Consumers Energy Retro-commissioning Tool (CERT)

Help Manual and Frequently Asked Questions

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CERT RCx Help

Overview

Help File: This help file must reside in the same directory as the **CERT RCx tool**.

Prerequisites: Excel 2003 Users: To Enable Macros: Go to the Macro Security dialog box via Tools menu, Macro submenu. Select Medium. Whenever you open the RCx Tool you will be prompted to enable the macros.

Prerequisites: Excel 2007 Users: To Enable Macros: Click on the Office button on the top left corner of the application. Then click on the Excel Options (You can find this near Exit Excel at the bottom). Under the Popular tab and Top options for working with Excel, check Show Developer tab in the Ribbon. Click Ok. Click the Developer ribbon and in the leftmost pane, click Macro Security. Select Enable all macros, and click ok. Whenever you open the RCx Tool you will not be bothered by a security warning. Alternatively you can choose Disable all macros with notification. Whenever you open the RCx Tool you will encounter a security warning just above the worksheet that reminds you that some content has been disabled and will need to allow macros at that time.

Inputs: All required user inputs are shaded in red:

Once they have been filled in the color will become yellow. Begin by entering project-specific information on the General Information worksheet. Progress through the worksheet by using the "Prev" and "Next" buttons. This will take you in a logical order to fill in data.

Outputs: After all inputs have been entered, including schedules and bin data, click the "Calculate" button on either the Summary by Equipment or Summary by Measure worksheets to generate data on the active sheet.

How To Use The Tool

This tool estimates the energy and demand impacts associated with implementing various ECMs for air handling units and chiller/cooling towers.

To use the tool, view each of the tabs listed below and enter the required information. The overall process is as follows:

- Enter information about the project, schedules, and equipment by selecting the tabs as listed below.
- Enter information about the ECMs to be analyzed on the ECM tab for each piece of defined equipment.
- Click the Calculate button located on the ECM tabs.
- View the results summary tabs.

Developing input information:

For best results, base the inputs for each component on field measurements. Use portable data loggers or Building Automation System trending capabilities to the extent possible to collect performance data, and then develop relationships between key variables and outside air temperature for the air and water-side components. Constants such as nameplate information, and reset schedules should be gathered while on-site.

Variables that are entered as a function of outside air temperature:

- Supply Air Flow
- Supply Air Temperature
- Return Air Temperature
- Outside Air Fraction (collect OAT, MAT, and RAT to calculate OAF)
- Chiller Load (ideally, collect OAT, CHWS, CHWR, CHW flow to calculate load)
- CHWS

Enter project information:

General Information

This screen is the first screen of user input, and is where information important to identifying your project is entered. More information about this screen is included in the General Information help topic.

Schedules

This screen provides methods to create, edit, or delete schedules that will be applied to both baseline and ECM cases. More information about this screen is included in the Schedules help topic.

Gas Rate

Enter the desired natural gas rates in $/therm. Winter and summer rates may be entered. The worksheet defaults to winter rate unless a summer rate is entered. Gas rates must be entered to provide meaningful financial results. More information about this screen is included in the Gas Rate help topic.

Electric Rate

This screen provides methods to create and edit electricity rates. Rates must be created to provide meaningful financial results. More information about this screen is included in the Electricity Rate help topic.

Demand

After the general information (including weather data) and schedules are entered, the Demand tab is populated with the highest and lowest weather temperature for each month based on the building operating schedule. Select whether the highest temperature or the lowest temperature will be used to calculate the demand for each month. More information about this screen is included in the Demand help topic.

AHU Heating and Cooling

This tab provides a centralized location to specify the heating and cooling source for all AHUs in the project. Note that it is also possible to apply specific cooling source efficiencies on each AHU tab. More information about this screen is included in the AHU Heating and Cooling help topic.

Equipment

Air Handling Units and Chillers/Cooling Towers are created using this tab. More information about this screen is included in the Equipment help topic.

When equipment is added, tabs for both the baseline condition and supported ECMs for that equipment type are generated. The baseline tab allows the user to specify the equipment size and baseline control characteristics. The ECM tab lists the available ECMs for each unit and allows the user to enter new conditions, schedules, or other information needed for the ECM. Finally, the ECM tab allows the user to select whether or not the ECMs are "stacked." More information about ECM stacking is included in the Stacking help topic.

Review results

Results from the calculations are displayed in four reporting formats:

- Calc Summary
- Bin Data Summary
- Summary by Measure
- Summary by Equipment

More information about each of these reports is included in their respective help topics.

Stacking and ECM Interactions

Stacking and ECM Interactions

This tool is designed to calculate savings for individual ECMs or groups of ECMs. When multiple ECMs are implemented on the same system, they are "stacked" to prevent overestimation of savings. Stacking is achieved by using the outputs of one ECM the baseline condition of the next ECM. The stacking occurs in a fixed order, as shown below. The user selects which ECMs to include in the overall calculation, and whether stacking will be applied. When stacking is applied, then the ECM conditions of the previous measure, i.e., MAT vs. OAT of the optimized economizer, will be applied to the subsequent ECM, i.e., SAT Reset.

Air-side and Water-side ECMs are evaluated separately; there is no interaction between the Air-side systems (AHU) and the Water-side systems (Chiller and cooling tower).

Air-side ECMs:

- **Optimize air handler scheduling.** Adjusting the operating schedules will reduce the number of operating hours and will reduce the impact of all subsequent ECMs. Changes in the operating schedule are applied first in the stacking order.
- **Optimize airside economizer operation (with SAT reset input).** Next, the economizer optimization ECM is applied. This further reduces the requirement for mechanical cooling and heating. If the SAT reset ECM is included in the set of ECMs for the AHU, then the economizer control is optimized using the new SAT reset schedule.
- **Optimize or reset supply air temperature.** Next, the impacts associated with the SAT reset ECM are applied. Since the SAT will be different from the baseline case, and since the building load is unchanged between the baseline and ECM case, the supply airflow will be different, which will affect the fan electrical demand, either decreasing it, if the new SAT is lower, or increasing it if the new SAT is higher. To realize full benefit of this ECM, the economizer control is always optimized for the new SAT reset schedule regardless of whether the optimized economizer operation ECM is explicitly included in the stacking order.
- **Optimize or reset discharge static pressure setpoint.** Next, the impacts associated with changing the supply static pressure are applied. The previous ECM, SAT reset, will change the supply airflow requirements. With the new airflow requirements established, the effects of changing the discharge static pressure can be evaluated.
- **Add or optimize VFD on supply fan.** Finally, once the new airflow and static pressure relationships have been established, the effects of changing the fan control can be evaluated.

Water-side ECMs:

- **Optimize or Reset Chilled Water Supply Temperature.** First, impacts due to changes to the CHW supply temperature ECM are evaluated. Note that the CHW delta temperature does not change with this ECM, and so there are no pumping power impacts.
- **Optimize or Reset Condenser Water Supply Temperature.** After the CHW supply temperature ECM has been applied, impacts due to changes to the Condenser Water Supply (CWS) temperature are evaluated. The CWS water flow rate is constant, and so there are no pumping power impacts, although there will be effects on the cooling tower fan power requirement.

- **Add or Optimize VFD on Chilled Water Pump.** Next, the impacts of adding a VFD to the chilled water pump are evaluated. Since there are no changes in CHW flow related to the previous ECMs, there is no stacking interaction.

- **Add or Optimize VFD on Cooling Tower Fans.** Finally, the tool evaluates the impacts of adding a VFD to the cooling tower fan. This includes the effects of changing the CWS setpoint, if that ECM was included.

General Information

The General Information screen is the first screen of user input. Not all of the fields are required, but all are important in identifying your project. The screen is grouped into three sections: ***General Project Information***, ***Provider Information*** and ***General Inputs***. The inputs are discussed below. Those highlighted in red are required.

General Project Information:

This information pertains to the site upon which the RCx is performed. Any input is allowed

Provider Information:

This information pertains to the person, team or organization performing the RCx activity. Any input is allowed.

General Inputs:

Building Type: A drop-down list containing valid building types. Only list values are allowed.

Zip Code: Enter a valid 5-digit zip code, then press 'Enter' or 'Tab'. The CA climate zone located directly below will be filled in as a result of this action. If there is more than one climate zone, you will be presented with a dialog containing a drop down list that allows you to select the desired zone.

CA Climate Zone: This field is automatically filled in after a valid zip code has been entered and the zip code field has been exited.

OA Design Cooling Temperature (F): This is the design cooling temperature for the selected CA Climate Zone. This field is automatically filled in after a valid zip code has been entered and the zip code field has been exited.

OA Design Cooling Temperature (F): This is the design heating temperature for the selected CA Climate Zone. This field is automatically filled in after a valid zip code has been entered and the zip code field has been exited.

Elevation (ft): Enter the building elevation in feet to calculate the proper air density.

Year Building Constructed: Enter the year constructed for the RCx site. Only whole numbers greater than zero are allowed.

Facility Gross Area (ft²): This is the total area, both conditioned and unconditioned, upon which the RCx is performed. Only whole numbers or decimals greater than zero are allowed.

Date: Enter the analysis date.

Command Buttons:

PREV:
Takes you to the PIER RCx Summary by Equipment report.

NEXT:
Takes you to the Schedules screen.

Schedules

Use this screen to add, delete and copy building schedules, or select and activate an existing building schedule for editing. Additional functionality allows you to either hide all schedules or show all previously hidden schedules.

Command Buttons:

Add Schedule:
Click this button to add a new schedule. Opens a dialog that allows you to enter a name (27 characters or less). The name field is required. Click *OK* to add the schedule. A new schedule worksheet with a default schedule is created.

Delete Schedule:
Select an existing schedule from the list. Then click this button to delete the schedule. Opens a dialog that confirms your decision to delete. The worksheet containing the schedule selected is deleted.

View/Edit Schedule:
Select an existing schedule from the list. Then click this button to view/edit the schedule. Activates the

worksheet containing the schedule selected. If hidden, the worksheet is made visible.

Copy Schedule:
Select an existing schedule from the list. Then click this button to copy the schedule. Opens a dialog that allows you to edit the name (27 characters or less). Click *OK* to copy the schedule. A new schedule worksheet is created containing a copy of the schedule previously selected.

Hide All Schedules:
Makes all schedule worksheets hidden.

Show All Schedules:
Makes all schedule worksheets visible.

Entering The Schedule:

Day Schedules: You may create up to 10 different schedules. The leftmost column is used to store the day schedule name. Then select the status (on or off), and the start/stop times. When the Status is set to off, the Start and Stop times are grayed out. When the Status is set to on, the Stop Time must be greater than the Start Time. If the Stop time is less than the Start time, then the tool will display a warning dialog when the user attempts to navigate to another screen and will require the user to correct the schedule problem.

Week Schedules: You may create up to 5 different schedules. The leftmost column is used to store the week schedule name. Then use the drop down lists to select 7 day schedules and one holiday schedule. Valid week schedules must have a Day schedule selected for each day of the week.

Annual Schedules: You may create up to 5 different schedules. The leftmost column is used to store the annual schedule name. Then enter the start/stop dates and select a week schedule from the drop down list in the last column. The following restrictions apply:

- The first schedule row must start with January 1.
- The dates for multiple schedules cannot overlap.
- The Stop Date for each schedule must be greater than the Start Date.
- Each schedule row must be in chronological order with no date gaps.
- The last schedule row must end with December 31.
- Each schedule row must include a valid Week Schedule.

If any of these restrictions are violated, the tool will display a warning dialog when navigating away from the schedule sheet and require the user to correct the problem.

Command Buttons:

PREV:
Takes you to the General Information screen.

NEXT:
Takes you to the Gas Rate screen.

Gas Rate

All gas rate information and schedules are input on this screen. Required fields are shown in red.

Summer Period Begin and End Dates: Enter a valid date that is greater than 12/31/1949. The winter period is automatically filled in after you enter the summer period.

Winter Period Begin and End Dates: These are automatically filled in after you select the summer periods. Manual editing is not allowed.

Energy ($/therm): Enter the rates in U.S. dollars for both the summer and winter periods.

Command Buttons:

OPEN:
Presents you with a *file open* dialog that allows you to load a previously saved gas rate configuration.

SAVE:
Presents you with a *file save as* dialog that allows you to save the current gas rate configuration as a comma separated (.csv) file.

PREV:
Takes you to the Schedules screen.

NEXT:
Takes you to the Electricity Rate screen.

Electricity Rate

The electricity rate inputs are discussed below. Those highlighted in red are required.

Name: Enter a name for the rate.

Summer Period Begin and End Dates: Enter a valid date that is greater than 12/31/1949. The winter period is automatically filled in after you enter the summer period.

Winter Period Begin and End Dates: These are automatically filled in after you select the summer periods. Manual editing is not allowed.

