they control operation based on occupant activity and do not schedule equipment operation for particular times. The software estimates the amount of savings from these controls based on the space type and applies a pre-determined reduction rate to the baseline operating hours.

These reduction rates and space types are based on empirical data from a variety of governmental sources. The table below lists these reduction rates of operating time based on space type.

Table 24-5. Occupancy Sensors Reduction in Operating Time

Space Type	% Savings	Space Type	% Savings	Space Type	% Savings
Assembly	45	Industrial	45	Restroom	45
Break room	25	Kitchen	30	Retail	15
Classroom	30	Library	15	Stair	25
Computer Room	35	Lobby	25	Storage	45
Conference	35	Lodging (Guest Rooms)	45	Technical Area	35
Dinning	35	Open Office	15	Warehouses	45
Gymnasium	35	Private Office	30	Other	15
Hallway	25	Process	45	Parking Garage	15
Hospital Room	45	Public Assembly	35		

The following calculation method is used to determine energy savings of the project for each of the measure types:

Baseline Calculation:

$$\text{QTY} \times \text{FW} \times \text{BOPHR} = \text{baseline annual kWh} \quad (\text{Eq. 1})$$

$$\text{QTY} \times \text{FW} = \text{baseline kW} \quad (\text{Eq. 2})$$

Where;

QTY = number of fixtures

FW = fixture wattage

BOPHR = baseline annual hours of operation

Proposed Calculation:

$$\text{QTY} \times \text{FW} \times \text{POPHR} = \text{proposed annual kWh} \quad (\text{Eq. 3})$$

$$\text{QTY} \times \text{FW} = \text{proposed kW} \quad (\text{Eq. 4})$$

Where;

POPHR = proposed annual hours of operation

For EMS and time clock measures, POPHR is entered by the user. For occupancy sensors, the user enters a "Space Type" which references Table 13-5 above and calculates POPHR from the following equation:

$$\text{BOPHR} \times (1 - \% \text{ savings}) = \text{POPHR} \quad (\text{Eq. 5})$$

Where;

% savings = value obtained from Table 24-5

Energy savings are obtained by taking the difference between the baseline cases and the proposed cases.

$$\text{Baseline kWh} - \text{Proposed kWh} = \text{Annual kWh savings} \quad (\text{Eq. 6})$$

$$\text{Baseline kW} - \text{Proposed kW} = \text{kW saved} \quad (\text{Eq. 7})$$

$$\text{Annual kWh savings} \times \$0.05/\text{kWh} = \text{Incentive payment} \quad (\text{Eq. 8})$$

2.2.25 Lighting - Lighting Retrofit

2.2.25.1 Description

Lighting systems are found throughout various facilities both internally and externally and are used for illumination purposes of all types. As such, lighting systems vary in the equipment that is employed. Replacing antiquated lighting systems with higher efficiency equipment provides significant opportunities for energy savings. The Customized Calculation Tool relies heavily on the incorporated Table of Standard Fixture Wattages that is included as Appendix B of the Customized Offering Procedures Manual and included at the end of this document.

The CCT addresses the replacement of existing lamps and fixtures with units of higher efficiency. Proposed equipment for T8 and T5 linear fluorescent lighting upgrades must meet the Color Rendering Index and Lamp Life specifications listed in Table 1-2, Section 1.4 for definition. LED fixtures must be specifically listed in Appendix E. Eligible LED lamp-only replacements must be specifically listed in Appendix F

De-lamping measures are eligible only as an integral part of a lighting efficiency upgrade. The removal of bulbs and/or the disabling of fixtures alone are not eligible for the program. Lighting retrofits that include the retention of existing ballasts are eligible only if the ballasts have at least five year of useful life remaining. The Utilities may require the Project Sponsor to certify the remaining useful life of the existing ballast.

Multiple line items (i.e. groupings of similar fixtures and similar usage patterns) can be entered as a single measure. Lighting fixtures and the associated savings are grouped by usage. Usage groups may include offices, restrooms, hallways/stairs, display lights, sales floor, process areas, and parking areas or structures. Inputs for each usage group should include a brief description of the area affected by the lighting, as well as specifications for both existing and new equipment. Pull-down menus are used to simplify this process, but input of custom fixtures is also supported.

If a particular lamp/fixture/ballast combination is not contained within the pull-down menus, N/A# will appear in the Watts/Fixture column and you must provide the necessary specifications by including a copy of the manufacturer's specification sheet along with the submittal documents. For measures involving partial delamping (e.g., removing two lamps from a three-lamp fixture), spot measurements used to verify fixture loads must be input into the Proposed Equipment—Manufacturer's Data/Spot Measurements table.

For lighting measures you may estimate the operating hours, but you should be able to support the estimate. Typically proposed operating hours should not differ from existing operating hours.

2.2.25.2 Appropriate Use of the Tool –Program Policy

The Lighting Retrofit tool can be used for lighting measures listed on the Table of Standard Fixture Wattages, or custom fixtures if appropriate manufacturing specifications are entered by the user.

2.2.25.3 Measure Tool Use

2.2.25.3.1 Inputs

After selecting the *Category* as Lighting, the software will self populate the *Install Type* as Retrofit (same load/production). The CCT only allows projects that are retrofits (same load).

User inputs can be divided into two basic categories - measure information and equipment specifications (existing/proposed).

Sheet 1 allows the user to define the project site. This will define the appropriate end use, building construction, and climate zone to be used in the analysis.

Table 25-1: Sheet 1, Measure Information

Input Name	Type	Description / Purpose
Line Item	Pull-down	Select a unique line item number for each lighting retrofit, consisting of identical equipment, within the same usage group.
Usage Group	Fill in	Enter an identifying name for a grouping of fixtures that have similar operating characteristics (i.e. they are turned off and on at the same time). A usage group may have multiple line items containing sub-groupings of identical fixture retrofits.
Area Description	Fill in	Enter a short description of the area of the proposed fixture retrofit (e.g. Warehouse, Building 123, etc.)

After Area Description is entered click “Edit Existing” to enter Equipment Specifications for baseline lighting, and “Edit Proposed” to enter Equipment Specifications for proposed lighting. See the table below for an explanation of the inputs.

Table 25-2: Sheet 2 and 3, Existing/Proposed Equipment Specification

Input Name	Type	Description / Purpose
Line Item	Pull-down	Select the appropriate line item number for each lighting retrofit.
Number of Fixtures	Fill in	Enter the number of existing/proposed fixtures.
Hours of Operation*	Fill in	Enter the number of annual hours the existing fixtures operate. The proposed fixture operating hours are the same as the existing hours and cannot be modified.
Fixture Type	Pull-down	Choose “Standard” if the fixture is identified in the Standard Table of Fixture Wattages in Appendix B. Choose “Custom” if the fixture is not identified on this table
Lamp Type	Pull-down	Select the lamp type (i.e. T12 Fluorescent, HPS, Incandescent, etc.)

Tube Length	Pull-down	For tube fixtures, select the tube length in inches. For non-tube fixtures select N/A.
Ballast Type	Pull-down	Select the ballast type for fixtures equipped with ballasts (i.e. Magnetic, Electronic, etc.). Select N/A for non-ballast fixtures.
Lamps/Fixture	Pull-down	Select the number of lamps per fixture.
Watts/Lamps	Pull-down	Select the nominal watts per lamp.

* The maximum allowable exterior lighting operating hours is 4,100 hours/year per DEER Database.

2.2.25.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 25-3: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.25.3.3 Output

Once all necessary input information has been gathered, the SCE Online Application Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 25-4: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.25.4 Energy Savings Explanation

The lighting model uses the following calculation to determine energy savings of the project:
Baseline/Proposed Calculation:

$$\text{QTY} \times \text{FW} \times \text{OPHR} = \text{annual kWh} \quad (\text{Eq. 1})$$

$$\text{QTY} \times \text{FW} = \text{kW} \quad (\text{Eq. 2})$$

Where;

QTY = number of fixtures

FW = fixture kW

OPHR = annual hours of operation

Energy savings are obtained by taking the difference between the baseline cases and the proposed cases.

$$\text{Baseline kWh} - \text{Proposed kWh} = \text{Annual kWh savings} \quad (\text{Eq. 3})$$

$$\text{Baseline kW} - \text{Proposed kW} = \text{kW saved} \quad (\text{Eq. 4})$$

$$\text{Annual kWh savings} \times \text{incentive rate} = \text{Incentive payment} \quad (\text{Eq. 5})$$

The software utilizes user inputs to determine the appropriate fixture wattage, which is obtained from the “Table of Standard Fixture Wattages”. This table is also part of the Customized Offering Procedures Manual.

2.2.26 Lighting - Timeclocks for Indoor Lighting (SCE Only)

2.2.26.1 Description

CCT can simulate energy savings associated with time clocks used to limit the unnecessary hours of operation of indoor lighting, including electro-mechanical time clocks or energy management system (EMS) type controls 'sweep-off' type controls.

2.2.26.2 Measure Tool Use

2.2.26.2.1 Inputs

Prior to selecting the Time clocks for Indoor lighting measure, the user is required to specify site information which is used to define the building for savings calculations on Screen 1, Basic Specifications. The critical inputs are defined in the table below.

Table 26-1: Screen 1, Building Specifications

Name	Description / Purpose
Location	Choose site location based on zip code or climate zone.
Building Type	Choose the building type most appropriate for the project site.
Vintage	Choose the year range in which the building was constructed.
HVAC system(s)	Choose the system type that best fits the type found on the project site.
Total Building Area	Enter the building area. The conditioned area is defined on screen 4.
Number of Floors	Enter the total number of floors of the building. The tool will automatically assign an equal amount of square feet per floor.

Sheet 2 allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 26-2 Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.
Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 26-3: Tool Inputs Sheet 3 of 4 Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must enter the amount of indoor lighting in kW that is controlled by proposed (i.e., new) time clock-type controls. Engage assumes no existing time clocks, and therefore any lighting kW in the existing facility currently served by operating time clocks should be excluded from the Controlled Lighting kW.

2.2.26.2.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 26-4: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.26.2.3 Output

Once all necessary input information has been gathered, the Time Clock Tool sends the required information to engage and computes the annual energy usage for the baseline and proposed systems. Finally, the energy savings and incentive is computed and the results are presented to the user. The following table and associated figure describes the SCE Online Application Tool outputs.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 26-5: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.

Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.27 Other - Carbon Monoxide Sensors for Parking Garages

2.2.27.1 Description

The CCT can be used to predict the energy savings estimate for exhaust fans in enclosed parking structures when these fans are controlled by Carbon Monoxide sensors. Exhaust fans are typically on 24 hours/day or controlled by time clocks. Controlling fan on-time using CO sensors to maintain an acceptable limit of CO in the parking structures can result in significant energy savings.

A number of parking structures with their exhaust fans under CO control were metered to determine the run-time of the exhaust fans.

2.2.27.2 Appropriate Use of the Tool –Program Policy

The CCT can be used to predict the savings attributed to the installation of Carbon Monoxide (CO) sensors in enclosed parking structures. The use of this tool is appropriate for all building types that contain enclosed parking structures.

2.2.27.3 Measure Tool Use

2.2.27.3.1 Inputs

Prior to selecting the Carbon Monoxide Sensors in Parking Garages measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. The CCT only allows projects that are retrofits (same load). Once the Carbon Monoxide Sensors in Parking Garages measure is selected, the user is then directed to enter the various inputs as described in the following tables.

Table 27-1: Inputs Sheet

Input Name	Type	Description / Purpose
Manufacturer of CO Controls/Sensors	<i>Fill in</i>	This Input is used for inspection purposes.
Model Number of CO Controls/Sensors	<i>Fill in</i>	This Input is used for inspection purposes.
Number of Sensors in Parking Structure	<i>Fill in</i>	This Input is used for inspection purposes.
Total Exhaust Fan Motors (HP)	<i>Fill in</i>	The total HP of all exhaust fans covered in the measure.
Average Exhaust Fan Motor Efficiency (%)	<i>Fill in</i>	The reviewer shall average the motor efficiencies and input the percentage. Motor efficiency can range from 70 to 98%.
Annual Operating Hours Before CO Controls	<i>Fill in</i>	The yearly operating hours of the exhaust fans.

2.2.27.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

27-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.27.3.3 Output

Once all necessary input information has been gathered, the Carbon Monoxide Sensors for Parking Garages Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 27-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.27.4 Energy Savings Explanation

Exhaust fans typically operate on a continuous basis (24 hours per day) in order to maintain minimum CO levels as required by public health codes. In other cases, these fans may be controlled by time clocks. Controlling the run time of this equipment using CO sensors can result in significant energy savings while still maintaining minimum health code standards.

The CCT estimates the energy savings achieved through the reduction in the operating hours of these fans by CO sensor control. Baseline energy consumption is estimated based on the total amount of exhaust fan horsepower (HP) and the total annual operating hours. These values are input directly by the user. The proposed operation (post-install) is calculated by the software tool. The general equation for the energy savings is as follows;

$$\text{Annual Savings (kWh)} = (\text{Total Fan Power}) \times (\text{Operating Hours}_{\text{before}} - \text{Operating Hours}_{\text{after}})$$

Exhaust fan equipment controlled with CO sensors at six (6) enclosed parking structures was sub-metered for a week's time. The post install operation operating hours are modeled based on this empirical data.

2.2.28 Other - Compressed Air System Upgrades

2.2.28.1 Description

Compressed air systems provide power for tools, presses, controls and a wide variety of industrial equipment and processes. As such, compressed air systems vary widely both in the equipment and controls that are employed. Compressed air systems afford significant opportunities for energy savings and the Customized Offering Program has provided incentives for equipment and control upgrades since the program's inception. The CCT draws extensively from information provided by the Department of Energy (DOE) Compressed Air Challenge program. Specifically, the AirMaster+ software package developed by DOE is used as a guide for generic equipment performance characteristics and operating ranges covered by this CCT.

The CCT provides for the following compressed air system measures:

- ❑ Direct replacement of one to three air compressors, including compressors equipped with variable speed drives,
- ❑ Installation or upgrade of system storage, and
- ❑ Installation of intermediate pressure/flow control valves.

The CCT allows implementation of any of these measures as retrofit projects that do not involve any increase in load (deferred load). Note that in the case of new installations the lack of operating data restricts the complexity of the savings analysis and limits the types of energy efficient measures that can be accommodated. Therefore, for applications involving new installations the CCT will only accommodate measures involving efficient compressor installations (increased storage and intermediate pressure controls are not accommodated).

2.2.28.2 Appropriate Use of the Tool

The Compressed Air System Upgrade tool can be used for compressed air systems and measures having the characteristics shown in Table 28-1.

Equipment Sizes or Capacities Covered by the Tool

The Compressed Air System Upgrade tool covers the same compressor types and pressure ranges that are covered by the AirMaster+ software package (also shown in Table 28-2).

Table 28-1: Air Compressor Common Measure Features

Description	Measure Feature
# of Compressors	1 – 3
Compressor types and sizes	Single and dual stage reciprocating, oil-flooded and oil-free rotary screw
Compressor drive	Conventional and Variable Speed Drive (VSD)
Storage	Existing or new storage will be accommodated but only storage located upstream of an installed intermediate flow/pressure control will be used to analyze compressor operation. This measure is not supported for deferred load or new installations.

Intermediate Flow / Pressure Controller	The addition of an intermediate flow/pressure controller is supported as an efficiency measure only (baseline system doesn't include this option). This measure is not supported for deferred load or new installations.
Baseline air compressor efficiency	Generic compressor efficiencies used in AirMaster+ software package are used as minimum acceptable efficiency for the types and sizes of compressors identified by the project sponsor.
Compressor Load Profile	Hourly load profile inputs (acfm or kW) used for up to 4 "day types" to establish baseline usage of each compressor and for overall system load.
Baseline air compressor drive efficiency	EPACT minimum used for baseline, measured values are corrected if existing motors do not meet EPACT requirements
Applicable operating pressure range	Pressure range varies with compressor type as per AirMaster+

Table 28-2: Compressed Air System Upgrade Measure Equipment Coverage Matrix

Compressor Types	Control Types	Size Range (hp)	Pressure Range (psig)
Single Stage lubricant injected rotary screw	Inlet Modulation w/o unloading Inlet Modulation w/unloading Load/Unload Variable Displacement w/unloading Variable Speed Drive	25 - 500	100 - 200
Two Stage lubricant injected rotary screw	Inlet Modulation w/o unloading Inlet Modulation w/unloading Load/Unload Variable Displacement w/unloading Variable Speed Drive	100 – 500	100 – 200
Two Stage lubricant-free rotary screw	Load/Unload	50 - 500	80 - 150
Single Stage reciprocating	Load/Unload	25 - 75	80 – 125
Two Stage reciprocating	Load/Unload	25 - 400	80 – 125

2.2.28.3 Measure Tool Use**2.2.28.3.1 Inputs**

Prior to selecting the Compressed Air System Upgrades measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. Once the Compressed Air System Upgrades measure is selected, the user is then directed to enter the various inputs as described in the following tables and associated figures.

Table 28-3: Site/System Inputs

Name	Description / Purpose
City	Pull-down menu with California cities. Used to lookup site elevation and average ambient temperature
Number of Existing Compressors	Used in inspection
Multi-compressor control?	Pull-down menu with “No Sequencer” and “Sequencer” selections. Used to determine if idle compressors can be turned off.
Nominal System Op. Press. (psig)	Pressure supplied to end uses (downstream of dryers and intermediate controls) – used to estimate changes in unregulated flow (if applicable)
Nominal Supply Pressure (psig)	Compressor output pressure – used to adjust compressor performance relative to manufacturer’s data
Total System Volume (cubic feet)	Volume of total system including receiver volume – used to estimate compressor cycle times (if applicable)
Receiver Volume (cubic feet)	Total volume of all installed receivers – use in inspection

Table 28-4: Compressor Inputs (1 page for each compressor)

Name	Description / Purpose
Compressor ID	Site/local designation -- used for site inspection
Manufacturer	Compressor manufacturer – used for site inspection
Model Number	Equipment model – used for site inspection
Serial Number	Equipment serial number – used for site inspection
Type	Pull-down menu with selections for: a. Single Stage Reciprocating b. Single Stage Rotary Screw (lubricant injected) c. Two Stage Reciprocating d. Two Stage Rotary Screw (lubricant injected) e. Two Stage Rotary Screw (lubricant free)
Full-load Package Power (kW)	Package power at full-load from CAGI data – used to estimate full- and part-load performance
Full-load Operating Pressure (psig)	Operating pressure corresponding to the full-load package power value (CAGI) – used to estimate full- and part-load performance
Rated Capacity @ Full-load Operating Press (acfm)	Airflow in acfm corresponding to the full-load package power value (CAGI) – used to estimate full- and part-load performance
After-cooling Method	Pull-down menu with selections for: a. Air (Integral Fan) b. Air (Separate Fan) - new c. Water

Table 28-5: Compressor Control Inputs (1 page for each compressor)

Name	Description / Purpose
Control Method	<p>Pull-down menu containing control options specific to the compressor type (see Table 28-2) which can include:</p> <ul style="list-style-type: none"> a. Load/Unload b. Inlet Modulation w/o unloading c. Inlet Modulation w/unloading d. Variable Displacement w/unloading e. Variable Speed Drive <p>Used to estimate part-load performance.</p>
Operating Mode	<p>Pull-down menu containing:</p> <ul style="list-style-type: none"> a. Lead/Baseload b. Trim/Variable <p>Used to determine loading sequence (multiple compressors)</p>
Unloading Control Setpoint - % of Capacity	<p>Pull-down menu that is activated whenever a control with unloading has been selected. Values shown are dependent on control type selected. (60% for inlet modulation w/unload, 40% or 50% for variable displacement w/unload). Value is used to refine the part-load performance map.</p>
Unloading Control Setpoint - % of Power	<p>Pull-down menu that is activated whenever a control with unloading has been selected. Values shown are dependent on control type selected. (88% for inlet modulation w/unload, 61% for variable displacement w/unload). Value is used to refine the part-load performance map.</p>
Full-load Pressure (cut-in)	<p>Compressor pressure control set point when declining pressure causes the compressor to load – used with storage amount, and cut-out pressure to estimate cycle time (if applicable)</p>
Max Flow Pressure (cut-out)	<p>Compressor pressure control set point when increasing pressure causes the compressor to unload -- used with storage amount, and cut-in pressure to estimate cycle time (if applicable)</p>
No Load Power (% of FL power)	<p>% of full-load power when compressor is fully-unloaded – used to refine part-load performance map.</p>
Auto Shut-down Timer?	<p>Checkbox – checked if there is a timer that will shut-down the compressor if fully unloaded?</p>
Setting (minutes)	<p>Auto shutdown timer setting; time after which an unloaded compressor is shut-down.</p>

Table 28-6: Compressor & Fan Motor Inputs (1 page for each compressor)

Name	Description / Purpose
<i>Compressor Drive Motor Inputs:</i>	
Manufacturer	Motor manufacturer – used for site inspection
Model	Motor model – used for site inspection
Size (HP)	Motor HP rating – used for site inspection and to lookup minimum EPACK efficiency

Speed (RPM)	Motor RPM – used for site inspection and to lookup minimum EPACT efficiency
Service Factor	Motor service factor – used for site inspection and to calculate maximum motor load
Enclosure Type	Motor enclosure type – used for site inspection and to lookup minimum EPACT efficiency
NEMA Nominal Effcy (full load)	Motor efficiency – used for load computation and to compare against EPACT minimum
<i>Fan Motor Inputs (only required if air-cooled and separate fan motor is specified):</i>	
<i>Same input fields as compressor drive motor.</i>	

Table 28-7: Compressor Operating Info Inputs

Name	Description / Purpose
Number of Day Types	Pull-down menu used to designate the number of profiles that will be entered (1 – 4).
Profile Units	Pull-down menu used to designate the type of profile information provided. Selections include: a. ACFM b. KW – Package c. KW – Compressor only
Day Type	The number of the day type (1 – 4 as selected above) associated with the remaining inputs (below)
Description	Text box to provide a name for the profile (e.g., weekday, etc.) – used in reports and for inspection
Weekday Operation?	Checkbox – checked if the day involves weekday operation – used to determine if peak demand savings are involved.
Days/Week (1)	Number of days per week for this day-type.
Weeks/Year (1)	Number of weeks per year for this day-type.
Average Flow (2)	Average airflow (ACFM) for each day-type
Peak Flow (2)	Maximum airflow (ACFM)
Hours / Day (2)	Hours of operation per day

Notes:

Total operating hours for all day-types cannot exceed 8760 hours or an error is flagged

Average flow, peak flow & hours/day inputs are required for new installations only (in lieu of profile data)

Table 28-8: Compressor Operating Profile Inputs

Name	Description / Purpose
Day Type	A pull-down menu with descriptions corresponding to the information entered previously in Sheet 5. Identifies the day-type associated with the profile information to be entered.
Hourly Profile Value	24 hourly values of ACFM or KW; separate profiles are entered for each compressor (required for retrofit applications only)

Table 28-9: Measure Specification Inputs

Name	Description / Purpose
Compressor Replacement / Modification?	Checkbox – checked if one of the measures involves compressor replacement or modification
Compressor Replacement / Modification Type	A pull-down menu that is activated if compressor replacement / modification is selected with choices for: a. No change b. Replace compressor c. Change op mode d. Remove / standby
Operating Mode	A pull-down menu that is activated if the compressor modification selected is “Change op mode”. Selections include: a. Lead / Baseload b. Trim / Variable Used to estimate loading order of proposed compressor.
Intermediate Flow Controller? (1)	Checkbox – checked if one of the measures involves installation of an intermediate flow controller
Proposed Nominal Supply (Upstream) Pressure (psig) (1)	Input activated if intermediate flow controller is selected. Input is pressure upstream of new controller in psig. Used to estimate the impact on compressor energy use (if applicable)
Proposed Nominal Operating (Downstream) Pressure (psig) (1)	Input activated if intermediate flow controller is selected. Input is pressure downstream of new controller in psig. Used to estimate the impact on system airflow of reduced system operating pressure.
Leakage Flow (% of total) (1)	Input activated if intermediate flow controller is selected. Input is % of total system flow attributed to leakage (unregulated). Used to estimate the impact on system airflow of reduced system operating pressure.
Other Unregulated End Use (1) (% of total)	Input activated if intermediate flow controller is selected. % of total system flow attributed to other unregulated flow (other than leakage). Used to estimate the impact on system airflow of reduced system operating pressure.

Existing Volume Upstream (%) (1)	Input activated if intermediate flow controller is selected. Input is % of system volume that is upstream of the proposed intermediate controller. Used to estimate the impact on compressor operation.
Storage Upgrade? (1)	Checkbox – checked if one of the measures involves the addition of receiver volume.
Total Added Volume (cubic ft) (1)	Input activated if storage upgrade is selected. Input is total volume in cubic feet that will be added. Used to estimate the impact on compressor operation.
Upstream of Flow Controller (%) (1)	Input activated if storage upgrade and intermediate flow controller are both selected. Input is % of additional volume that will be located upstream of the new flow controller. Used to estimate the impact on compressor operation.
% Increase (2)	The percentage increase in the airflow for each day-type

Notes:

Measure information not required for deferred load & new installations.

Measure information required for deferred load applications only.

