PROCESS VFD SAVINGS CALCULATOR USER GUIDE

SMART $AVER CUSTOM INCENTIVES

CUSTOM-TO-GO

CONTENTS

1. GETTING STARTED

The current version of the Process Variable Frequency Drive (VFD) Savings Calculator can be downloaded from http://duke-energy.com/CustomToGo. It is included in the Smart $aver Custom-To-Go tool suite, which contains a number of useful tools that can help you calculate savings and incentives for various energy saving measures.

The ZIP output file from the calculator must be submitted with the Smart $aver application (Step 1) in order to receive an incentive payment. For application submissions and questions about the application process, contact us at CustomIncentives@duke-energy.com.

2. MEASURE TOOL DESCRIPTION

Variable Speed Drives (VSD), also referred to as Variable Frequency Drives (VFD), are used for controlling AC motors. The VFD is a solid-state device that controls the frequency and voltage supplying the motor. Many AC motors used for process applications are oversized to accommodate peak loads even though the average loads are lower. The most common applications involve centrifugal pumps and fans which have large savings potential due to their power versus speed curves. Without VFDs the motors are left operating at full speed or are controlled by primitive part-load strategies. Often times the motors cannot be cycled on and off too frequently so the motors remain at full speed. The VFD offers large energy savings for these AC motors that operate at partial loads.

This tool was developed to assist customers in identifying and estimating VFD saving opportunities on process pumps and fans.

Process VFD Calculator can be used for facilities with the characteristics shown in Table 1.

Table 1: EMS Savings Calculator Common Features

Description	Measure Feature
States	• Ohio • Indiana • Kentucky • North Carolina • South Carolina
Locations	• All
Building Types	• Office • School K-12 • College/University • Retail/Service • Restaurant

	• Hotel/Motel (Guest Rooms) • Hotel/Motel (Other) • Medical • Grocery • Warehouse • Light Industry • Heavy Industry • Parking Garage
Operating Hours	• Monday – Friday, 8am – 5pm • Monday – Friday, 7am – 7pm • Monday – Friday, 6am – 10pm • Monday – Friday, 24 hours per day • Monday – Friday, 6am – 8pm, Saturday and Sunday, 8am – 6pm • Monday – Saturday, 8am – 5pm • Monday – Saturday, 10am – 9pm • Monday – Saturday, 7am – 7pm, Sunday, 8am – 5pm • Monday – Sunday, 8am – 5pm • Monday – Sunday, 9am – 9pm • Monday – Sunday, 11am – 11pm • Monday – Sunday, 6am – 10pm • Monday – Sunday, 24 hours per day
System Types	• Fan • Pump

2.1. Applicable Types of Equipment and size Covered by the Tool

Process VFD Calculator covers the pump and fan systems described in Table 2.

Table 2: Equipment Coverage Matrix

Description	Type	Control Type	Drive Type
Centrifugal Fan	• Airfoil, SISW • Airfoil, DIDW • Backward Inclined Backward Curved, SISW • Backward Inclined Backward Curved, DIDW • Radial, SISW • Radial Tip, SISW • Forward Curved, SISW • Forward Curved, DIDW • Tubular • Industrial and Commercial Air Handling • Industrial and Commercial Material Handling • Industrial and Commercial Long Shavings	• On/Off • Outlet Dampers • Inlet Vanes	• Direct • V. Belt • Rubber Chain
Centrifugal Exhaust Fan	• Centrifugal Exhaust	• On/Off • Outlet Dampers	• Direct • V. Belt • Rubber Chain
Axial Fan	• Vaneaxial • Tube Axial • Propeller	• On/Off • Outlet Dampers	• Direct • V. Belt • Rubber Chain
Axial Exhaust Fan	• Axial Exhaust	• On/Off • Outlet Dampers	• Direct • V. Belt • Rubber Chain
Centrifugal Pump	• End Suction ANSI/API • End Suction Slurry • End Suction Stock • End Suction Sewage • Large End Suction • API Double Suction • Multistage Boiler Feed • Axial • Double Suction • Vertical Turbine	• On/Off • Throttling • Recirculating	• N/A

Positive Displacement Pump	• N/A	• Recirculating	• N/A

3. MEASURE TOOL USE

3.1. Select Your Service Territory

In order to properly load the correct utility program the user must first select the service territory associated with their account. To begin, select your state from the list presented in the *Select State* dialog box.

If the State of Indiana, Kentucky, or Ohio is selected the application will open the appropriate service territory version of the software.

If one of the Carolinas is selected the application needs a little more information. In these cases, a *Select Service Territory* dialog box will appear. Please either enter the service address zip code or select the Utility associated with the service account.