Consumption: Enter the peak, mid-peak, and off-peak electricity rates for consumption in $/kWh for both the winter and summer periods.

TOUs: Click the first cell and while pressing the 'Ctrl' key, drag the mouse through the desired selection in the summer period. Then click the "Set" button below the summer period section. All three TOUs must have at least one hour selected. Repeat this process for the winter period. Make sure you save your changes by selecting "***Set***".

Command Buttons:

OPEN:
Opens a previously saved electricity rate TOU file in the **.csv** format.

SAVE:
Saves the current electricity rate TOU for both the summer and winter periods in the **.csv** format.

SET:
Saves the currently selected TOU period (summer or winter.)

PREV:
Takes you to the Gas Rate screen.

NEXT:
Takes you to the Demand screen.

Demand

Begin by selecting a *Master Building Schedule.* This action calculates and inserts the monthly high/low temperatures used by the calculations. Next enter the summer/winter demand rates in $/kW. Finally, for each month, select whether the high or low temperature is used in the output calculations.

The demand inputs are discussed below. Those highlighted in red are required.

Master Building Schedule: Select a building schedule from the drop-down list. When the building schedule has changed, the monthly high/low temperatures based on the electricity summer/winter TOU periods are automatically calculated. If you clear this field then all temperatures and high/low settings in the Select Temp fields are cleared. Only list values are allowed.

Demand ($/kW) - Summer: Enter the summer demand in $/kW.

Demand ($/kW) - Winter: Enter the winter demand in $/kW.

Monthly High/Low Temperatures: These temperatures are automatically filled in after you change the master building schedule and are based on the selected schedule, the climate zone and the summer/winter Electric TOU.

Select Temp: These settings determine whether the high or low temperature is used in the output calculations. Select a value from the drop-down list. Only list values are allowed.

Command Buttons:

PREV:
Takes you to the Electricity Rate screen.

NEXT:
Takes you to the Central Plant screen

AHU Heating and Cooling

This screen, AHU Heating and Cooling, provides a centralized location to specify the heating and cooling source for all AHUs in the project. Note that it is also possible to apply specific cooling source efficiencies on each AHU tab.

The inputs are discussed below. Those highlighted in red are required.

HVAC Heating System Type: Select from the drop-down list. Only list values are allowed. Note that the HVAC heating system type is used for both the AHU and reheat system.

Heating Plant Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Cooling Plant Efficiency: Enter the efficiency for the centralized cooling plant that provides a cooling source for AHUs.

OAT: Provide four data points for the outside air temperature

kW/ton: Provide four data points in kW/ton that coincide with the OAT.

Note that this cooling plant efficiency is used ONLY for the AHU equipment (air-side equipment). Chillers (water-side equipment) calculate efficiency independently of the information shown in this screen.

Command Buttons:

PREV:
Takes you to the Demand screen.

NEXT:
Takes you to the Equipment screen

Equipment

Use this screen to add, delete and copy equipment.

Command Buttons:

Add Equipment:
Click this button to add a new piece of equipment. Opens a dialog that allows you to enter a name (25 characters or less) and select an equipment type. Both fields are required. Click *OK* to add the equipment. Both an equipment and corresponding ECM worksheet are created.

Copy Equipment:
Select an existing piece of equipment from the list. Then click this button to copy the equipment. Opens a dialog that allows you to edit the name (25 characters or less). Click *OK* to copy the equipment. Both an equipment and corresponding ECM worksheet are created.

Delete Equipment:
Select an existing piece of equipment from the list. Then click this button to delete the equipment. Opens a dialog that confirms your decision to delete. Both the equipment and corresponding ECM worksheets are deleted.

PREV:
Takes you to the Central Plant screen.

NEXT:
Takes you to the next worksheet in the tabbed worksheet list.

AHU

The AHU screen allows the user to input the baseline values for an AHU. It consists of four main user input sections (described below), and five regression tables with corresponding charts. **All user inputs are required.**

General Information:

Baseline Schedule: Select from the drop-down list. The list box is filled in with predefined schedules created on the Schedule tab.

Fan Heat (°F): Fan heat in degrees Fahrenheit. This is the temperature rise across the supply fan. It is assumed to be constant.

Return Fan: Select whether or not there is a return fan.

If "**No**" is selected then:
The return fan *Capacity (CFM)* is cleared, grayed out and locked.
The return fan *Max Fan Power (kW)* is set to: "**Set Operating kW**".
The return fan *Fan Control* is set to: "**Constant Volume**".
Since there is no return fan, the return fan inputs are not used in any calculations.

If "**Yes**" is selected then:
The return fan *Capacity (CFM)* is unlocked.
The return fan *Max Fan Power (kW)* is set to: "**Set Operating kW**".
The return fan *Fan Control* is set to: "**Constant Volume**".
If the return fan *Fan Control* is set to: "**Variable Volume**," the return fan tracks the supply fan airflow, scaled to the return fan capacity.
The return fan power calculations are based on a cubic relationship between flow and pressure with no minimum static pressure requirement, since the return fan is not required to maintain a constant static pressure.

Total Static Pressure (in. WC): Enter the supply fan design total static pressure as measured in inches of water column. This is not the static pressure setpoint, but the static pressure that the fan is capable of generating at design flow.

System No-Reheat Point (°F): The input format is degrees Fahrenheit. The No-Reheat point is defined as the temperature above which no reheat is required. Below the No-Reheat point, the reheat requirement increases linearly to the design heating temperature. For VAV boxes, the reheat supply temperature is a constant (Default 95 F), and the airflow increases linearly as the outdoor temperature decreases below the balance point. For CV systems, the No-Reheat point definition is similar, although since Constant Volume Reheat systems modulate to match the zone load, reheat is generally necessary up to a much higher temperature. Therefore, the No-Reheat point is at a much higher temperature, approaching the design cooling temperature. For CV boxes, the airflow is constant, but the Reheat Discharge Air Temperature increases linearly as the outdoor temperature decreases below the balance point.

Reheat Information:

Fraction of zone terminal boxes with reheat capability: This represents the fraction of zone terminal boxes that can provide reheat. The remaining terminal boxes only provide cooling. Enter a value from 0.01 to 1.

Reheat DT for CV systems (°F): Reheat DT is the maximum temperature rise across the constant volume zone reheat box. At maximum heating, the discharge air temperature will be higher than the AHU SAT by this amount.

Reheat Air Discharge Temp (°F): The Reheat Air Discharge Temp is the reheat VAV box discharge air temperature. The discharge air temperature for VAV boxes with reheat is maintained at a constant value, while the fraction of terminal boxes actually providing reheat varies.

Duct Static Pressure Information:

This sets the Duct Static Pressure to a fixed value, or allows it to reset as a function of supply airflow.

When Reset control is chosen, the static pressure will reset linearly between the minimum and maximum static pressure setpoints, corresponding to the minimum and maximum airflow ratios. If the actual airflow ratio is below the Min Airflow Ratio listed in the reset schedule, the setpoint will be equal to the Min Setpoint. Similarly, if the actual airflow ratio is above the Max Airflow Ratio listed in the reset schedule, the setpoint will be equal to the Max Setpoint.

Control: Select from the drop-down list. Only list values are allowed.

If "**Fixed**" is selected then:

The *Setpoint Min* and *Setpoint Max*, and *Min Airflow Ratio* and *Max Airflow Ratio* are cleared, grayed out and locked.

The *Setpoint(in. WC)* is unlocked.

If "**Reset**" is selected then:

The *Setpoint Min* and *Setpoint Max*, and *Min Airflow Ratio* and *Max Airflow Ratio* are unlocked.

The *Setpoint(in. WC)* is cleared, grayed out and locked.

Setpoint (in. WC): Enter the pressure as measured in inches of water column.

Setpoint Min: Enter the minimum static pressure setpoint, corresponding to the Min Airflow ratio, as measured in inches of water column.

Setpoint Max: Enter the maximum static pressure setpoint, corresponding to the Max Airflow ratio, as measured in inches of water column.

Flow Ratio at Min Setpt: Enter the airflow ratio that corresponds to the Minimum Static Pressure setpoint as measured in percent.

Flow Ratio at Max Setpt: Enter the airflow ratio that corresponds to the Maximum Static Pressure setpoint as measured in percent.

Supply/Return Fan Information:

Capacity (CFM): Enter the fan capacity in CFM. Only positive decimal values are allowed.

Max Fan Power (kW):

If "**Set Operating kW**" is selected then:

The *Operating kW* is unlocked.

The *Motor Size*, *Motor Efficiency*, and *Load Factor* are cleared, grayed out and locked.

If "**Calculate**" is selected then:

The *Operating kW* is cleared, grayed out and locked.

The *Motor Size*, *Motor Efficiency*, and *Load Factor* are unlocked.

Operating kW: Enter the fan operating power (kW). Only positive decimal values are allowed.

Motor Size (HP): Enter the fan motor size (HP). Only positive decimal values are allowed.

Motor Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Load Factor (%): Enter a decimal number that is greater than zero and less than or equal to one.

Fan Control:

If "**Constant Volume**" is selected then:

The *Fan Control Type* and *VFD Drive Efficiency* are cleared, grayed out and locked.

If "**Variable Volume**" is selected then:

The *Fan Control Type* is.set to "**Discharge Dampers**".

The *VFD Drive Efficiency* is cleared, grayed out and locked.

Fan Control Type:

If "**Variable Speed Drive**" is selected then:

If the *Fan Control* is set to "**Variable Volume**" then the *VFD Drive Efficiency* is unlocked.

If "**Inlet Guide Vanes**" is selected then:

The *VFD Drive Efficiency* is cleared, grayed out and locked.

If "**Discharge Dampers**" is selected then:

The *VFD Drive Efficiency* is cleared, grayed out and locked.

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Supply Air Flow Regression:

Enter four values of Outside Air Temperature in degrees Fahrenheit and Supply Airflow as a percent of the Supply Fan Capacity. The values are plotted for visualization.

Supply Air Temperature Regression (SAT):

Enter four values of Outside Air Temperature in degrees Fahrenheit and Supply Air Temperature in degrees Fahrenheit. The values are plotted for visualization.

Return Air Temperature Regression (RAT):

Enter four values of Outside Air Temperature in degrees Fahrenheit and Return Air Temperature in degrees Fahrenheit. The values are plotted for visualization.

Mixed Air Temperature Regression (MAT):

MAT Data:

If "**Calculate**" is selected then:

The *Max Outside Air Fraction (%)* and *Min Outside Air Fraction (%)* and the *OAT/MAT grid* are cleared, grayed out and locked.

The *MAT Calculation Type* is set to "**Fixed OSA (%)**".

If "**User Input**" is selected then:

The *MAT Calculation Type* and *Fixed OSA (%)* are cleared, grayed out and locked.

The *Max Outside Air Fraction (%)* and *Min Outside Air Fraction (%)* and the *OAT/MAT grid* are unlocked.

MAT Calculation Type:

If "**Fixed OSA (%)**" is selected then: The *Fixed OSA (%)* is set to 10%.

If "**Fixed OA (CFM)**" is selected then: The *Fixed OA (CFM)* is set to 1000.

If "**Econo**" is selected then:
The *Fixed OSA (%)* is cleared, grayed out and locked.
The *Max Outside Air Fraction (%)* and *Min Outside Air Fraction (%)* are unlocked. In Econo mode, the MAT follows the Supply Air Temperature Regression.

Fixed OSA (%)/Fixed OA (CFM): For OSA (%) enter a decimal number that is greater than zero and less than or equal to one. For OA (CFM) enter a number that is between 1000 and 200000 inclusive.

Max Outside Air Fraction (%): Enter a decimal number that is greater than zero and less than or equal to one.

Min Outside Air Fraction (%): Enter a decimal number that is greater than zero and less than or equal to one.

kW/ton Regression (Cooling Plant Efficiency):

Use instead of central plant: If this is checked the calculations will use the information here instead of the values on the Plant tab. Allows the user to differentiate between central plant or packaged units.

User Documentation: This area to the right of the user inputs is reserved for any noteworthy documentation related to the current equipment. Text, graphics and internet links may be inserted in this area.

Command Buttons:

PREV:
Takes you to the previous worksheet in the tabbed worksheet list.

NEXT:
Takes you to the next worksheet in the tabbed worksheet list.

AHU ECM

The AHU ECM screen consists of user input sections (described below) for the **Schedule**, **Economizer**, **SAT Reset**, **Fixed/Reset Duct Static Pressure Setpoint**, **Supply Fan VFD** and **Return Fan VFD** ECMs. These inputs are changes to the baseline values that are on the AHU screen. **All user inputs for each selected section are required.**

Schedule ECM:

Select ECM Schedule: Select from the drop-down list. The list box is filled in with predefined schedules created on the Schedule tab.