2.2.28.3.1.1 Additional Inputs

Additional input forms are provided to define the performance and operating characteristics of the proposed compressor. These forms and inputs are the same as those used to define the performance and operating characteristics of the existing equipment, and are identical to the forms and inputs previously described in Tables 28-4 and 28-5.

2.2.28.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 28-10: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.28.3.3 Output

Once all necessary input information has been gathered, the Compressed Air Systems Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 28-11: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.28.4 Energy Savings Explanation

Annual energy savings is calculated by subtracting the proposed energy usage from the baseline usage. Incentive values are then calculated as the product of the incentive rate (\$0.09 / kWh) and the estimated energy savings value.

$$\text{Annual Savings (kWh)} = \text{Baseline kWh} - \text{Proposed kWh}$$

$$\text{Incentive Amount} = \text{Annual Savings (kWh)} * \text{Incentive Rate (\$/kWh)}$$

The following discussion of the calculation methodology steps through the process used to establish the baseline and proposed energy use values and focuses on the inputs, assumptions and calculations involved. Also, as noted previously the compressed air measure software accommodates both retrofit applications (with and without an increase in load) as well as new installations, so additional discussion is provided as needed to describe how the assumptions and/or calculations vary between these different scenarios.

2.2.28.4.1 Step 1: Establish Existing Compressor(s) Full Load Performance

Air compressor full load performance values (full load kW, full load rated airflow, full load operating pressure), as entered by the user (see Table 28-5) are based on manufacturer supplied data that is compliant with CAGI standards. These standards dictate that air compressor performance be reported at standard atmospheric conditions (14.5 psia & 68 DegF). Typically, air compressor operating conditions will differ from these standard values and it is therefore necessary to correct these values to actual operating conditions. Thus, the software corrects the full load kW and airflow values based on:

- Site elevation (atmospheric pressure) and average ambient temperature based on the user selected city (see Appendix B)
- Compressor operating pressure (user input)

The following expressions are used to correct the compressor full load performance information to the site specific conditions.

$$\text{corrKW}_{\text{FL}} = \text{KW}_{\text{FL}} * \frac{(((\text{opPress} + \text{altPress}) / \text{altPress}) ^ (0.395 / 1.395) - 1)}{(((\text{FullLoadPress} + 14.5) / 14.5) ^ (0.395 / 1.395) - 1)}$$

$$\text{corrC}_{\text{FL}} = \text{C}_{\text{FL}} * (1.1189 - (0.001978 * \text{SiteTemp}))$$

Where:

KW_{FL} = Full load kW (user input) @ full load capacity and pressure
 C_{FL} = compressor full load flow, ACFM (user input)
 SiteTemp = site average ambient temperature, DegF (lookup)
 SiteElevation = site elevation above sea level, feet (lookup)
 altPress = 14.5 - (0.271875 * SiteElevation / (460 + SiteTemp))
 opPress = Site operating pressure, site (user input)
 FullLoadPress = Full load performance pressure (user input)

2.2.28.4.2 Step 2: Establish System Baseline Airflow & Electric Demand

In order to estimate the performance of the proposed air compressor(s) it is necessary to establish both the baseline airflow and electric demand for the existing equipment. To accomplish this, the user enters an individual hourly operating load profile for each compressor for up to four types of system operation ("day-types"). Either average hourly electric demand (kW) or airflow (acfm) values may be entered. These values are used in conjunction with the previously entered compressor performance information in the following fashion.

If hourly airflow values are entered then it is necessary to estimate the hourly average hourly kW demand. This conversion is accomplished by:

Dividing each hourly airflow by the full load airflow value (corrected value from Step 1) to obtain a % of full load ACFM value,

- Translating the % of full load ACFM value to a % of full load kW value using compressor performance maps for the various compressor and control types.
- Multiplying the % of full load kW value by the corrected full load kW value obtained in Step 1.
- If hourly kW values are specified then it is necessary to estimate the hourly average airflows. This conversion is accomplished by:
- Dividing each hourly kW demand airflow by the full load kW value (corrected value from Step 1) to obtain a % of full load kW value,
- Translating the % of full load kW value to a % of full load ACFM value using compressor performance maps for the various compressor and control types.
- Multiplying the % of full load ACFM value by the corrected full load ACFM value obtained in Step 1.

2.2.28.4.3 Compressor Control Methods

Additional discussion of the various controls types follows.

- Modulation – Inlet Valve Throttling

Throttling is a form of inlet modulation accomplished by a butterfly or slide valve, and is typically found on rotary screw compressors. For a given compressor load, expressed as a fraction (%C) of compressor full-load capacity, the corresponding power expressed as a fraction (%P) of full-load power can be calculated using the following linear relationship:

$$\%P = (1 - \%P_{nl}) * \%C + \%P_{nl}$$

Where

$\%P_{nl}$ = power at no load condition divided by full load power (user input).

- Load-Unload

Load-unload controls on rotary screw and reciprocating compressors allow the compressor to operate at two points: full-load and no load (unloaded). The compressor operates at full load until the system reaches the maximum discharge pressure at which time the compressor unloads. For a given compressor load, expressed as a fraction (%C) of compressor full-load capacity, the corresponding power expressed as a fraction (%P) of full-load power can be calculated using the following linear relationship:

$$\%P = (1 - \%P_{nl}) * \%C + \%P_{nl}$$

Where

$\%P_{nl}$ = power at no load condition divided by full load power (user input).

- Modulation w/Unload

This control strategy is a combination of modulation and load-unload controls, and is found only on rotary screw compressors. Modulation may be by either via an inlet valve or by turn or poppet valves (variable displacement). Compressors operate at full-load until the full-load discharge pressure is reached, then begin to modulate to match system air requirements (reduced airflow at required output pressure) until the compressor unload point (%C_{ul}) is reached. Once this point is reached the compressor will unload fully (zero output airflow) and remain unloaded until the output pressure declines (see Figure 28-1).

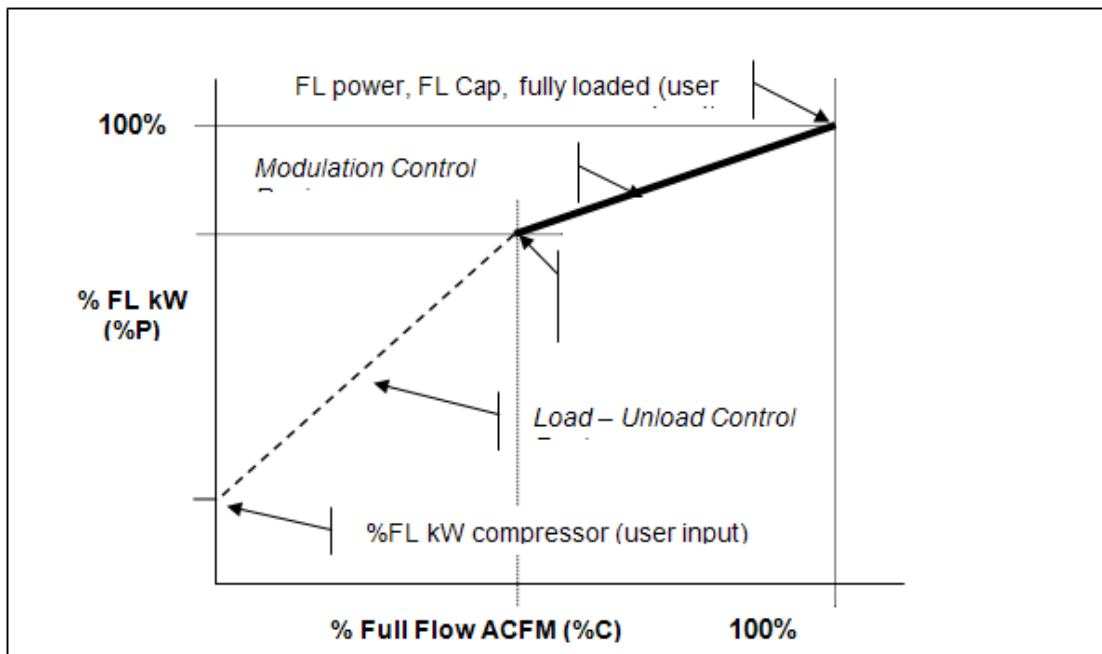


Figure 28-1: Modulation w/unload Performance Map

For a given compressor load, expressed as a fraction (%C) of compressor full-load capacity, the corresponding power expressed as a fraction (%P) of full-load power can be calculated using the following formulae (illustrated in Figure 28-1) for :

$$\%P = ((\%P_{ul} - \%P_{nl}) / \%C_{ul}) * \%C + \%P_{nl} \quad (\%C < \%C_{ul})$$

$$\%P = (\%C^n - 1) * ((1 - \%P_{ul}) / (1 - \%C_{ul})) + 1 \quad (\%C > \%C_{ul})$$

where

if control type is throttle then n=1

if control type is variable displacement then n=2

%P_{ul} = power at unloading point divided by full load power (user input)

%P_{nl} = power at no load conditions divided by full load power (user input)

%C_{ul} = airflow at unloading point divided by full load ACFM (user input)

2.2.28.4.4 Compressor After-Cooling

Air compressors generate significant amounts of heat that must be removed from the air prior to use. This after-cooling step is accomplished using either an air-to-air or water-to-air heat exchanger that is typically integrated into the air compressor package. The parasitic energy associated with after-cooling varies depending on the method employed and must therefore be accounted for properly during the analysis. In the case of air-cooling both the heat exchanger and associated fan(s) are integrated into the air compressor package itself. The fan can be driven either by the main compressor drive motor or a separate drive motor may be used. The user must specify the type of after-cooling method (Air (Integral Fan), Air (Separate Fan), or Water). In the case of air cooling with a separate fan the user must also provide motor performance information (see Table 28-6).

For water-cooled applications the air-to-water heat exchanger is integrated into the air compressor package and typically receives cooling water from a centralized cooling system that also supplies various other systems in the facility. If both the existing and proposed air compressors use water for after-cooling then the incremental impact on the central cooling system is assumed to be negligible and no action is taken. The CCT does not allow for changing of the after-cooling method. The analysis associated with estimating the incremental cooling load impact on a large centralized cooling system is beyond the scope of the CCT since it requires knowledge of the various other systems that may also be using cooling water. The CCT employs a check to determine if the existing and proposed equipment use *different* after-cooling methods and notifies the user that the CCT cannot be used in cases where the after-cooling method has changed.

2.2.28.4.5 Total Package versus Compressor-only Power

As noted previously, the user must enter hourly load profile information for each compressor for up to four day-types. The user can choose to enter either electric demand (kW) or airflow (ACFM) data. For electric demand data, the software converts these data points into % of full load values by dividing each value by the air compressor full load kW value (user input that has been corrected for ambient temperature, elevation and operating pressure). The full load package power value entered by the user, as supplied by CAGI datasheets is the total package power and includes control and after-cooling fan power, if applicable. The hourly profile values entered by the user are obtained via direct measurement and in the case of electric demand values may or may not include control and after-cooling fan power (depending on how the measurement equipment was installed). For this reason, the user must specify whether hourly electric demand profile values include control and fan power (kW - Package) or the compressor drive motor only (kW – Compressor Only).

If the user has selected kW – Compressor Only and Air (Separate Fan) was previously specified for the after-cooling type then the software must correct the hourly profile kW values by adding in an estimated fan power value (prior to dividing by the total package power value to obtain %FL kW). The added fan power is calculated as follows using the Fan HP and Fan Motor Efficiency inputs with an assumed fan loading of 0.75.

$$\text{Fan kW} = 0.75 * \text{Fan HP} * 0.746 / \text{Fan Motor Efficiency}$$

2.2.28.4.6 Baseline Demand – Deferred Load

Deferred load in this instance refers to cases where an existing business requires additional compressed air capacity. This additional capacity will normally result in increased electric load. In order to minimize this load increase, the Customized Offering Program provides an incentive to the business to purchase more efficient compressed air system equipment, which helps to reduce or defer a portion of the added electric load. Deferred savings, in this case is the difference between the increased load that would have resulted in the absence of the incentive and the estimated load that will occur using the proposed energy efficient measure.

The baseline consumption for deferred load applications is the sum of the existing energy use and the estimated increased energy use that would have occurred in the absence of the incentive. An important issue associated with estimating deferred savings therefore deals with defining what a business would do in order to meet the increased airflow in the absence of the incentive. The CCT estimates the baseline usage for deferred load applications based on the following assumptions:

- In the absence of an incentive, the customer would purchase, install and operate additional compressor capacity with performance characteristics equivalent to the equipment that is already on-site (e.g., purchase/lease one or more additional compressors just like they already own).
- The need for added airflow capacity is related to the addition of production equipment that operates during the same hours as the existing equipment (i.e., 5 days/week, 16 hours per day, etc.) and is therefore covered by the existing day-types.

For deferred load applications the user input screens contain the same inputs as for any retrofit application, with one exception. Additional input(s) are required on the measure specification input screen (see Table 28-4) that indicates the percentage increase in the airflow for each day-type. To facilitate entry of this input the software displays the peak airflow for each day-type (calculated based on previously entered profile data). The software uses this % increase value to adjust the airflow and kW profile information for each day-type. Based on the assumption that the customer would utilize the same type of equipment (kW/cfm remains unchanged), the adjustment for the added capacity is:

New Baseline kW = Previous kW * (1+ % Increase/100)

The profile data for each day-type are modified in this fashion to arrive at the estimated baseline profile with the added airflow capacity.

2.2.28.4.7 Baseline Demand – New Installations

For new installations, savings occur when SCE via the Customized Offering incentive program induces a customer to install more efficient equipment when adding new equipment to an existing facility/business. Savings analysis differs significantly for new installations due to the absence of operating data. The lack of operating data restricts the complexity of the savings analysis and therefore also limits the types of energy efficient measures that can be accommodated. For this reason, only applications involving efficient compressor installations are accommodated by the CCT.

- For these types of applications the user inputs provide for entry of the following information (see Table 28-4):
 - Proposed compressor equipment and performance data (same as existing CCT applications)
 - Air system configuration and operating conditions (same as existing CCT applications)
 - Peak and average airflow values (in lieu of profile data) for each anticipated operating mode (i.e., normal weekday, weekend, etc.), for each compressor.
 - Equipment operating hours for each operating mode

New installations do not involve the replacement of existing equipment, and as such, the user does not specify the performance characteristics of baseline equipment. Therefore, the software selects a baseline compressor of the same size and type (i.e., reciprocating, screw, etc.) as each of the proposed air compressors from the AirMaster+ compressor list (see Appendix A) with a default baseline control type as noted in Table 28-5. Having selected the baseline compressor(s) the software then inserts N average airflow values into the hourly profile for each day-type where N is the number of daily operating hours specified by the user for that day-type. The software then allocates airflow to the different baseline compressors according to the compressor load order specified by the user. Having allocated airflow to each compressor in this fashion it is then possible to estimate the energy use of each compressor as discussed previously.

Table 28-11: Baseline Compressor Controls for New Installations

Compressor Type	Baseline Control Type
Single stage rotary screw – lubricant injected	Inlet valve modulation w/unload
Single stage rotary screw – lubricant free	Load / Unload
Two stage rotary screw – lubricant injected	Inlet valve modulation w/unload
Single stage reciprocating	Load / Unload
Two stage reciprocating	Load / Unload

2.2.28.4.8 Step 3: Calculate Baseline Annual Energy Use and Peak Demand

Prior to using the day-type profile data to calculate the annual baseline energy usage the CCT first checks if the baseline compressor package efficiency meets minimum requirements. These requirements are based on the “typical” specific package power values (kW/100 cfm) as used in the AirMaster+ software program (see Appendix A). These values were compiled as part of the DOE Compressed Air Challenge program and comprise the most comprehensive survey of existing equipment. Specific package power (SPP) and the associated correction factor are defined as follows:

$$\text{SPP}_c = \text{Full load kW} / (\text{Full load airflow}/100)$$

$$\text{BCF} = \text{SPP}_c \text{ AM+} / \text{SPP}_c \text{ Compr}$$

where:

SPP_c = Specific package power (kW/100 cfm)

BCF = Baseline correction factor

$\text{SPP}_c \text{ AM+}$ = AirMaster+ specific package power (table lookup using existing compressor type, size and pressure) corrected for site amb. temperature, elevation & operating pressure.

$\text{SPP}_c \text{ Compr}$ = Existing compressor specific package power corrected for site ambient temperature, elevation and oper. press. (calculated based on user inputs)

A BCF is calculated for each existing compressor in this fashion. If the BCF is equal to or greater than one (1) then this indicates that the existing compressor meets the minimum efficiency threshold and no action is taken. If the BCF is less than one then each of the hourly demand profile values associated with this compressor is multiplied by the BCF to arrive at an equivalent demand for a compressor meeting the minimum efficiency requirement. In addition, a warning message is generated indicating to the user that demand values have been corrected to meet minimum efficiency requirements.

Once the hourly profile values have been examined and corrected as needed, the baseline annual energy use is estimated by summing the hourly energy use for each compressor and day-type. The day-type totals are then multiplied by the corresponding days per week and weeks per year user input values (see Table 28-10) to arrive at a total annual baseline energy use. The baseline peak electric demand is calculated by trapping the highest hourly demand for any day-types that the user has designated as having “weekday” operation.

2.2.28.4.9 Step 4: Establish System Proposed Airflow & Electric Demand

The proposed system electric demand is estimated using the airflow information previously developed as part of the baseline demand analysis (Step 2) in conjunction with the performance specifications of the proposed equipment. The approach used to estimate the proposed system demand varies based on the efficiency measure involved as described in the following sections. Note that no correction factor is calculated for the proposed equipment.

2.2.28.4.9.1 Efficiency Measure – Single Compressor Replacement

In the case of replacement of a single compressor, or when multiple compressors are replaced by a single new compressor, the software uses the airflow profile data previously developed for each day-type to estimate the electric demand of the proposed air compressor. The approach used to estimate the electric demand of the new compressor is the same as that used to estimate the performance of the existing equipment (see Step 2 discussion) with the exception that the control and performance characteristics as specified by the user are used (after correcting to local conditions) in the analysis.

- **Variable Speed Drive (VSD)**

Variable speed drive controls vary the frequency of the power delivered to the compressor drive motor to regulate the motor speed in response to changing airflow requirements. These controls achieve significant savings at part-load with some tradeoff of efficiency at full load due to drive inefficiency. The control method employed by VSD controls vary depending on the manufacturer and whether the VSD is a retrofit or if the VSD is integral to the air compressor. For retrofit VSD drives the existing electric motor is retained and the control is typically restricted to motor speeds/frequencies exceeding 50% of the normal motor speed (to prevent damage to the electric motor). If airflow requirements fall below the level needed to maintain the minimum motor speed then the control will either unload the compressor, while operating at minimum speed, or will shut off the compressor entirely.

Computation of electric demand for VSD equipped air compressors was not covered previously in the Step 2 discussion, since VSD equipped compressors are not supported as baseline/existing equipment. The power requirements of a VSD equipped air compressor are computed in the same basic manner as for a compressor equipped with a modulation w/unload control. Specifically, the control performance map is divided into two linear parts (see Figure 28-2).

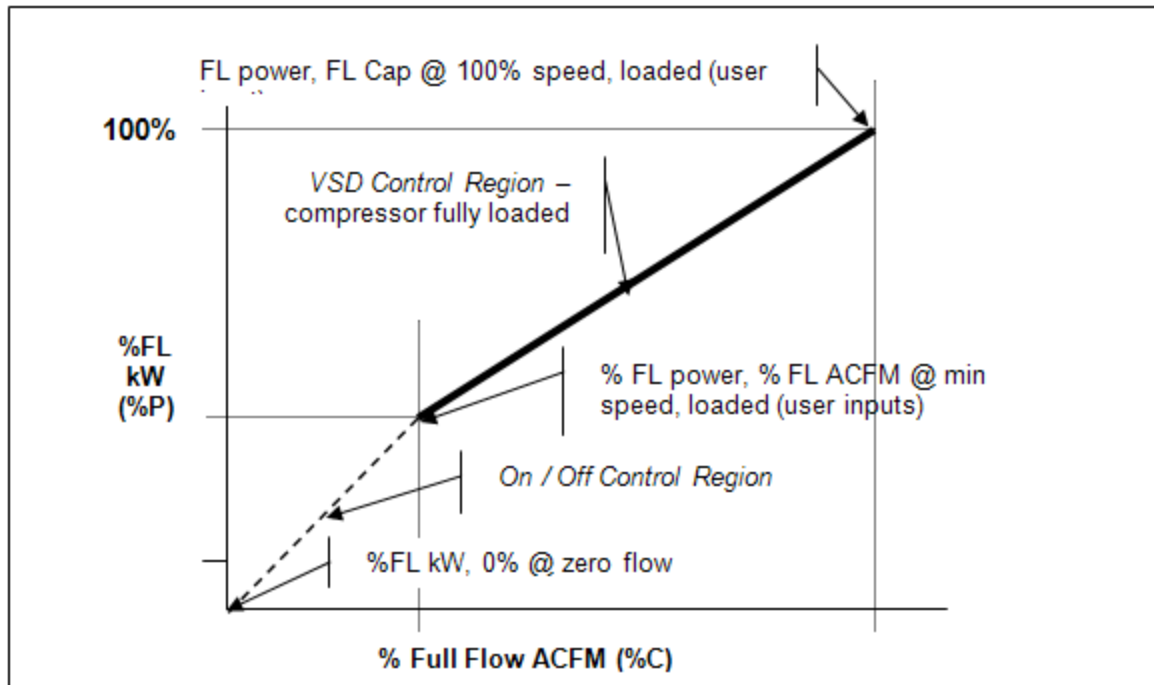


Figure 28-2: VSD Control Performance Map

The CCT uses the following procedure to estimate the VSD equipped compressor energy use. Using the airflow allocated to the VSD equipped machine as the input, the software:

- Computes the % FL Airflow by dividing the hourly profile airflow value by the FL capacity of the proposed compressor.
- Determines if the %FL Airflow value is above the minimum airflow value (input) for the proposed machine (airflow at minimum operating speed)
- If the airflow is equal to or exceeds the airflow at min speed then the VSD is controlling airflow with the compressor in a fully loaded configuration. The %FL Power value is estimated using the following expression:

$$\%FL \text{ Power} = m_{vsd} * \%FL \text{ Airflow} + b_{vsd}$$

where:

$$m_{vsd} = (100 - \%FLkW_{ms}) / (100 - \%FLCap_{ms})$$

$$b_{vsd} = 100 * (1 - m_{vsd})$$

$\%FLkW_{ms}$ = %FL power at min speed (compressor loaded), *input*

$\%FLCap_{ms}$ = %FL airflow capacity at min speed (compressor loaded), *input*

$\%FL \text{ Airflow}$ = %FL airflow in question

$\%FL \text{ Power}$ = %FL power corresponding to the %FL Airflow value, *calculated*

□ If the airflow value is less than the airflow at min speed (and is non-zero) then the VSD is assumed to be either at minimum speed (minimum airflow) or the compressor is turned off (on / off control). Within this range the %FLkW value is estimated using the following expression:

$$\%FL \text{ Power} = m_{l/u} * \%FLAirflow + \%FLkW_0$$

where:

$$m_{l/u} = (\%FLkW_{ms} - \%FLkW_0) / \%FLCap_{ms}$$

$$\%FLkW_0 = 0$$

$\%FLkW_{ms}$ = %FL power at min speed (compressor loaded), *input*

$\%FLCap_{ms}$ = %FL airflow capacity at min speed (compressor loaded), *input*

%FLAirflow = %FL airflow in question

%FL Power = %FL power corresponding to the %FL Airflow value, *calculated*

2.2.28.4.9.2 Efficiency Measure – Multiple Compressor Replacement or Upgrade

The CCT supports replacement or upgrade of up to three air compressors. The electric demand of each of the proposed compressors is estimated in much the same way as for a single compressor. A compressor performance map, specific to the type of compressor and type of proposed control is used to estimate the electric demand. In the case of a single proposed compressor, all of the system airflow is assigned to the proposed compressor.

- Compressor Loading Order

For multiple compressors the analysis must include a step where the total system airflow is allocated amongst the various proposed compressors. A compressor loading order is used to accomplish this allocation of system airflow. The user determines the loading order by designating each proposed compressor as one of the following:

- Lead/Baseload (L/B),
- Additional Baseload (A/B), or
- Variable/Trim (V/T).

Since the software supports up to three compressors, two may be designated as base loaded and as one as V/T. The analysis approach used by the software is limited to considering a single VSD drive, which if present, must be designated as V/T. The software requires that the user keep the compressor designations (L/B, A/B, V/T) fixed for all day-types and all hours of operation (i.e., the compressors are always sequenced in the same fashion).

For each day-type profile the software steps through each hour and allocates the system airflow using the following procedure.

1. If the system airflow during any given hour is zero then all of the compressors are assumed to be turned off.
2. If system airflow is non-zero then all compressors are set to their minimum flow setting (assumed to be zero). If the system airflow is less than the V/T machine full load capacity then all of the airflow is allocated to the V/T machine and the L/B and A/B machines remain at their minimum setting.
3. If the system airflow exceeds the V/T capacity then the V/T machine is set to its minimum operating point and the remaining airflow is allocated to the L/B machine. Airflow in excess of the L/B machine capacity is then assigned to the V/T machine.
4. If system airflow exceeds both L/B and V/T capacities then the V/T machine is set to its minimum operating point, the L/B machine is loaded fully and the remaining capacity is allocated to the A/B machine. Airflow in excess of the A/B machine capacity is added to the V/T airflow.