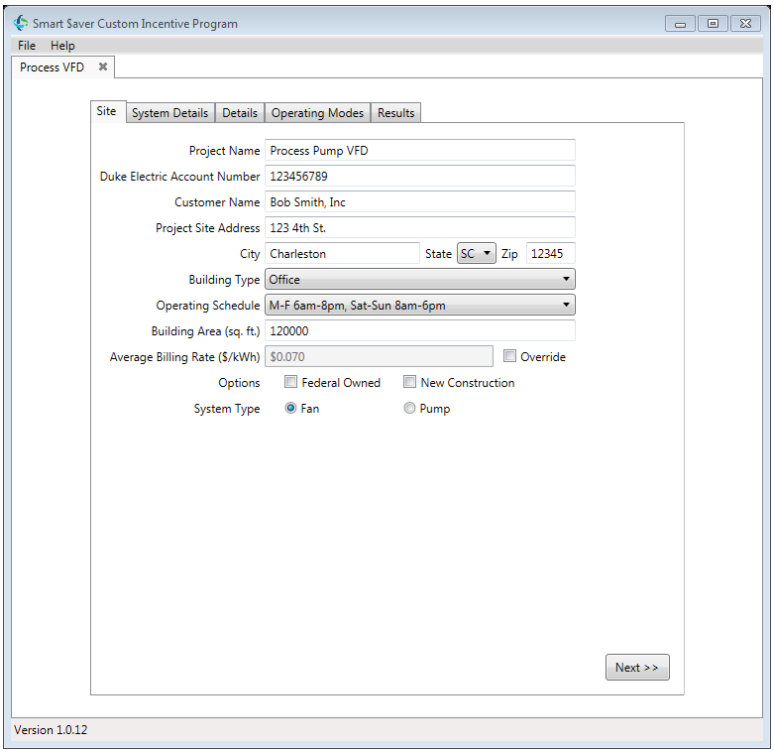
To return to the state selection dialog box click on the "Choose State" link.

3.2. Tool Inputs

Tool inputs are done either by selecting predefined dropdown options or entering numerical values as prompted by the tool.

Inputs window is divided into tabs. Refer to tables below for input details.

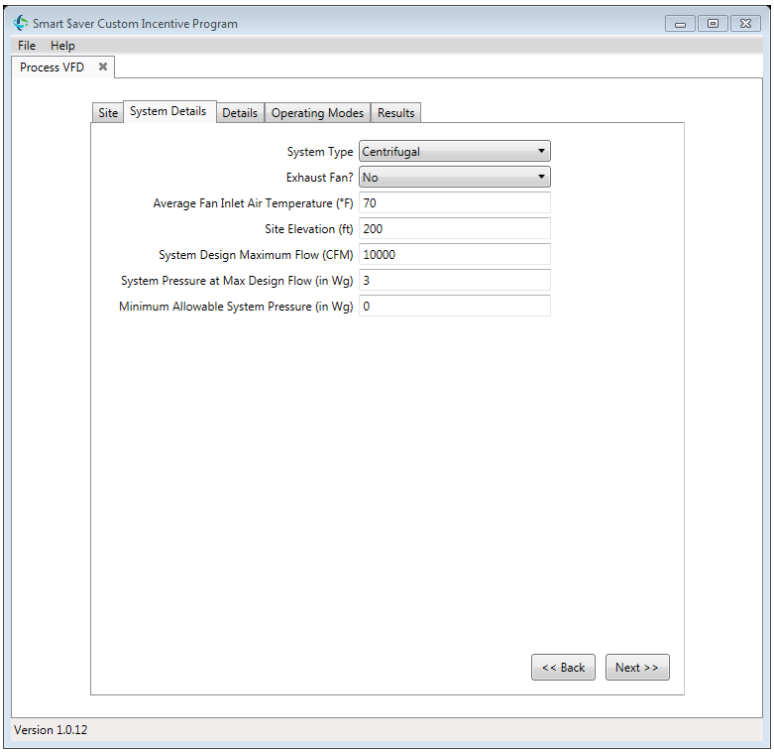
Table 2 – Site Inputs



Input Name	Description / Purpose
Duke Electric Account Number	Enter the customer's Duke Energy electric account number.
Customer Name	Enter the name of company or facility.
Site Address	Enter address of the facility.
State	Select state from pull down.
Building Type	Select building type from pull down.
Operating Hours	Select operating hours from pull down.
Square Footage	Enter square footage of the facility. Do not enter decimals (whole numbers only).
Average Billing Rate ($/kWh)	Default can be used or actual average can be entered by user.
Options	Check if the project is Federal Owned or New Construction
System Type	Select Fan or Pump