Economizer ECM:

Max Outside Air Fraction (%): Enter a decimal number that is greater than zero and less than or equal to one.

Min Outside Air Fraction (%): Enter a decimal number that is greater than zero and less than or equal to one.

SAT Reset ECM:

The SAT Reset ECM changes the supply air temperature reset schedule. This can have the benefit of allowing more economizer cooling and reducing the reheat requirements. However, when the SAT is increased, the supply airflow must also increase to provide the same amount of cooling. This will also increase the fan energy requirements. This is referred to as a fan penalty.

Excess supply airflow warning: Increasing the SAT will increase the supply airflow requirements. If the baseline supply airflow is close to the fan design capacity, it is possible that the airflow requirements will exceed the capacity of the fan. In Constant Volume systems, since the fan is already running at its design flow, increasing the flow requirement (due to increased SAT at high OAT) will cause the airflow to exceed the fan capacity.

If the required airflow exceeds the fan capacity, a warning will be displayed but the calculations will proceed, calculating the fan power requirements as if the supply fan could provide the required airflow.

Reduce the SAT reset schedule to eliminate this problem.

Supply Air Temperature Regression:

Provide four data points for the supply air temperature to be used as SAT in the ECM. Note that the OAT and Baseline column are filled in with values from the corresponding AHU screen, and cannot be changed.

Fixed/Reset Duct Static Pressure Setpoint:

This ECM changes the Duct Static Pressure to a new value, or allows it to reset as a function of supply airflow.

When Reset control is chosen, the static pressure will reset linearly between the minimum and maximum static pressure setpoints, corresponding to the minimum and maximum airflow ratios. If the actual airflow ratio is below the Min Airflow Ratio listed in the reset schedule, the setpoint will be equal to the Min Setpoint. Similarly, if the actual airflow ratio is above the Max Airflow Ratio listed in the reset schedule, the setpoint will be equal to the Max Setpoint.

Control: Select from the drop-down list. Only list values are allowed.
If "**Fixed**" is selected then:
The *Setpoint Min* and *Max* are cleared, grayed out and locked.
The *Setpoint(in. WC)* is unlocked.

If "**Reset**" is selected then:
The *Setpoint Min* and *Max* are unlocked.
The *Setpoint(in. WC)* is cleared, grayed out and locked.

Setpoint (in. WC): Enter the pressure as measured in inches of water column.

Setpoint Min: Enter the minimum static pressure setpoint, corresponding to the Min Airflow ratio, as measured in inches of water column.

Setpoint Max: Enter the maximum static pressure setpoint, corresponding to the Max Airflow ratio of 100%, as measured in inches of water column.

Flow Ratio at Min Setpt: Enter the airflow ratio that corresponds to the Minimum Static Pressure setpoint as measured in percent.

Flow Ratio at Max Setpt: Enter the airflow ratio that corresponds to the Maximum Static Pressure setpoint as measured in percent.

Supply Fan / Return Fan VFD:

Fan Control: This field is locked out and set to "**Variable Volume**".

Fan Control Type: This field is locked out and set to "**Variable Speed Drive**".

Min Flow Ratio (%): Enter a decimal number that is greater than zero and less than or equal to one.

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Stack ECMs: Check this box to combine all ECMs currently selected in the order they are displayed on this screen. The order cannot be changed.

User Documentation: This area to the right of the user inputs is reserved for any noteworthy documentation related to the current equipment. Text, graphics and internet links may be inserted in this area.

Command Buttons:

PREV:
Takes you to the previous worksheet in the tabbed worksheet list.

NEXT:
Takes you to the next worksheet in the tabbed worksheet list.

Chiller

The Chiller screen consists of four main user input sections (described below), and one regression table with corresponding chart. **All user inputs are required.**

There is a one-to-one relationship between the chiller and the cooling tower. Systems of multiple chillers and cooling towers are not supported. For multi-chiller/cooling tower systems, estimated savings, with reduced precision and accuracy, may be achieved by aggregating multiple chillers and cooling towers into a single chiller/cooling tower plant.

General Information:

Baseline Schedule: Select from the drop-down list. Only list values are allowed.

Chiller Type: Select from the drop-down list. Only list values are allowed.

Condenser Type: Water cooled chillers are supported.

Rated Capacity (tons): Enter the chiller capacity in US tons.

Rated Efficiency (kW/ton): Enter the chiller efficiency in kW/ton. The entry must be a decimal number that is greater than zero and less than or equal to one.

Chilled Water Supply Information:

Temperature Control: Select from the drop-down list. Only list values are allowed.

If "**Fixed**" is selected then:
The *Min Temperature, OAT at Min Temperature, Max Temperature* and *OAT at Max Temperature* are cleared, grayed out and locked.
The *Temperature Setpoint* is unlocked.

If "**Reset**" is selected then:
The *Min Temperature, OAT at Min Temperature, Max Temperature* and *OAT at Max Temperature* are unlocked.

The *Temperature Setpoint* is cleared, grayed out and locked.

Temperature Setpoint (°F): Enter the setpoint in degrees Fahrenheit.

Min Temperature (°F): Enter the minimum CHWS temperature in degrees Fahrenheit that corresponds to the *OAT at Min Temperature*. If the actual OAT is below *OAT at Min Temperature*, the CHWS will equal the *Min Temperature*.

OAT at Min Temperature (°F): Enter the temperature in degrees Fahrenheit.

Max Temperature (°F): Enter the temperature in degrees Fahrenheit.

OAT at Max Temperature (°F): Enter the maximum CHWS temperature in degrees Fahrenheit that corresponds to the *OAT at Max Temperature*. If the actual OAT is above *OAT at Max Temperature*, the CHWS will equal the *Max Temperature*.

Delta Temperature (°F): This is the Chilled Water temperature rise across the load. It is used to calculate the CHW flowrate. Enter the temperature in degrees Fahrenheit

Chilled Water Load Regression:

The outside air temperature range for the Chilled Water load regression should correspond to the selected climate zone outside air temperature range. If the bin temperature is below or above the outside air temperature range used for the regression, the load will be maintained at the minimum or maximum load corresponding to the minimum or maximum temperature, respectively.

Enter four values of Outside Air Temperature in degrees Fahrenheit and Chilled Water Load in Tons. The values are plotted for visualization.

Condenser Water Supply Information:

This information is used by the cooling tower to provide the desired CWS temperature. The actual CWS temperature provided by the cooling tower is subject to the capacity of the cooling tower, the heat rejection load, and the outdoor conditions. The CWS temperature provided to the chiller will never be lower than the temperatures entered here.

Temperature Control: Select from the drop-down list. Only list values are allowed.

If "**Fixed**" is selected then:

The *CWS Temperature* is maintained at the *Temperature Setpoint*, within the capabilities of the cooling tower and the outdoor wet bulb temperature. Under high load and wet bulb conditions, the *CWS Temperature* may rise above the setpoint. Enter the Temperature Setpoint.

If "**Reset**" is selected then:

The *CWS Temperature* will be maintained at the *Min Temperature*, within the capabilities of the cooling tower and the outdoor wet bulb temperature. Under high load and wet bulb conditions, the *CWS Temperature* may rise above the *Min Temperature*.

The *Temperature Setpoint* is cleared, grayed out and locked.

Temperature Setpoint (°F): This is the Condenser Water Setpoint. The cooling tower will attempt to maintain this temperature. Note that if the outdoor wetbulb temperature is high, then the Condenser Water Supply Temperature may float above this value. Enter the setpoint in degrees Fahrenheit.

Min Temperature (°F): This is the minimum condenser water temperature allowed by the Chiller. This value is entered when Reset temperature control is selected. The Cooling Tower will attempt to maintain this temperature. When the outdoor wetbulb temperature increases, the Condenser Water Supply Temperature may float above the minimum temperature, subject to the load and the outdoor wetbulb temperature. Enter the Min Temperature in degrees Fahrenheit.

The cooling tower approach temperature is automatically calculated, and is a function of outdoor conditions and the heat rejection load.

Chilled Water Supply Pump Information:

The Chilled Water Supply Pump serves the full capacity of the chiller, i.e., there is a one-to-one relationship between the chiller and the CHW supply pump.

Design Flow (gpm): Enter the design pump flow in gpm. Only positive decimal values are allowed.

Motor Size (hp): Enter the pump motor size (hp). Only positive decimal values are allowed.

Motor Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Pump Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Design Total Dynamic Head (ft): Enter the chilled water pumping head at design flow. Only positive decimal values are allowed.

Pump Control:

If "**Constant Volume w/ Bypass**" is selected then:
The flowrate will be maintained at the Design Flow

If "**Constant Speed w/ 2-way valves**" is selected then:
The flowrate will vary as a function of the chilled water load and the User-entered Delta Temperature. The pump will ride the pump curve.

If "**Variable Volume w/ Variable Drive**" is selected then:
The flowrate will vary as a function of the chilled water load and the User-entered Delta Temperature. Enter the VFD Drive Efficiency.
Enter the Min Pressure Setpoint.

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Min Pressure Setpoint (ft): Enter the chilled water pumping minimum pressure setpoint. Only positive decimal values are allowed

Design Cooling Tower Information:

Entering Water Temperature (°F): Enter the design entering water temperature in degrees Fahrenheit. This is the design temperature used for sizing, not the operating temperature.

Exiting Water Temperature (°F): Enter the design exiting water temperature in degrees Fahrenheit. This is the design temperature used for sizing, not the operating temperature.

Wet Bulb Temperature (°F): Enter the design wet bulb temperature in degrees Fahrenheit. This is the design wetbulb temperature used for sizing.

Condenser Water Flow (gpm): Enter the condenser pump flow in gpm. Only positive values are allowed. The condenser water flow is constant.

Condenser Pump Horsepower (hp): Enter the condenser pump motor size (hp). Only positive decimal values are allowed.

Condenser Pump Head (ft): Enter the condenser pumping head. Only positive decimal values are allowed.

Condenser Pump Motor Efficiency (%): Enter the condenser pump motor efficiency (%) as a decimal number that is greater than zero and less than or equal to one.

Condenser Pump Efficiency (%): Enter the condenser pump efficiency (%) as a decimal number that is greater than zero and less than or equal to one.

Design Heat Rejection (tons): This is a calculated value that shows the cooling tower design heat rejection based on the design values entered above.

Max Fan Operating kW (kW): Enter the cooling tower fan operating electrical demand in kW. Only positive decimal values are allowed.

Fan Control: Choose the baseline cooling tower fan control. Choices include single speed, two-speed, and VFD control.

CFM Fan Off (%): Enter the cooling tower flowrate when the fan is off as a percentage of full flow. When the fan is off, this represents the amount of flow due solely to natural convection. The entry must be a decimal number that is greater than zero and less than or equal to one. The default is 10% of full flow.

CFM Fan Low Speed (%): For a two-speed fan, enter the cooling tower flowrate when the fan is running at low speed as a percentage of full flow. The entry must be a decimal number that is greater than zero and less than or equal to one. The default is 50% of full flow.

CFM Fan High Speed (%): Enter the cooling tower flowrate when the fan is running at high speed as a percentage of full flow. Typically this value will be 100%. The entry must be a decimal number that is greater than zero and less than or equal to one.

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

User Documentation: This area to the right of the user inputs is reserved for any noteworthy documentation related to the current equipment. Text, graphics and internet links may be inserted in this area.

Command Buttons:

PREV:
Takes you to the previous worksheet in the tabbed worksheet list.

NEXT:
Takes you to the next worksheet in the tabbed worksheet list.

Chiller ECM

The Chiller ECM screen consists of four user input sections (described below) for the **Chilled Water Pump VFD**, **Fixed/Reset Chilled Water Supply Temperature, Fixed/Reset Condenser Water Supply Temperature**, and **Cooling Tower Fan VFD** ECMs. **All user inputs are required.**

Chilled Water Pump VFD:

Pump Control Type: This field is locked out and set to "**Variable Speed Drive**".

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Fixed/Reset Chilled Water Supply Temperature:

Temperature Control: Select from the drop-down list. Only list values are allowed.

If "**Fixed**" is selected then:

The *Min Temperature, OAT at Min Temperature, Max Temperature* and *OAT at Max Temperature* are cleared, grayed out and locked.
The *Temperature Setpoint* is unlocked.

If "**Reset**" is selected then:

The *Min Temperature, OAT at Min Temperature, Max Temperature* and *OAT at Max Temperature* are unlocked.
The *Temperature Setpoint* is cleared, grayed out and locked.

Temperature Setpoint (°F): Enter the setpoint in degrees Fahrenheit.

Min Temperature (°F): Enter the minimum CHWS temperature in degrees Fahrenheit that corresponds to the *OAT at Min Temperature*. If the actual OAT is below *OAT at Min Temperature*, the CHWS will equal the *Min Temperature*.