5. As system airflow decreases the V/T machine will unload first followed by the A/B and L/B machines until each machine reaches its minimum operating point. If the user has indicated that an auto shutdown timer is present and the compressor is capable of unloading, then the compressor cycle time is also checked to determine if the compressor can be turned off (see Auto Shutdown Timer discussion).
6. If the system airflow exceeds the total capacity of the proposed equipment during any hour the software generates an error message and requires user intervention in order to proceed.

Once the airflows have been allocated the software then estimates the kW demand for each compressor using the approach described previously for a single compressor.

It should be noted that the CCT does not employ a dynamic simulation of equipment operation, and as such, no attempt is made to estimate, and account for, the actual operating pressure for each compressor (the operating pressure for each compressor is assumed to be equal).

- **Auto Shutdown Timer**

Some air compressor controls employ a timer that automatically shuts off a compressor that has remained in an unloaded condition for a preset period of time. To account for this type of control the user inputs include a check box (see Table 28-5) indicating if this type of control is present and the unloaded time threshold value (if applicable).

If the user has specified that an auto shutoff timer is present and the compressor in question is capable of unloading (load/unload, modulation with unload, variable displacement with unload) then the cycle time will also be estimated to determine if the auto shutdown timer threshold has been reached. A compressor load / unload cycle consists of two parts. When the outlet pressure exceeds the "Cut Out" pressure the compressor is unloaded and outlet pressure is allowed to decrease. This portion of the cycle is called the "drain down time" (Tdr). Drain down ends when the outlet pressure has dropped below the "Cut In" pressure at which time the compressor is loaded. This "loaded" portion of the cycle is called "pump up time" (Tpu) and will continue until the outlet pressure has again reached the Cut Out setting, and then the cycle repeats. The amount of time spent in either state is a function of the compressor capacity, system airflow requirement and total system volume along with the cut out and cut in pressures. If the drain down (unloaded) time exceeds the auto shutdown timer setting, then the compressor will be shut off during part of the hour being examined.

The following expressions are used to determine if an auto shutdown will occur:

$$Tdr = Strg * (Pmax - Pmin) / (Patm * dACFM)$$

where:

Strg = Site.SystemVolume + AdditionalStorage (user inputs)

Pmax = FullFlowPressCutOut (user input)

Pmin = FullLoadPressCutIn (user input)

Patm = 14.5 - (0.271875 * SiteElevation / (460 + SiteTemp))

dACFM = air compressor air flow (allocated by compressor loading scheme)

If the drain down time exceeds the auto shutdown timer setpoint (SDTimer) then the air compressor will be off during a portion of the hour. The impact of shutting down the air compressor is estimated as follows:

$$T_{pu} = S_{trg} * (P_{max} - P_{min}) / (P_{atm} * (C_{fl} - dACFM))$$

$$PctP = ((1.0 * T_{pu}) + (P_{nl} * SDTimer)) / (T_{pu} + T_{dr})$$

where:

PctP = fraction of full load compressor power
 Pnl = compressor power (kW) when fully unloaded
 Cfl = compressor full load airflow (acfm) capacity
 SDTimer = shut down timer setting (mins)

2.2.28.4.9.3 Efficiency Measure – Intermediate Flow/Pressure Controller

An intermediate flow/pressure controller ultimately achieves energy savings by allowing the end uses (system) to operate at a lower pressure than the centrally located compressors. Lowering the system operating pressure downstream of the new flow/pressure control valve reduces the airflows to unregulated end uses (e.g., leaks). Energy savings are achieved via the reduced power demand of the compressors when supplying less overall airflow. It is important to note that only airflow associated with leakage or unregulated end uses (without individual pressure regulators) will be affected by this measure. It is for this reason that the user must input the estimated leakage rate (default of 5%) and the percentage of total system airflow represented by unregulated end uses (default is 0%).

Using the estimated leakage and unregulated end use % values entered by the user the software calculates new system airflows for each day-type profile using the following expressions:

$$Q_c = Q_e * dLeakFactor$$

$$dLeakFactor = (1.0 + a * (b - 1.0))$$

$$a = (\%Leak + \%Unreg) / 100$$

$$b = (P_p + 14.7psia) / (P_e + 14.7psia)$$

where:

Q_e = existing system airflow before correction, acfm
 Q_c = corrected system airflow, acfm
 $\%Leak$ = % of total airflow from leaks, *user input*
 $\%Unreg$ = % of total airflow from unregulated end uses, *user input*
 P_p = proposed system press (downstream of new controller), *user input*
 P_e = existing average system pressure, *user input*

Once the system airflow values (day-type profile values) are modified then it is possible to reallocate the system airflows to the air compressors and estimate their energy use using the procedures described previously in the discussion of Multiple Compressor Replacement or Upgrades.

2.2.28.4.9.4 Efficiency Measures – Storage System Upgrade

As noted in the discussion of auto shutdown timers, a compressor capable of load / unload control may be turned off if the drain down time exceeds the auto shutdown timer setting. Since this drain down time increases with system volume it is possible to increase this time by adding to the system volume. Thus increasing the amount of storage can result in increased operation at an unloaded condition, and possibly result in a compressor being shut off.

The CCT estimates these potential savings by using the same basic calculations as discussed previously under the auto shutdown timer section. The only difference is that the presence of an intermediate flow controller must be accounted for in the calculations. Storage located downstream of an intermediate pressure controller does not directly impact the compressor cycle time and as such it is important to differentiate between storage located upstream and downstream of the controller. For this reason, the user inputs for this measure include values for the amount of storage upstream and downstream of the controller (if present). Only storage located upstream of the controller is included in the system volume value used in the drain down time calculation. It is also important to note that this measure will only achieve savings if an auto shutdown timer is present.

2.2.28.4.9.5 Proposed Energy Use – New Installations

The process used to estimate the proposed energy use of proposed equipment associated with new installations is the same as described above with the following exceptions:

- Measures involving intermediate flow controllers and added storage are not supported, and
- The system airflow used to allocate individual compressor airflows is based on the individual day-type average airflow user input values (see Table 28-7) and the process described in Section 2.2.13.5.7.

2.2.28.4.10 Step 5: Estimate Proposed Annual Energy Use and Peak Demand

Once the proposed electric demand profiles have been developed for each day-type using the approaches discussed above, it is a simple matter of summing up the hourly energy usage for each compressor and each day-type. The day-type totals are then multiplied by the corresponding days per week and weeks per year user input values (see Table 28-10) to arrive at the total annual proposed energy use. The proposed peak electric demand is calculated by trapping the highest hourly demand for any day-types that the user has designated as having “weekday” operation.

2.2.28.4.11 Step 6: Estimate Energy and Demand Savings

Once the annual baseline and proposed energy use and peak demand values have been estimated it is simple matter of subtracting the proposed energy use from the baseline energy use to arrive at the estimated savings. Likewise, the demand savings is estimated by subtracting the proposed peak demand baseline peak demand.

2.2.29 Other - Fan System Upgrades

2.2.29.1 Description

Fan and blower systems have been identified as one of the largest end use applications in industrial settings. Under the sponsorship of the DOE Industrial Technologies Program, a computer program called FSAT (Fan System Assessment Tool) was jointly developed by the Air Movement and Control Association (AMCA) and Oak Ridge National Laboratory to assist end users in estimating fan system energy saving opportunities. FSAT uses generic fan performance characteristics in conjunction with minimal user inputs to estimate the efficiency and potential savings associated with fan and/or electric drive motor replacements. The FSAT output is limited to an estimate of the potential annual savings associated with single fan operating point and does not attempt to identify how the potential savings can be obtained nor does it characterize savings associated with specific savings measures.

This CCT utilizes some of the information contained in FSAT (fan efficiency based on specific speed) in conjunction with the fan laws to estimate energy and demand savings, and the associated incentive amount. Additionally, this CCT allows for entry of multiple fan operating points as well as installation of a variable frequency drive (VFD); a measure that is not included in FSAT.

This tool currently estimates savings for the following measures, either singly or in combination:

- ☐ Direct replacement of a fan or fan and motor with equipment of higher efficiency;
- ☐ Installation of an electronic variable frequency drive (VFD) on the fan drive motor; and installation of a more efficient belt drive on the fan drive motor.

Currently the software will only accommodate measures involving a single fan. Therefore projects involving multi-fan systems should not use this tool to estimate savings.

2.2.29.2 Appropriate Use of the Tool –Program Policy

The Fans System Upgrade tool can be used for fans and measures having the characteristics shown in Table 29-1. Note that fans equipped with variable pitch blades or fans equipped with mechanical drives capable of variable speed operation are not currently accommodated. It is also important to note that this tool utilizes a variety of assumptions related to the condition and operation of fan systems, which are explained in detail in the following sections. This tool provides results representative of “typical” fan systems and may not represent the specific operating conditions present at an individual site/installation. This tool should not therefore be used to design or otherwise specify fan systems or equipment.

Table 29-1: Fan Savings Measure Features

Description	Measure Feature
# of Fans	1
Fan Types	Centrifugal and axial fans with drives of 5 HP or more
Fan Drive	Direct drive, belt drive and electronic Variable frequency Drive (VFD)
Baseline Fan Efficiency	Generic fan efficiencies are displayed for information purposes. (see Appendix A)

Fan Operating Profile	Daily/Monthly or Total Annual Operating hours accommodated for up to eight (8) modes of operation. (User may input either fan flow or fan kW)
Static Discharge Pressure	Fan total static pressure in the range of 0 – 35 "Wg (recommended) <i>Increased pressures can be accommodated with some reduction in accuracy due to compressibility effects. Please contact AESC for additional information.</i>

2.2.29.3 Applicable Types of Equipment

The fan types and controls accommodated in the estimation tool software parallel those covered in the FSAT software. The exception is that this software will also calculate savings associated with VFD-equipped fan drives. Table 29-2 summarizes the fan type and control options covered by the estimation software. See Appendix H for additional background information on different fan types. Note that fans deployed as "blowers" may be accommodated subject to the static pressure restrictions noted above.

Table 29-2: Equipment Included in Fan Savings Estimation Software

System Type	Fan Type	Control Type
Centrifugal	Airfoil (SISW, DIDW), Forward Curved (SISW & DIDW), Backward Inclined (SISW & DIDW), Radial (SISW), Radial Tip (SISW), Exhaust, Industrial Commercial Fan (ICF)- Air Handling, Industrial Commercial Fan (ICF)- Material Handling, Industrial Commercial Fan (ICF)- Long Shavings	On/off (no control), Outlet Dampers, Inlet Vanes**, Variable Frequency Drive*
Axial	Tubeaxial, Vaneaxial, Propeller, Exhaust	On/off (no control), Outlet Dampers, Variable Frequency Drive*

* -- part of energy savings measure only

** -- inlet vane control is not an option for exhaust fan applications

2.2.29.4 Measure Tool Use

2.2.29.4.1 Inputs

The Fan System Upgrades measure is only available for use with retrofit applications (selection only appears when a retrofit application has been specified). Having selected the Fan System Upgrades measure the user is directed to enter the inputs as described in the following tables.

The fan system upgrades software requires a significant number of inputs, which can be divided into three basic areas: system requirements, equipment performance (fan, motor, drive) and fan operating modes. Additional information is provided on the inputs related to system pressure requirements and fan performance.

System Pressure and Flow Inputs:

The two system inputs of most importance are System Static Pressure at Maximum Flow and the System Maximum Flow. These two inputs (see Figure 29-1) are used by the software to develop a simplified system pressure curve². The curve is assumed to have a basic quadratic shape with a zero intercept. Thus the system pressure curve can be established using the single maximum flow point. Note that system maximum flow will likely correspond to the maximum fan operating flow for most single fan applications.

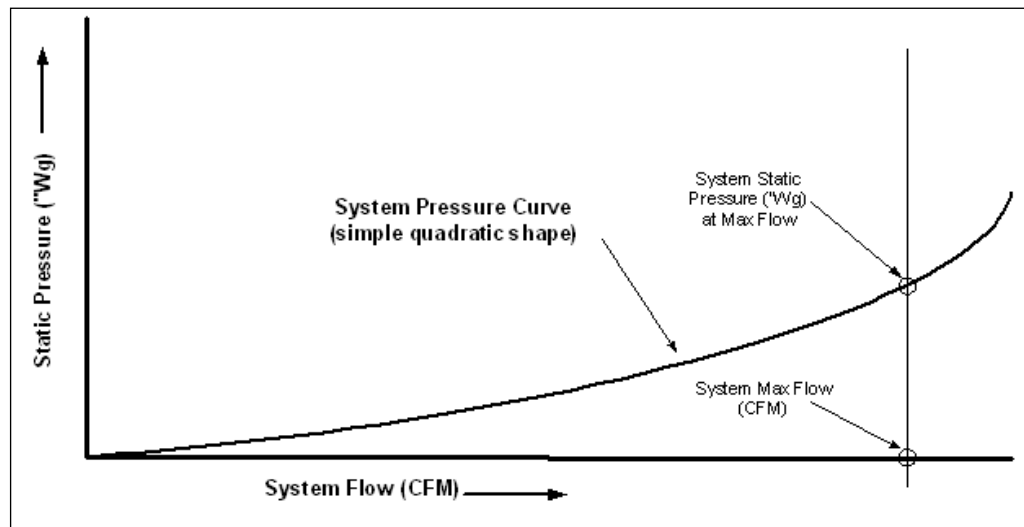


Figure 29-1: System Pressure and Flow Inputs (not to scale)

The system inputs are located on Sheet 1 along with the site specific inputs in the table below.

Table 29-3: Site/System Inputs

Input Name	Description [Purpose]
Location/city	Site location [air density correction for site altitude]
Fan System Name	Identifies fan system involved [inspection purposes]
Fan System Type	Select either Centrifugal or Axial
Exhaust Fan?	Pull down menu; "yes" indicates an unducted exhaust fan
Number of Fans	1 is the only selection currently available

¹ A system pressure curve is not needed for applications involving unducted exhaust fans and these inputs do not therefore appear when the exhaust fan checkbox is checked.

Estimate Ambient Air Temperature?	Pull down menu; “yes” indicates that Inlet Air Temperature will be calculated by the software based on the average air temperature for this location/city (CEC weather zone data).
Inlet Air Temperature, DegF	Nominal temperature of air entering the fan [air density correction] <i>If ambient air temperature checkbox is selected then the average ambient for the location/city will be automatically displayed.</i>
System Design (Max) Flow, or Maximum Exhaust Flow, CFM	Maximum flow through system [establish system pressure & flow requirements] or maximum exhaust fan flow (if “yes” is selected on the exhaust fan pull down menu)
System Total Static Pressure @ Max Flow, “Wg	Fan total static pressure requirement at max system flow in inches Water gauge [establish system pressure and flow requirements] <i>This input does not appear if “yes” is selected on the exhaust fan pull down menu.</i>

Fan Performance Inputs:

The fan performance inputs of most importance are the fan Total Static Pressure, Static Efficiency and the fan Flow at the fan’s best efficiency point (BEP). The relationship of these inputs is illustrated in Figure 29-2 below. These three values are used in conjunction with generic normalized fan curve shapes to develop an estimated fan performance map. Note that the BEP values are taken from manufacturer’s data and will likely be significantly different from the fan operating points (for most fan types).

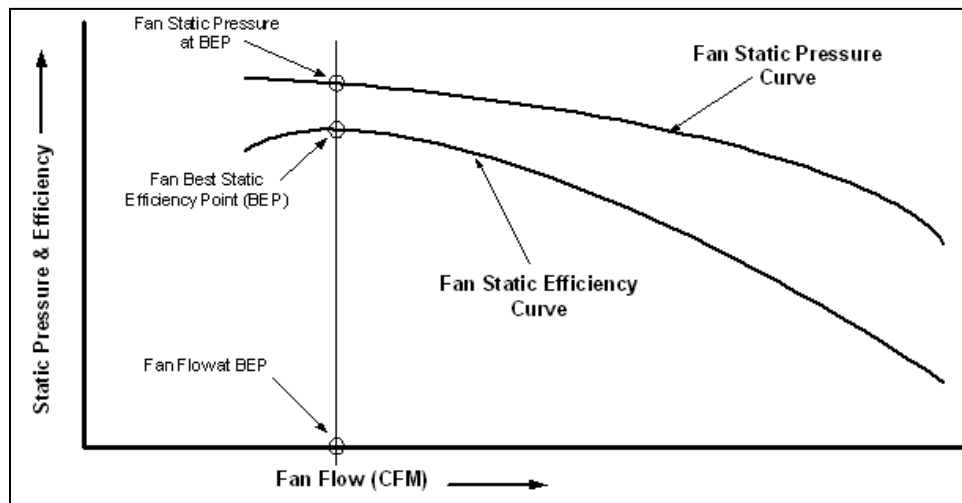


Figure 29-2: Fan Performance Inputs (not to scale)

The fan performance inputs are located on Sheet 2 along with the site specific inputs (see Table 29-4).

Table 29-4: Existing Fan Inputs

Input Name	Description [Purpose]
Fan ID	Fan identifier [inspection purposes]
Manufacturer	Fan manufacturer [inspection purposes]

Model	Fan model [inspection purposes]
Serial Number	Fan SN [inspection purposes]
Type	See Table 29-2 for menu selections
Control Type	See Table 29-2 for menu selections
Drive Type	Direct, V-belt, or Rubber Chain Drive
Fan Speed	Fan speed value (RPM)
Flow, CFM	Flow at fan best efficiency point (BEP) [establish fan performance curve(s)]
Total Static Pressure, "Wg	Total fan static pressure requirement at BEP [establish fan performance curve(s)]
Static Efficiency, %	Fan static efficiency at BEP [establish fan performance curve(s)] <i>Note that the estimated maximum fan efficiency for this fan type & specific speed (FSAT data) are displayed for comparison purposes</i>

Select "Edit Motor Details" to enter existing drive motor information as described in below table.

Table 29-5: Existing Drive Motor Inputs

Input Name	Description
Manufacturer	Motor manufacturer (nameplate data)
Model	Motor model (nameplate data)
Size, HP	Motor size (nameplate data)
Speed, RPM (nominal)	Select from pull-down; 1200, 1800, 3600
FL Speed, RPM	Motor speed at full load (nameplate data)
Enclosure Type	ODP or TEFC/TXPL
Service Rating	Motor service rating; 1.15 or 1.25
NEMA Nominal Efficiency @ full load	<i>EPACT min value is displayed for comparison purposes</i>

Next, Fan Operating Conditions are entered up to 8 operating modes. For inputs, refer to the table below.

Table 29-6: Fan Operating Information Inputs

Input Name	Description
<i>Fan Operating Conditions:</i>	
Number of Operating Modes	Number of different operating points that will be considered (8 max)
Operating Hour Input	Yearly (total annual hours as input) or Daily (days/month as input) may be selected
Operating Data Type	Flow (CFM) or Power (kW)

Operating Mode Information:	
Operating Mode Number	Selections are 1 through the number of modes entered above (8 maximum).
Description	Name or description of operating mode (i.e., process air, etc.)
On-Peak Operation?	Check this box if <i>any</i> fan operation during this operating mode occurs during the on-peak period (as defined by local utility).
Average Operating Data	Average fan flow rate (CFM) or fan power (kW) during this operating mode

Click “Edit. Oper. Mode” to enter Fan Operating Information.

Table 29-7: Proposed Measure Inputs

Input Name	Description
Fan Replacement / Mod.	Select “Fan” and/or “Motor” checkboxes (or neither)
Fan Drive Replacement	Select “VFD added to existing drive” or “Rubber Chain Drive (or equivalent)” (or neither)
VFD Full Load Efficiency, %	VFD efficiency at full load @ 100% speed [used to calculate overall efficiency] <i>(input only appears if VFD checkbox is selected)</i>
VFD Minimum Operating Speed, %	VFD minimum operating speed [used to check for violation of min speed during operation] <i>(input only appears if VFD checkbox is selected)</i>

2.2.29.4.2 Additional Inputs

Additional input forms are provided to define the performance and operating characteristics of the proposed fan and associated drive motor. These forms / inputs will only appear if a fan replacement has been selected in the measure specification page. These forms are identical to the forms used to enter existing fan and motor details as described previously in Tables 29-6 and 29-7, respectively.

2.2.29.4.3 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 29-8: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.29.4.4 Output

Once all necessary input information has been gathered, the Fan System Upgrade Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 29-9: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.

1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.29.4.5 Tool Outputs – Optional Intermediate Calculation Report

The software can, if directed, create a text file containing the results of the various intermediate calculations. In this way a reviewer can more closely examine how the final results are generated. Under normal circumstances, creation and examination of this file would not be needed so the software, by default does not create the file. To generate the file the user must hold down the CTRL key while selecting the NEXT button from either the measure selection screen (Sheet 6) or the proposed fan input screen (Sheet 7). See Appendix G for additional information on the content and format of this output file.

2.2.29.5 Energy Savings Explanation

Annual energy savings is calculated by subtracting the proposed energy usage from the baseline usage. Incentive values are then calculated as the product of the incentive rate and the estimated energy savings value.

$$\begin{aligned}\text{Annual Savings (kWh)} &= \text{Baseline kWh} - \text{Proposed kWh} \\ \text{Incentive Amount (\$)} &= \text{Annual Savings (kWh)} * \text{Incentive Rate (\$/kWh)}\end{aligned}$$

Baseline Energy Use – Power as Operating Point Input

In this case the user has already input a measured fan power value for each of the various operating points (up to 8). If the proposed measure does not include replacement of the electric motor then no correction for minimum electric motor efficiency is required and the baseline energy use for each operating mode is simply the product of the measured fan kW and the total annual operating hours that have been entered. This process is repeated for each of the operating modes with the sum equal to the annual baseline energy use of the fan. Additionally, the software calculates the weighted average electric demand using data from each operating mode that the user has previously designated as having on-peak operation. This value is displayed as the potential DEER peak demand on the DEER peak demand worksheet. Note that in the event that an electric motor replacement has been specified then it is necessary to correct the baseline data if the existing motor does not meet or exceed the EPACT minimum efficiency standard. The software uses existing algorithms developed for the electric motor measure to accomplish this correction (if needed).

Baseline Energy Use – Flow as Operating Point Input

The electric demand of a fan is calculated using the following expression.

$$kW_{FAN} = 0.7457 * K_p * \frac{Q_F * P_S * \rho_{in}}{6349.6 * \eta_F * \eta_d * \eta_e * \rho_{std}} \quad (\text{Equation 29-1})$$

where:

Q_F	= Fan flow (CFM)
P_S	= Fan static discharge pressure (inches Wg)
K_p	= Compressibility Factor (initially set to 1.0)
ρ_{in}	= Air density corrected for fan inlet conditions
ρ_{std}	= Air density at standard conditions (0.075 lbs/ft ³)
η_F	= Fan efficiency @ operating conditions
η_e	= Electric drive motor efficiency
η_d	= Drive efficiency (if applicable)

Note that fan total static pressure has been substituted for total pressure in the above expression. Many of the variables shown in this expression are dependent on operating conditions and must therefore be calculated separately prior to use in Equation 29-1.

Estimating Fan Performance

Fans exhibit dynamic performance characteristics such that fan total static pressure (P_S), brake horsepower and static efficiency (η_F) vary with flow. These performance parameters must therefore be calculated for each operating point (for use in Equation 29-1). Fan total static pressure and efficiency are typically characterized in a fan performance curve. These curves are generated by the fan manufacturer using test data and are used to determine the fan operating point (pressure and efficiency) under varying flows and speeds.

- Generic Fan Performance Curves**

Since fan performance curves can be difficult to locate for older fans the estimation tool software assumes that fan performance will follow one of five generic fan curve shapes³ based on fan type. See Figures 29-1 and 29-2 for generic static pressure and static efficiency curve shapes, respectively. Note that these curves are normalized based on fan performance parameters at the Best Efficiency Point (BEP). Fan performance at flows other than BEP is estimated using these curves, fan BEP data provided by the user and the following expressions:

$$Q_F = Q_{norm} * Q_{BEP} \quad (\text{Equation 3a})$$

$$\eta_F = \eta_{norm} * \eta_{BEP} \quad (\text{Equation 3b})$$

$$P_S = P_{norm} * P_{BEP} \quad (\text{Equation 3c})$$

where:

Q_F	= Fan flow (CFM) @ operating conditions
Q_{BEP}	= Fan flow (CFM) @ BEP
Q_{norm}	= Normalized fan flow (from curves)
P_S	= Fan total static pressure ("Wg) @ operating conditions

³Curve data extracted from generic curves shown in AMCA Publication 201-02, "Fans & Systems".