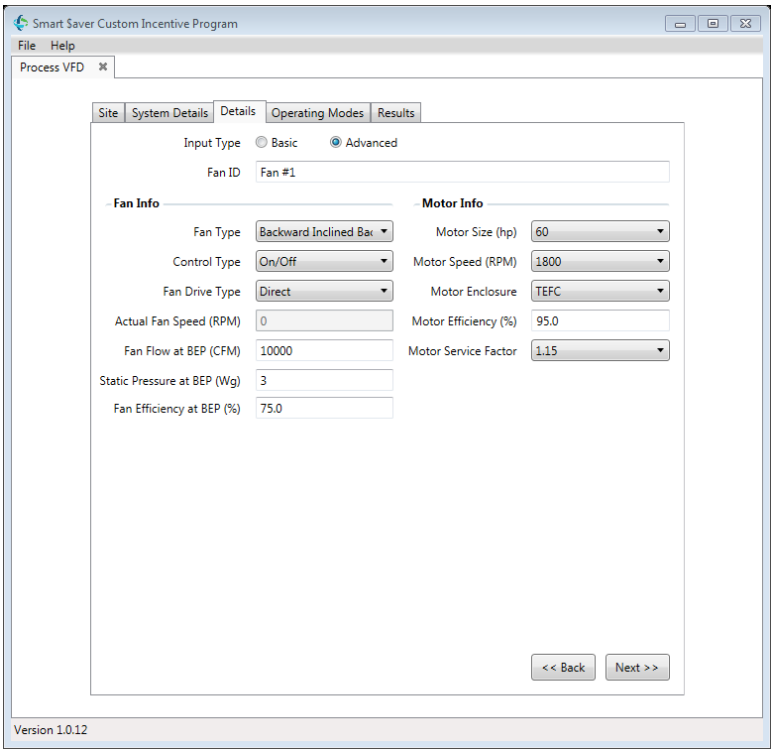
The selection of a system type (Fan or Pump) will determine if the Fan Inputs (Table 4 and Table 5) or the Pump Inputs (Table 6 and Table 7) will be required.

Table 3 – Fan System Details Inputs



Input Name	Description / Purpose
System Type	Select existing fan type from pull down
Exhaust Fan?	If the existing fan an exhaust fan (Yes/No)
Average Fan Inlet Air Temperature (°F)	Enter the average fan inlet temperature in °F.
Site Elevation (ft)	Enter the site elevation of the fan in feet.
System Design Maximum Flow (CFM)	Enter the system's design maximum design flow per the manufactures fan performance curve in CFM
System Pressure at Max Design Flow (in Wg)	Enter the system's pressure at maximum design flow per the manufactures fan performance curve in inches Wg.
Minimum Allowable System Pressure (in Wg)	If there is a minimum allowable operating pressure for the fan system, enter it here. Otherwise, leave blank.

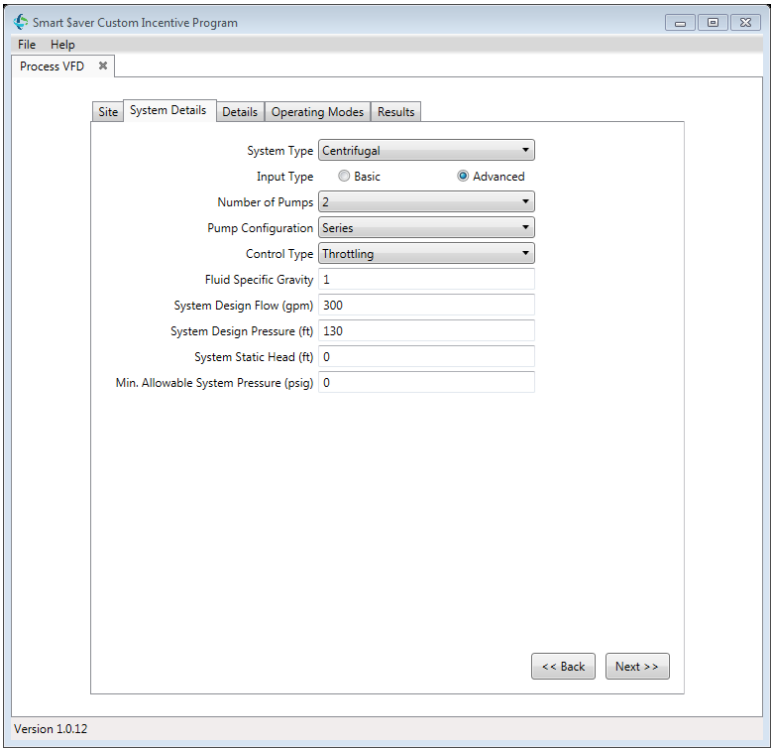
Table 4 – Fan Details



Input Name	Description / Purpose
Input Type	Select advanced if you know the fan efficiency, motor efficiency, motor RPM, motor service factor, and motor enclosure type.
Fan ID	Enter an ID for the fan
Fan Type	Select existing fan type from pull down
Control Type	Select existing fan control type from pull down
Fan Drive Type	Select existing fan drive type from pull down
Actual Fan Speed (RPM)	Enter the actual fan speed when a belt drive has been specified. This field is meant to account for differences in the motor and fan gear ratios.
Fan Flow at BEP (CFM)	Enter fan flow at the best efficiency point (BEP), as specified by the manufacturer.
Static Pressure at BEP (in WG)	Enter fan pressure at the best efficiency point (BEP), as specified by the manufacturer.
Fan Efficiency at BEP (%)	Enter maximum pump efficiency, as defined by the manufacturer's performance information.
Motor Size (hp)	Select fan motor size in horse power, as specified by the manufacturer.
Motor Speed	Select fan motor speed in RPM, as specified by the manufacturer.
Motor Enclosure	Select fan motor enclosure type, as specified by the manufacturer.