OAT at Min Temperature (°F): Enter the temperature in degrees Fahrenheit.

Max Temperature (°F): Enter the temperature in degrees Fahrenheit.

OAT at Max Temperature (°F): Enter the maximum CHWS temperature in degrees Fahrenheit that corresponds to the *OAT at Max Temperature*. If the actual OAT is above *OAT at Max Temperature*, the CHWS will equal the *Max Temperature*.

Note that the CHW Delta Temperature is the same for both the baseline case and the ECM case. The CHW flowrate will also be the same for the baseline and ECM cases.

Fixed/Reset Condenser Water Supply Temperature:

This information is used by the cooling tower to provide the desired CWS temperature. The actual CWS temperature provided by the cooling tower is subject to the capacity of the cooling tower, the heat rejection load, and the outdoor conditions. The CWS temperature provided to the chiller will never be lower than the temperatures entered here.

Temperature Control: Select from the drop-down list. Only list values are allowed.

If "**Fixed**" is selected then:

The *CWS Temperature* is maintained at the *Temperature Setpoint*, within the capabilities of the cooling tower and the outdoor wet bulb temperature. Under high load and wet bulb conditions, the *CWS Temperature* may rise above the setpoint. Enter the Temperature Setpoint.

If "**Reset**" is selected then:

The *CWS Temperature* will be maintained at the *Min Temperature*, within the capabilities of the cooling tower and the outdoor wet bulb temperature. Under high load and wet bulb conditions, the *CWS Temperature* may rise above the *Min Temperature*.

The *Temperature Setpoint* is cleared, grayed out and locked.

Temperature Setpoint (°F): This is the Condenser Water Setpoint. The cooling tower will attempt to maintain this temperature. Note that if the outdoor wetbulb temperature is high, then the Condenser Water Supply Temperature may float above this value. Enter the setpoint in degrees Fahrenheit.

Min Temperature (°F): This is the minimum condenser water temperature allowed by the Chiller. This value is entered when Reset temperature control is selected. The Cooling Tower will attempt to maintain this temperature. When the outdoor wetbulb temperature increases, the Condenser Water Supply Temperature may float above the minimum temperature, subject to the load and the outdoor wetbulb temperature. Enter the Min Temperature in degrees Fahrenheit.

The cooling tower approach temperature is automatically calculated, and is a function of outdoor conditions and the heat rejection load.

Cooling Tower Fan VFD:

VFD Drive Efficiency (%): Enter a decimal number that is greater than zero and less than or equal to one.

Stack ECMs: Check this box to combine all ECMs currently selected.

User Documentation: This area to the right of the user inputs is reserved for any noteworthy documentation related to the current equipment. Text, graphics and internet links may be inserted in this area.

Command Buttons:

PREV:
Takes you to the previous worksheet in the tabbed worksheet list.

NEXT:
Takes you to the next worksheet in the tabbed worksheet list.

AHU Calculation Methodology

AHU thermal calculations:

The thermal calculations for the six AHU-related ECMs are based on energy balances. In all cases, the zone load remains constant as ECMs are applied. The six AHU-related ECMs are Schedule, Economizer, SAT Reset, Fixed/Reset Duct Static Pressure Setpoint, Supply Fan VFD, and Return Fan VFD.

User-entered Inputs:

Inputs that vary as a function of outside air temperature:

- Return air temperature (RAT)
- Supply air temperature (SAT)
- Supply airflow (AHUAirflow). AHUAirflow is a fixed value for CV systems.
- Mixed air temperature (MAT). Varies depending on user-selected control methodology:
  - User input MAT vs. outside air temperature (OAT), constrained to min and max-allowable outside air fraction (OAF)
  - Fixed OAF
  - Fixed OA CFM
  - Follow SAT, constrained to min and max-allowable OAF and FanHeat

Fixed inputs:

- Fan Heat: Temperature rise across fan (fixed temperature rise)

Other values included in equations below:

- Air density of air (Rho), in units of lb/ft3.
- Specific heat of air (Cp). 0.24 BTU/lb-F.

Governing AHU equations:

Cooling provided by the AHU cooling coil. Constrained to be positive:

$$Qcooling = Rho * Cp * AHUAirflow * 60 * (MAT + FanHeat - SAT)$$

Heating provided by the AHU heating coil. Constrained to be positive:

$$Qheating = Rho * Cp * AHUAirflow * 60 * (SAT - MAT - FanHeat)$$

Cooling or heating provided by outside air via economizer. May be positive or negative (cooling is positive, heating is negative)

$$Qecon = Rho * Cp * AHUAirflow * 60 * (RAT - MAT)$$

Economizer calculations

The baseline economizer control is specified by the user, using one of the following control methods:

User Input: The user can enter four MAT values at corresponding OAT values. The tool confirms that the user-entered MAT values are allowable, i.e., are between OAT and RAT.

Calculate: The tool calculates the MAT based on one of the following economizer control methods:

Fixed OSA (%): The user enters a constant OAF, and the program calculates

Fixed OA (cfm): The user enters a constant OA airflow volume, and the program calculates the OAF using the Fixed OA and the Supply Airflow, as follows:

$$OAF = \frac{CFM_{OA}}{CFM_{SA}}$$

Econo: During economizer mode the MAT tracks the SAT as follows:

$$OAF = \frac{(SAT - FanHeat - RAT)}{(OAT - RAT)}$$

MAT is constrained to always be between OAT and RAT. Furthermore, OAF is constrained to be between the minimum and maximum allowable OAF, as specified by the user. Therefore, once the constrained OAF is determined, the actual MAT is calculated as follows:

$$MAT = OAT * OAF + RAT * (1 - OAF)$$

The Optimize Economizer control ECM uses the Econo control method calculations.

Enthalpy economizer control is not addressed.

Heat added to the airstream by the fan. This is based on an assumed constant temperature rise.

$$QFanHeat = AHUAirflow * (FanHeat) * Rho * Cp * 60$$

For calculating the related cooling and heating plant demand, the user-input cooling and heating plant efficiencies are applied to *Qcooling* and *Qheating*, respectively.

Reheat thermal calculations:

Fixed inputs:

- Fraction of zone terminal boxes with reheat capacity (FrBoxReheat)
- Reheat air discharge temperature (variable volume systems only) (ReHtDAT)
- Reheat box temperature discharge air temperature (DAT) rise (constant volume systems only) (ReheatDT)

- System No-reheat temperature. The outside air temperature above which no reheat is required. (NoReheatTemp)
- Design outside air heating temperature (DesignHeatingTemp)

Reheat Airflow Determination:

VAV system:

$$ReHtFlow = AHUflow * FrBoxReheat * \frac{(NoReheatTemp - OAT)}{(NoReheatTemp - DesignHeatingTemp)}$$

Constrained to be less than or equal to AHUAirflow

CV system:

$$ReHtFlow = AHUAirflow * FrBoxReheat$$

Reheat Discharge Air Temperature Determination

VAV System:

$$ReHtDAT = Fixed\ user\ input\ (default\ 95\ F)$$

CV System:

$$ReHtDAT = SAT + ReheatDT * \frac{(NoReheatTemp - OAT)}{(NoReheatTemp - DesignHeatingTemp)}$$

Constrained to be equal to or greater than SAT

Reheat energy:

$$Qreheat = Rho * Cp * ReHtFlow * 60 * (ReHtDAT - SAT)$$

The Zone load is based on the AHU load and the reheat load:

$$Qzone = Qecon + Qcooling - Qheating - QFanHeat - Qreheat$$

A positive zone load indicates a net cooling load, while a negative value indicates a net heating load.

When applying ECMs that change the SAT, MAT, or AHU Airflow, the zone load (Qzone) remains constant. For example, if the economizer control is improved through the Economizer ECM, then Qcooling will lower due to increased cooling provided by the economizer Qecon. If the SAT changes due to implementing the SAT Reset ECM, this will change the AHU airflow, which affects all elements of the zone load equation. However, Qzone will remain constant.

Specific AHU ECM calculation notes

Schedule ECM

The Schedule ECM changes the operating schedule for the AHU. When changing the AHU schedule, the run hours are usually reduced which reduces the energy consumption for the unit. Since this is a static bin model, effects of reducing the operating hours on warmup/cooldown load outside of the operating schedule are not considered.

Economizer ECM

The Economizer ECM controls the economizer based on a differential dry bulb control strategy, comparing RAT to OAT. The Econo control method and calculations discussed above are also used for the Economizer ECM. If the SAT Reset ECM is implemented, the SAT based on this ECM will be used.

SAT Reset ECM

This ECM follows the governing AHU equations described previously. For all temperature bins, the zone load for the base case and the ECM case will be the same. If the SAT changes due to implementing this ECM, the AHU airflow will also change, which will affects all elements of the zone load equation.

Since the AHU airflow will change, there will be a corresponding change in fan power. The fan power calculations are governed by the equations included in AHU fan power and pressure calculations.

Limitations:

- If the Reset SAT is high, then the AHU airflow will increase in order to meet the zone cooling load. It is possible that the AHU airflow can exceed the maximum fan capacity. If this occurs, the user will be warned at the completion of the calculations.

AHU fan power and pressure calculations:

The three fan and pressure-related ECMs are calculated using the same algorithms, due to their similarity. These ECMs include Fixed/Reset Duct Static Pressure Setpoint, Supply Fan VFD, and Return Fan VFD. These fan calculations do not affect the thermal calculations, and when a stacked is performed, are calculated after any changes to air flow rate related to the SAT Reset ECM are implemented.

The Fixed/Reset Duct Static Pressure Setpoint ECM calculation estimates the reduction in fan energy related to reducing the duct static pressure setpoint. The calculation utilizes a user-entered reset schedule of static pressure vs. flow ratio.

The calculation methodology used for these three ECMs is based on methods developed by Englander and Norford in their 1992 ACEEE paper, "Variable-Speed Drives: Improving Energy Consumption Modeling and Savings Analysis Techniques".

User-entered Inputs:

Inputs that vary as a function of outside air temperature:

- Supply airflow (CFM). CFM is a fixed value for CV systems.

Fixed inputs:

- Maximum airflow rate (CFMmax)
- Design fan static pressure (PDesign). This is the pressure that the fan will produce at design flowrate.
- Maximum fan power
- Static pressure reset schedule

The parameters of interest are:

$$f = flow\,ratio = CFM/CFMmax$$

$$p_0 = \frac{P_{setpoint}}{P_{Design}}$$

$$H = fan\,power\,ratio = kW_{fan}/kW_{max}$$

where

$$P_{setpoint} = Static\,pressure\,setpoint$$

$$P_{Design} = Fan\,static\,pressure\,rise\,at\,design\,flow$$

$$kW_{max} = \frac{hp_{fan} * FanLoadFactor * .746}{\eta_{motor}}$$

Note: kWmax can also be input directly by user.

Constant volume systems:

$$H = 1$$

Fans with Discharge Damper control

$$H = 0.646f + 0.354$$

Fans with Inlet Vane control

$$H = a + \frac{f}{(b + c * f^2)}$$

Where

$$a = 0.354$$

$$b = \frac{(2 - p_0)}{0.646}$$

$$c = \frac{(p_0 - 1)}{0.646}$$

Fans with VFD fan control:

$$H = \frac{(a + b * f + d * f^3)}{\eta_{drive}}$$

Where

$$a = \left(\frac{p_0}{2}\right)^{1.5}$$

$$b = p_0 * (1 - a)$$

$$d = 1 - a - b$$

$$\eta_{drive} = VFD\ Drive\ Efficiency$$

Static pressure reset:

When reset static pressure control is selected, the static pressure setpoint will vary linearly between a user-entered static pressure reset schedule based on minimum and maximum setpoints corresponding to user-entered minimum and maximum flow ratios, according to the following equation:

$$P_{setpoint} = \left(\frac{P_{max} - P_{min}}{f_{max} - f_{min}}\right) * (f - f_{min}) \; + \; P_{min}$$

Where

$P_{max} = maximum\ static\ pressure\ (at\ f_{max})$

$P_{min} = minimum\ static\ pressure\ (at\ f_{min})$

$f_{max} = maximum\ flow\ ratio\ for\ static\ pressure\ reset\ schedule$

$f_{min} = minimum\ flow\ ratio\ for\ static\ pressure\ reset\ schedule$

All other calculations follow the governing fan power and pressure equations above.