P_{norm} = Normalized fan total static pressure (from curves)

P_{BEP} = Fan total static pressure ("Wg) @ BEP

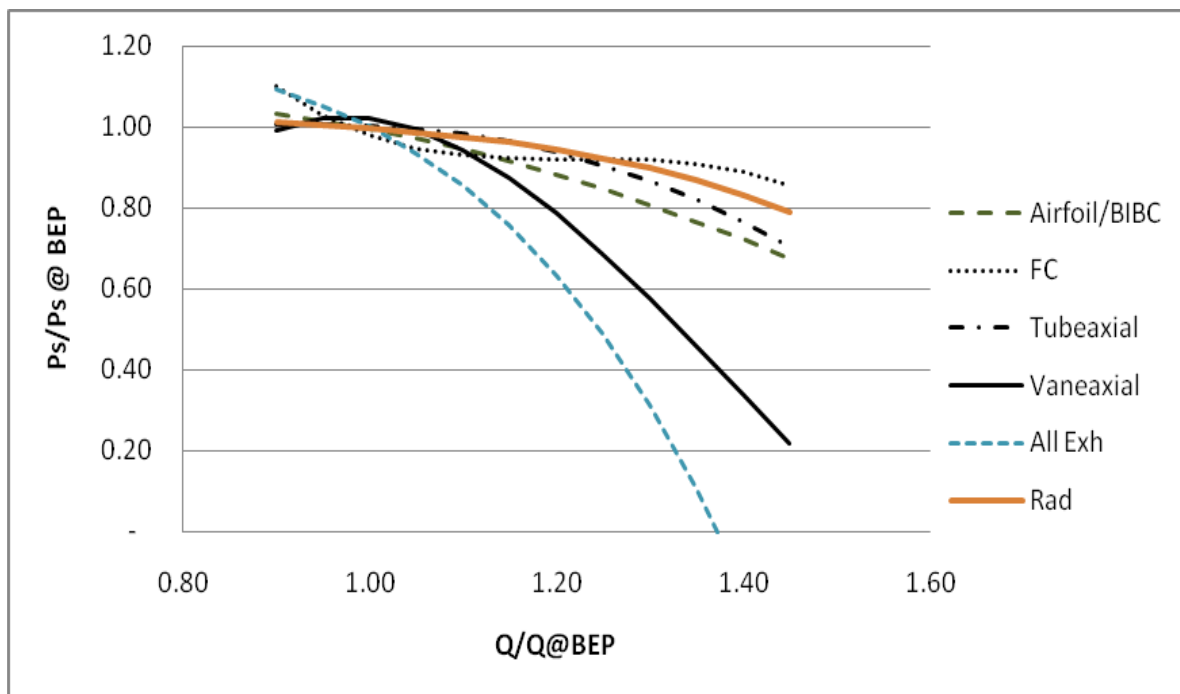
η_{BEP} = Fan efficiency @ BEP

η_{norm} = Normalized fan efficiency (from curves)

η_F = Fan efficiency @ operating conditions

- **Fan Flow Range Restrictions**

Fans are typically designed to operate at flows exceeding the flow at peak output pressure. This is done to avoid potentially unstable fan operation. This problem is more pronounced in axial fans and in some centrifugal fans. In order to avoid this potential problem the software will only estimate fan performance at flows falling within the stable operating region (i.e., flows exceeding the flow at the maximum static pressure).



**Figure 29-1. Generic Fan Total Static Pressure Curves
(normalized based on Flow and Total Static Pressure at the Best Efficiency Point (BEP))**

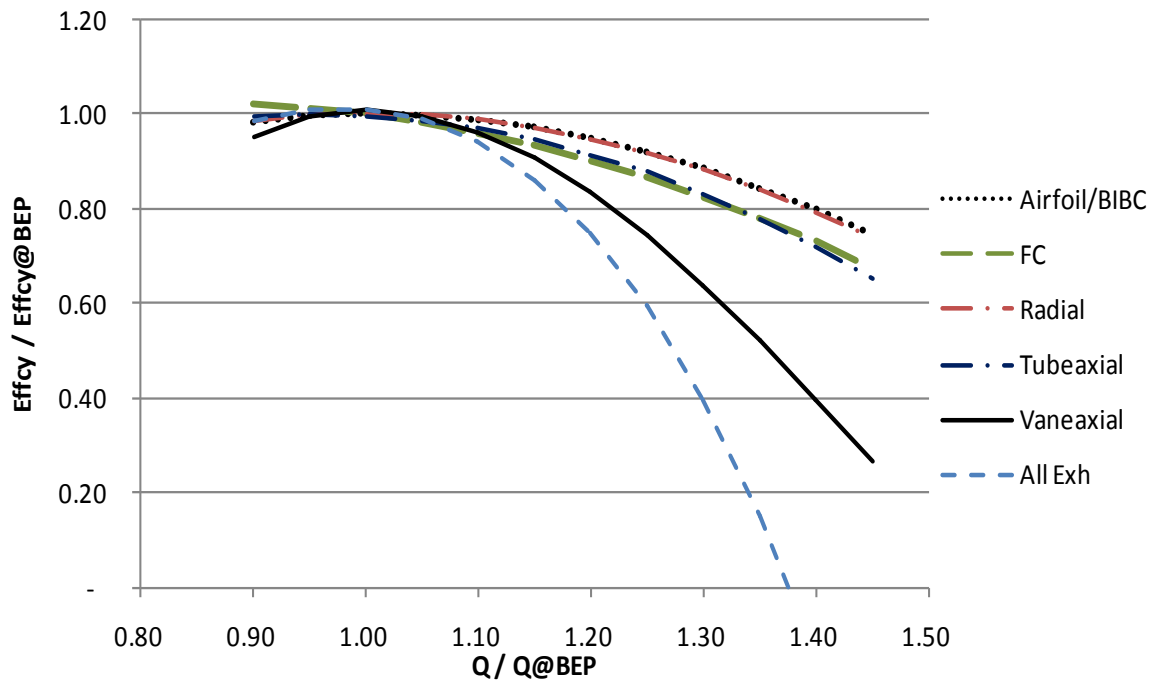


Figure 29-2. Generic Fan Static Efficiency Curves
(normalized based on Flow, Efficiency at the Best Efficiency Point (BEP))

Compressibility Factor

The impact of the compressibility of air is considered negligibly small (less than 1% error) at fan pressures less than 10 "Wg (e.g., compressibility factor, K_p , in Equation 4 is set to 1.0). The potential error associated with compressibility remains below 3% for pressures as high as 35" Wg. It is unlikely that applications involving fans (as opposed to blowers) will involve pressures above this value and as such the software does not account for compressibility effects.

- **Estimated Fan Speed and Drive Efficiency (if applicable)**

If a belt drive has been specified then the software will calculate and use a drive efficiency based on drive size and type specified by the user (see Table 29-11).

Table 29-10: Belt Drive Efficiency⁴

Drive Type	Drive Size, HP	Efficiency, %
Standard V-Belt Drive	5 – 100	$93.29 * (HP_{motor})^{0.00619}$
	>100	96
Rubber Chain Drive	Any size	98

⁴ See AMCA 203-90, Field Performance Measurement of Fan Systems, Annex L. Estimated Belt Drive Loss. *Belt drives are assumed to be in good working condition.*

Matching System Requirements and Fan Performance

In order to estimate the fan baseline energy use it is necessary to calculate the fan efficiency (η_F) at the operating point conditions. This is accomplished by identifying where the fan is operating on its characteristic performance curve. The method used to identify this point varies depending on the control that is utilized. The software provides for three fan control methods: outlet dampers, on/off control and inlet vanes. Exhaust fans represent a special case of unducted fan applications where “inlet vane control” is not a baseline control option (VFD is applicable only as a measure). Figure 29-3 illustrates the relationships between the various control methods with additional explanation in the following paragraphs.

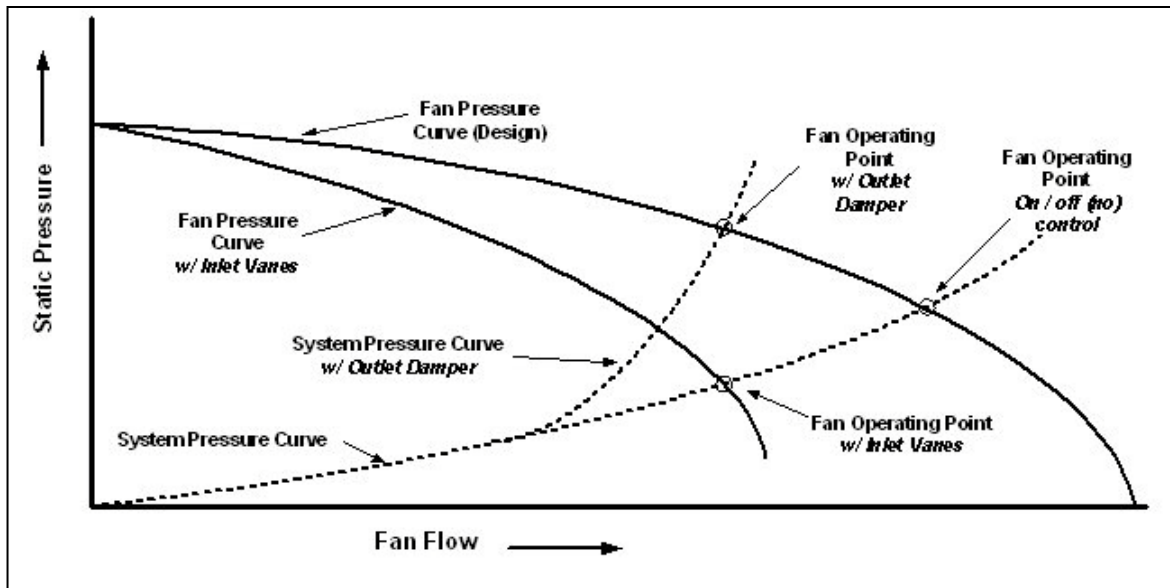


Figure 29-3. Fan Operating Point Examples (not to scale)

- **Outlet Dampers**

In the case of outlet dampers, a damper located on the fan outlet will increase or decrease the system pressure requirement causing fan flow to decrease or increase (moving to the left or right on the fan performance curve) until the fan flow matches the system requirement. For fan systems that use outlet dampers the fan flow is equal to the system flow while the fan total static pressure will be higher than the system pressure requirement. The shape and location of the fan performance curves are unaffected by outlet dampers so fan performance is estimated using the previously discussed generic performance curves and the operating point flow value (user input). See Figure 29-3 for examples of this and other control operating points.

- **On/off control (no control)**

When there is no control damper the fan flow will only be limited by the system pressure requirements (i.e., fan pressure and flow operating point is equal to system pressure and flow requirement). This situation is represented by the intersection of the system pressure and fan total static pressure performance curves (see Figure 29-3). The estimation software must therefore locate this intersection. Site/system information, provided by the user for system flow and pressure (at design flow) is used to generate an expression⁵ and associated curve for system pressure. Equating and solving the fan total static pressure and system pressure expressions for flow yields the intersection of the two expressions.

Exhaust Fans -- Note that in the case of unducted exhaust fans the system pressure and flow requirements are assumed to match the fan discharge pressure at the designated operating point flow. The process of identifying the intersection of the fan and system pressure curves is not therefore required for exhaust fan applications.

- **Inlet Vanes (centrifugal fan types)**

Inlet vanes induce swirl into the inlet of a centrifugal fan, this swirl is normally in same direction as the rotation of the fan impeller and results in reduced fan output. Unlike outlet damper and on/off control, inlet vane controls alter the fan performance characteristic so it is not possible to use the generic fan characteristic curves to estimate fan performance.

Using data from a blower / damper manufacturer, a curve (see Figure 29-4) and associated relationship was generated for fan % of full load power and of % of fan full flow⁶. The software utilizes this relationship along with the fan full-load power to establish the fan BHP at each operating point flow.

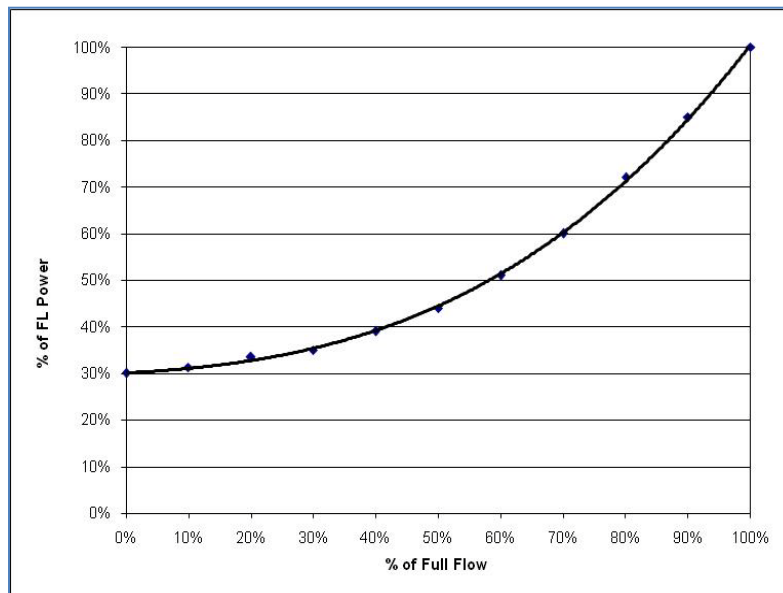


Figure 29-4. Inlet Vane Performance Characteristic

⁵ System pressure is assumed to follow a simple quadratic expression of the form: $P = mQ^2$, where m is calculated using the design flow and pressure information provided by the user.

⁶ Source: NYB Engineering Letter 11 -- Selection Criteria for Dampers (www.nyb.com)

Drive Motor Efficiency & Completion of Baseline kW Calculation

Once the fan efficiency (for either On/off control or Outlet Damper control types) is determined it is possible to estimate the electric motor load using the following expression:

$$BHP_{Motor} = K_p * \frac{Q_F * P_S * \rho_{in}}{6349.6 * \eta_F * \eta_d * \rho_{std}} \quad (\text{Equation 5a})$$

When an inlet vane control is indicated then the software estimates the fan BHP directly using the inlet vane performance characteristic and the electric motor load is subsequently estimated using the following expression:

$$BHP_{Motor} = \frac{BHP_F}{\eta_d} \quad (\text{Equation 5b})$$

Having established the drive motor load, electric motor efficiency (η_e) is calculated using existing CCT functions (based on DOE MotorMaster). Substituting motor efficiency into the following expression yields the fan kW at this operating point.

$$kW_{FAN} = 0.7457 * \frac{BHP_{Motor}}{\eta_e} \quad (\text{Equation 6})$$

Baseline energy use for each operating mode is the product of the fan kW and the total annual operating hours that have been entered for the operating mode. The estimation software repeats the process of locating the fan operating point, estimating fan, drive and motor efficiency and calculating the baseline energy usage for each of the operating modes (up to eight) specified by the user. The sum of the energy use of all of the operating modes is equal to the annual baseline energy use of the fan.

Calculation of the baseline peak electric demand is accomplished in one of two ways. If only annual operating mode information has been entered then the software calculates the weighted average demand for all operating modes that the user has previously designated as having on-peak operation. This is the value reported as the average demand of the proposed system.

However if daily/monthly data has been entered then the software will identify the DEER three-day peak period for the specific city/location and will only utilize information (operating hours and kWh usage) from the month or months of operating data that include this period when calculating the weighted average electric demand.

Note that in the event that the software is unable to locate the estimated fan operating point (intersection of fan and system operating curves) or the estimated operating point is deemed invalid (flow is negative or exceeds system maximum flow) then the calculation will be aborted, and an error window will appear indicating that the specified fan appears incompatible with system requirements and will suggest a possible cause.

Efficiency Measure – Fan Replacement

The estimation software calculates the savings associated with replacement of an existing fan with a fan of the same or different type, having a higher efficiency. If the user provided fan flow information for each operating point then the energy use of the new fan is calculated in the same manner as previously described for baseline energy use. The difference being that the new fan information (fan type, fan efficiency, etc.) is substituted for the existing fan information.

The software provides for input of either a baseline fan flow or fan kW value for each operating point. In the event that the user provided baseline kW values in lieu of fan flow then it is first necessary to estimate the fan flow for each operating point before the performance of the replacement fan can be calculated.

Efficiency Measure – Fan and Drive Motor Replacement

If both the fan and motor are being replaced the estimation software calculates the savings associated with replacement of the existing fan drive motor with a motor having a higher efficiency. The energy use of the new motor is calculated in the same manner as previously described for baseline energy use. The exception being that the new motor efficiency is substituted for the existing motor efficiency.

Unintentional fan speed changes can significantly impact fan energy use. A common problem with motor replacement involves an inadvertent fan speed increase resulting in higher fan energy use, and reduced savings. For this reason, if a VFD has not been specified, the software will warn the user if the full load speed for the new motor is higher than the motor that it replaces.

Efficiency Measure – Rubber Chain Drive (or equivalent) Installation

The electric demand of a fan operating with an improved belt drive is calculated using the same basic expression as the baseline fan calculation with the exception that the new drive efficiency value is used in the drive efficiency term (η_d) in the following equation. Note that the software does not provide for direct user input of belt drive efficiency but instead uses the 98% value noted previously in Table 29-10 for Rubber Chain drives.

$$kW_{FAN} = 0.7457 * K_p * \frac{Q_F * P_s * \rho_{in}}{6349.6 * \eta_F * \eta_d * \eta_e * \rho_{std}} \quad (\text{Equation 7})$$

where:

Q_F	= Fan flow (CFM)
P_s	= Fan static discharge pressure (inches Wg)
K_p	= Compressibility Factor (initially set to 1.0)
ρ_{in}	= Air density corrected for fan inlet conditions
ρ_{std}	= Air density at standard conditions (0.075 lbs/ft ³)
η_F	= Fan efficiency @ operating conditions
η_e	= Electric drive motor efficiency
η_d	= Belt Drive efficiency

Efficiency Measure – Variable Frequency Drive (VFD) Installation

The electric demand of a fan operating under VFD control is calculated using the same basic expression as the expression used for Rubber Chain Drive installation (see Equation 7) with the exception that the VFD efficiency (η_{VFD}) is included next to the drive efficiency term (η_d) in the denominator. However since both fan and VFD performance varies with speed it not possible to utilize this expression without first identifying the VFD (fan) operating speed.

Estimating VFD Operating Speed

The fan affinity laws state that with a constant impeller diameter and varying fan speed the following ratios are maintained without any change to fan efficiency.

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2} \quad (\text{Equation 8})$$

$$\frac{P_1}{P_2} = \left(\frac{n_1}{n_2} \right)^2 = \left(\frac{Q_1}{Q_2} \right)^2 \quad (\text{Equation 9})$$

where:

Q = Fan flow (CFM)
 P = Fan total static pressure ("Wg)
 n = Fan speed (RPM)

In our case we set P_2 and Q_2 equal to the system pressure (P_{OPMode}) and system flow at the specified operating point (Q_{OPMode}), respectively while P_1 and Q_1 represent the pressure and flow of the existing fan when operating at the same efficiency. Substituting and solving for P_1 yields:

$$P_1 = P_{OPMode} * \left(\frac{Q_1}{Q_{OPMode}} \right)^2 \quad (\text{Equation 10})$$

To calculate the intermediate flow term (Q_1) we equate the above expression to the expression representing the existing fan pressure curve (polynomial expression based on generic curve shape) and solve for the fan flow (Q_1). Having solved for Q_1 the affinity laws are used to estimate the VFD operating speed (n_{VFD}):

$$n_{VSD} = n_{Motor} * \frac{Q_{OPMode}}{Q_1} \quad (\text{Equation 11})$$

Note that the software checks the estimated VFD operating speed against the minimum speed entered by the user (see Table 29-8). If the estimated operating speed is less than the stated minimum:

- The calculation will be paused,
- An error window will appear indicating that "Operating Mode X requires VFD operation below the minimum allowable range."
- The software will ask if the user would like to continue the calculations using the minimum VFD operating speed.
- If yes then the calculations will proceed with the software adding a note to the reporting describing the action that was taken.
- If no, then the calculations will be aborted.

Estimating Fan Efficiency

Fan efficiency at each operating point is calculated using the same process as the baseline calculations, only in this case the intermediate flow, Q_1 is used.

Estimating VFD Efficiency

The software uses the VFD operating speed with the full load VFD efficiency (user input) to estimate VFD efficiency. The relationship between VFD speed and efficiency utilized by the software is illustrated in Figure 29-5. Once the VFD efficiency has been calculated it is then possible to calculate the electric demand of the VFD equipped fan using Equation 7.

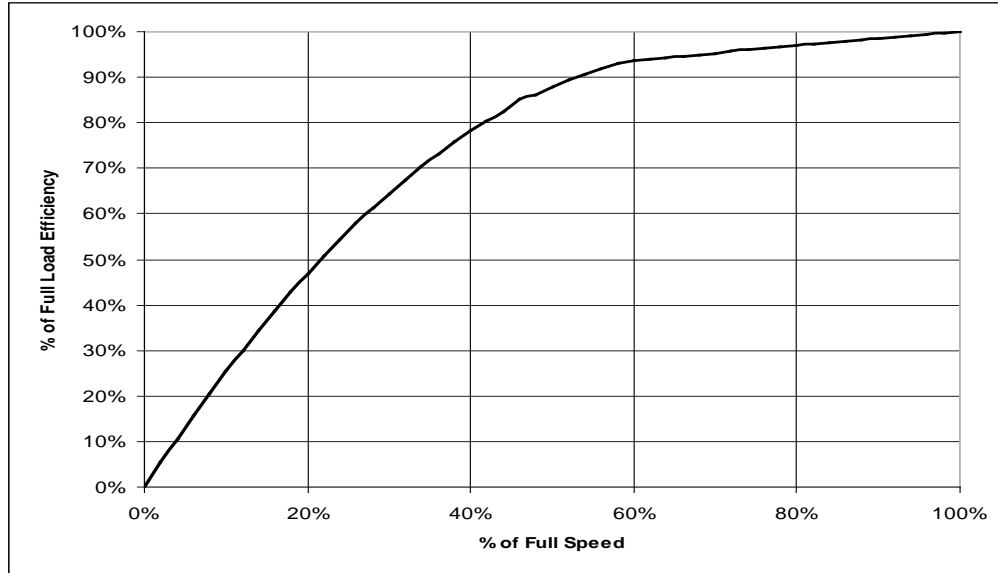


Figure 29-5. Generic Variable Frequency Drive Performance
(derived from EPRI TR-101140 Adjustable Speed Drives Application Guide)

Drive Motor Efficiency & Completion of Proposed kW Calculation

Once the fan efficiency (for either On/off control or Outlet Damper control types) is determined it is possible to estimate the electric motor load using the following expression:

$$BHP_{Motor} = K_p * \frac{Q_F * P_S * \rho_{in}}{6349.6 * \eta_F * \eta_d * \rho_{std}} \quad (\text{Equation 12a})$$

When an inlet vane control is indicated then the software estimates the fan BHP directly using the inlet vane performance characteristic and the electric motor load is subsequently estimated using the following expression:

$$BHP_{Motor} = \frac{BHP_F}{\eta_d} \quad (\text{Equation 12b})$$

Having established the drive motor load, electric motor efficiency (η_e) is calculated using existing CCT functions (based on DOE MotorMaster). Substituting motor efficiency into the following expression yields the fan kW at this operating point.

$$kW_{FAN} = 0.7457 * \frac{BHP_{Motor}}{\eta_e} \quad (\text{Equation 13})$$

The proposed energy use for each operating mode is the product of the fan kW and the total annual operating hours that have been entered for the operating mode. The estimation software repeats the process of locating the fan operating point, estimating fan, drive and motor efficiency and calculating the proposed energy usage for each of the operating modes (up to eight) specified by the user. The sum of the energy use of all of the operating modes is equal to the annual energy use of the proposed fan.

Calculation of peak electric demand for the proposed equipment is accomplished in one of two ways. If only annual operating mode information has been entered then the software calculates the weighted average demand for all operating modes that the user has previously designated as having on-peak operation. This is the value reported as the average demand of the proposed system. However if daily/monthly data has been entered then the software will identify the DEER three-day peak period for the specific city/location and will only utilize information (operating hours and kWh usage) from the month or months of operating data that include this period when calculating the weighted average electric demand.

2.2.30 Other - High Efficiency Motors

2.2.30.1 Description

This tool calculates the energy and demand savings resulting from the installation of High Efficiency Motors. It covers replacement (replace on burnout), retrofit (early retirement), increased load, and new installation measures.

2.2.30.2 Appropriate Use of the Tool – Program Policy

The 2007 Energy Independence and Security Act established the minimum efficiency standards for motors. The motors that are affected by this change and covered by this tool are divided into two groups, Subtype I (NEMA Table 12-12 and 12-11) and Subtype II (NEMA Table 12-11).

2.2.30.3 Applicable Types of Equipment

This tool covers Subtype I and Subtype II motors. Subtype I are general purpose motors ranging from 1-200 Hp and either NEMA Design A or B. These motors must meet NEMA Table 12-12 (otherwise known as NEMA Premium Efficiency). Subtype I motors also include motors that are general purpose, ranging from 201-500 Hp and are NEMA Design B. These motors must meet NEMA Table 12-11 (otherwise known as EPart Efficiency). Subtype II motors range from 1-200Hp and included Design C motors and 8-pole motors. These motors were not previously covered by EPart 1992 but now they must meet NEMA Table 12-11.

The efficiency values shown in *Appendix C. Minimum Equipment Efficiency Standards* are used to determine the baseline motor energy consumption. Motors installed under the Statewide Customized Offering must be more efficient than the standards shown in order to be eligible for incentives.

2.2.30.4 Measure Tool Use

2.2.30.4.1 Equipment Sizes or Capacities Covered by the Tool

This tool covers motors rated from 1 to 500 horsepower. Multiple motors with different horsepower ratings should be treated as separate measures.