Motor Efficiency (%)	Enter fan motor full load efficiency, as specified by the manufacturer.
Motor Service Factor	Select fan motor service factor, as specified by the manufacturer.

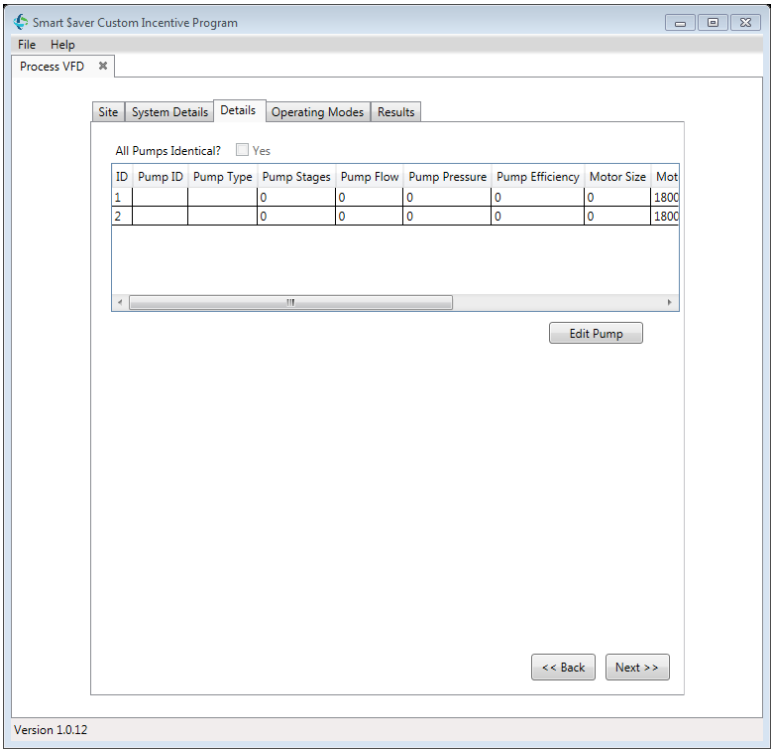
Table 6 – Pump System Details Inputs



Input Name	Description / Purpose
System Type	Select existing pump type from pull down
Input Type	Select Advanced if you know the System Design Flow (gpm) and System Design Pressure (ft).
Number of Pumps	Select the number of pumps included in the project.
Pump Configuration	For projects with more than one pump, select pump configuration
Control Type	Select existing pump control type from pull down
Fluid Specific Gravity	Enter the specific gravity of the fluid being pumped. Examples: Water - 1.0 Seawater - 1.025 Gasoline - 0.7 Corn oil - 0.92 Milk - 1.03 Wine - 1.0 Beer - 1.0 Clarified sewage sludge - 1.1 Glycol Based Water Solution (25% @ 40F) - 1.048

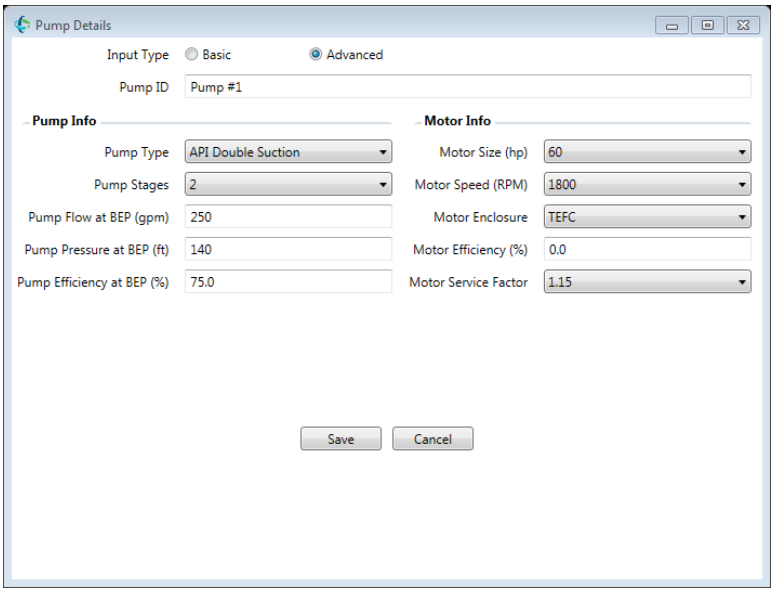
	To calculate specific gravity of slurry: $$S_m = \frac{S_l}{1 + C_w\left(\frac{S_l}{S_t} - 1\right)}$$ S_m = Specific gravity of mixture or slurry S_l = Specific gravity of liquid phase S_t = Specific gravity of solid phase C_w = Concentration of solids by weight
System Design Flow (gpm)	Enter system flow at design conditions (Centrifugal pumps only).
System Design Pressure (ft)	Enter system pressure at design conditions (Centrifugal pumps only).
System Static Head (ft)	Enter system static head. Static head is the difference in height (ft) between the source and destination of the pumped liquid. Closed systems have a static head of zero feet.
Min. Allowable System Pressure (psig)	If there is a minimum allowable operating pressure for the pumping system, enter it here. Be sure to include static lift in the minimum pressure value. Otherwise, leave blank.