Chiller and Cooling Tower Calculation Methodology

There are four ECMs related to the cooling plant:

- Chilled Water Pump VFD ECM
- Fixed/Reset Chilled Water Supply Temperature ECM
- Fixed/Reset Condenser Water Supply Temperature ECM
- Cooling Tower Fan VFD ECM

These utilize the chiller and cooling tower calculation methodologies as follows:

ECM	Calculation Methodology
Chilled Water Pump VFD ECM	Pump calculation methodology
Fixed/Reset Chilled Water Supply Temperature ECM	Chiller calculation methodology Pump calculation methodology
Fixed/Reset Condenser Water Supply Temperature ECM	Chiller calculation methodology Cooling tower calculation methodology
Cooling Tower Fan VFD ECM	Cooling tower calculation methodology

Chiller Calculation Methodology:

The impact of chilled water supply temperature (CHWST) and condenser water supply temperature (CWST) on chiller efficiency is calculated using DOE-2.2 chiller performance curves for various chillers.

The calculation methodology follows DOE-2.2 algorithms and utilizes the default DOE-2.2 curves based on the chiller type selected for calculating chiller power based on chilled water load, chilled water supply temperature, condenser water supply temperature, and part load ratio. Chilled water load is calculated based on a user input four-point linear regression versus outdoor air temperature.

From the DOE-2.2 documentation:

$$Cap_{hour} = Capacity * CAPf(t1,t2)$$
$$PLR = Load / Cap_{hour}$$
$$dT = t2 - t1$$
$$Elec_{hour} = Cap_{hour} * EIR * EIRf(t1,t2) * EIRf(PLR,dT) / 3413\ Btu/kW$$

Where:

Cap_{hour}	hourly capacity, Btuh
Capacity	rated capacity input by user, Btuh
CAPf(t1,t2)	correction to capacity for temperatures, curve CAP-FT
t1	CHWST input by user (fixed or linear reset with OAT), °F
Approach	difference between CWST and OA wet bulb temperature, °F
t2	CWST input by user (fixed or reset with OA wet bulb (CWST = OA WB + Approach)), °F
PLR	Part load ratio
Load	Hourly load, Btuh
dT	Temperature differential across chiller, °F
Elec	electric input to the chiller, kW
EIR^{hour}	rated electric input ratio, based on user-input rated efficiency (kW/ton)
EIRf(t1,t2)	correction to EIR for temperatures, curve EIR-FT EIRf(PLR,dT)
	correction to EIR for part-load ratio and dT, curve EIR-FPLR

Cooling Tower Calculation Methodology:

The cooling tower calculations are based on the methods presented in the DOE-2 Engineers Manual, LBL-11353, beginning on page v.45. A summary of the approach is included here.

Two key parameters are the Rating Factor (Fr) in units of (TU/gpm) and the Required Area (Ar) in units of (TU) which describe whether a certain cooling tower can handle a given load, given the set of operating and design conditions. A tower unit (TU) is defined as the ability to lower one (1) gpm from 90-80 Deg F @ 70 Deg F Wet-Bulb.

$$Fr = 10^{(a*\log R+C*\log R*Twb+d+e*\log AP+f*Twb+g*\log AP*Twb)}$$

$$Ar = Fr * gpm * \frac{DesignCFM}{OperatingCFM}$$

Where:

Fr Rating Factor =f(R,Ap,Twb)
Ar Required Area =f(Fr,gpm,cfm) R Range (CWRT – CWST)
AP Approach (CWST – Twb) Twb Wet Bulb Temperature
CWRT Condenser water return temperature (Entering water temperature to cooling tower)
CWST Condenser water supply temperature (Leaving water temperature from cooling tower) gpm Condenser water flow
cfm Tower fan air flow

The methodology calculates the installed capacity of a cooling tower at a known set of design conditions (the design conditions for range, approach, entering wet-bulb, water flow, and air flow) from the user inputs.

Next, the program calculates whether the installed tower can handle the load at each bin temperature.

If the tower can handle the load without fan assistance (through natural convection, assumed but adjustable at 10% of full airflow), fan power is 0% and the CWST is calculated. If the calculated CWST is below the CWST setpoint, the CWST is fixed at the CWS setpoint.

If the tower cannot handle the load with the fan running at 100%, fan power is set at 100% and the CWST is calculated, floating above the CWST setpoint.

If the tower can handle the load at an airflow between the minimum and maximum allowable air flow rate, the program calculates the fraction of the hour the fan operates at a speed (off/low/hi) for 1 & 2 speed motors, or the speed at which a VFD fan operates for the entire hour. The CWST is equal to the CWST set point.

Once the required airflow rate is known, the fan power is calculated using fan laws and the user input fan nameplate horsepower, fan motor load, fan motor efficiency, and fan VFD efficiency. The CWST is then fed back to the chiller calculation module.

The tower performance curves shown in the reference were used to solve for the coefficients (bi-linear) a-g in the equation for Fr, with the boundary conditions (5<=Range<=20, 5<=Approach<=30, 60<=Wet-Bulb<=80).

Pump Calculation Methodology:

The pump power calculation methodologies for the three pump control methods are shown below. The three control methods are:

- Constant speed pump with 3-way valves (Constant flow)
- Constant speed pump with 2-way valves (Variable flow with pump riding its curve)
- Variable speed pump with 2-way valves (Variable flow)

Calculation Assumptions and Limitations

All variables that are not schedules or single point variables are assumed to vary linearly with the outside air temperature.

Assumptions:

- Steady state conditions
- Differential pressure set point is constant
- VFD speed is directly proportional to pump speed
- Single pump operation
- Fluid density is 62.3 lb/ft3 at 68°F
- If the pump is throttled, assume the actual flow equals the design flow
- Pump is either a primary or secondary chilled water pump.
- Pump flow is determined from regression of chilled water load vs. OAT, assuming a constant (user input) CHW delta temperature.
-

Analysis

The baseline is either a constant speed pump in a constant flow system (3-way valves, or 2-way valves with bypass), or a constant speed pump in a variable flow system (2-way valves). For the constant flow system baseline, the head and flow are assumed to be constant. For the variable flow system baseline, where the pump rides its curve, the pump power will follow the curve.

The ECM involves adding a VFD to the pump motor, adding differential pressure sensors in the piping system to control the pump VFD speed to maintain a constant differential pressure setpoint, and changing the bypass valve or 3-way valves to 2-way valves.

Pump Power

The pump power at each bin temperature depends on the PumpControl selected by the user.

In all cases, MaxPumpPower (kW) is either a direct measured value (input by the user), or calculated by the tool as:

$$MaxPumpPower\ (kW) = \frac{DesignPumpFlow * DesignHead/2.31}{DesignPumpEff * FLMotorEff * 2298}$$

Where

DesignPumpFLow	Design flowrate
DesignHead	Design Total Dynamic Head, at design flowrate
DesignPumpEff	Pump efficiency
FLMotorEff	Full Load Motor efficiency

PumpControl = Constant speed with bypass (constant flow)

In this case, the pump flow is constant, and therefore the pump power is constant, and is equal to MaxPumpPower

$$Pump\ power\ =\ MaxPumpPower$$

PumpControl = Constant speed pump with 2-way valves (variable flow)

In this case, the flowrate varies as a function of the chilled water load and the user-entered Delta Temperature. The pump will ride the pump curve.

$$Pump\ power\ =\ Pump\ Power\ Ratio\ *\ MaxPumpPower$$

$$\text{PumpPowerRatio} = a + b * \text{PumpFlowRatio} + c * \text{PumpFlowRatio}^2$$

a, b, and c are pump power coefficients from DOE2.2, representative of a pump with a typical curve. Additional documentation can be found in the DOE 2.2 documentation.

a:	0.369774
b:	0.840375
c:	-0.21015

$$PumpFlowRatio\ =\ \frac{PumpFlow}{DesignPumpFlow}$$

$$PumpFlow = \frac{CHWLoad(tons) * 12000}{500 * CHWdT}$$

PumpControl = Variable speed with 2-way valves (variable flow)

In this case, the pump speed is controlled by a variable speed drive. The flowrate varies as a function of the chilled water load and the User-entered Delta Temperature.

$$Pump\ Power\ Ratio = \frac{Ptheo}{(effVFD * effMotor * effPump)}$$

$$Ptheo = \frac{PumpFlow * \left(dPsetpoint + (DesignHead - dPsetpoint) * \left(\frac{PumpFlow}{DesignPumpFLow}\right)^{2}\right)}{3960}$$

$$PumpFlow = \frac{CHWLoad(tons) * 12000}{500 * CHWdT}$$

$$Pump\ Power\ = PumpPowerRatio * MaxPumpPower$$

dPsetpoint – Minimum pump pressure setpoint. Generally, the pump must maintain a minimum pressure to ensure adequate differential pressure across system valves and coils. Not considering this minimum pressure can under-predict the power requirements of a pump controlled by a VFD.

Summary by Equipment

Summary by Equipment

The summary by equipment report lists the electric demand consumption and the gas consumption for the baseline case, and also with each ECM added to the baseline. Results are shown for each season and TOU period.

The summary by equipment report contrasts with the Summary by Measure report in that it lists the actual consumption and demand for the baseline and ECM cases, while the Summary by Measure report lists the impact on energy, demand, and cost for each ECM case.

Unstacked analysis

If the ECM analysis is "unstacked," the energy impact for each measure is referenced to the baseline. When evaluating a package of ECMs, the overall savings will be overstated if each ECM is evaluated separately, i.e., unstacked. For this reason, the total savings for a package of unstacked ECMs is not displayed.

Stacked analysis

If the ECM analysis is stacked, then the incremental energy impact for each measure is reported, rather than the energy impact referenced to the baseline. Using a stacked analysis will ensure that the impact of all the ECMs is evaluated as a package, i.e., is not overstated. In a stacked analysis, the total savings for a package of ECMs is displayed.

Summary by Measure

Summary by Measure

The Summary by Measure report lists the demand and energy impact for each measure, as well as their cost impacts. This report also calculates simple payback for each measure, based on user-specified implementation costs and incentive payments. The formulas for each simple payback case are shown in pop-up comments.

The summary by equipment report contrasts with the Summary by Measure report in that it lists the actual consumption and demand for the baseline and ECM cases, while the Summary by Measure report lists the impact on energy, demand, and cost for each ECM case.

Unstacked analysis

If the ECM analysis is not stacked, the energy impact for each measure is referenced to the baseline. When evaluating a package of ECMs, the overall savings will be overstated if each is evaluated separately, i.e., unstacked. For this reason, for an unstacked evaluation, the total savings for a package of ECMs is not displayed.

Stacked analysis

If the ECM analysis is stacked, then the incremental energy impact for each measure is reported, rather than the energy impact referenced to the baseline. Using a stacked analysis will ensure that the impact of all the ECMs is evaluated as a package, i.e., is not overstated. In a stacked analysis, the total savings for a package of ECMs is displayed.

Bin Data Summary

Bin Data Summary

The Bin Data Summary report provides detailed consumption data at each temperature bin.

Temperature Bin. This column lists each temperature bin that occurs for at least one hour in the weather data used for the analysis.

Electric Hours. These columns list the operating hours in each bin based on the selected schedule, and the operating hours in each electric TOU period.

Gas Hours. These columns list the operating hours within each summer and winter gas rate period.

Total. These columns list the hourly electrical demand and heating energy for each temperature bin.

Demand Savings (kW). These columns list the electrical demand and energy savings, and the month that had that temperature as a peak for that month.

Unstacked Analysis. In an unstacked analysis, the demand savings for each ECM are referenced to the demand in the baseline case in each temperature bin.

Stacked Analysis. In a stacked analysis, the demand savings for each ECM are referenced to the previous ECM's demand in each temperature bin.

Electric Savings (kWh). These columns list the electric energy savings for each TOU period within each temperature bin, as well as the total energy savings for all TOU periods.

Unstacked Analysis. In an unstacked analysis, the energy savings for each ECM are referenced to the energy consumption in the baseline case in each temperature bin.

Stacked Analysis. In a stacked analysis, the energy savings for each ECM are referenced to the previous ECM's energy consumption in each temperature bin.

Gas Savings (Therms). This column lists the gas savings within each temperature bin.

Unstacked Analysis. In an unstacked analysis, the gas savings for each ECM are referenced to the gas consumption in the baseline case in each temperature bin.

Stacked Analysis. In a stacked analysis, the gas savings for each ECM are referenced to the previous ECM's gas consumption in each temperature bin.

Calc Summary

Calc Summary

The Calc Summary report lists the electrical demand, gas consumption, and other parameters of interest for each temperature bin. The format of the report is different, as shown below. The definitions for each heading are shown below.

Unstacked Analysis. In an unstacked analysis, the values shown for each ECM are referenced to the baseline case in each temperature bin. Each ECM is evaluated separately.

Stacked Analysis. In a stacked analysis, the values shown for each ECM also include the impact of the previous ECMs.