2.2.30.4.2 Inputs

Proposed, Existing Motor and usage information are entered into the input sheets described below. At a minimum, a spot measurement is required in order to determine average motor loading.

Table 30-1: Equipment Description

Description	
Location	Type the motor location – for reference only.
Function	Type the motor function – for reference only.
Designation	Type the motor designation – for reference only.
Existing Motor Parameters	

Duty Cycle (%)	Percent of time the motor is cycled ON during operating hours. (This will be used along with the Hours/Day, Days/Week, and Weeks/Year inputs to find Total Hours/Year.)
Hours/day	Hours per day motor is operated.
Days/Week	Days per week motor is operated.
Weeks/Year	Weeks per year motor is operated.
Load Type	For reference only. Pull-down menu with "Centrif. Fan", "Centrif. Pump", "Fan, Other", "Pump, Other", "Compressor", "Extruder", "Crush/Mill", "Mix/blend", and "General" options.
Quantity	Number of existing motors.
Year Manufactured	Enter the year that the existing motor was manufactured.
Rewound?	Select "yes" if the existing motor has been rewound.
Year Rewound	If rewound, enter the year that the existing motor was rewound.
Proposed Motor Parameters	
Duty Cycle (%)	Percent of time the motor will be cycled ON during operating hours. (This will be used along with the Hours/Day, Days/Week, and Weeks/Year inputs to find Total Hours/Year.)
Hours/day	Hours per day motor will be operated.
Days/Week	Days per week motor will be operated.
Weeks/Year	Weeks per year motor will be operated.
Quantity	Number of proposed motors.
Motor Nameplate Data	
Manufacturer	Type the motor manufacturer – for reference only.
Model	Type the motor model – for reference only.
Serial #	Type the motor serial # – for reference only.
HP(size)	The horsepower of the existing motor. Pull-down menu with options from 1 HP to 500 HP. Used to partially determine baseline efficiency.
FL RPM	Enter the Full Load RPM of the motor. Used to partially determine baseline efficiency.
Service Factor	Enter the motor service factor. Typically 1.15 (can handle a 15% motor overload). Found on nameplate.
Volts	Pull-down menu with 208, 230, or 460 Volt options.
FL AMPS	Full load Amps. (FLA from nameplate)
FL Power Factor (%)	Enter the Full Load Power Factor.
FL Efficiency	Enter the full load efficiency. Not necessary for early retirement. Automatically filled in if a letter code is selected.
Letter Code	Choose an efficiency letter code from the pull down menu. Not necessary if FL Efficiency input was filled in. Not necessary for early retirement.

NEMA Class Design	Choose NEMA Class A, B, or C. Used to partially determine baseline efficiency.
ENCLOSURE	Choose open drip-proof (ODP), or totally enclosed fan-cooled (TEFC) or explosion-proof (TXPL) motor enclosure. Used to partially determine baseline efficiency.
FRAME	Type in Frame Size – for reference only.
Motor Field Measurements	
Existing motor power measurements - These are critical for establishing brake horsepower (BHP, motor load). The preferred method is to measure power in kW, using a true RMS power meter. Next best would be to measure voltage, current, and power factor with a true RMS meter. At a minimum, both the voltage and current must be measured. Ensure that all voltages are measured line-to-line and measurements are taken under normal motor operation conditions. If power factor is not measured, then the software will estimate a power factor. The measured values are used to establish the load on the existing motor.	
Date	Date measured – for reference only.
Time	Time measured – for reference only.
Normal Load?	Select “Yes” if measured at a normal load.
Power - kW	Enter the measured kW. The remaining inputs (power factor, volts, amps) are only necessary if kW was not measured.
Power Factor (%)	Enter the power factor, if measured. Otherwise the software will estimate a power factor based on the load and the Full Load power factor entered above. Typical motor power factors range from 70% to 90%, where partly loaded or smaller motors have the lowest power factors, and fully loaded larger motors have the highest power factors.
Volts - Phase ab	Enter the measured line-to-line voltage.
Volts - Phase bc	Enter the measured line-to-line voltage.
Volts - Phase ca	Enter the measured line-to-line voltage.
Amps - Phase a	Enter the measured current (Amps).
Amps - Phase b	Enter the measured current (Amps).
Amps - Phase c	Enter the measured current (Amps).

2.2.30.4.3 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 30-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.30.4.4 Output

Once all necessary input information has been gathered, the High Efficiency Motor Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 30-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.

1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.31 Other - Injection Molding Machines

2.2.31.1 Description

Standard injection molding machines use electric motor-driven hydraulic pumps that pressurize the hydraulic rams that compress plastic pellets and inject them into the desired mold. During the machine's cycle, there are many instances when the hydraulic force is not required, and the fluid is bypassed through a throttling valve. High efficiency hydraulic units avoid this energy loss through the use of variable speed drives or variable volume configurations. The most efficient machines do not use hydraulics, but rather use high torque servo motors to drive the ram directly. The high efficiency hydraulic systems (variable volume & variable speed) generally save between 30% and 60% of motor energy usage, while the all electric units save between 50% and 80% of the machines total energy usage.

Several machines were evaluated, measuring their electrical use. The approach evaluates the specific energy usage of machines based on a mass throughput basis and the required energy use. An average specific energy use value before and after installation of the energy efficient equipment is determined and then used to estimate the annual savings.

The average specific energy usage for injection molding machines was determined through the field measurement of approximately fifty machines. The first step in the evaluation process was to measure the energy use of a machine, weigh the parts produced, and determine the specific energy usage (kWh/kg). Electrical measurements were recorded every second for at least 15 minutes to determine the average electrical demand. Energy usage for the parts produced was determined by multiplying the average demand by the total cycle time to produce the parts. This process was performed for a wide variety of parts and machine types. In several cases, a comparison was made of two machine types producing the identical part. Five separate types of machines were identified. These were old standard hydraulic, standard hydraulic, variable volume, variable speed, and all electric. The preliminary results of this evaluation are shown below:

Table 31-1: Specific Energy Usage

Machine Type	Specific Energy Usage
Standard hydraulic	0.93 kWh/kg
Variable-volume hydraulic	0.53 kWh/kg
Variable-speed hydraulic	0.53 kWh/kg
All-electric	0.20 kWh/kg

These results were evaluated to determine average values for each type of machine. Using these values, the energy savings per kilogram of throughput (difference between old and new specific energy use) can be multiplied by the annual production (in kg) to arrive at an annual savings value.

2.2.31.2 Appropriate Use of the Tool – Program Policy

The High-Efficiency Injection Molder tool can be used to estimate energy savings for high-efficiency injection molding machines.

2.2.31.3 Applicable Types of Equipment – Program Policy

The tool covers the following four types of injection molding machines: standard hydraulic, variable volume, variable speed drive, and all electric. Standard hydraulic machines may only be input as existing equipment. Proposed equipment must be one of the three more efficient types. Standard hydraulic machines are an option for baseline equipment because these machines are still sold by various manufacturers, as listed in Appendix B: Fixed Displacement Injection Molder Manufacturers. Old standard hydraulic machines are not accepted as baseline because they are considered below the average industry standard. Thus, if the customer is changing an old standard hydraulic machine to any of the three high efficiency machines, the baseline will consist of a standard hydraulic.

2.2.31.4 Equipment Sizes or Capacities Covered by the Tool

All capacities are covered by the tool. However, energy savings are reduced by 20% for machines with hourly production less than 0.275 pounds of plastic per ton of capacity. These low-production machines typically produce small, intricate parts requiring longer hold times, thus reducing the energy savings.

2.2.31.5 Measure Tool Use

2.2.31.5.1 Inputs

Prior to selecting the High-Efficiency Injection Molders measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load), or New Installation. Once the High-Efficiency Injection Molders measure is selected, the user is then directed to enter the various inputs as described in the following table. The following set of inputs are required for both the existing and proposed cases if a Retrofit project was specified, while inputs are only required for the proposed case if a New Installation was specified.

Table 31-2: Tool Inputs

Name	Description
Manufacturer	Equipment manufacturer. Found on nameplate or in specifications.
Model Number	Equipment model number. Found on nameplate or in specifications.
Serial Number	Equipment serial number. Found on nameplate.
Quantity of Machine	Number of injection molders included in retrofit.
Type of Machine	Pull-down menu with “Standard Hydraulic”, “Variable Volume”, “Variable Speed Drive”, and “All Electric” options. (“Standard Hydraulic” option is only available for the existing case.) Used to estimate specific energy usage.
Machine Capacity (tons)	Rated clamping force. Found on nameplate or in specifications.

Average Production Rate (lb/hr)	Average pounds of production per hour per machine. Must take into account variation in parts produced. Obtained through production records or measurement.
Annual Operating Hours	Must be the best estimate of the actual number of hours the machine is producing parts in one year.

2.2.31.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 31-3: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.31.5.3 Output

Once all necessary input information has been gathered, the High Injection Molder Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 31-4: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.32 Other - Low Solar Heat Gain Coefficient Windows

2.2.32.1 Description

This tool is designed to compute the savings and incentive achieved from the installation of windows that have a low solar heat gain coefficient (SHGC). Low SHGC windows save energy by reducing the transmission of heat from the outside to the inside of a structure during the hotter months. This results in a reduction in cooling load. In addition, during the colder months, heat loss is reduced due to an increase in the U-factor of the window. Heating energy is offset to some extent based on reduced transmission of solar heat during colder periods. The 2012 CCT calculates savings using the Engage software for a measure of this type. The Engage software is a stand-alone, DOE2 based modeling program.

2.2.32.2 Appropriate Use of the Tool

This CCT is utilized for the following low SHGC measures:

- ☐ The retrofit of existing windows.
- ☐ The addition of glazing or film to existing windows.

2.2.32.3 Applicable Types of Equipment

Only retrofits are covered by this tool. New installations or increased load projects are not covered. Incentive criteria are limited to Title 24 Non-Residential Prescriptive Envelop Criteria. The criteria varies between climate zones and building types. Engage will automatically select appropriate program baseline inputs for the windows based on the defined building type and climate zone on Screen 1 of the Engage software.

2.2.32.4 Measure Tool Use

2.2.32.4.1 Inputs

Prior to selecting the actual Low Solar Heat Gain Coefficient Windows measure, the user is required to specify site information which is used to define the building for savings calculations on Sheet 1, Basic Specifications. The critical inputs are defined in the table below.

Table 32-1: Tool Inputs Sheet 1 of 4, Building Specifications

Tool Input	Description / Purpose
Location	Choose site location based on zip code or CTZ (California Thermal Zone - CEC climate zone). In the adjacent menu select the appropriate Zip Code or CTZ. (refer to Appendix D in the Customized Offering Procedures Manual for detailed CTZ descriptions).
Building Type	Choose the building type most appropriate for the project site. Select a "predefined" building configuration from the list of "DEER prototypical" buildings (refer to Appendix D in the Customized Offering Procedures Manual for detailed building descriptions).
Vintage	Choose the year range in which the building was constructed.

HVAC System(s)	Choose the system type that best fits the type found on the project site. One or more typical HVAC System will be available based on the chosen Building Type.
Allow HVAC System Downsizing	If the measure(s) you include in the analysis result in reduced cooling or heating loads (many do), selecting this option allows the CCT to downsize HVAC systems. This option is only enabled for a building vintage after 2005.
Total Building Area	Enter the total conditioned and unconditioned primary building area in square feet. The conditioned area is defined on screen 4 in the "Area Served" input.
Secondary Building Area	Enter the secondary building area in square feet (if applicable). The conditioned area is defined on screen 4. applicable to your Building Type.
Number of Floors	Enter the number of floors of primary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.
Secondary Number of Floors	Enter the number of floors of secondary building space. The title of this input may change based on the chosen Building Type. This option may be disabled if it is not applicable to your Building Type.

Sheet 2 (Table 32-2) allows users to define seasons and observed holidays for the project site. By clicking the 'Observed Holidays' button, the user will be able to select or deselect holidays as appropriate. Seasons will allow the user to define multiple site schedules. By default, a single season is selected assuming typical use based on the building type chosen on sheet 1. If multiple seasons are needed to more accurately reflect the operation of the project site, the user can select up to (3) seasons and up to (3) separate time periods during which the season type will occur. Please note, seasons only allow for multiple schedules and not chiller operation. If multiple chillers of varying sizes are involved in the project, a more detailed analysis method may be necessary.

Table 32-2: Tool Inputs Sheet 2 of 4, Building Seasons

Tool Input	Description / Purpose
Seasonality Pattern	Choose a seasonal usage pattern. One or more typical usage patterns will be available based on the previously chosen Building Type.
Number of Seasons	Select one, two or three.
Season #1	Insert an appropriate label for the season.

Season #2	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Season #3	Insert an appropriate label for the season, from the pull-down menu choose an appropriate number of periods when the season occurs and from the pull-down menus define the periods for the season.
Observed Holidays	Click this button and insert check marks next to the observed holidays.

Sheet 3 will allow users to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season.

Table 32-3: Tool Inputs Sheet 3 of 4 Building Seasons

Tool Input	Description / Purpose
Select Active Building Shell	Choose the appropriate shell. The number of shells available in the drop down list is based on the previously chosen Building Type.
Seasons – Weekly Schedule	Users are allowed to define operation for up to (3) defined seasons. Only one opening time and one closing time can be defined per day type, per season. From the pull-down menu, choose opening and closing hours for each day of the week and holidays.

Once the appropriate selections are made, the user must define the values for the existing and proposed windows.

Existing Windows and Proposed Windows

The Existing and Proposed Window types can be selected as NFRC rated or Glass Manufacturer Data. The NFRC rated selection automatically defines Ufactor and SHGC per the National Fenestration Rating Council (NFRC) which are consistent with Title 24 requirements for use of NFRC rated glass. Glass Manufacturer Data allows the user to define customized values which may be obtained from the glass manufacturer. The appropriate boxes may also be checked or unchecked to define the appropriate window orientation. Title 24 permits higher solar transmission glass on north facing windows.

Program Baseline Windows

The user should note that the eligible program incentive is calculated using the “Program Baseline Windows” definition. The types available for selection contain pre-defined values for all pertinent factors and coefficients for the baseline windows. Window orientation for “Program Baseline Windows” is automatically defined based on “Existing Window” inputs. The user should note that changing orientation may result in the change of baseline SHGC and Ufactor in the case that a window does not meet Title 24 requirements of NFRC ratings.

Total Window Area

The user must first select an input method which can be either % Gross Wall Area (floor to floor) or Total Facility Window Area (SqFt). If the % Gross Wall area is selected, the user can specify the % glass, which will be based on the total wall area. The total wall area is defined by the building type selection in Screen 1 – Basic Specifications. Engage will then automatically calculate the appropriate glass area based on the provided inputs. Total Facility Window Area (SqFt) indicates that the total glass area will be specified by the user. Engage will then use this information to automatically specify the appropriate area on the respective building orientations.

Replacement Window Areas

Under either option, the user can manually override the calculated replacement window areas specified. The software will automatically assume the “Total Window Area” described will be replaced in the proposed measure. If these areas are not equivalent, the user should manually input the total window area to be replaced per window orientation.

The Windows can be defined by either the dimensions or the total Window area. Defining the lights by dimensions assumes the lights to be square or rectangular. If the lights do not fit these criteria, the user may elect to define the area by the total Window area in square feet by selecting the appropriate selection and entering the appropriate value.

Table 32-4: Tool Inputs Sheet 4 of 4 Building Measure Specifications

Name	Description / Purpose
Existing Windows to be Replaced	Enter up to 2 different existing window types for each cardinal point (North, South, East, and West). Enter the performance data source type (NFRC Rating, Glass Manufacturer) for each window type. Enter the rated U-Factor and Solar Heat Gain Coefficient (SHGC) for each window type.
Program Baseline Windows	Information will be calculated by the CCT
Proposed Windows	Enter up to 2 different proposed window types for each cardinal point (North, South, East, and West). Enter the performance data source type (NFRC Rating, Glass Manufacturer) for each window type. Enter the rated U-Factor and Solar Heat Gain Coefficient (SHGC) for each window type.
Total Window Area	Indicate the total window area using one of two methods (%Gross Wall Area [floor to floor], or Total Facility Window Area [Sq. Ft.]). Enter the actual percent glass.
Proposed Window Area	The CCT will initial distribute the window area by cardinal point using the DEER Prototypical building and the % glass input. The user has the ability to override each cardinal position for the applicable two different window types. The user must verify that the total glass area is accurate.

2.2.32.4.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 32-5: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.32.4.3 Output

Once all necessary input information has been gathered, the Low Solar Heat Gain Coefficient Windows Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 32-6: Building Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.33 Other - Professional Wet Cleaning Replacement

2.2.33.1 Description

This tool is designed to compute the Customized Offering savings and incentive achieved from converting a Perchloroethylene (Perc) dry cleaning system to a Professional Wet Cleaning process. This reduces the energy usage of clothes cleaning facilities, while reducing contaminants to the air. This measure may qualify for additional incentives through a local air quality management district.

New regulations and business pressures are pushing many clothes cleaners to consider switching from Perc dry cleaning systems to alternative cleaning systems. The two main pressures are coming from the South Coast Air Quality Management District and building landlords. One of the alternative cleaning systems, wet cleaning, has proven to save energy as compared to the standard Perc system.

When evaluating the energy efficiencies of different cleaning machines' subsystems, professional wet cleaning appears to be the most efficient cleaning system. Perc, Hydrocarbon, and GreenEarth (silicone) cleaning systems typically have the same machine subsystems (vapor recovery, refrigeration compressor, water tower circulation pump, and water tower fan) and should have similar electrical energy consumption levels. A CO₂ system has a large air compressor and may actually use more energy than the Perc machine.

2.2.33.2 Appropriate Use of the Tool –Program Policy

This measure is for the conversion of an existing dry cleaning (Perchloroethylene) facility to a professional wet cleaning facility. This measure is only for converting to a professional wet cleaning process and does not include CO₂, Hydrocarbon, or GreenEarth (silicone) systems. This estimation tool is applicable only to professional cleaning facilities with a monthly average energy use of less than or equal to 4,000 kWh.

2.2.33.3 Measure Tool Use

2.2.33.3.1 Inputs

Table 33-1: Inputs:

Input Name	Description / Purpose
Average Monthly kWh	Enter average monthly energy use from utility bills
Average Monthly kW	Enter average monthly demand from utility bills

2.2.33.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 33-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.33.3.3 Output

Once all necessary input information has been gathered, the Professional Wet Cleaning Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 33-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.

1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.34 Other - Pulse Cooling for Injection Molding Machines

2.2.34.1 Description

This tool estimates the savings achievable by installing Pulse Cooling retrofit units in Injection Molding Machines. This allows the removal of the thermolator units, as the pulse-cooling unit makes the thermolators unnecessary.

Injection molders inject molten plastic into a set mold, and then release the final product when it is sufficiently cooled. One conventional process to cool the plastic in the mold involves a constant flow chilled water system, which continuously cools the mold. However, this system may result in overcooling the mold during certain periods in the molding cycle, which may result in a flawed product. To counteract this overcooling, thermolator units are often put in place to cycle hot fluid (either oil or water) through the mold when needed. The thermolator units typically consist of an electric thermolator heater and a circulation pump.

A pulse cooling unit consists of a controller, temperature probes, and water valves. This controller monitors the mold temperature and pulses chilled water to cool the mold only when needed to achieve a uniform product. At other times water flow is terminated, which avoids any overcooling of the mold. As overcooling is eliminated, the thermolator units often can be eliminated. The software tool calculates the electricity savings achieved by removing the thermolators and replacing them with a pulse cooling unit, which consumes a relatively small amount of electricity.

The CCT provides the energy savings related to the installation of a pulse cooling unit(s) in conjunction with the removal of thermolator heater unit(s).

2.2.34.2 Appropriate Use of the Tool

The Pulse Cooling for Injection Molders tool is used to estimate energy savings associated with the installation of a pulse cooling unit(s) in conjunction with the removal of thermolator heater unit(s).

This tool shall be used exclusively for pulse cooling equipment that is installed on injection molding machines. This tool should not be utilized when pulse-cooling is installed on other types of equipment.

2.2.34.3 Applicable Types of Equipment

The Pulse Cooling for Injection Molders tool applies to injection molding machines that are currently served by constant flow cooling and thermolator heating. The thermolators should be removed and pulse-cooling units installed.

2.2.34.4 Equipment Sizes or Capacities Covered by the Tool

The Pulse Cooling for Injection Molders tool applies to all injection molder machines currently being served by thermolator units. This tool is to be utilized to calculate the savings for the installation of a single pulse cooling unit serving a single injection molding machine. If the installation entails installing multiple pulse cooling units onto many injection molding machines, a separate tool run would have to be completed for each injection molding machine retrofit.

2.2.34.5 Measure Tool Use

2.2.34.5.1 Inputs

In the CCT 2012 software, prior to selecting the Pulse Cooling for Injection Molders measure, the user is required to specify whether the proposed project is one of the following: Retrofit (same load), Retrofit (increased load) or New Installation. This CCT only allows projects that are Retrofits (same load). Once the Pulse Cooling for Injection Molders measure is selected, the user is then directed to enter the various inputs as described in the following tables. The data in the tables appear in the same order as a user experiences while using the CCT.

Table 34-1: Injection Molding Machine Inputs

Name	Description / Purpose
Manufacturer	Manufacturer of the Injection Molding Machine (can be read from equipment nameplate).
Model #	Model number of the Injection Molding Machine (can be read from equipment nameplate).
Serial #	Serial number of the Injection Molding Machine (can be read from equipment nameplate).
No. of machines	Number of injection molders that will be retrofitted with pulse cooling devices.
Capacity per machine (tons)	Capacity (in tons) of injection molders (can be read from nameplate)
Manufacturer	Manufacturer of the Thermolator unit(s) to be removed (can be read from equipment nameplate).
Model #	Model # of the Thermolator unit(s) to be removed (can be read from equipment nameplate).
Serial #	Serial # of the Thermolator unit(s) to be removed (can be read from equipment nameplate).
Thermolator	Thermolator unit inputs (below)
No. of Thermolators	No. of thermolator units to be removed.
Type	Options of “oil” or “water”. Refers to the fluid type which is circulated by the thermolator units.
Input Power per Unit (kW)	The power input (kW) per thermolator unit. This can be either measured with a power meter or read from the thermolator unit. If multiple thermolators are removed, the input power per unit (kW) value entered shall be the average kW value of all the removed thermolators.
Power Estimation Method	Options of “Nameplate rating” and “Measured with Power Meter”. This refers to method used to determine input power (kW).

Annual Operating Hours	The number of annual operating hours of the thermolators. This may or may not match the injection molding runtime hours, as the thermolators may cycle on only when needed.
Circulation Pump	Circulation pump associated with thermolator units (below)
Number of Units	Number of circulation pumps serving the thermolator unit(s) input above.
Input Power per unit (numerical value input)	User inputs a numerical value, which represents either the nameplate rating (HP) or the measured power (kW) of the circulation pump. The user indicates either "kW" or "HP" in the input described directly below.
Input Power method (dropdown menu)	A drop down menu with options of "HP" or "kW". If the user measures the power with a meter, "kW" should be selected. If the user reads the pump's nameplate, "HP" should be selected.
Power Estimation Method	Software tool automatically fills this space in. If the user selects "kW" for input power method, this space reads "measure with power meter". If "HP" is selected, this space reads "Nameplate rating".
Manufacturer	Manufacturer of Pulse Cooling unit(s)
Model #	Model # of Pulse Cooling unit(s)
Serial #	Serial # of Pulse Cooling unit(s)

2.2.34.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 34-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)

Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.34.5.3 Output

Once all necessary input information has been gathered, the Pulse Cooling for Injection Molding Machine Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 34-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.35 Other - Pumping System Upgrades

2.2.35.1 Description

Pumping systems have been identified as one of the largest end-use applications in industrial settings. Under the sponsorship of the DOE Motor Challenge program, a computer program called PSAT (Pumping System Assessment Tool) was developed to assist end users in identifying and estimating pumping system energy saving opportunities. These opportunities include pump and/or motor replacement and resizing. This CCT utilizes some of the same methodologies as the PSAT tool but incorporates some basic assumptions to simplify its use. Savings associated with installation of variable speed drives (VSD) is also estimated; a measure that is not included in PSAT.

This tool currently estimates savings for the following measures, either singly or in combination:

- ☐ Direct replacement of a pump with one of higher efficiency,
- ☐ Direct replacement of an electric pump drive motor with one of higher efficiency, and
- ☐ Installation of a variable speed drive on the electric pump drive motor.

2.2.35.2 Appropriate Use of the Tool-Program Policy

The Pumping System Upgrade Tool can be used for pumping systems and measures having the characteristics shown in Table 35-1.

Table 35-1: Pump Savings Measure Features

Description	Measure Feature
# of Pumps	1
Pump Types	Centrifugal pumps with up to eight (8) stages and Positive Displacement
Pump Drive	Conventional and Variable Speed Drive (VSD)
Baseline Pump Efficiency	Generic pump efficiencies used in PSAT are displayed for information purposes. (see Appendix D)
Pump Operating Profile	Daily/Monthly or Total Annual Operating hours accommodated for up to eight (8) modes of operation.
Baseline Motor Efficiency	EPACT minimum used for baseline if existing drive is less efficient
TDH or Pressure Range	No restriction on Total Developed Head (TDH) for centrifugal pumps; 0 – 1000 psig discharge pressure range for positive displacement pumps

2.2.35.3 Applicable Types of Equipment

The pump types and controls accommodated in the estimation tool software parallel those covered in the PSAT software. The exception is that this software will also calculate savings associated with positive displacement pumps while the PSAT software deals exclusively with centrifugal pumps. Additionally the CCT covers VSD-equipped pump drives. Table 35-2 summarizes the pump and control options covered by the estimation software.