The Pump Details tab includes the option to set all pumps identical or to provide pump details for each pump. To enter pump details select a pump ID and press the "Edit Pump" button.



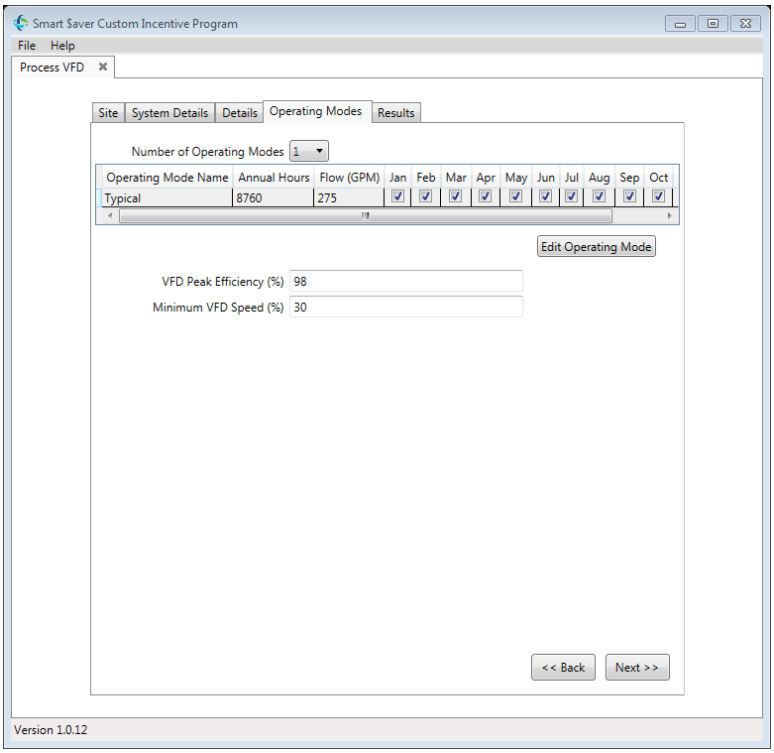
This will open up the input screen detailed in Table 7.

Table 7 – Pump Details



Input Name	Description / Purpose
Input Type	Select advanced if you know the pump efficiency, motor efficiency, motor RPM, motor service factor, and motor enclosure type.
Pump ID	Enter an ID for the pump
Pump Type	Select existing pump type from pull down
Pump Stages	Select the number of stages in the pump.
Pump Flow at BEP (gpm)	Enter pump flow at the best efficiency point (BEP), as defined by the manufacturer's performance information (Centrifugal pumps only).
Pump Pressure at BEP (ft)	Enter pump discharge pressure at the best efficiency point (BEP), as defined by the manufacturer's performance information (Centrifugal pumps only).
Pump Efficiency at BEP (%)	Enter maximum pump efficiency, as defined by the manufacturer's performance information. (Centrifugal pumps only).
Motor Size (hp)	Select fan motor size in horse power, as specified by the manufacturer.
Motor Speed	Select fan motor speed in RPM, as specified by the manufacturer.
Motor Enclosure	Select fan motor enclosure type, as specified by the manufacturer.
Motor Efficiency (%)	Enter fan motor full load efficiency, as specified by the manufacturer.
Motor Service Factor	Select fan motor service factor, as specified by the manufacturer.

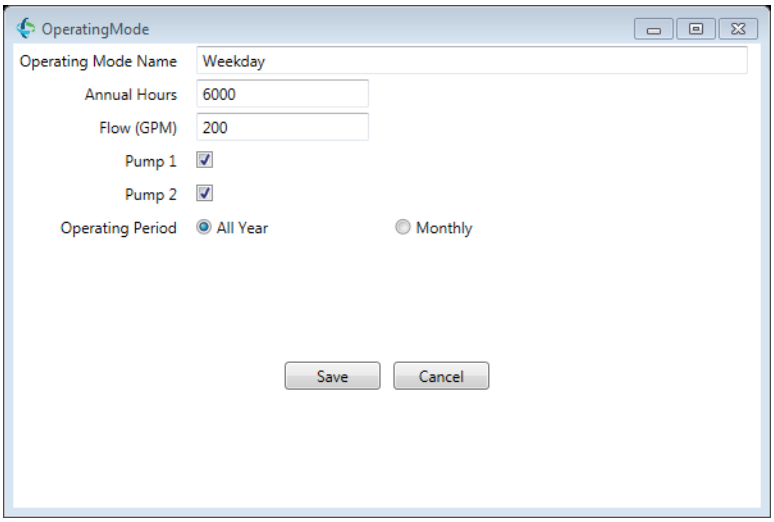
Table 8 – Operating Modes



Input Name	Description / Purpose
Number of Operating Modes	Select the number of operating modes for the equipment (fan or pump).
VFD Peak Efficiency (%)	Enter the peak efficiency of the proposed VFD, as specified by the manufacturer.
Minimum VFD Speed (%)	Enter the minimum allowable VFD speed. Must be between 30% and 100%.