AHU Calc Summary:

Dry-bulb outside air temperature °F	Temperature bin
Cooling Plant kW	Electrical demand of AHU cooling source
Heating Therms	AHU gas heating requirement (either Gas or Electric heat is used, not both)
Reheat Therms	Reheat gas heating requirement (either Gas or Electric heat is used, not both)
Heating kW	AHU electrical heating requirement (either Gas or Electric heat is used, not both)
Reheat kW	Reheat electrical heating requirement (either Gas or Electric heat is used, not both)
Supply Fan Flow Ratio	The ratio of the actual supply fan flow to its design fan flow.
Supply Fan kW	Supply fan electrical demand
Return Fan kW	Return fan electrical demand
Total kW	Total electrical demand of supply/return fans, cooling plant, and heating requirement
Total Therms/hr	Total gas heating energy in therms

Chiller/Cooling Tower Summary:

Dry-bulb outside air temperature °F	Temperature bin
OAWB temperature °F	Mean coincident wet bulb temperature
CHW Pump VFD kW	Chilled Water Pump electrical demand (kW)
Chiller kW	Chiller electrical demand (kW)
Clg Twr Fan VFD kW	Cooling tower fan electrical demand (kW)
Clg Twr CWS Temp	Condenser Water Supply Temperature (F)
Clg Twr HR Load	Cooling tower heat rejection load (BTUH)
Total kW	Total electrical demand of chiller, pumps, and cooling tower fan

Additional ECM User's Guide

Custom Building Optimization Analysis Tool

Version
7/20/2020

Nexant Energy Conservation Measures Instructions

(Note: Instructions below applies to the Nexant section of the tool only)

1. Fill out the **General Information** worksheet. Please make sure to choose the appropriate building type and climate zone from the dropdown list.

2. Fill out the Utility Information section on the **Common Inputs & Savings Summary** worksheet, cells M14 to M18. *Note that these utility data are not linked to the C-BOA Electricity Rate, Gas Rate, and Demand worksheets and have to be entered separately.*

3. Choose from one of the Nexant ECM worksheets below as applicable to your current project. Each ECM worksheet has to be independently filled out, including Equipment name or ID, schedules and equipment type, operating setpoints, and the Estimated Project Cost in cell M9.

- **Schedule Lights (ScheduleLighting)**
- **Night Setback (NightSetback)**
- **Adjust Unoccupied Operation (Unocc Ops)**
- **Reduce Outside Air (ReduceOA)**
- **Pump Pressure Reset or Reduce Pump Pressure Setpoint (Pump P SP)**

4. If more than one instance of the ECMs above is needed, each worksheet can be copied or duplicated by right clicking on the ECM tab, from the list choose Move or Copy, on the popup window click on 'Create a Copy' check mark, scroll down the list and choose which worksheet the duplicate worksheet will be inserted before. Note: Make sure to enter a unique Equipment name or ID on each additional ECM worksheet.

5. Once the appropriate Nexant ECM worksheets have been filled out, go back to the **Common Inputs & Savings Summary** worksheet and scroll down to the Savings Summary table in row 47.

6. In the Savings Summary table column B (Tab Name), enter the exact worksheet or tab name of corresponding Nexant ECM to be included in the current project. Tip: Double click the tab name to set it into edit mode, then press Ctrl+C to copy, then go back to the **Common Inputs & Savings Summary** worksheet Savings Summary table column B and insert the tab name by pressing Ctrl+V to paste.

7. The calculator will not be able to discern whether the Tab names inserted are duplicate or whether they are appropriately filled out. It is up to the user to ensure data entered into each applicable ECM worksheets are accurate, and that each applicable ECM worksheet tab name is inserted into the Savings Summary table.

8. Once all applicable ECM tab names have been inserted into the Savings Summary table, go to the **Summary By Measure** worksheet, then click on the Calculate button. Note that if the current project include C-BOA related ECMs, those must be appropriately filled out in accordance with instructions found in the C-BOA help file before clicking on the Calculate button. Depending on the number, type of, and accuracy of the data entered for each ECM included in the project, analysis time could take anywhere from less than one minute up to 10 minutes.

9. Once the analysis is completed, go to the **Savings Summary** worksheet for the energy and cost savings summary of all ECMs included in the current project.

10. Implementation costs for C-BOA ECMs must be manually entered in the **Summary By Measure** worksheet, column Q.

Measures Summary and Utility Data Input Worksheet

Nexant

Retro-commissioning ECM Calculations

Version: 4.3 Last Revised: 3/05/2019

Legal Disclaimer

This spreadsheet calculation tool is created by Nexant for the Consumer Energy Retro-Commissioning Program offerings and is Company Proprietary information. Use and disclosure of this spreadsheet calculation tool is governed by Section 2 of the Master Services Agreement between Subcontractor (Retro-commissioning Service Provider) and Nexant. Subcontractor will not, during or subsequent to the terms of this Agreement, use this spreadsheet calculation tool for any purpose other than the performance of the Task Order and may not disclose this spreadsheet calculation tool to any third party. This spreadsheet calculation tool shall remain the sole property of Nexant and/or Consumer Energy.

Calculator Usage Criteria

- The use of these calculation tools is permitted for Tier 1 (large) and Tier 2 (Small) Measures. If used for Tier 1 measures, trend data must be provided in support of the measure per Program M&V Guidelines.
- The identified measure at the customer site must meet the criteria given in the "Assumptions" section of the associated calculation tool
- Interactions between measures must be accounted for by assuming an order of implementation, i.e. assuming the baseline case for the 2nd measure is the proposed case of the 1st measure.

Instructions for Use

0.) Update the location below to use the TMY3 weather location nearest the facility.

Chosen Location

CZ 1 : Alpena County Regional

1.) Delete tabs for measures that will not be used. If multiple instances of the same measure will be used, tabs may be duplicated.

2.) Enter Utility Information for the appropriate rate in the tables to the right

3.) Proceed to enter data into calculator tabs.

Yellow	Indicates entry is required and missing
White	Are editable
Grey	Are calculations and not editable

4.) Enter the tab name in the white boxes in the table below to sum the total savings of all measures.

Note: To make the calculator respond more quickly, the calculation mode may be switched to Manual (In Excel 2007, go to Formulas → Calculation Options → Manual). In Manual calculation mode, key Shift + F9 to calculate the worksheet or F9 to calculate the entire workbook.

If you have questions or comments regarding this calculation tool, please contact Nexant.

Utility Information		
Electricity Usage Charge ($/kWh)	$0.080	
Electricity Demand Charge ($/kW)	$6.00	
Therm Usage Charge ($/therm)	$1.00	
Average Annual kWh Usage (kWh/yr)	200,000	Over Past 24 Months
Average Annual Therm Usage	50,000	Over Past 24 Months

Usage Tip: Weighted Entries

If you have multiple similar devices (e.g. AHUs), you can calculate a measure using a single calculator instead of using multiple versions of the same calculator. To do so, you need to enter the total CFM and hp of the combined units, and then the other entries should be the

For Example:

Consider the two air handlers shown below. The intent is to change the economizer setpoint to 65°F on each. All operational parameters are the same, but they air handlers are different sizes and have different existing economizer setpoints.

Name	AHU-1	AHU-2	Calculator Entries
Design Flow (CFM)	5,000	20,000	25,000
Fan Horsepower (hp)	10	30	40
Baseline - Economizer Setpoint (°F)	55	60	59
Proposed - Economizer Setpoint (°F	65	65	65

Entering the "Calculator Entries" would yield the same result as entering each air handler individually and summing the result. Note that flow and CFM are summed, and the economizer setpoint is weighted to flow since flow is the independent variable for an economizer.

Weighting setpoints to flow works whenever flow is present in the calculator. If flow is not present (e.g. Pump Pressure Setpoint), the weighting should be based on horsepower.

Savings Summary

Tab Name	Measure Name	Annual Electric Use Reduction (kWh/yr)	Utility Peak Demand Reduction (kW)	Average Monthly Demand Reduction (kW/mo)	Annual Electric Cost Reduction ($/yr)	Annual Gas Use Reduction (therm/yr)	Annual Gas Cost Reduction ($/yr)	Total Annual Cost Reduction ($/yr)	Estimated Project Cost ($)	Simple Payback (yr)	Simple Payback - Electric Only (yr)
	Total	0	0.0	0.0	$0	0	$0	$0	$0	#DIV/0!	#DIV/0!

Outputs for the ECM Form Template:

Measure Name	Peak Demand Savings (kW)	Electrical Energy Savings (kWh/year)	Electrical Cost Savings ($/year)	Gas Energy Savings (therms/year)	Gas Cost Savings ($/year)	Full Measure Cost ($)

Night Setback ECM

Nexant

Night Setback	
Version: 4.3	Last Revised: 3/05/2019

Model Assumptions

*The air handler only provides heating and cooling; a dehumidification mode is not included in the model.
*Sensible loads account for 90% of total cooling loads during occupied hours and 98% of total loads during unoccupied hours.
*Unoccupied savings are based on heat loss from the building shell. Solar gains are ignored for unoccupied cooling operation.
*The slab and below-grade space is assumed to be temperature-neutral and no savings are calculated for below-grade unoccupied spaces.

Data Collection Requirements

*Trend data is required for Tier 1 measures
*BMS screenshots showing existing and proposed AHU operation schedule
*BMS screenshots showing existing and proposed unoccupied space temperature setpoints
*Photo of design drawing mechanical equipment schedules (supply fan motor HP & CFM, chiller tons, boiler MBH)
or
*Photos of equipment nameplates
- Chiller nameplate indicating chiller manufacturer and model number
- Boiler nameplate indicating boiler manufacturer and model number

Project Description and Additional Notes

To be completed by service provider

Savings Summary	
Annual Electric Use Reduction (kWh/yr)	#N/A
Average Monthly Demand Reduction (kW/mo)	0.0
Annual Electric Cost Reduction ($/yr)	#N/A
Annual Gas Use Reduction (therm/yr)	#N/A
Annual Gas Cost Reduction ($/yr)	#N/A
Total Annual Cost Reduction ($/yr)	#N/A
Estimated Project Cost ($)	$500
Simple Payback (yr)	#N/A
Simple Payback - Electric Only (yr)	#N/A
Utility Peak	
Utility Peak Demand Reduction, DS_{peak} (kW)	#VALUE!
Feasibility Check	
Calculated Baseline (kWh/yr)	#N/A
Calculated Baseline - Percent of Annual Usage	#N/A
Typical Baseline - Percent of Annual Usage	7-27%
Project Savings - Percent of Baseline	#N/A
Project Savings - Percent of Annual Usage	#N/A

		Baseline		Upgrade		Reduction	
Monthly Breakdown		kWh/yr	kW	kWh/yr	kW	kWh/yr	kW
1	Jan	#N/A	0.0	#N/A	0.0	#N/A	0.0
2	Feb	#N/A	0.0	#N/A	0.0	#N/A	0.0
3	Mar	#N/A	0.0	#N/A	0.0	#N/A	0.0
4	Apr	#N/A	0.0	#N/A	0.0	#N/A	0.0
5	May	#N/A	0.0	#N/A	0.0	#N/A	0.0
6	Jun	#N/A	0.0	#N/A	0.0	#N/A	0.0
7	Jul	#N/A	0.0	#N/A	0.0	#N/A	0.0
8	Aug	#N/A	0.0	#N/A	0.0	#N/A	0.0
9	Sep	#N/A	0.0	#N/A	0.0	#N/A	0.0
10	Oct	#N/A	0.0	#N/A	0.0	#N/A	0.0
11	Nov	#N/A	0.0	#N/A	0.0	#N/A	0.0
12	Dec	#N/A	0.0	#N/A	0.0	#N/A	0.0
	Total	#N/A		#N/A		**#N/A**	

Gas Usage Reduction (therms/yr)	#N/A

Baseline

BASELINE PARAMETERS AND OPERATION

Air Handler Specifications	DF	Inputs & Notes	
AHU Name			
Heating Equipment			
Equipment Turned On in	X	Oct	
Equipment Turned Off in	X	Apr	
Heating Equipment Off Above OA Temp (°F)	X	65	
Heating Type			
Cooling Equipment			
Equipment Turned On in	X	Apr	
Equipment Turned Off in	X	Sep	
Cooling Equipment Off Below OA Temp (°F)	X	55	
Cooling Type			
Cooling Efficiency (kW/ton)			
Space Temperature Setpoint			
		Cooling	Heating
Occupied Space Temperature (°F)	X	72	70
Unoccupied Space Temperature (°F)	X	80	60

Air Handler Schedule				
Day		Time On	Time Off	Notes
Mon				Please enter time to nearest hour
Tues				on 24-hour clock
Wed				If there is no input, the default value is 0
Thur				
Fri				
Sat				
Sun				