Table 35-2: Equipment Included in Pump Savings Estimation Software

System Type	Pump Type	Control Type
Centrifugal	End Suction Slurry End Suction Sewage End Suction Stock End Suction ANSI/API API Double Suction Double Suction Vertical Turbine Large End Suction Multi-stage Boiler Feed Axial Flow	Throttling, On / Off, Variable Speed Drive*
Positive Displacement	Positive Displacement	Recirculating/Bypass with constant discharge pressure, Variable Speed Drive*

* -- part of energy savings measure only

2.2.35.4 Measure Tool Use

2.2.35.4.1 Inputs

The Pumping System Upgrades measure is only available for use with retrofit (same load applications) and as such, does not appear as a menu selection unless the application has been specified as a Retrofit application. Once the Pumping System Upgrades measure is selected, the user is then directed to enter the various inputs as described in the following tables.

Table 35-3: Site/System Inputs

	Description / Purpose
Pump System Name	Identifies pump system involved / inspection purposes
Pump System Type	Select either Centrifugal or Positive Displacement (PD)
Pumping System City	Select city from pull down
Fluid Type	Fluid being pumped (i.e., water, etc.) / inspection purposes
Number of Pumps	1 is the only selection available
Fluid Temperature, °F	Nominal temperature of fluid being pumped / inspection purposes
Fluid Specific Gravity	Specific gravity of pumped fluid (i.e., water at 60 F equals 1.0)
System Design Flow, GPM	Maximum flow through system / establish system head curve

Total Developed Head or Supply Pressure (psig) @ Max Flow, Ft	Total developed head (TDH) at max system flow in Ft, or Supply Pressure (psig) for PD pump applications / establish system head curve
System Static Head, Ft	System head requirement at 0 flow (centrifugal pump system only) / establish system head curve

Table 35-4: Existing Pump Inputs

Input Name	Description / Purpose
Pump ID	Pump identifier / inspection purposes
Manufacturer	Pump manuf. / inspection purposes
Model	Pump model / inspection purposes
Serial Number	Pump SN / inspection purposes
Type	See Table 35-2 for menu selections
Control Type	See Table 35-2 for menu selections
Number of Stages	Number of impellers (1- 8) / calculate specific speed
Flow, GPM	Flow at pump design point / establish pump performance curve(s) <i>System design flow is displayed for comparison purposes</i>
Total Developed Head (TDH), Ft or, Discharge Pressure, psig	Pump TDH at design flow (centrifugal) or, Pump Discharge Pressure (PD pumps) / establish pump performance curve(s), <i>System design head is displayed for comparison purposes</i>
Efficiency, %	Pump efficiency at design flow / establish pump performance curve(s) <i>Average pump efficiency for this pump type & specific speed values (PSAT data) are displayed for comparison purposes</i>

Table 35-5: Existing Drive Motor Inputs

Input Name	Description / Purpose
Manufacturer	Motor manuf. / nameplate data
Model	Motor model / nameplate data
Size, HP	Motor size / nameplate data
Speed, RPM	Motor rotating speed / nameplate data
Enclosure Type	ODP or TEFC/TXPL
Service Rating	Motor service rating; 1.15 or 1.25
NEMA Nominal Efficiency (full load)	<i>EPACT min value is displayed for comparison purposes</i>

Table 35-6: Pump Operating Information Inputs

Input Name	Description/Purpose
<i>Pump Operating Information:</i>	
Number of Operating Modes	Number of different flow points that will be considered
Operating Hour Input	Yearly (total annual hours as input) or Daily (days/month as input) may be selected
<i>Operating Mode Information:</i>	
Operating Mode Number	Selections are 1 through the number of modes entered above.
Description	Name or description of operating mode (i.e., irrigating north fields, etc.)
On-Peak Operation?	Check this box if <i>any</i> pump operation during this operating mode occurs during the PG&E on-peak period.
Average Flow Rate, GPM	Pump flow rate during this operating mode

Table 35-7: Proposed Measure Inputs

Input Name	Description/Purpose
Pump Replacement/Modification	Check this box if the pump or pump drive motor will be replaced
Pump Replacement/Modification	Select from this pull-down if the Pump Replacement/Modification checkbox was selected. Selections include Motor Only, Pump Only, Pump and Motor
Variable Speed Drive (VSD) Installation	Check this box if a variable speed drive will be installed.
Full Load Efficiency, %	VSD efficiency at full load @ 100% speed / used to calculation overall efficiency
Minimum Operating Speed, %	VSD minimum operating speed / used to check for violation of min speed during operation

2.2.35.4.2 Additional Inputs

Additional input forms are provided to define the performance and operating characteristics of the proposed pump and associated drive motor. These forms / inputs (Sheets 7 & 8) will only appear if a pump replacement has been selected in the measure specification page (Sheet 6). These forms are identical to the forms used to enter existing pump (Sheet 2) and motor (Sheet 3) details as described previously in Tables 35-4 and 35-5.

2.2.35.4.3 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 35-8: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.35.4.4 Output

The following table describes the CCT outputs.

Table 35-9: Measure Energy Savings, Runtime Hours & Incentive

Name	Description / Purpose
Baseline Pump System, kW	Estimated maximum on-peak demand of the existing pump
Proposed Pump System, kW	Estimated maximum on-peak demand of the proposed pump
Baseline Pump System, kWh/yr	Estimated annual energy use of the existing pump
Proposed Pump System, kWh/yr	Estimated annual energy use of the proposed pump
Savings, kW	Estimated on-peak demand savings for measure (difference between baseline and proposed)
Savings, kWh/yr	Estimated annual energy savings for measure (difference between baseline and proposed)
Pump System Runtime	Annual operating hours for pumping system
Incentive (\$)	Estimated incentive amount based on 2012 program rates.

2.2.35.4.5 Tool Outputs – Optional Intermediate Calculation Report

The software can, if directed, create a text file containing the results of the various intermediate calculations. In this way a reviewer can more closely examine how the final results are generated. Under normal circumstances, creation and examination of this file would not be needed; so the software, by default, does not create the file. To generate the file the user must hold down the CTRL key while selecting the NEXT button from either the measure selection screen (Sheet 6) or the proposed pump input screen (Sheet 7). See Appendix B for additional information on the content and format of this output file.

2.2.35.5 Energy Savings Explanation

As with any efficiency measure the estimated savings is the difference between the baseline and proposed energy usage. In the case of pump related measures the calculations can be divided into two basic types; those dealing with positive displacement pumps (i.e., rotary, screw, lobe, vane and reciprocating) and those dealing with dynamic pumps (i.e., centrifugal, mixed flow and axial).

2.2.35.5.1 Baseline Energy Use -- Positive Displacement Pumps

The electric demand of a positive displacement pump is calculated using the following expression.

$$kW_{PUMP} = 0.7457 * \frac{Q_D * P_D}{1714 * \eta_p * \eta_e} \quad (\text{Equation 21-A})$$

where:

Q_D = Pump design flow (gpm)

P_D = Pump discharge pressure (psig)

η_p = Pump design efficiency

η_e = Drive motor efficiency

Note that pump discharge pressure has been substituted for pump total developed pressure under the assumption that pump suction pressure will be very small relative to discharge pressure.

We assume that the baseline positive displacement pump is operating with a recirculating type control that provides for a constant pump flow and discharge pressure when driven by an electric motor without a variable speed capability. This is to say that while the system flow may vary for each of the operating modes, the pump flow and associated power will remain constant (as excess pump capacity is recirculated back to the pump suction). Likewise, pump efficiency is assumed to be equal to the design values regardless of system flow. The estimation software uses existing software functions (based on DOE MotorMaster) to estimate the electric motor efficiency (based on motor load).

Baseline energy use is calculated as the product of the total operating hours and the pump electric demand with total operating hours equal to the sum of the operating hours for each of the system operating modes.

2.2.35.5.2 Baseline Energy Use – Dynamic Pumps

The electric demand of a dynamic pump such as a centrifugal or axial flow pump is calculated using the following expression.

$$kW_{PUMP} = 0.7457 * \frac{S * Q * H}{3960 * \eta_p * \eta_e} \quad (\text{Equation 21-B})$$

where:

S = specific gravity of pumped fluid relative to water at 60F

Q = fluid flow (gpm)
 H = Total developed head (Ft)
 η_p = Pump efficiency
 η_e = Drive motor efficiency

The specific gravity term in this expression, S , is considered constant and is based on the type and temperature of the pumped fluid. With the exception of pump flow, Q , the remaining terms will vary based on pump flow. Therefore this expression must be evaluated separately for each individual operating mode.

Estimating Dynamic Pump Performance

As noted previously, dynamic pump head and efficiency vary depending on pump flow and must be evaluated at each operating point. The total developed head and efficiency of a dynamic pump are typically characterized in a pump performance curve. These curves are generated by the pump manufacturer and are used to determine the pump operating point (head and efficiency) under varying flows. Since these curves can be difficult to locate for older pumps the estimation tool software assumes that pump performance will follow one of three generic pump curves. Curve selection is based on pump specific speed where pump specific speed is calculated using the following expression:

$$N_s = \frac{RPM * \sqrt{Q}}{(H / NS)^{3/4}} \quad \text{(Equation 21-C)}$$

where:

NS = number of pump stages
 Q = pump design flow (gpm)
 H = Total developed head (Ft)
 RPM = Drive motor speed, rpm

Pumps with a specific speed in the range of 300 - 4,999 are assumed to follow a radial pump curve (Figure 35- 1) while pumps with a specific speed in the 5,000 – 9,999 range are assumed to follow the mixed flow pump curve (Figure 35-2). Pumps with a specific speed equal to or exceeding 10,000 are assumed to follow the axial pump curve (Figure 35-3).

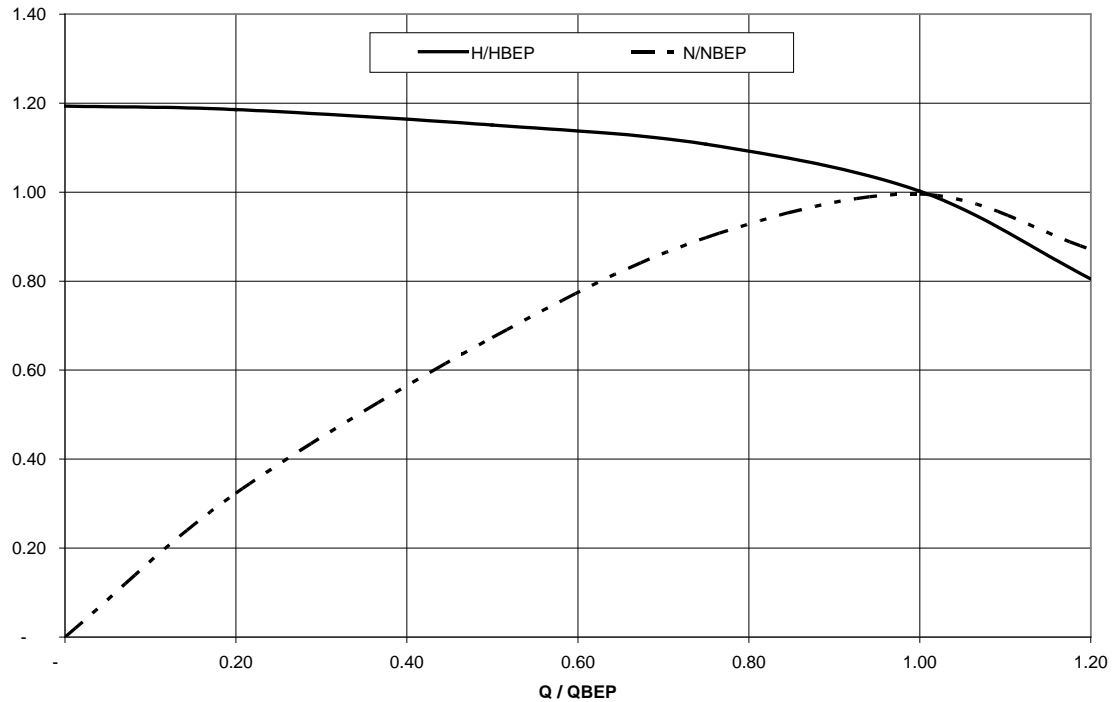


Figure 35-1: Generic Dynamic Pump Curves (Radial)
(normalized based on flow, head and efficiency at the Best Efficiency Point (BEP))

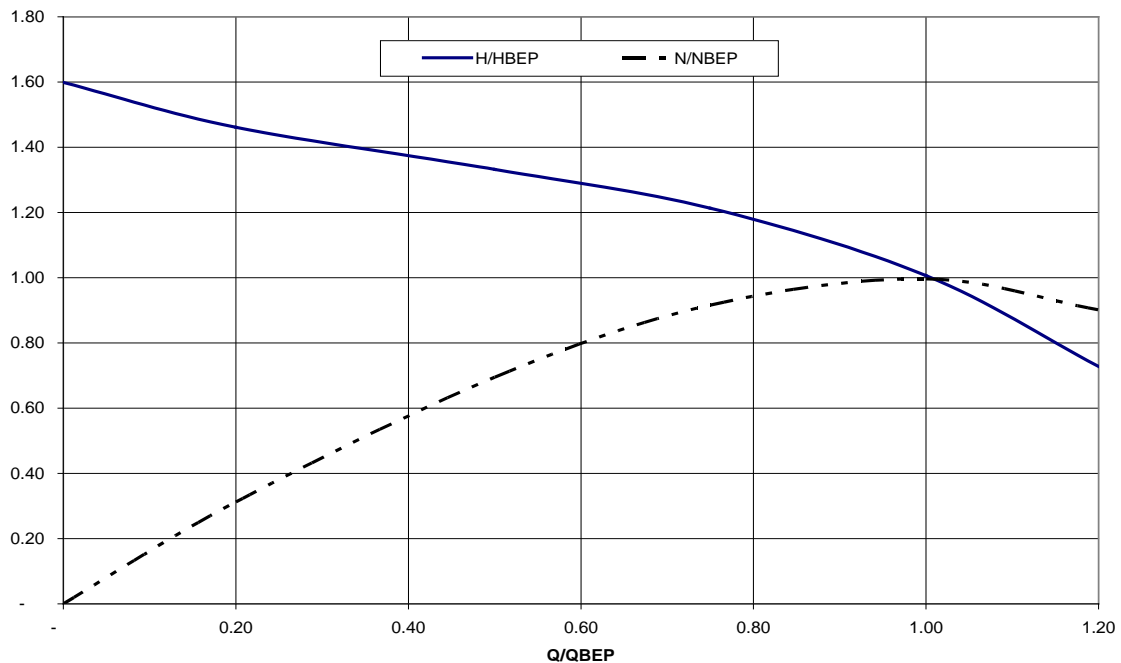


Figure 35-2: Generic Dynamic Pump Curves (Mixed Flow)
(normalized based on flow, head and efficiency at the Best Efficiency Point (BEP))

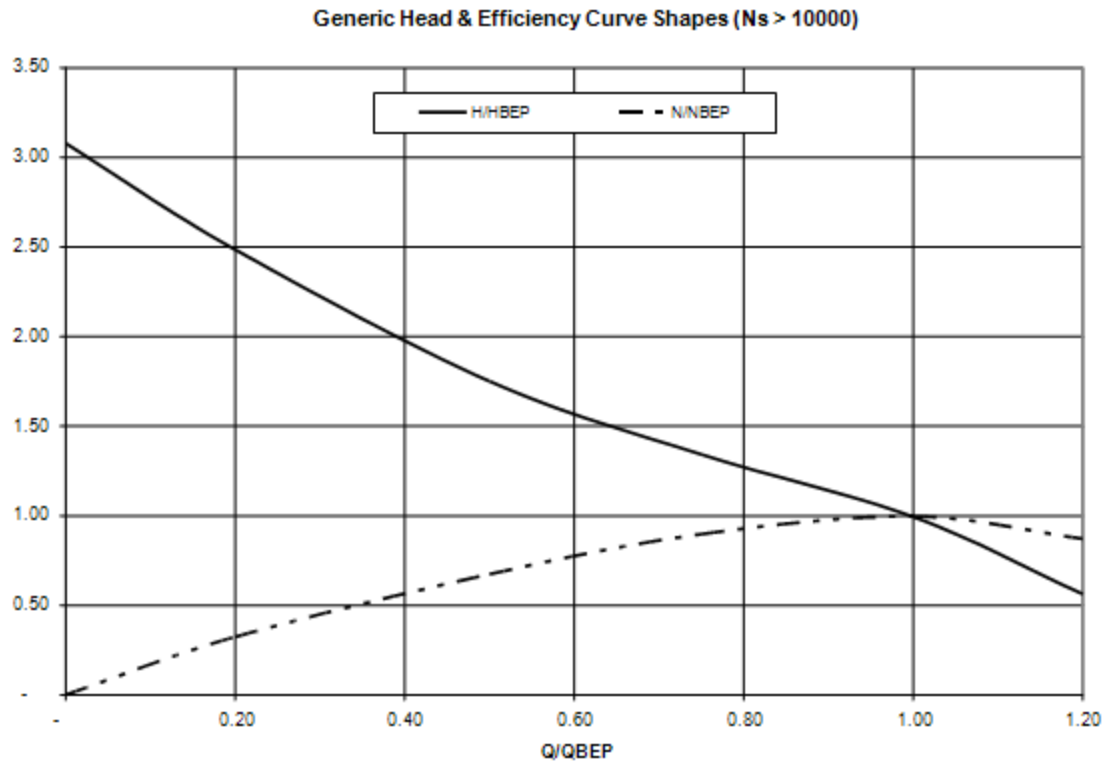


Figure 35-3: Generic Dynamic Pump Curves (Axial)
(normalized based on flow, head and efficiency at the Best Efficiency Point (BEP))

Note that these pump performance curves are normalized based on pump design data as described below:

- Q = Pump flow (Pump flow (gpm))
- Q_{BEP} = Pump Design Flow (gpm)
- H = Pump TDH (Ft)
- H_{BEP} = Pump TDH at design flow
- N = Pump efficiency
- N_{BEP} = Pump efficiency at design flow

Normalizing the curves allows their use in estimating the performance of any dynamic pump as long as the pump design information (flow, head and efficiency) is provided by the user. Note that the design point is used if the Best Efficiency Point (BEP) is not available. The estimated error is within 10% if the design point is used instead of the BEP. It is important to note that actual pump performance may vary from the generic curve profile. Therefore, if the user has access to the manufacturer's pump curve information the user should use this information, either directly to estimate pump performance, or should compare the manufacturer's information against the generic curve to confirm that the estimation software is providing a reasonable estimate of pump performance.

Matching System and Pump Performance

In order to estimate the baseline energy use of a dynamic pump it is first necessary to locate where the pump is operating on its characteristic performance curve. In the case of a throttling type of control a control valve located on the pump discharge will increase or decrease the system loss causing the pump flow to decrease or increase until the pump flow matches the system requirement. For throttling type controls the pump flow is therefore equal to the system flow and the pump performance parameters are calculated using the previously discussed generic performance curves and the system flow value.

For On/Off type controls there is no control valve on the discharge and the pump flow will therefore only be limited by the system losses. This limitation is represented by the intersection of the system loss and pump performance curves. For On/Off controls the estimation software must therefore locate this intersection. An example of this intersection is illustrated in Figure 35-4 below (using a radial pump curve).

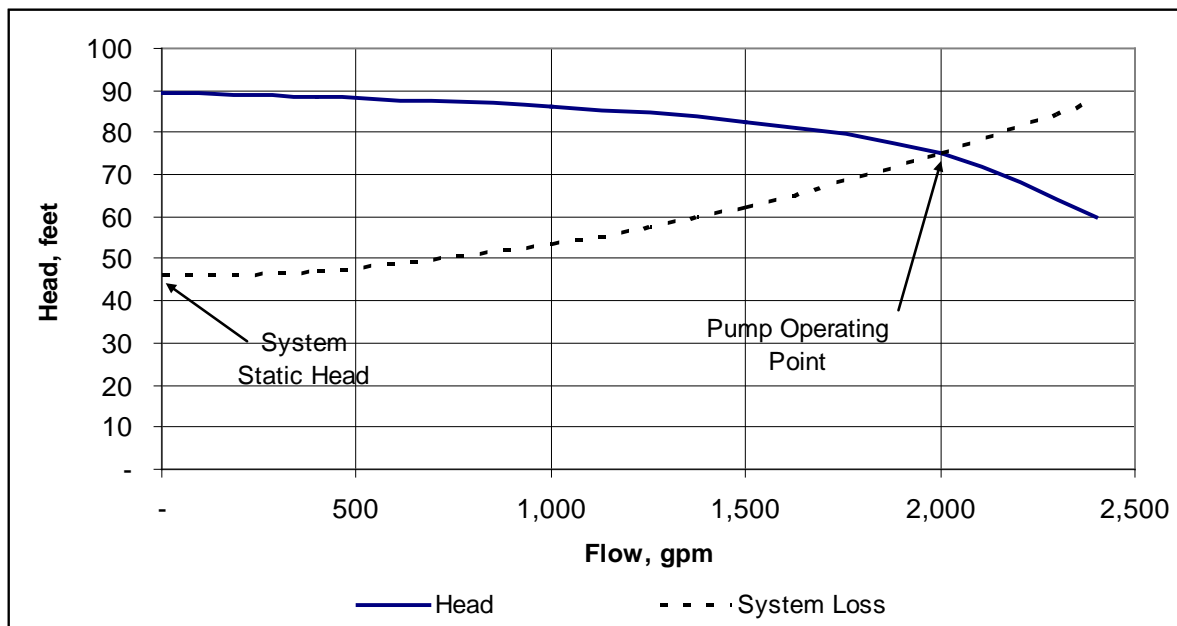


Figure 35-4: Dynamic Pump Operating Point Example

The software uses the site/system information provided by the user (max system flow, max and static head) to generate the estimated system loss curve. The intersection is then located and the pump efficiency is estimated using the generic pump performance curves discussed earlier. Once the pump efficiency (for either On/Off or Throttling control types) is determined it is then possible to estimate the electric motor loading and efficiency using existing Statewide Customized Offering software functions (based on DOE MotorMaster). The resulting pump and electric motor efficiencies are then used in conjunction with Equation 21-B to estimate the pump kW for the specified operating mode. Baseline energy use for the operating mode is the product of the pump kW and the total annual operating hours that have been entered for the operating mode. The estimation software repeats the process of locating the pump operating point, estimating pump and motor efficiency and calculating the baseline energy usage for each of the operating modes (up to eight) specified by the user.

Note that in the event that the software is unable to locate the estimated pump operating point (intersection of pump and system operating curves) or the estimated operating point is deemed invalid (flow is negative or exceeds system maximum flow) it will cause the calculation to be aborted and an error window will appear. The window will indicate that the specified pump appears incompatible with system requirements. This condition must be corrected (i.e. different pump or system specifications, etc.) before the calculations can be completed.

2.2.35.5.3 Efficiency Measure – Pump Replacement

The estimation software calculates the savings associated with replacement of an existing pump with a pump having a higher efficiency. The energy use of the new pump is calculated in the same manner as previously described for baseline energy use. The exception being that the new pump efficiency information is either directly substituted for the existing pump efficiency in equation 21-A (positive displacement pumps) or is used to generate a pump performance curve (dynamic pumps), which in turn allows a pump operating point and efficiency value to be estimated for the new pump.

2.2.35.5.4 Efficiency Measure – Drive Motor Replacement

The estimation software calculates the savings associated with replacement of an existing pump drive motor with a motor having a higher efficiency. The energy use of the new motor is calculated in the same manner as previously described for baseline energy use. The exception being that the new motor efficiency is substituted for the existing motor efficiency in either equation 21-A (positive displacement pumps) or equation 21-B (dynamic pumps) depending on the pump type.

2.2.35.5.5 Efficiency Measure – Variable Speed Drive (VSD) Installation

Variable speed drives can achieve significant energy savings in pumping applications. Savings vary significantly depending on pump type and the estimation software therefore calculates the estimated savings associated with VSD operation differently depending on pump type.

2.2.35.5.6 VSD Measure -- Positive Displacement Pumps

The electric demand of positive displacement pumps when operating under VSD control is calculated using the following expression.

$$kW_{PUMP} = 0.7457 * \frac{Q * P_D}{1714 * \eta_p * \eta_e * \eta_{VSD}} \quad \text{(Equation 21-D)}$$

where:

Q = fluid flow (gpm) @ operating mode

P_D = Pump discharge pressure (psig)

η_p = Pump efficiency

η_e = Drive motor efficiency

η_{VSD} = VSD efficiency

The baseline energy calculation for positive displacement pumps assumed constant pump flow regardless of the operating mode. Under VSD control, pump flow will match system flow and the flow value in the above expression is therefore equal to the operating mode flow specified by the user. Pump discharge pressure and pump efficiency are both assumed to be constant and equal to the pump design values (consistent with baseline calculation). The estimation software uses existing Statewide Customized Offering software functions (based on DOE MotorMaster) to estimate the electric motor efficiency (based on motor load).