To edit the Operating Modes, select an Operating Mode and press the "Edit Operating Modes" button. This will open up the input screen detailed in Table 9.

Table 9 – Operating Mode



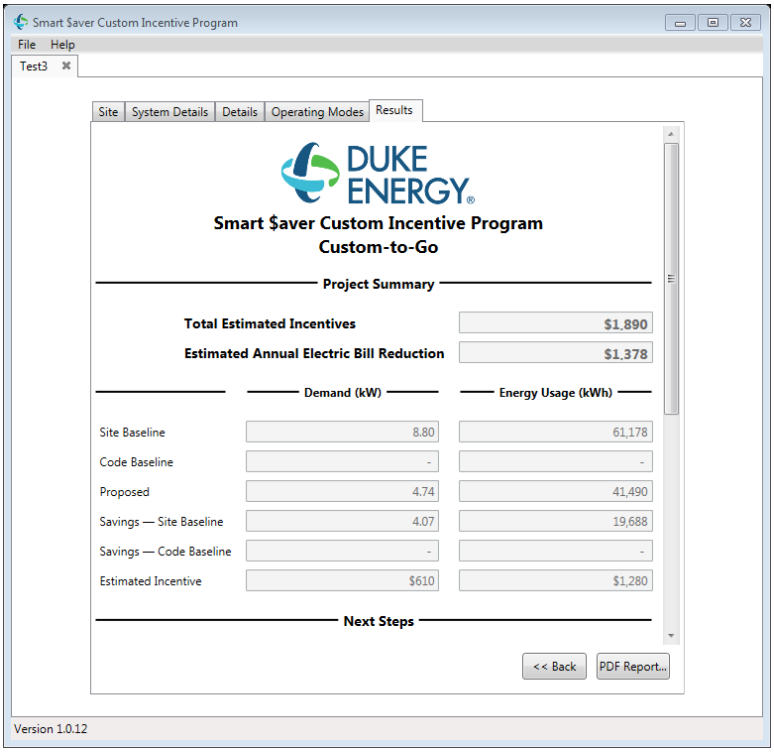
Input Name	Description / Purpose
Operating Mode Name	Enter a name to identify the operating mode.
Annual Hours	Enter the annual operating hours of the equipment (fan or pump).
Flow (GPM/CFM)	Enter the flow required during the operating profile. CFM for fan measures and GPM for pump measures.
Select Equipment	Check equipment which operate during the operating mode.
Operating Period	Select the operating period. If monthly, select the months the equipment will operate.

Once all information is entered, select “Next” button on the bottom right corner of the Operating Modes tab. The tool will then calculate savings based on the information entered and display the results.

3.3. Tool Outputs – Savings Summary

The following table describes the tool outputs.

Table 9- Measure Energy Savings and Incentive

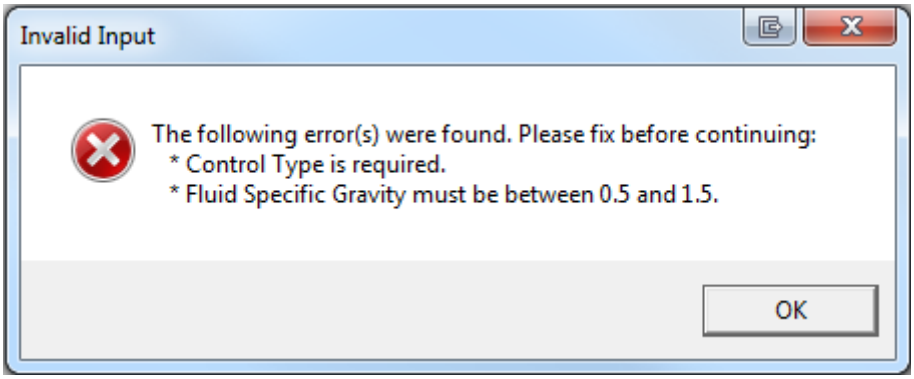


Name	Description / Purpose
Total Estimated Incentives	Estimated total incentive for the project in dollars
Estimated Annual Electric Bill Reduction	Estimated annual electric bill reduction in dollars
Site Baseline, kW	Estimated maximum on-peak demand of the existing system
Code Baseline, kW	Estimated maximum on-peak demand of the code baseline system
Proposed, kW	Estimated maximum on-peak demand of the proposed system
Site Baseline, kWh	Estimated energy use of the existing system
Code Baseline, kWh	Estimated energy use of the code baseline system
Proposed, kWh	Estimated energy use of the proposed system
Savings - Site Baseline, kW	Estimated maximum on-peak demand savings for the measure (difference between site baseline and proposed)
Savings - Site Baseline, kWh	Estimated energy savings for the measure (difference between site baseline and proposed)
Savings - Code Baseline, kW	Estimated maximum on-peak demand savings for the measure (difference between code baseline and proposed)

