User’s Guide
to the Vermont State Screening Tool
for Demand-Side Management projects

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1. Introduction

This User's Guide explains the use of the Vermont state screening tool for societal cost-effectiveness screening of demand-side management (DSM) measures, also commonly known as energy efficiency measures. It focuses on the inputs necessary to screen measures, rather than on the internal calculations that the screening tool performs automatically.

1.1. Overview

The screening tool evaluates the societal cost-effectiveness of DSM measures by comparing the present values of measure costs and benefits, based on regional avoided generation capacity and energy costs, avoided transmission and distribution costs, and environmental externalities. The screening tool takes into account the economic impacts of changes in measure energy consumption (electric, oil, natural gas and LPG) and non-energy costs and benefits (e.g., labor, water, low income benefits, and health impacts).

The tool can screen new equipment having up to two replaceable components with different economic lives. Up to 50 measures can be screened at one time. Either standard or custom load profiles may be chosen.

1.2. Real vs. Nominal Accounting

DSM alternatives can be meaningfully compared with the energy supply they avoid only when all costs are stated in the same year's dollars (real $) and discounted to the same year. Avoidable supply costs (both direct and external costs) and DSM measure costs (including equipment, installation labor, maintenance, fuel, external and other costs) must be expressed in the same year's real dollars. The 2019 tool uses 2018 real dollars as the default base year, and all costs and benefits are discounted back to 2018.

1.3. Software

The screening tool is designed to work with Microsoft's Excel 365, although it is also compatible with many earlier versions of Excel.

1.4. Tool Structure

The screening tool is an Excel workbook containing many linked but functionally distinct worksheets. Enter measure screening inputs into the Multi Measure Input sheet.

The other workbook sheets in the workbook contain statewide assumptions, lookup table data and intermediate calculations. Most other sheets are hidden, and it should not be necessary for most users to view them. The data and formulas in these sheets should not be modified by users.

The workbook has been protected to prevent accidental entries into cells with formulas, so users can only change the contents of the gray cells or selection boxes in the input areas.

2. Using the Field Screening Tool

Measure screening requires up to 32 inputs that characterize measure

- timing,
- costs,
- savings,
- fuel type and use,
- water, and
- existing equipment the measure would replace.

To clear all inputs from a sheet, select the "Reset inputs to blank" macro button that appears on each of the input sheets. This will only clear the inputs for the active sheet.

2.1. Input Fields

2.1.1. General Guidance

NEVER <u>cut</u> and paste data anywhere in the screening tool; this will result in calculation errors. Use copy and paste instead. It is best to avoid copying and pasting the columns with pulldown menus in them, however, as this too may result in unintended consequences.

Also do not insert or delete rows in the screening tool; this too will result in calculation errors.

The following input descriptions are listed in the order in which they appear on the **Multiple Measure** input sheet. It allows for multiple measure inputs with a different format and input order. The inputs and outputs for any one measure on the **Multiple Measure** sheet are all in the same row.

NEB Flag, Customer Name, and Account # inputs are only entered once and apply to all measures.

Most of these fields are optional and no entry is required if they are not useful or not relevant to the particular measure. Fields for which entry is required for all measures are identified as such in the descriptions below. Unless otherwise noted, blank entry is treated as an entry of zero.

2.1.2. Informational Inputs

NEB Flag

Pull down selection of a flag to indicate whether the screening should use Standard assumptions or Low Income residential or Energy Savings Account (ESA) assumptions. Select "Economic Development" for ESA projects, "Low Income" for qualifying low income residential projects, and "Standard" otherwise. Projects with the Economic Development flag include a 10% adder on benefits. Projects with the Low Income flag include a 15% adder on benefits.

Customer Name

The name of the customer considering the measure. Typically, this would be the name appearing on the electric bill.

Account #

The account number appearing on the customer's electric bill.

Measure Name

Enter a brief name for the energy efficiency measure.

Measure ID

The user may use this input to assign a short alphanumeric code to the measure. This may be an abbreviation of the measure name with numbers designating variations among similar measures (e.g., CFL1, CFL2).

1.1.1. General Inputs

Analysis Period

Analysis Period usually refers to the expected average useful life of the measure savings, once installed. This is typically equal to the average life of the equipment. However, for some measures the expected useful life of the measure savings may be less than the equipment life, due to the likelihood of changes in settings and operating conditions.