For positive displacement pumps the VSD speed (fraction of full speed) can be estimated as the ratio of the operating mode flow divided by the pump's rated flow capacity. The software uses this value along with the full load VSD efficiency (user input) to estimate VSD efficiency. The relationship between VSD speed and efficiency utilized by the software is illustrated in Figure 35-5.

Note that the software checks the estimated VSD operating speed against the minimum speed entered by the user on input sheet 6. If the estimated operating speed is less than the stated minimum the calculation will be aborted and an error window will appear indicating that "Operating Mode X requires VSD operation below its minimum allowable range." The software will abort the calculations and return to the previous screen. The savings calculation cannot therefore be completed if one of the operation modes violates the minimum speed limit for the VSD.

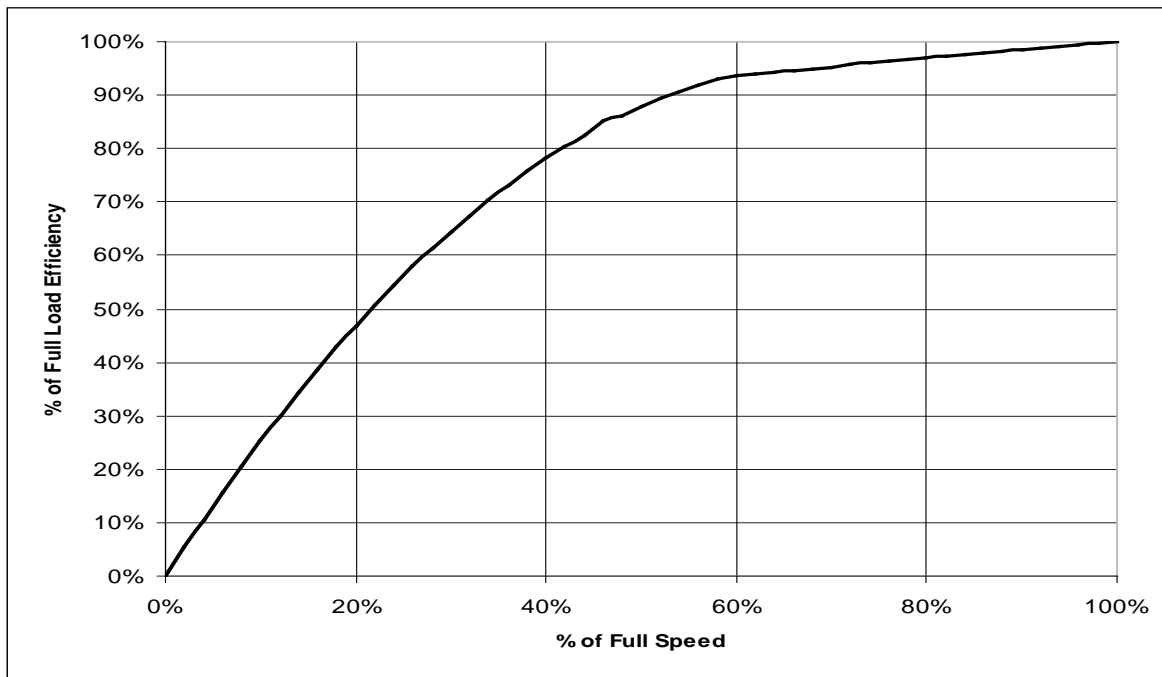


Figure 35-5: Generic Variable Speed Drive Performance
(derived from EPRI TR-101140 Adjustable Speed Drives Application Guide)

Once the VSD efficiency has been calculated it is then possible to calculate the electric demand of the VSD equipped pump using Equation 21-D. The difference between the previously calculated baseline electric demand and the proposed demand represents the average demand savings for this operating mode. The energy savings are calculated as the product of the average demand savings and the operating hours for the operating mode. The software repeats this process for each of the operating modes specified by the user.

VSD Measure – Dynamic Pumps

The electric demand of a dynamic pump when operating under VSD control is calculated using the same basic expression as the baseline dynamic pump calculation with the exception that a VSD efficiency term is included.

$$kW_{PUMP} = 0.7457 * \frac{S * Q * H}{5310 * \eta_P * \eta_e * \eta_{VSD}} \quad (\text{Equation 21-E})$$

where:

S = specific gravity of pumped fluid relative to water at 60F
 Q = fluid flow (gpm)
 H = Total developed head (Ft) at this operating mode point
 η_p = Pump efficiency
 η_e = Drive motor efficiency
 η_{VSD} = VSD efficiency

However since dynamic pump performance varies with pump speed it not possible to assume constant pump efficiency or constant pump discharge pressure. Furthermore, it is not possible to calculate these performance parameters until the operating speed of the pump is calculated.

Estimating VSD Operating Speed -- Dynamic Pumps

The pump affinity laws state that with a constant impeller diameter and varying pump speed the following ratios are maintained without any change to pump efficiency.

$$\frac{Q_1}{Q_2} = \frac{n_1}{n_2} \quad (\text{Equation 21-F})$$

$$\frac{H_1}{H_2} = \left(\frac{n_1}{n_2} \right)^2 = \left(\frac{Q_1}{Q_2} \right)^2 \quad (\text{Equation 21-G})$$

where:

Q = Pump fluid flow (gpm)
 H = Pump total developed head (Ft)
 n = Pump speed (RPM)

In our case we set H_2 and Q_2 equal to the system loss (H_{OPMode}) and system flow at the specified operating point (Q_{OPMode}), respectively while H_1 and Q_1 represent the head and flow of the existing pump when operating at the same efficiency. Substituting and solving for H_1 yields:

$$H_1 = H_{OPMode} * \left(\frac{Q_1}{Q_{OPMode}} \right)^2 \quad (\text{Equation 21-H})$$

To calculate the intermediate flow term (Q_1) we equate the above expression to the expression representing the existing pump head curve (polynomial expression based on generic curve shape) and solve for the pump flow (Q_1). Having solved for Q_1 the affinity laws are used to estimate the VSD operating speed (n_{VSD}):

$$n_{VSD} = n_{Motor} * \frac{Q_{OPMode}}{Q_1} \quad (\text{Equation 21-I})$$

Pump efficiency at this operating point is calculated using the existing pump efficiency curve (generic curve, as before) at the intermediate flow, Q_1 . The remaining terms, VSD and electric motor efficiency are calculated in the same manner as previously described for the positive displacement pump case. Once these terms have been calculated it is then possible to calculate the electric demand of the VSD equipped pump using Equation 21-E. The difference between the previously calculated baseline electric demand and the proposed electric demand represents the average demand savings for this operating mode. The energy savings are calculated as the product of the average demand savings and the operating hours for the operating mode. The software repeats this process for each of the operating modes specified by the user.

Note that the software checks the estimated VSD operating speed against the minimum speed entered by the user on input sheet 6. If the estimated operating speed is less than the stated minimum the calculation will be aborted and an error window will appear indicating that “Operating Mode X requires VSD operation below its minimum allowable range.” The software will abort the calculations and return to the previous screen. The savings calculation cannot therefore be completed if one of the operation modes violates the minimum speed limit for the VSD.

2.2.36 Other - Pump-Off Controllers for Oil Wells

2.2.36.1 Description

This tool estimates savings for the installation of pump-off controllers on sucker rod pumping systems. Pump-off controllers save energy by reducing motor operation. Typically, these wells operate 24 hours per day regardless of their production level. When the wells are operating below capacity, the pump may experience a condition known as fluid pounding. Fluid pounding occurs when an insufficient amount of fluid, water and oil, is drawn into the well sleeve, decreasing the overall pumping efficiency. As a result, air can be drawn into the pump, decreasing the pumping efficiency of the well.

2.2.36.2 Appropriate Use of the Tool – Program Policy

The appropriate application of this tool is to estimate energy savings from POC installations on sucker rod pump wells that are experience fluid pounding and have no existing controls (i.e., timers or VSDs).

2.2.36.3 Measure Tool Use

2.2.36.3.1 Inputs

The savings estimation tool requires the user to input a well's identification number, motor size, production level, annual hours of operation, pump diameter, pump downhole stroke length and pump stroke speed.

Table 36-1. Pump Tool Inputs

Name	Description / Purpose
Well Identification Number	Enter the well's identification number. This value can be numeric or alphanumeric.
Motor Horsepower (hp)	Enter the rated motor capacity.
Average Daily Production (bfpd)	Enter the average daily production in units of barrels of fluid per day. The estimate should be based on the last twelve months of operation. Include supporting data as an attachment.
Annual Hours (hr/yr)	Enter the estimated annual hours of operation.
Pump Diameter (inches)	Enter the pump diameter. This is the inner diameter of the pump plunger.
Stroke Length (inches)	Enter pump stroke length. This is the downhole stroke length of the pump.
Strokes per Minute (spm)	Enter pump strokes per minute.

2.2.36.3.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures.

It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 36-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.36.3.3 Output

Once all necessary input information has been gathered, the Pump-Off Controller Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 36-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.

Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.36.4 Energy Savings Explanation

The estimated savings is based on a simplified empirical model, which correlates volumetric efficiency, percentage runtime and percentage energy use. The results may not accurately reflect the performance of an individual well; rather they represent an average performance. Accurate modeling of an individual well requires a more complex simulation model, which is commercially available.

2.2.37 Other - Tape Drip Irrigation

2.2.37.1 Description

Drip irrigation is the frequent, slow application of water to soil through mechanical devices called emitters that are located at selected points along water-delivery lines. Most emitters are placed on the ground, but they can be buried at shallow depths for protection. Water enters soil from the emitters, and most water movement to wet the soil between emitters occurs by capillarity beneath the soil's surface (Marsh 1982).

The drip irrigation saves energy by increasing irrigation efficiency and, potentially, reducing pump pressure head. The amount of irrigation required depends on local weather conditions, crop type, and soil type. For analysis purposes, it is assumed that there is a single pumping plant supplying water to a site irrigation system. This provides a simple conceptual basis for calculating energy savings.

2.2.37.2 Appropriate Use of the Tool – Program Policy

This model was designed to estimate potential energy savings for farmers that are currently irrigating their fields with sprinklers but will in the future (i.e., for a minimum of five years) be irrigating with tape drip. As with any estimating tool, results should be compared to annual billing data to verify the reasonableness of the results. Where discrepancies are observed, documentation supporting the project assumptions should be requested, and revisions to the project assumptions may be required.

2.2.37.3 Types of Equipment

Tape drip refers to thin walled hoses ranging from 4 to 20 millimeters. Other types of drip irrigation are eligible as Itemized (Express Efficiency) Measures.

2.2.37.4 Size of Capacity Covered

The software is limited to the crop types summarized in the list below:

Cauliflower, Artichokes, Asparagus, Beans (pinto), Beans (dry), Beans (green), Beets (table), Broccoli, Cabbage, Carrots, Celery, Corn (grain), Corn (silage), Cotton, Cucumber, Eggplant, Lentil, Lettuce, Melon, Millet, Onion (dry), Onion (green), Peas, Peppers, Potato, Radishes, Sorghum, Spinach, Squash, Sugarbeet, Sunflower, Sweet Potatoes, Tomato, Watermelon, Almonds, Apple, Grapevines, Kiwifruit, Stone fruits, Walnuts, Avocado, Citrus, Citrus (desert), Date Palm, Evergreen, Olives.

Table 37-1: Eligible Crop Types & Typical Grow./Irrig. Parameters (Orang et al. 2004)

CUP-E Number	Crop Name	% Season			K_c			Planting		Harvest		Planting	Harvest
		B	C	D	A-B	C-D	E	Month	Day	Month	Day	Date	Date
1.1a	Cauliflower	20	50	83	0.3	1	0.8	3	15	7	1	3/15/11	7/1/11
1.02	Artichokes	6	19	90	0.65	0.65	0.65	7	1	5	1	7/1/11	5/1/12
1.03	Asparagus	12	25	95	0.25	1	0.25	1	1	12	31	1/1/11	12/31/11
1.05	Beans (pinto)	24	40	91	0.2	0.9	0.1	6	15	9	30	6/15/11	9/30/11
1.06	Beans (dry)	24	40	91	0.2	1	0.1	6	15	9	30	6/15/11	9/30/11

1.07	Beans (green)	22	56	89	0.8	1	0.85	3	1	5	31	3/1/11	5/31/11
1.08	Beets (table)	25	60	90	0.3	0.9	0.9	4	1	6	20	4/1/11	6/20/11
1.09	Broccoli	20	50	83	0.3	1	0.8	3	15	7	1	3/15/11	7/1/11
1.10	Cabbage	25	63	88	0.3	1	0.85	8	1	11	15	8/1/11	11/15/11
1.11	Carrots	20	50	83	0.85	0.95	0.8	1	15	5	15	1/15/11	5/15/11
1.12	Celery	15	40	90	0.8	0.95	0.95	9	15	1	15	9/15/11	1/15/12
1.13	Corn (grain)	20	45	75	0.2	1.05	0.6	5	1	9	30	5/1/11	9/30/11
1.14	Corn (silage)	20	45	99	0.2	1	1	5	1	8	15	5/1/11	8/15/11
1.15	Cotton	15	25	85	0.35	0.95	0.5	5	15	10	15	5/15/11	10/15/11
1.16	Cucumber	19	47	85	0.8	0.85	0.85	3	15	6	15	3/15/11	6/15/11
1.17	Eggplant	23	54	85	0.8	0.9	0.85	4	1	11	15	4/1/11	11/15/11
1.21	Lentil	24	40	91	0.2	1	0.1	6	15	9	30	6/15/11	9/30/11
1.22	Lettuce	25	65	90	0.8	0.8	0.8	3	15	7	15	3/15/11	7/15/11
1.23	Melon	21	50	83	0.8	0.95	0.75	4	1	11	15	4/1/11	11/15/11
1.24	Millet	14	36	75	0.3	1	0.3	11	1	5	31	11/1/11	5/31/12
1.27	Onion (dry)	10	26	75	0.8	1	0.75	3	1	10	1	3/1/11	10/1/11
1.28	Onion (green)	25	70	90	0.8	1	0.9	3	1	8	1	3/1/11	8/1/11
1.29	Peas	20	47	83	0.2	1	1	3	1	5	31	3/1/11	5/31/11
1.30	Peppers	20	45	85	0.8	1	0.85	3	1	8	31	3/1/11	8/31/11
1.31	Potato	20	45	78	0.8	1.1	0.7	4	15	8	15	4/15/11	8/15/11
1.32	Radishes	20	45	85	0.8	0.85	0.75	4	1	5	1	4/1/11	5/1/11
1.36	Sorghum	16	42	75	0.2	1.05	0.5	4	1	11	15	4/1/11	11/15/11
1.37	Spinach	33	67	92	0.8	0.95	0.9	11	15	1	31	11/15/11	1/31/12
1.38	Squash	20	50	80	0.52	0.9	0.7	1	15	4	15	1/15/11	4/15/11
1.40	Sugar beet	15	45	80	0.2	1.15	0.95	3	15	9	30	3/15/11	9/30/11
1.41	Sunflower	20	45	80	0.2	1.1	0.4	5	1	9	10	5/1/11	9/10/11
1.42	Sweet Potatoes	20	45	78	0.8	1.1	0.7	4	15	8	15	4/15/11	8/15/11
1.43	Tomato	25	50	80	0.3	1.1	0.65	4	1	8	31	4/1/11	8/31/11
1.46	Watermelon	20	50	75	0.8	1	0.75	4	1	11	15	4/1/11	11/15/11
3.01	Almonds	0	50	90	0.55	1.05	0.65	3	1	10	15	3/1/11	10/15/11
3.02	Apple	0	50	75	0.55	1.05	0.8	4	1	11	15	4/1/11	11/15/11
3.03	Grapevines	0	25	75	0.45	0.8	0.35	4	1	11	1	4/1/11	11/1/11
3.04	Kiwifruit	0	22	67	0.3	1.05	1	5	1	10	31	5/1/11	10/31/11
3.05	Stone fruits	0	50	90	0.55	1.05	0.65	3	1	10	15	3/1/11	10/15/11

3.06	Walnuts	0	50	75	0.55	1.05	0.8	4	1	11	15	4/1/11	11/15/11
4.01	Avocado	0	33	67	0.7	0.7	0.7	1	1	12	31	1/1/11	12/31/11
4.02	Citrus	0	33	67	1.3	1	1.3	1	1	12	31	1/1/11	12/31/11
4.03	Citrus (desert)	0	33	67	1.3	1	1.3	1	1	12	31	1/1/11	12/31/11
4.04	Date Palm	0	33	67	0.95	0.95	0.95	1	1	12	31	1/1/11	12/31/11
4.05	Evergreen	0	33	67	1.15	1.15	1.15	1	1	12	31	1/1/11	12/31/11
4.06	Olives	0	33	67	0.8	0.8	0.8	1	1	12	31	1/1/11	12/31/11

2.2.37.5 Measure Tool Use

2.2.37.5.1 Inputs

The input screens are defined by the following table and field descriptions.

Table 32-2. Tape Drip Inputs

Input Name	Description / Purpose
<i>Site / System Information:</i>	
Manufacturer	Drip tape manufacturer
Tape Drip Name	Drip system name
Model	Identifies drip tape model number
ETo Zone	Select an appropriate evapotranspiration zone. There are 18 evapotranspiration zones in California. See the evapotranspiration reference map developed by the California Department of Water Resource http://www.cimis.water.ca.gov/cimis/images/etomap.jpg
Average Pumping Depth, ft	Sum of average well water depth and well drawdown
Average Pumping Lift, ft	Average elevation the water needs to be lifted for irrigation
Average Water Main Length, ft	Average distance of the water main. This is the distance from the pump to the submain
Average Well Flow, gpm	Average well pump flow rate
Average Water Main Diameter, inches	Average diameter of main water line
Sprinkler Pressure Head, psi	Sprinkler operating pressure (should be consistent with equipment specifications and operating conditions)
Overall Pump Efficiency (OPE), %	Efficiency of entire pump system, use default value of 72% if unknown
<i>Crop Specific Information:</i>	
Crop Type	Row, Tree or Vine crop
Crop Name	Crop being irrigated

Crop Area, acre/crop	Enter crop area
Crop Planting Dates (month/day)	Date crop planting begins for row crop, Date leaf out begins for tree and vine.
Crop Harvest Dates (month/day)	Date harvest begins
Soil Type	Select coarse sand, fine sand, loam or heavy clay
Irrigation Method (Before / After)	Enter the irrigation method during each phase of growth, either Tape Drip or Sprinklers. For row crops, there are four phases of growth (A-B = "initial", B-C = "rapid", C-D = "mid-season", and D-E = "late-season"), typically the "initial" phase is irrigated with sprinklers both pre- and post- install and should be confirmed with the customer. For tree and vine crops, there are three phase of growth (B-C = "rapid", C-D = "mid-season", and D-E = "late-season"). Note that Tree and Vine crops will not have an "Initial" growth period

2.2.37.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 37-3: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.37.5.3 Output

Once all necessary input information has been gathered, the Tape Drip Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 37-4: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.37.6 Energy Savings Explanation

In general, the calculations are based on guidelines provided by WATERIGHT (2003). This website was developed by the Center for Irrigation Technology at California State University, Fresno. The site and its content are intended to be an educational resource for irrigation water management. The savings will occur when the energy required to deliver a given amount of water (kWh/AF) is decreased, or the annual amount of water is decreased (AF/yr), or both:

$$\text{kWh/yr} = \text{kWh/AF} * \text{AF/yr}.$$

The start and stop dates set the boundaries of each crop rotation. Each season is divided into different growth phases. They are rapid (A-B), initial (B-C), mid-season (C-D) and late-season (D-E) growth periods. Given the crop type the software automatically gives the growth period.

Even though it is possible that there will be demand (kW) savings, the difficulty associated with estimating how much and the uncertainty associated with making general assumptions are too great. Therefore, no demand savings are reported.

2.2.38 Other - Variable-Speed Drives for Dairy Vacuum Pumps

2.2.38.1 Description

This tool estimates the potential annual electrical energy savings and peak demand reduction that can be achieved by adding a variable-speed drive (VSD) to a standard dairy vacuum milking system. The estimated savings calculated by the program exceed the requirements of the national Energy Policy Act (EPA) of 1992, and are therefore reportable.

2.2.38.2 Appropriate Use of the Tool – Program Policy

Savings estimates are based on the following assumptions:

- ❑ The existing standard dairy milking vacuum pump system is significantly oversized and runs at a constant speed. Piping changes are made to move the vacuum system regulator (or controller), increase the vacuum system efficiency, and replace and downsize the main vacuum pump.
- ❑ The new, smaller vacuum pump motor is controlled by a VSD, which in turn receives feedback from the vacuum system through a pressure transducer. Any additional vacuum pumps and motors are either removed from service or replaced with premium-efficiency models.
- ❑ All motors are three phase, 1800 RPM, and operating at 90% load.

2.2.38.3 Applicable Types of Equipment

The program contains efficiency tables for standard, NEPA, and premium-efficiency motors. Turbine, water ring, blower, and vane vacuum pump types are all included.

2.2.38.4 Equipment Sizes or Capacities Covered by the Tool

The tool covers various pump motor sizes up to 50HP.

2.2.38.5 Measure Tool Use

2.2.38.5.1 Inputs

The user is directed to enter the inputs as described in the following table.

Table 38-1: Tool Inputs

Input Name	Description / Purpose
Site Name	Identifies the site involved
Measure Name	Identifies the measure
Location	Identifies project location
Description	Brief description of project
Size	Existing and proposed motor size. Options up to 50 HP.

Motor Type	Existing and proposed motor types.
Vacuum Pump Type	Only necessary if pump type will change – allows savings for a change to a more efficient pump type.
Variable Speed Drive	Only available for proposed pump motor. Check only if VFD installation is proposed.
Operating Hours per Day	Existing and proposed average operating hours per day.
Number of Motors	Number of existing additional vacuum pump motors
Size	Horsepower per additional vacuum pump motor. Options up to 50 HP.
Plan for Additional Motors	Select the plan for the additional motors. Pull-down menu with “Remove from Service”, “Replace with a NEPA motor”, and “Replace with a premium motor” options.

2.2.38.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 38-2: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.

Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives
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2.2.38.5.3 Output

Once all necessary input information has been gathered, the Tape Drip Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 38-3: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.38.6 Energy Savings Explanation

The software estimates the existing electrical demand and energy usage using the nameplate horsepower of the vacuum pump motors and the average number of hours the system operates every day. Survey data indicate that most dairy vacuum pump motors run close to 90% loaded. Thus, the electrical demand of each vacuum pump motor is calculated as follows:

$$\text{Demand (kW)} = [\text{Motor Horsepower (HP)} \times 0.746 \times 90\%] / \text{Motor Efficiency (\%)} \quad (\text{Eq. 1})$$

where 0.746 is the factor used to convert HP to kW.

The existing demand is calculated for both the primary vacuum pump motor and any additional vacuum pump motors. The existing annual energy usage is determined as follows:

$$\text{Energy Usage (kWh)} = \text{Demand} \times \text{Average Daily Operating Hours} \times 365 \text{ days/year} \quad (\text{Eq. 2})$$

Equations 1 and 2 are also used to calculate the proposed demand and energy usage. If there is a change in pump type, the demand is adjusted to take into account differences in pump efficiencies.

If an additional standard vacuum pump motor is replaced with an additional premium vacuum pump motor and no adjustment is made for the increase in speed, the calculations are adjusted to take into account the reduction in savings due to the increased speed of the premium motor.

The software allows for control of the proposed pump motor with a VSD. When a VSD is installed to control a motor, the total energy savings depends on how the load changes over time and the amount of time spent at each load level. Testing at several dairies retrofitted with a VSD to control a downsized vacuum pump motor recorded savings close to half of the expected energy usage for the new system. This estimating tool uses a VSD motor speed and operating time distribution that yields an average annual energy savings of 46.9%. The tool outputs both a Milking Cycle Demand Reduction and a Wash Cycle Demand Reduction.

The 2007 Energy Independence and Security Act established the minimum efficiency standards for motors. The software incorporates these efficiency requirements to determine the amount of motor replacement energy savings for energy efficiency incentives. The motors that are affected by this change and covered by this tool are divided into two groups, Subtype I (NEMA Table 12-12 and 12-11) and Subtype II (NEMA Table 12-11).

2.2.39 Other - Variable-Speed Drives for Process Applications

2.2.39.1 Description

Variable Speed Drives (VSD), also referred to as Variable Frequency Drives (VFD), are used for controlling AC motors. The VSD is a solid-state device that controls the frequency and voltage supplying the motor. Many AC motors used for process applications are oversized to accommodate peak loads even though the average loads are lower. The most common applications involve centrifugal pumps and fans which have large savings potential due to their power versus speed curves. Without VSDs the motors are left operating at full speed or are controlled by primitive part-load strategies. Often times the motors cannot be cycled on and off too frequently so the motors remain at full speed. The VSD offers large energy savings for these AC motors that operate at partial loads.

2.2.39.2 Appropriate Use of Tool – Program Policy

This tool covers the installation of a VSD onto an AC motor that doesn't currently have one. If the Energy Efficiency Measure consists of one or more VSDs being installed on centrifugal chillers, cooling tower fan motors, HVAC fans, or dairy vacuum pumps then there are separate specific calculators available for those measures, and this tool should not be utilized.