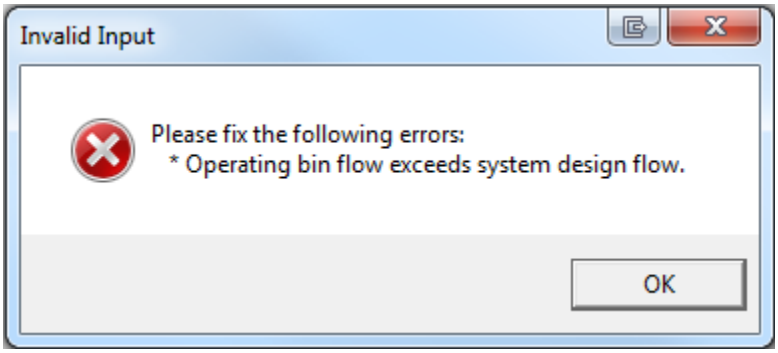
Savings - Code Baseline, kWh	Estimated energy savings for the measure (difference between code baseline and proposed)
Estimated Demand Incentive ($)	Estimated demand incentive for the project in dollars
Estimated Energy Use Incentive ($)	Estimated energy use incentive for the project in dollars

3.1. Tool Outputs – Notes and Error Messages

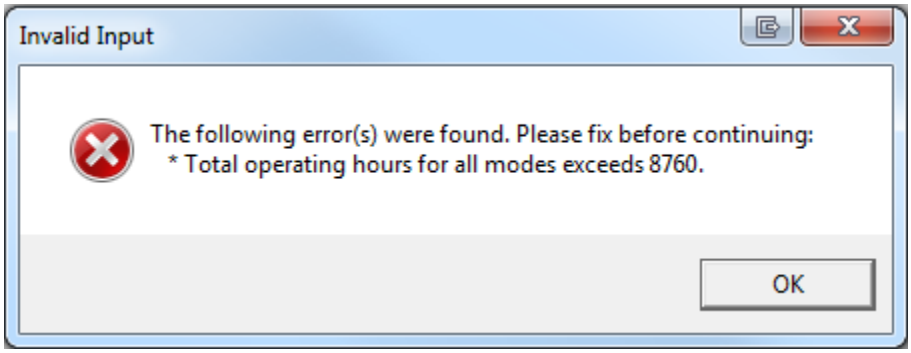
While using the Process VFD Calculator, you may see one of the following error messages:



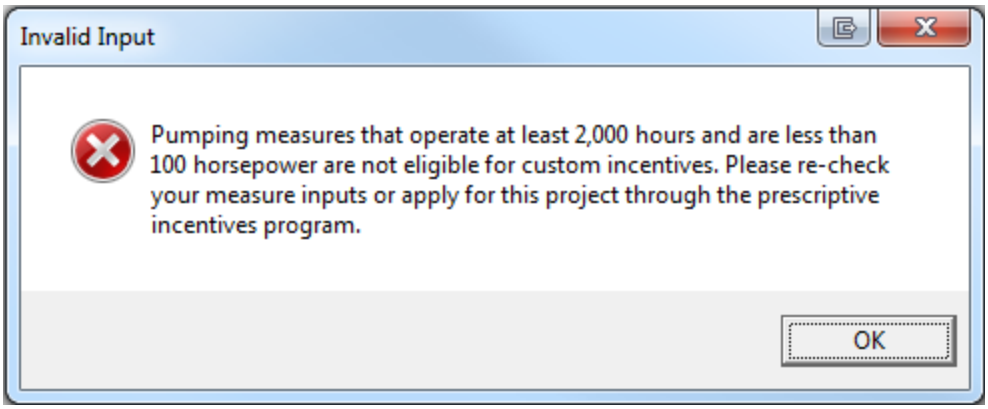
This indicates that you have not made a selection or entered an appropriate value in one or more required fields. Please review your inputs and make sure that you have entered appropriate values in the indicated input fields.



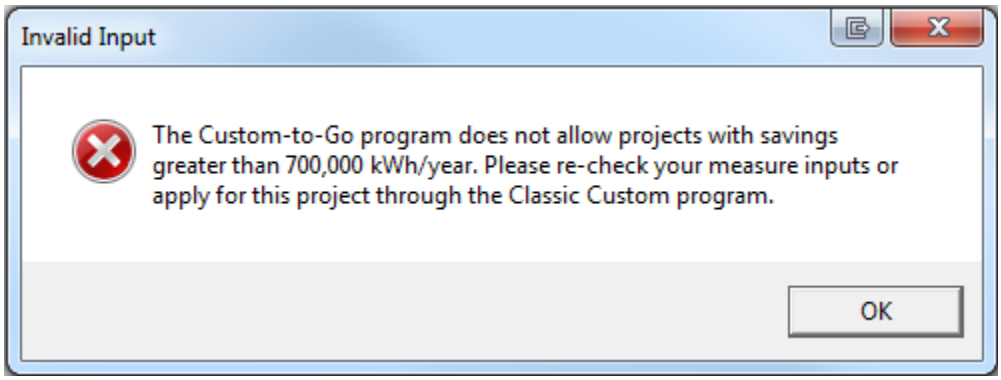
This indicates that the flow that you have entered for the current operating mode exceeds the system design flow. Please reduce the flow for the current mode or review your input for the system design flow.