Building Construction			
Wall Area (Sq. ft)			
Roof Area (Sq. ft)			
Window to Wall Ratio (%)			
Window Type			
Wall Type			
Roof Type			
Window U Factor (Btu/h-ft2-F)			
Wall U Factor (Btu/h-ft2-F)			
Roof U Factor (Btu/h-ft2-F)			

Modeled Baseline Scheduled Hours:	0

Upgrade

UPGRADE PARAMETERS

Space Temperature Setpoint			
		Cooling	Heating
Occupied Space Temperature (°F)	X	72	70
Unoccupied Space Temperature (°F)	X	80	60

Consumers Energy
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Okemos, MI 48805

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Pump Pressure Reset or Reduce Pump Pressure Setpoint ECM

Nexant

Implement Pump Pressure Reset or Reduce Pump Pressure Setpoint	
Version: 4.3	Last Revised: 3/05/2019
Model Assumptions	
*Model assumptions shown in inputs	
Data Collection Requirements	
*Trend data is required for Tier 1 measures	
*BMS screenshots showing existing pump operation schedule	
*BMS screenshots showing existing and proposed differential pressure setpoint	
*Photo of design drawing mechanical equipment schedules (pump motor HP & GPM)	
or	
*Photos of equipment nameplates indicating pump motor horsepower	
Project Description and Additional Notes	
To be completed by service provider	

Savings Summary	
Annual Electric Use Reduction (kWh/yr)	#DIV/0!
Average Monthly Demand Reduction (kW/mo)	0.0
Annual Electric Cost Reduction ($/yr)	#DIV/0!
Annual Gas Use Reduction (therm/yr)	0.0
Annual Gas Cost Reduction ($/yr)	$0
Total Annual Cost Reduction ($/yr)	#DIV/0!
Estimated Project Cost ($)	$500
Simple Payback (yr)	#DIV/0!
Simple Payback - Electric Only (yr)	#DIV/0!
Utility Peak	
Utility Peak Demand Reduction, DS_{peak} (kW)	0.0
Feasibility Check	
Calculated Baseline (kWh/yr)	0
Calculated Baseline - Percent of Annual Usage	0%
Typical Baseline - Percent of Annual Usage	0-10%
Project Savings - Percent of Baseline	#DIV/0!
Project Savings - Percent of Annual Usage	#DIV/0!

		Baseline		Upgrade		Reduction	
Monthly Breakdown		kWh/yr	kW	kWh/yr	kW	kWh/yr	kW
1	Jan	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
2	Feb	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
3	Mar	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
4	Apr	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
5	May	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
6	Jun	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
7	Jul	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
8	Aug	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
9	Sep	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
10	Oct	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
11	Nov	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
12	Dec	0	0.0	#DIV/0!	0.0	#DIV/0!	0.0
	Total	0		#DIV/0!		**#DIV/0!**	

Gas Usage Reduction (therms/yr)	0

Baseline

BASELINE PARAMETERS AND OPERATION

Pump Specifications	DF	Inputs & Notes
Pump Name		
Pump Application		
Pump Horsepower (hp)		
Design Flow (gpm)		
Pump Efficiency	X	60%
Pump Type		Variable-Speed Drive

Flow Parameters		Flow		OAT (°F)	
	X	60%	@	90	and higher
	X	60%	@	55	
	X	60%	@	5	and lower
		With a linear variation between the indicated points			

Pressure Setpoint Parameters		Pressure (psid)		OAT (°F)	
			@	90	and higher
			@	55	
			@	5	and lower
		With a linear variation between the indicated points			

Unoccupied Parameters		
Is the pump allowed to cycle at night?	X	Yes
Unoccupied Cycling Factor	X	30%
Pump Operation Schedule		
Pump Off Above Outside Temperature (°F)	X	80
Pump Off Below Outside Temperature (°F)	X	50

Day		Time On	Time Off	Notes
Mon				Please enter time to nearest hour
Tues				on 24-hour clock
Wed				If there is no input, the default value is 0
Thur				
Fri				
Sat				
Sun				

Month		Status	Notes
January	X	On	
February	X	On	
March	X	On	
April	X	On	
May	X	On	
June	X	On	
July	X	On	
August	X	On	
September	X	On	
October	X	On	
November	X	On	
December	X	On	

Upgrade

UPGRADE PARAMETERS

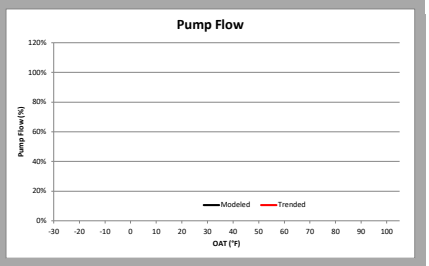
Static Pressure Setpoint

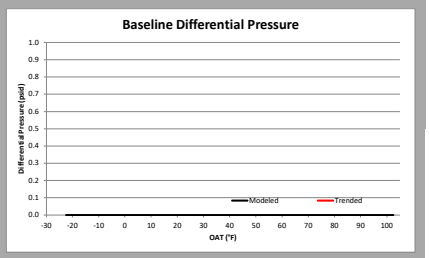
Pressure Setpoint Parameters		Pressure (psid)		OAT (°F)	
			@	90	and higher
			@	55	
			@	5	and lower
		With a linear variation between the indicated points			

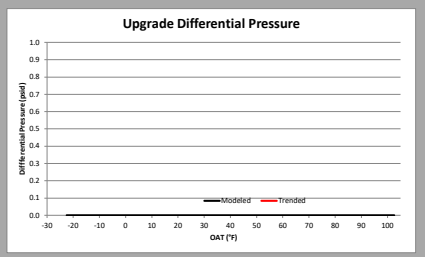
Trend Data						Modeled Data		
OAT High (°F)	OAT Low (°F)	Avg. OAT (°F)	Pump Flow (%)	Baseline DP (psid)	Upgrade DP (psid)	Pump Flow (%)	Baseline DP (psid)	Upgrade DP (psid)
105	100	102.5					0.0	0.0
100	95	97.5					0.0	0.0
95	90	92.5					0.0	0.0
90	85	87.5					0.0	0.0
85	80	82.5					0.0	0.0
80	75	77.5					0.0	0.0
75	70	72.5					0.0	0.0
70	65	67.5					0.0	0.0
65	60	62.5					0.0	0.0
60	55	57.5					0.0	0.0
55	50	52.5					0.0	0.0
50	45	47.5					0.0	0.0
45	40	42.5					0.0	0.0
40	35	37.5					0.0	0.0
35	30	32.5					0.0	0.0
30	25	27.5					0.0	0.0
25	20	22.5					0.0	0.0
20	15	17.5					0.0	0.0
15	10	12.5					0.0	0.0
10	5	7.5					0.0	0.0
5	0	2.5					0.0	0.0
0	-5	-2.5					0.0	0.0
-5	-10	-7.5					0.0	0.0
-10	-15	-12.5					0.0	0.0
-15	-20	-17.5					0.0	0.0
-20	-25	-22.5					0.0	0.0

Enter trend data above. Adjust applicable inputs to the model such that the modeled operation reasonably simulates trended operation. Always consider the potential flaws in trend data. Transients, varying space loads, and inaccurate sensors can create scatter in the data not representative of actual operation. Trend data should help validate model inputs while still using your engineering judgement to provide reasonable entries to the model that considers more than just the short-term data collection period.

Modeled Baseline Scheduled Hours:	0







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Reduce Outside Air ECM

Nexant

Reduce Outside Air	
Version: 4.3	Last Revised: 3/05/2019

Model Assumptions

*The air handler only provides heating and cooling; a dehumidification mode is not included in the model.
*Sensible loads account for 90% of total cooling loads during occupied hours and 98% of total loads during unoccupied hours.

Data Collection Requirements

*Trend data is required for Tier 1 measures
*BMS screenshots showing existing and proposed minimum outside air setpoint (CFM or percentage)
*BMS screenshots showing existing and proposed economizer setpoints
*BMS screenshots showing existing and proposed AHU operation schedule
*Photo of design drawing mechanical equipment schedules (supply fan motor HP & CFM, chiller tons, boiler MBH)
or
*Photos of equipment nameplates
- Supply fan motor horsepower nameplate
- Chiller nameplate indicating chiller manufacturer and model number
- Boiler nameplate indicating boiler manufacturer and model number

Project Description and Additional Notes

To be completed by service provider

Savings Summary	
Annual Electric Use Reduction (kWh/yr)	#N/A
Average Monthly Demand Reduction (kW/mo)	#N/A
Annual Electric Cost Reduction ($/yr)	#N/A
Annual Gas Use Reduction (therm/yr)	#N/A
Annual Gas Cost Reduction ($/yr)	#N/A
Total Annual Cost Reduction ($/yr)	#N/A
Estimated Project Cost ($)	$500
Simple Payback (yr)	#N/A
Simple Payback - Electric Only (yr)	#N/A
Utility Peak	
Utility Peak Demand Reduction, DS_{peak} (kW)	#N/A
Feasibility Check	
Calculated Baseline (kWh/yr)	#N/A
Calculated Baseline - Percent of Annual Usage	#N/A
Typical Baseline - Percent of Annual Usage	7.27%
Project Savings - Percent of Baseline	#N/A
Project Savings - Percent of Annual Usage	#N/A

		Baseline		Upgrade		Reduction	
Monthly Breakdown		kWh/yr	kW	kWh/yr	kW	kWh/yr	kW
1	Jan	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	Feb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	Mar	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	Apr	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
5	May	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
6	Jun	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
7	Jul	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
8	Aug	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
9	Sep	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10	Oct	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
11	Nov	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
12	Dec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Total	#N/A		#N/A		**#N/A**	

Gas Usage Reduction (therms/yr)	#N/A

Baseline

BASELINE PARAMETERS AND OPERATION					
Air Handler Specifications	DF	Inputs & Notes			
AHU Name					
AHU Type	X	VAV			
Total Fan Horsepower (hp)					
Design Flow (CFM)					
Fan Type	X	Variable-Speed Drive			
Air Flow Parameters		Flow		OAT (°F)	
	X	90%	@	90	and higher
	X	50%	@	55	
	X	50%	@	5	and lower
		With a linear variation between the indicated points			
Economizer & Outside Air					
Type	X	Percent Flow	Outside air varies with AHU flow		
Min Outside Air (%)	X	10%			
Economizer Setpoint (°F)	X	65			
Supply Air Temperature					
Supply Air Temperature Parameters		SAT (°F)		OAT (°F)	
	X	55	@	90	and higher
	X	60	@	55	
	X	65	@	5	and lower
		With a linear variation between the indicated points			
Heating Equipment					
Equipment Turned On in	X	Oct			
Equipment Turned Off in	X	Apr			
Heating Equipment Off Above OA Temp (°F)	X	65			
Heating Type					
Cooling Equipment					
Equipment Turned On in	X	Apr			
Equipment Turned Off in	X	Sep			
Cooling Equipment Off Below OA Temp (°F)	X	55			
Cooling Type					
Cooling Efficiency (kW/ton)					
Return Air					
		Cooling	Heating		
Occupied Return Air Temperature (°F)	X	72	70		
Unoccupied Return Air Temperature (°F)	X	80	60		
Unoccupied Parameters					
Is the AHU allowed to cycle during unoccupied hours?	X	Yes			
Is the AHU providing OA during unoccupied hours?	X	No			
Is the economizer used during unoccupied hours? (NA if no OA)	X	No	No outside air, economizer not applicable		
Is the AHU fan cycled for unoccupied space heating?	X	No	Fan-powered VAV boxes or radiant heat meets unoccupied space heating requirements and the AHU fan		
Reheat					
Reheat Parameters		Reheat (°F)		OAT (°F)	
	X	0	@	70	and higher
	X	1	@	55	
	X	10	@	5	and lower
		With a linear variation between the indicated points			
Air Handler Schedule					
Day		Time On	Time Off	Notes	
Mon				Please enter time to nearest hour	
Tues				on 24-hour clock	
Wed				If there is no input, the default value is 0	
Thur					
Fri					
Sat					
Sun					

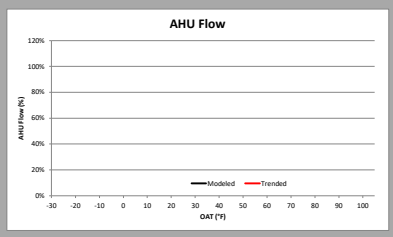
Upgrade

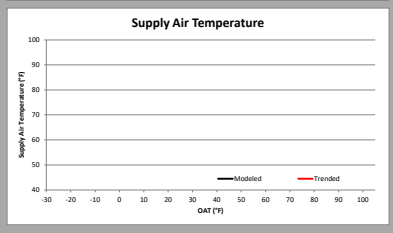
UPGRADE PARAMETERS			
Air Handler Schedule			
Type	X	Percent Flow	Outside air varies with AHU flow
Min Outside Air (%)	X	10%	
Economizer Setpoint (°F)	X	65	