The tool is used for same load retrofits exclusively. This means that this tool is not appropriate for measures involving increased load retrofits or new installs.

2.2.39.3 Types of Equipment for Which the Tool is Applicable

Equipment (typically fans and pumps) that use one or more AC motors, and that do not already use a VSD are eligible.

2.2.39.4 Size or Capacities Which are Covered by the Tool

This tool covers the installation of VSDs on AC motors ranging from 1 to 500 HP. The program has minimum motor efficiencies that must be observed when determining the baseline conditions. The efficiency values shown in *Appendix C. Minimum Equipment Efficiency Standards* are used to determine the baseline motor energy consumption

The estimate of savings from the Variable Speed Drives for Process Application tool can be calculated for the following available options:

- ☐ Direct Drive (e.g. mixer, conveyor) to VSD

Pump and Fan VSD application should utilize the Pump (2.2.35) or Fan (2.2.29) tools.

2.2.39.5 Measure Tool Use

2.2.39.5.1 Inputs

The measure tool VSD for Process Applications is only available under Retrofit (Same Load / Production). The following inputs are required for the measure:

Table 39-1: Sheet 1, Site/System Input page (Sheet 1 of 2)

Name	Description / Purpose
Location	Site location – used for reference only
Function	Equipment function – used for reference only
Designation	Equipment Designation – used for reference only
Quantity	Quantity of identical motors undergoing retrofit – power multiplier
Duty Cycle (%)	Motor duty cycle – used to estimate the total operating hours per year
Hours/day	Average hours per day the machine operates– used to calculate the total operating hours per year
Days/week	Days per week the machine operates – used to calculate the total operating hours per year
Weeks/year	Weeks per year the machine operates – used to calculate the total operating hours per year
Op Strategy	Pull-down menu – Only available options is “Direct Drive (mixer, conveyor) to VSD”.
Percent of Time at Part Speed	Enter the percentage of time when motor(s) is running at corresponding part speed (20 – 100%) for existing and proposed operating conditions. The total should be 100%.

Table 39-2: Motor Specification (Sheet 2 of 2)

Name	Description / Purpose
Manufacturer	Equipment manufacturer – used for reference only
MODEL	Equipment model – used for reference only
SERIAL #	Equipment serial number – used for reference only
Rewound?	Pull-down menu – choose Yes or No – effects BHP and Load %
HP (size)	Pull-down menu – choose between 1 through 500 HP – effects BHP and Load %
FL (Full Load) RPM	Rated FL RPM – effects BHP and Load %; will effect kW if HP (size) and measured kW are out of range
Service Factor	Rated service factor – used for reference only
VOLTS	Rated volts – can be used to calculate motor details depending on which inputs are left blank
FL AMPS	Rated FL amps – can be used to calculate motor details depending on which inputs are left blank
FL Power Factor (%)	Rated FL power factor – can be used to calculate motor details depending on which inputs are left blank
FL Efficiency	Rated FL efficiency – proportionally effects the BHP and Load %
Letter Code	Pull-down menu – if used, automatically chooses FL Efficiency

NEMA Class Design	Pull-down menu – used for reference only
ENCLOSURE	Pull-down menu – choose between “ODP” and “TEFC/TXPL” – effects BHP and Load %
FRAME	Motor Frame type and size, taken from motor nameplate – used for reference only
Date	Date measurements were taken – used for reference only
Time	Time measurements were taken – used for reference only
Normal Load?	Pull-down menu – used for reference only
kW	Measured kW – determines the kW per motor
Power Factor (%)	Measured power factor – Can be used to calculate the motor details depending on which inputs are left blank
phase ab	Measured phase ab voltage – Can be used to calculate the motor details depending on which inputs are left blank
phase bc	Measured phase bc voltage – Can be used to calculate the motor details depending on which inputs are left blank
phase ca	Measured phase ca voltage – Can be used to calculate the motor details depending on which inputs are left blank
phase a	Measured phase a current – Can be used to calculate the motor details depending on which inputs are left blank
phase b	Measured phase b current – Can be used to calculate the motor details depending on which inputs are left blank
phase c	Measured phase c current – Can be used to calculate the motor details depending on which inputs are left blank

2.2.39.5.2 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 39-3: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable

Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.39.5.3 Output

Once all necessary input information has been gathered, the Tape Drip Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 39-4: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.39.6 Energy Savings Explanation

The annual energy savings are the difference between the estimated baseline and proposed annual energy consumption and on-peak demand. If the proposed on-peak demand is greater than the baseline on-peak demand, the demand reduction will result in 0.00 kW. This is the case for many VSD applications since the motor may still run at full load during peak hours with the added parasitic loss through the VSD. The CCT estimates the existing (baseline) energy consumption and on-peak demand as well as the proposed energy consumption and on-peak demand according to the inputs supplied.

The tool uses the inputs to calculate the Load %, BHP, and kW. The motor is assumed to be the same for the existing and proposed systems; therefore the motor details are only entered once. The results are then used in conjunction with the Operating Parameters and Percent of Time at Part Speed to calculate the total energy savings.

The user describes the existing and proposed Percent of Time at Part Speed. For the existing conditions, some motors have basic controls which allow them to run at more than one speed. Therefore both the Existing Percent of Time at Part Speed and the Proposed Percent of Time at Part Speed may be allocated throughout the entire range from 20% through 100%.

The kW at each Percent Part Speed is calculated and then used to calculate the annual kWh at that Percent Part Speed. The annual kWh is then calculated.

2.2.40 Other - Wastewater Retrocommissioning (RCx)

2.2.40.1 Description

This tool estimates savings for three different energy efficiency measures common to wastewater treatment facilities: (1) Aeration Device Replacement, (2) Aeration Controls, and (3) Blower Efficiency Improvements, and (4) Pumping Efficiency Improvements.

Aeration systems typically account for 45-60% of the energy consumed at a conventional municipal wastewater treatment facility. Potential efficiency improvements range from 30-70%⁷. Aeration methods include waterfall aerators, diffused-gas aerators, and mechanical aerators. For each method there are a number of different aeration devices. An aerator's performance is defined by the energy required to deliver dissolved oxygen (DO) and the effectiveness of treating the biochemical oxygen demand (BOD).

The Aeration Control measure saves energy by more accurately monitoring aeration system DO levels. The objective of the automation is to more consistently control DO levels regardless of fluctuations in the treatment load. For example, DO sensors can be used to adjust air flow, tank level, or mechanical aerator speed. Small treatment systems with no control can be operating at DO levels of 4-5 mg/L. Ideal control levels are 1-2 mg/L.

Blower Efficiency Improvements include increased motor and/or pump efficiency, impeller rightsizing, blower downsizing and improved air flow control. If the measure is a motor replacement only, then the appropriate measure category is High-Efficiency Motor Replacement or Early Retirement.

Pumping Efficiency Improvements include increased motor and/or pump efficiency, impeller rightsizing, pump downsizing and improved flow control. If the measure is a motor replacement only, then the appropriate measure category is High-Efficiency Motor Replacement or Early Retirement.

2.2.40.2 Appropriate Use of the Tool – Program Policy

The appropriate application of this tool is to estimate energy savings from wastewater system improvements described above. Both the Aeration Device Replacement and Aeration Control measures are simplified models of what can be much more complicated and dynamic systems. The blower and pump efficiency calculation approximations based on static system conditions. Load and system variability will increase the uncertainty associated with these estimates. In all cases, the risk associated with using these models needs to be weighed against the cost of requiring more detailed calculations and/or measurement and verification⁸.

⁷ These estimates are based on reported oxygen transfer rates for various aeration devices. See Table 1. The 30% efficiency improvement would be typical of surface mechanical aerators or jet aerators to fine bubble diffusers. The 70% efficiency improvement would be typical for coarse to fine bubble diffuser retrofits.

⁸ For an additional discussion of the cost of measuring and verifying savings versus stipulated estimates see paper by Jump, Johnson, and Farinaccio (2000).

2.2.40.3 Size or Capacity Covered

These models do not have a size or capacity constraints. However, if the estimated system demand (kW) exceeds the reported capacity of the equipment (hp) then the user will be notified in the output file.

2.2.40.4 Measure Tool Use**2.2.40.4.1 Inputs**

This section summarizes the user inputs. The estimation tool software includes a total of five input screens for entry of aeration system, aeration control, blower and pump information. Model assumptions should be based on the last twelve months of operation. Supporting documentation should be provided with the Application. Once the Wastewater RCx measure is selected, the user is then directed to enter the various inputs as described in the following tables.

The Wastewater RCx Improvements input page allows the user to select the measures to be implemented.

Table 40-1: Sheet 1 of 5, Choice of Wastewater RCx Measures

Input Name	Description/Purpose
Install Type	Select Install Type: Retrofit (Same Load/Production) or Retrofit (Increased Load/Production)
Aeration System Replacement	Choose aeration system replacement as a measure
Aeration Controls Improvement	Choose aeration controls improvement as a measure
Blower Efficiency Improvement	Choose blower efficiency improvement as a measure
Pumping Efficiency Improvement	Choose pumping efficiency improvement as a measure

The Aeration Device Replacement input page allows the user to select the pre and post aeration devices and typical system loads.

Table 40-2: Sheet 2 of 5, Aeration Device Replacement

Input Name	Description/Purpose
Existing Aeration Type	Select existing aeration device.
Proposed Aeration Type	Select proposed aeration device.
Influent Biochemical Oxygen Demand (BOD), mg/L	Enter the average daily BOD entering the aeration zone in units of milligram per liter
Effluent Biochemical Oxygen Demand (BOD) f, mg/L	Enter the average daily BOD leaving the aeration zone in units of milligram per liter

Nitrification Demand (TKN), mg/L	Enter the average nitrogen levels entering the aeration zone in units of milligram per liter
Flowrate of Aeration System, MGD	Enter the average daily flowrate in units of millions of gallons per day
Aerator Capacity, hp	This is the total rated motor capacity of the aeration system

The Aeration Controls input page allows the user to select the pre and post aeration control types and DO levels.

Table 40-3: Sheet 3 of 5, Aeration Controls

Input Name	Description/Purpose
Aeration Type	Select aeration device. If this measure is being installed in conjunction with an Aeration Device Replacement. The proposed aeration device is already selected.
Average Flowrate, MGD	Enter the average daily flowrate in units of millions of gallons per day
Existing Control Description	Describe existing controls
Existing Fan Type	Select existing fan type.
Existing Average Dissolved Oxygen Levels, mg/L	Enter the average dissolved oxygen level prior to the installation of aeration control improvements
Proposed Control Description	Describe proposed controls. Include equipment specifications.
Proposed Fan Type	Select proposed fan type
Proposed Average Dissolved Oxygen Levels, mg/L	Enter the average dissolved oxygen level after the installation of aeration control improvements
Aerator Capacity, hp	This is the total rated motor capacity of the aeration system
Influent Biochemical Oxygen Demand (BOD), mg/L	Enter the average daily BOD entering the aeration zone in units of milligram per liter
Effluent Biochemical Oxygen Demand (BOD) f, mg/L	Enter the average daily BOD leaving the aeration zone in units of milligram per liter
Nitrification Demand (TKN), mg/L	Enter the average nitrogen levels entering the aeration zone in units of milligram per liter

The Blower Efficiency Improvements input page allows the user to select the pre and post blower conditions.

Table 40-4: Sheet 4 of 5, Blower Efficiency Improvements

Input Name	Description/Purpose
Mass Flowrate, lb/s	Enter the average mass flowrate. If this measure is being installed in conjunction with an Aeration Device Replacement and/or Aeration Control, this should be the post-installation mass flowrate.
Absolute Inlet Temperature, °R = 460 + °F	Enter the absolute inlet temperature.
Blower Efficiency, %	Enter the blower efficiency (pre- and post-installation).
Motor efficiency, %	Enter the rated motor efficiency (pre- and post-installation).
Absolute Inlet Pressure, lb _f /in ²	Enter the absolute inlet pressure (pre- and post-installation).
Absolute Outlet Pressure, lb _f /in ²	Enter the absolute outlet pressure (pre- and post-installation)
Annual Hours, hr/yr	Enter the estimated annual hours of operation.
Blower Capacity, hp	Enter total rated blower capacity.
Description	Used in inspection.

The Pump Efficiency Improvements input page allows the user to select the pre and post pump conditions.

Table 40-5: Sheet 5 of 5, Pumping Efficiency Improvements

Input Name	Type	Description/Purpose
Average Flowrate, gpm	Fill in	Enter the average flowrate in units of gallons per minute. The estimate should be based on the last twelve months of operation. Include supporting documentation as an attachment.
System Head, ft	Fill in	Enter the system head.
Fluid Specific Gravity, dimensionless	Fill in	The specific gravity of a substance is a comparison of its density to that of water. The default value is 1.0.
Pump Efficiency, %	Fill in	The pump efficiency, pre and post, based on the manufacturer's pump performance curve, which should be submitted with the project application.
Motor Efficiency, %	Fill in	Enter the rated motor efficiency.
Annual Hours, hr/yr	Fill in	Enter the average annual hours of operation.
Pumping Capacity, hp	Fill in	This is the pump motor nameplate rating.
Description	Fill in	Used in inspection.

2.2.40.4.1 CPUC Defined Peak Demand Savings

The Peak Demand Incentive Worksheet uses the DEER Peak method to calculate kW savings and incentive. The software chooses the appropriate DEER peak period based on the location inputs of the sheet 1. The software calculates DEER Peak directly for weather-based measures. It estimates DEER Peak for non-weather related measures (e.g. industrial, process, etc.) using accepted estimating techniques.

Table 40-6: Peak Demand Incentive Worksheet

Name	Description / Purpose
City	Pull-down list of applicable zip codes that is used to identify the 3 day DEER peak period (displayed in text below the pull-down)
Equipment Operates During the Peak Demand Period Defined Above? (Input)	Check box that allows user to confirm that the equipment operates during the 3 day DEER peak period that is described in the paragraph above.
Eligible Peak Demand Savings, kW	Estimated demand savings is displayed; user can enter a different value if applicable
Reason Savings Differ	Text box input where user enters a reason for using a demand savings value that differs from the value estimated by the software. (only activated if the user has entered a value that differs from the calculated value)
Incentive Rate, \$/kW	Demand reduction incentive rate
Qualified Peak Demand Incentive, \$	Product of eligible demand savings and incentive rate is displayed.
Total Incentive, \$	The sum of the qualified peak demand and energy savings incentives

2.2.40.4.2 Output

Once all necessary input information has been gathered, the Waste Water RCx Tool utilizes these inputs to compute the annual energy demand and usage for the baseline and proposed systems. From these values, the energy savings and incentive payment is calculated, and the results are presented to the user.

Measure savings will be presented to the user as both “Customer Savings” and “Above Code Savings”. “Customer Savings” represent the net savings associated with the information defining the measure, in other words, the actual savings based on the actual site information. “Above Code Savings” represent the net savings eligible for an incentive under customized program guidelines. This may differ from “Customer Savings” when the actual equipment installed differs from Title 24 requirements.

Table 40-7: Measure Results

Tool Output	Description/Purpose
Customer Baseline Energy Usage (Early Retirement Only)	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the existing equipment is displayed.
Code/Industry Standard Practice Baseline Energy Usage	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the Title-24 or ISP minimum efficient equipment is displayed.
Proposed Measure Energy Usage Equipment	Estimated on-peak demand, annual electrical energy use, and annual thermal energy use of the proposed equipment is displayed.
1 st Baseline Energy Savings	The difference between the Customer Baseline Equipment values and Proposed Equipment values are displayed.
2 nd Baseline Energy Savings (Early Retirement Only)	The difference between the Code/ISP Baseline Equipment values and Proposed Equipment values are displayed.
Total Incentive, \$	Estimated incentive amount based on 2012 program rates.

2.2.40.5 Energy Savings Explanation

Aeration Device Replacement

The estimated energy consumption for a given aeration device is a function of the treatment loads and aeration device performance (i.e., oxygen transfer rate (OTR)). The OTR depends on the type of aeration device. Five different types of aeration devices are modeled: fine bubble diffusers, coarse bubble diffusers, surface mechanical aerators, submerged turbine aerators and jet aerators. Device performance can be affected by elevation and temperature. This model assumes standard atmospheric pressure (14.7 psia) and an average annual water temperature of 20°C (77°F). For smaller sites (<1.0 MGD), aeration control capabilities may play a larger role in realizing energy savings, something not accounted for here. For example, improved aeration efficiency may allow a smaller facility to completely shut down one of two aerators.

Aeration Device Control

The energy savings resulting from automated control of dissolved oxygen (DO) is a function of the current aeration efficiency, part-load performance of the blower, and load profile. The Aeration Controls Model uses part load performance coefficients for the aeration equipment based on the affinity law, ASHRAE curves and manufacturer's data. To simplify the model an assumed Dissolved Oxygen profile (DOP) is used based on a case study presented in the EPA design manual for fine pore aeration systems which has scaled down typical relative diurnal BOD5 loading. Automated DO aeration controls can reduce the required energy consumption by 25 to 50%. When both Aeration Device Replacement and Aeration Controls are implemented, the baseline for the controls measures is the post case of the replacement project.

Blower Efficiency Improvements

Savings can be realized by increasing motor and/or blower efficiency, downsizing, and reducing average air flowrates and head pressure.

Pumping Efficiency Improvements

Savings can be realized by increasing motor and/or pumping efficiency, downsizing, and reducing average flowrates and head pressure.

The equations used to model blower and pump average demand assume constant loading. Blowers and pumps with variable loading may require a more detailed calculation methodology and/or measurement and verification.

2.3 Customized Measures - Engineering Calculations

If you cannot find an existing program savings calculation method that adequately represents your measure you can choose to submit your own savings estimate (Engineering Calculations). The purpose of this section is to provide basic guidelines in preparing your savings estimate that will help ensure a timely and successful review by the Utility Administrator. An engineering calculation worksheet is available (see Appendix E) to assist in the documentation process.

Preparation Basics

When preparing your application assume that the reviewer, while having a technical background, *will not have direct knowledge of your specific project*. Therefore, the description(s) that you provide should contain sufficient detail to clearly understand the processes involved, the proposed savings measure, and how the measure will achieve the stated savings. To facilitate the review process, please consider the following:

- ❑ Break up your calculations and associated descriptions into smaller steps, since this will make your thought process easier to follow,
- ❑ Fully describe how you obtained any data used in the calculations (i.e., equipment load, operating hours, etc.),
- ❑ Fully describe any simulations/software used,
- ❑ Attach (and be able to electronically submit) printouts/reports summarizing both the inputs and results of simulations or other software used in preparing the calculation(s), and
- ❑ Attach any manufacturer's data, production data and/or other documentation that supports the inputs and assumptions used in your calculations or descriptions. *Note that spot measurements of load, whether in kW or amps, under realistic operating conditions are preferred over assumed loads and or use of manufacturer's design values.*

The process of preparing and documenting your savings estimate can be divided into four basic steps, which are described in detail in the following sections.

Step 1. Process / Measure Description

The importance of providing a detailed description of the process and associated energy saving measure cannot be overstated, since it provides the reviewer with the necessary background information to understand the calculations that follow. Your description should be divided into the following three sections:

1. Existing process/equipment (w/o measure),
2. Proposed new equipment retrofit or enhancement, and
3. Resultant equipment and/or process (post installation).

In each section include sufficient information on the process and equipment involved making it clear to the reviewer how the proposed measure will be implemented and how it will achieve the stated savings. *For instance, if energy savings will be achieved using an energy management system (EMS) that implements a new control strategy, then you provide a complete description of the EMS, the existing and proposed control strategies, and the controlled equipment.*

Step 2. Establish Baseline Annual Energy Use and Demand

Statewide Customized Offering incentives are based on equipment/improvements that go beyond standard efficiency or “baseline” equipment. “Standard efficiency” refers to equipment that meets either State/Federal efficiency requirements or current industry practice. The baseline for any given project is the standard efficiency or Title 24 requirement for an individual measure. Baseline energy use is established using accepted standards for currently available equipment. For instance, the Energy Policy Act of 1992 established Federal guidelines for electric motor efficiency (See Appendix E for a list of equipment types and applicable standards, or contact your Utility Administrator).

The simplified equation used for the baseline energy use calculation is shown below.

Baseline Energy Use (kWh or Therms/year) = (Op Hours * Equipment Load (kW or Therms/hr))_{base}

Note that it may be necessary to develop a table of equipment loads and the annual operating hours at each load to arrive at an annual energy use estimate (see Appendix E for engineering calculation worksheet).

To obtain the baseline value, it may be necessary to adjust the energy use estimate for the existing equipment to account for “standard equipment” efficiency. For example, a customer that proposes to replace an existing 50-hp motor with a nominal full-load efficiency of 90.2% with a premium efficiency motor having an efficiency of 94.1% must establish the baseline energy using the accepted standard motor efficiency. In this case, the previously mentioned Energy Policy Act of 1992 guideline for a 50-hp motor is 93%. The baseline energy use of the existing motor must therefore be calculated based on the higher 93% efficiency value, which reduces the baseline (and associated savings) value.

The baseline energy use and demand calculations are critical to the savings calculations, so it is important that your calculations and associated descriptions provide sufficient information on the process, equipment and applicable standards to justify the proposed baseline energy use and demand.

Step 3. Establish Post-Installation Annual Energy Use and Demand

The simplified equation used for the post-installation energy use calculation is essentially the same as for the baseline calculation.

Post Install Energy Use (kWh or Therms/year) = (Op Hours * Equip Load (kW or Therms/hr))_{post}

Note that it may be necessary to develop a table of equipment loads and the annual operating hours at each load to arrive at an annual energy use estimate (see engineering calculation worksheet, Appendix E).

While the baseline energy use calculation is based on “standard efficiency” equipment, the post-installation calculation is based on the projected performance of the new equipment or process. Use of simulation software such as Engage, eQUEST, or another DOE2 based software package is acceptable as long as the inputs and associated assumptions (if any) are clearly stated and can be verified. Use of a manufacturer-specific simulation product can be acceptable but will require additional information on the underlying principles used by the software. Again, it is important that your description provide sufficient detail so that the reviewer will understand the basis for your projection. It is important to note that the reviewer has the option of substituting an alternative method of estimating the post-installation energy use and/or may require monitoring to confirm the estimate.

Step 4. Calculate Energy Saving, Demand Savings, and Incentive Amount

Once the baseline and post-installation annual energy use and demand estimates are completed then the savings estimate is simply the difference between the annual baseline and post installation use and demand estimates.

Savings (kWh/year) = Baseline Energy Use - Post-Installation Energy Use

The peak demand savings (kW) are based on the DEER Peak Definition (see section 1.4.8). The total incentive amount is then calculated by multiplying the savings estimate by the appropriate program incentive multiplier (see Section 1, Table 1-3).

Incentive (\$) = program Incentive Multiplier (\$/ (kWh or Therms)) * Savings (kWh or Therms/year)

Note that the calculated incentive is limited to 50% of the installed measure cost or incremental cost depending on the project type.
– see Section 1.8.2.

2.4 Measurement & Verification (M&V) Process

The M&V process begins after the Utility Administrator reviews the submitted application **and has determined at its sole discretion that an M&V process is appropriate for the proposed project.**

The M&V process proceeds as follows:

1. **M&V Requirement Notification.** The Utility Administrator contacts the Project Sponsor and notifies them of the M&V requirement. The Utility Administrator sends the Project Sponsor the Measurement & Verification Guidelines.
2. **M&V Plan Development.** The Project Sponsor develops an M&V plan based on the M&V Guidelines. The Project Sponsor submits the M&V plan, and any required baseline data to the Utility Administrator.
3. **Application and M&V Plan Approval.** If the application and the M&V plan are approved, incentive funding for the project is reserved and the Project Sponsor and Utility Administrator initiate the application approval review.
4. **Project Installation.** For SDG&E and SCE service territories, the Project Sponsor submits a signed Installation Report and invoices after all project measure(s) have been **installed and are fully commissioned and fully operational**. For PG&E service territory, the Project Sponsor notifies the Utility Administrator in writing and submits invoices after all project measure(s) have been **installed and are fully commissioned and fully operational**.
5. **Installation Review.** Upon receipt of Installation Report (SCE and SDG&E), or Installation notification (PG&E), the Reviewer will evaluate the submittal package and conduct a post-installation inspection to verify project installation and ensure the scope of work has not altered from the agreed-upon project.
6. **First Payment.** For SDG&E service territory, the designated Payee receives 60 percent of the Installation Report approved incentive along with an M&V adder, upon approval of the Installation Report.

For SCE and PG&E service territories, the designated payee receives the 10% M&V adder, to defray the M&V cost, upon approval of the Installation Review. The M&V adder is 10% of the IR approved incentive amount, not to exceed \$50,000.
7. **Project Performance Period.** The Applicant performs the agreed-upon M&V activities on the new operating equipment for a period up to two years (at discretion of Utility Administrator). At the end of the project performance period, the Project Sponsor submits the Operating Report.
8. **Operating Report.** The Applicant submits the Operating Report and operating data to the Utility Administrator. Upon receipt, the Utility Administrator reviews the report and data.
9. **Final Payment.** For SDG&E service territory, the designated Payee receives the remaining balance of the incentive based on the measured savings upon approval of the Operating Report. For SCE and PG&E service territories, 100% of the incentive is paid at the end of the project performance period when the Operating Report is approved.
The energy savings incentive is based on actual performance as indicated by the M&V results.