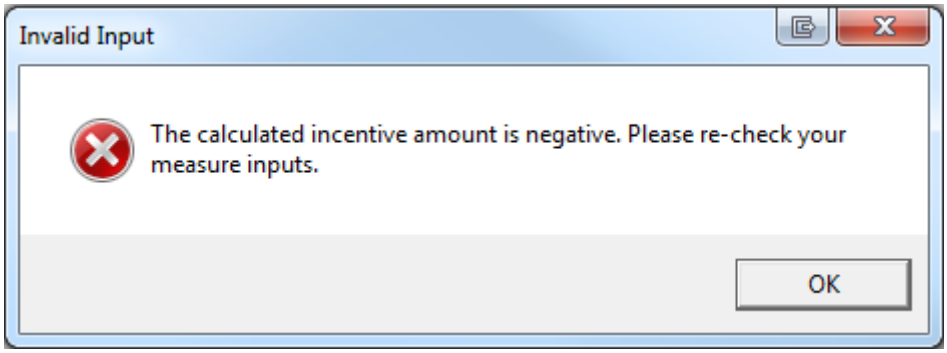
This indicates that too many operating hours have been entered. The maximum number of hours for all operating modes combined is 8,760. Please review your operating mode inputs.



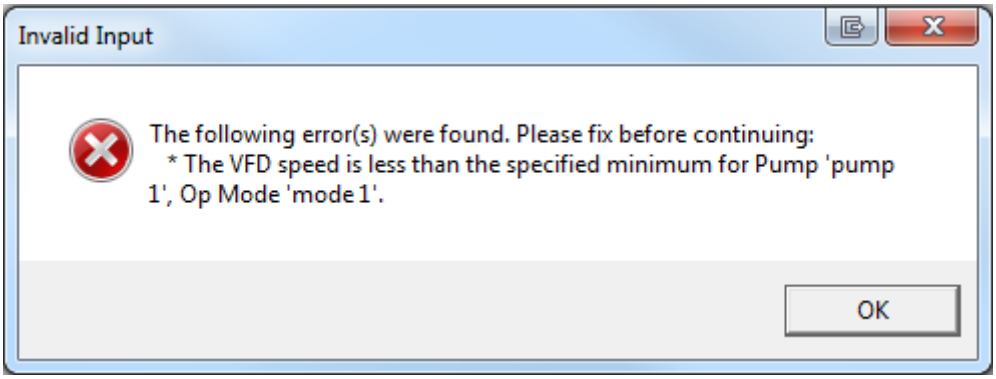
This indicates that the proposed retrofit qualifies for incentives through the prescriptive incentives program. Measures that qualify through the prescriptive program cannot apply for incentives through the custom incentives program (classic custom or custom-to-go).



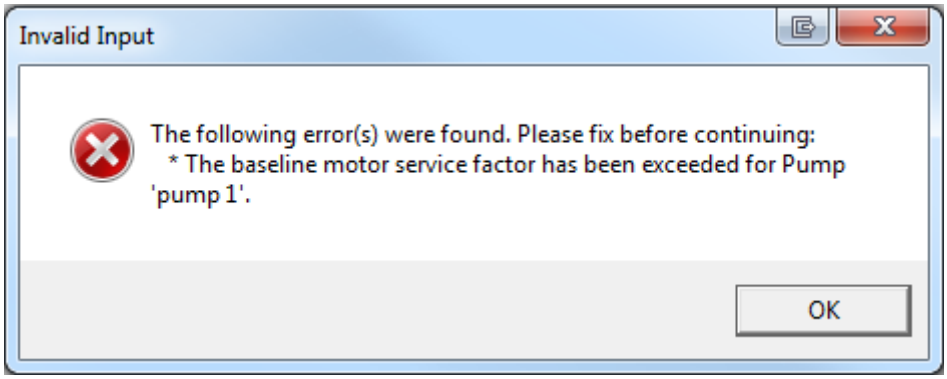
This indicates that the proposed project exceeds the upper limit of the Custom-to-Go program and is only eligible for incentives through the Classic Custom program. Please submit an application to the Classic Custom program for this project.



This indicates that your project will result in negative savings and incentives. Please review your measure inputs and ensure that all inputs are correct. You will not be able to generate a report for a project that has negative savings.



This indicates that your project may not be a good candidate for a VFD due to a system flow that would cause the VFD to operate below its lower limit. Please review your operating mode and minimum VFD speed inputs.



This indicates that the motor for the indicated pump appears to be undersized, based on the pump or system flow. Please review your pump and/or fan inputs along with your operating mode inputs.