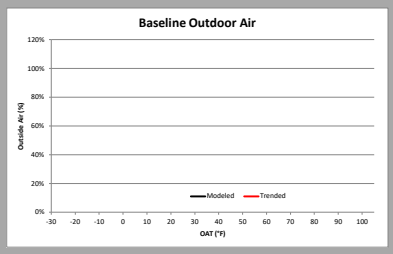
Trend Data							Modeled Data			
OAT High (°F)	OAT Low (°F)	Avg. OAT (°F)	AHU Flow (%)	SAT (°F)	Baseline % OA	Upgrade % OA	AHU Flow (%)	SAT (°F)	% OA	% OA
105	100	102.5								
100	95	97.5								
95	90	92.5								
90	85	87.5								
85	80	82.5								
80	75	77.5								
75	70	72.5								
70	65	67.5								
65	60	62.5								
60	55	57.5								
55	50	52.5								
50	45	47.5								
45	40	42.5								
40	35	37.5								
35	30	32.5								
30	25	27.5								
25	20	22.5								
20	15	17.5								
15	10	12.5								
10	5	7.5								
5	0	2.5								
0	-5	-2.5								
-5	-10	-7.5								
-10	-15	-12.5								
-15	-20	-17.5								
-20	-25	-22.5								

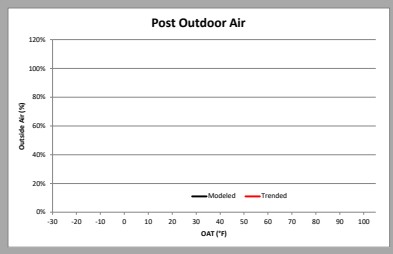
Enter trend data above. Adjust applicable inputs to the model such that the modeled operation reasonably simulates trended operation. Always consider the potential flaws in trend data. Transients, varying space loads, and inaccurate sensors can create scatter in the data not representative of actual operation. Trend data should help validate model inputs while still using your engineering judgement to provide reasonable entries to the model that considers more than just the short-term data collection period.

Modeled Baseline Scheduled Hours:	0









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Adjust Unoccupied Operation ECM

Nexant

Adjust Unoccupied Operation
Version: 4.3 Last Revised: 3/05/2019
Model Assumptions
*The air handler only provides heating and cooling; a dehumidification mode is not included in the model.
*Sensible loads account for 90% of total cooling loads during occupied hours and 98% of total loads during unoccupied hours.
Data Collection Requirements
*Trend data is required for Tier 1 measures
*BMS screenshots showing existing AHU operation schedule
*BMS screenshots showing existing and proposed unoccupied operation modes
*Photo of design drawing mechanical equipment schedules (supply fan motor HP & CFM, chiller tons, boiler MBH) or *Photos of equipment nameplates - Supply fan motor horsepower nameplate - Chiller nameplate indicating chiller manufacturer and model number - Boiler nameplate indicating boiler manufacturer and model number
Project Description and Additional Notes
To be completed by service provider

Savings Summary	
Annual Electric Use Reduction (kWh/yr)	#N/A
Average Monthly Demand Reduction (kW/mo)	#N/A
Annual Electric Cost Reduction ($/yr)	#N/A
Annual Gas Use Reduction (therm/yr)	#N/A
Annual Gas Cost Reduction ($/yr)	#N/A
Total Annual Cost Reduction ($/yr)	#N/A
Estimated Project Cost ($)	$500
Simple Payback (yr)	#N/A
Simple Payback - Electric Only (yr)	#N/A
Utility Peak	
Utility Peak Demand Reduction, DS_{peak} (kW)	#VALUE!
Feasibility Check	
Calculated Baseline (kWh/yr)	#N/A
Calculated Baseline - Percent of Annual Usage	#N/A
Typical Baseline - Percent of Annual Usage	7-27%
Project Savings - Percent of Baseline	#N/A
Project Savings - Percent of Annual Usage	#N/A

		Baseline		Upgrade		Reduction	
Monthly Breakdown		kWh/yr	kW	kWh/yr	kW	kWh/yr	kW
1	Jan	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	Feb	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	Mar	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	Apr	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
5	May	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
6	Jun	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
7	Jul	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
8	Aug	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
9	Sep	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
10	Oct	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
11	Nov	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
12	Dec	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	Total	#N/A		#N/A		**#N/A**	

Gas Usage Reduction (therms/yr)	#N/A

Baseline

BASELINE PARAMETERS AND OPERATION					
Air Handler Specifications	DF	Inputs & Notes			
AHU Name					
AHU Type	X	VAV			
Total Fan Horsepower (hp)					
Design Flow (CFM)					
Fan Type	X	Variable-Speed Drive			
Air Flow Parameters		Flow		OAT (°F)	
	X	90%	@	90	and higher
	X	50%	@	55	
	X	50%	@	5	and lower
		With a linear variation between the indicated points			
Economizer & Outside Air					
Type	X	Percent Flow	Outside air varies with AHU flow		
Min Outside Air (%)	X	10%			
Economizer Setpoint (°F)	X	65			
Supply Air Temperature					
Supply Air Temperature Parameters		SAT (°F)		OAT (°F)	
	X	55	@	90	and higher
	X	60	@	55	
	X	65	@	5	and lower
		With a linear variation between the indicated points			
Heating Equipment					
Equipment Turned On in	X	Oct			
Equipment Turned Off in	X	Apr			
Heating Equipment Off Above OA Temp (°F)	X	65			
Heating Type					
Cooling Equipment					
Equipment Turned On in	X	Apr			
Equipment Turned Off in	X	Sep			
Cooling Equipment Off Below OA Temp (°F)	X	55			
Cooling Type					
Cooling Efficiency (kW/ton)					
Return Air					
		Cooling	Heating		
Occupied Return Air Temperature (°F)	X	72	70		
Unoccupied Return Air Temperature (°F)	X	80	60		
Unoccupied Parameters					
Is the AHU allowed to cycle during unoccupied hours?	X	Yes			
Is the AHU providing OA during unoccupied hours?	X	No			
Is the economizer used during unoccupied hours? (NA if no OA)	X	No	No outside air, economizer not applicable		
Is the AHU fan cycled for unnocupied space heating?	X	No	Fan-powered VAV boxes or radiant heat meets unoccupied space heating requirements and the AHU fan		
Reheat					
Reheat Parameters		Reheat (°F)		OAT (°F)	
	X	0	@	70	and higher
	X	1	@	55	
	X	10	@	5	and lower
		With a linear variation between the indicated points			
Air Handler Schedule					
Day		Time On	Time Off	Notes	
Mon				Please enter time to nearest hour	
Tues				on 24-hour clock	
Wed				If there is no input, the default value is 0	
Thur					
Fri					
Sat					
Sun					

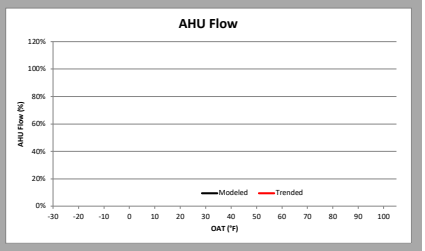
Upgrade

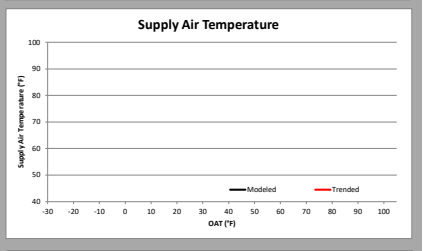
UPGRADE PARAMETERS			
Unoccupied Parameters			
Is the AHU allowed to cycle during unoccupied hours?	X	Yes	
Is the AHU providing OA during unoccupied hours?	X	No	
Is the economizer used during unoccupied hours?	X	No	No outside air, economizer not applicable
Is the AHU fan cycled for unnocupied space heating?		Yes	The AHU fan cycles to meet space conditions (No radiant heating or fan-powered VAV boxes)

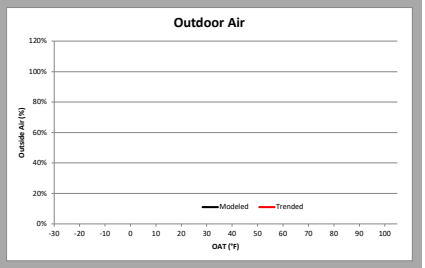
Trend Data						Modeled Data		
OAT High (°F)	OAT Low (°F)	Avg. OAT (°F)	AHU Flow (%)	SAT (°F)	Occupied % OA	AHU Flow (%)	SAT (°F)	Occupied % OA
105	100	102.5						
100	95	97.5						
95	90	92.5						
90	85	87.5						
85	80	82.5						
80	75	77.5						
75	70	72.5						
70	65	67.5						
65	60	62.5						
60	55	57.5						
55	50	52.5						
50	45	47.5						
45	40	42.5						
40	35	37.5						
35	30	32.5						
30	25	27.5						
25	20	22.5						
20	15	17.5						
15	10	12.5						
10	5	7.5						
5	0	2.5						
0	-5	-2.5						
-5	-10	-7.5						
-10	-15	-12.5						
-15	-20	-17.5						
-20	-25	-22.5						

Enter trend data above. Adjust applicable inputs to the model such that the modeled operation reasonably simulates trended operation. Always consider the potential flaws in trend data. Transients, varying space loads, and inaccurate sensors can create scatter in the data not representative of actual operation. Trend data should help validate model inputs while still using your engineering judgement to provide reasonable entries to the model that considers more than just the short-term data collection period.

Modeled Baseline Scheduled Hours:	0







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Consumers Energy Retro-commissioning Tool (CERT) FAQs

What is the 'Common Inputs & Savings Summary' tab and how to use it?

A: The Common Inputs & Savings Summary tab is utilized to summarize any (and all) of the Nexant side measures that are being recommended for a project. To summarize any (and all) Nexant side measures for a project, the user will have to enter the excel tab names (only for the Nexant created measures) in cells B47:B59 in the Common Inputs & Savings Summary tab. For example, if you're recommending Night Setback as a measure, please enter this calculator sheet tab name in column B in the Common Inputs & Savings Summary tab for the savings and cost metrics associated with the project to be automatically populated in the savings summary table.

How to enter utility information for all the Nexant side measures?

A: In the Common Inputs & Savings Summary tab, please enter electric and gas utility related charges in the utility information section (Cells J13-N18). This table is linked to the savings summary table in all the Nexant side measures calculation tabs.

How to populate the Common Inputs and Savings Summary tab for all Nexant side measures?

A: Please enter the tab name of the ECM calculation sheets in cells B47-B59 of the Common Inputs and Savings Summary tab to populate data related to the ECMs. The order of the recommendations will display as listed in this tab.

How to summarize all the calculations made in the CERT tool?

A: Once all the Nexant side recommendations are entered to the Common I& Savings Summary tab, please go to the 'Savings Summary' tab of the workbook, and hit the calculate button in Cell C1 to pull in all metrics associated with both the CBOA and the Nexant side calculations.

Is it required to enter the utility rate and climate zone at two places in the same tool?

A: Yes, as there are two components of the calculator (CBOA and Nexant), utility rates and climate zones have to be entered for both in order for savings to reflect for all the measures.

Do the calculations use TMY data? Are they using OAT Bin method or something else?

A: Yes, CERT (both Nexant and C-BOA components) uses TMY3 weather data obtained from the National Renewable Energy Laboratory, and performs its analyses using bin method based on outdoor air dry bulb temperature in degrees Fahrenheit. (TMY is Typical Meteorological Year).

How do I include trend data into the Nexant Calculation Tool?

A: When using the Nexant calculator, trend data may be added to support calculator inputs. When applicable, outdoor air temperature binned trend data inputs can be pasted into each calculator sheet Columns M-O or M-P, and the model parameters are adjusted to replicate trend data collected. This ensures calculator inputs closely track the trends.

Will input data entered into the CBOA section of CERT be carried forward to the Nexant Tool?

A: Except for the weather data, inputs entered into the CBOA section of CERT are not carried forward to the Nexant Tool. Users will have to make sure input data such as AHU heating and cooling capacities, or chiller/heating plant capacities and efficiencies that are common between CBOA and Nexant are consistent.

Are there any best practices for use of the tool?

A: Please use the calculator default values for the Nexant side measure inputs if data is not available.

If we find 100,000 kWh saved with CERT, what is the rebate?

A: Please find the program information including the rebate amounts listed at ConsumersEnergy.com/Retrocommissioning.

Who do we reach out to with CERT related questions?

A: Please reach out to our team at Retro-Commissioning@cmsenergy.com with any questions about the tool.