In some cases, the analysis period may be greater than the equipment life of some components, in which case all parts requiring replacement over the analysis period need to be input into the Maintenance and Component Costs section.

If a measure consists of two components with different useful lives (e.g., a gas furnace and ductwork), then one may input the useful life of the longer-lived component as the analysis period. Inputs concerning timing and costs of replacing the shorter-lived components are addressed in the Maintenance and Component Costs section.

Analysis Period can be any positive number up to 50. In practice, however, analysis periods should be limited to no greater than 30 except in extraordinary circumstances. Analysis periods may be less than one year. Non-integer analysis periods greater than 1 year will be rounded to the nearest integer for screening purposes.

Entry of an Analysis Period is required for all measures.

Year Installed

Enter the calendar year in which the measure is being installed. Installation year determines when savings begin and when measure costs are expended. If nothing is entered in this field the tool assumes that the measure is being installed in the current year.

Measure Cost

The costs of measure equipment, installation labor, and incidental costs. Depending on how savings are input, these costs should be expressed as either incremental or total costs.

For natural replacement and purchases of new equipment, installed cost should be set at the incremental cost of the efficiency improvement, calculated as the cost of the efficient equipment less the cost of purchasing and installing new baseline equipment.

For early replacement and retrofit measures (efficient equipment replacing functioning existing equipment, or add-on efficiency improvements such as controls), installed cost should be set at the full installed cost of the efficient equipment. In addition, for early replacement, additional cost information should be entered in the Early Replacement/Retrofit section (see below).

1.1.2. Impact on Electric use

First Year Annual Electric Savings (kWh)

Enter the annual electric energy savings (kWh) for the measure. Measure savings should be input consistently with measure costs, either as incremental (for natural replacement or new equipment) or total savings (for early replacement or retrofit).

Enter the incremental savings when equipment is being purchased because the existing equipment is nearing the end of its life or otherwise needs to be replaced for non-efficiency reasons, or when new equipment is being purchased for expansion, renovation, or new construction. If new equipment would be purchased even without energy savings, then use incremental savings. Examples include a chiller that is 30 years old and needs to be replaced because of high maintenance costs, or a larger air compressor to meet an increased load, or new lighting or HVAC equipment for a space that is being fully renovated. Incremental savings are calculated as the energy use of new equipment of standard efficiency, minus the energy use of the efficient equipment, using the same assumptions of use.

Enter savings compared to existing equipment when the new equipment or other change is being made primarily for the purpose of energy savings. Examples include installing a VFD to improve efficiency on a hot water distribution system that was previously uncontrolled, replacing operational T8 lighting with LED lights with no other changes in the space, or switching from oil heat to electric heat pumps. Savings in this case are calculated as the energy use of the existing equipment minus the energy use of the new or modified equipment.

If the savings in the first year are different from the savings in future years, enter the first year savings here and use the inputs in the Early Replacement/Retrofit section to adjust future savings (see below).

For measures that increase electric use (such as installing a heat pump to replace a fuel-fired boiler), enter the electric impact as a negative number.

Calculated electric load reduction (kW)

In most cases it is preferable to leave the calculated kW load reduction blank; it will be calculated based on the kWh savings and the assumed Full Load Hours.

Enter a value for calculated kW load reduction when the selected End-Use Load Shape does not include an assumption for hours of use, or when a custom load shape is used.

In some cases the maximum connected load may not be reduced by the efficient measure, but the number of hours that the equipment is operating is lowered. In this case the calculated kW connected load reduction represents a demand reduction that is proportional to the kWh reduction, reflecting the change in diversified demand.

End-Use (Load Profile)

The user selects an end use from a list in the drop-down selection box. This selection determines the default load profile, which sets the distribution of electric energy and peak savings, and full load hours. Select the load profile that most closely matches the distribution of electric savings (not load). If the desired end use is not included in the list, then the user may select the end use most closely resembling the measure or add the requisite inputs in the custom load profile section.

The standard load profiles can be seen on the Lookup Tables sheet of the screening tool.

1.1.3. Early Replacement and Retrofit Measure Data

The screening tool uses these inputs to calculate a credit to measure cost associated with the deferral of future replacements of existing (for retrofit) or new baseline (for new construction and natural replacement) equipment. For example, replacing a standard water heater with 10 years of remaining life with an efficient model having a 15-year life will avoid the cost of replacing the existing equipment in 10 years. The screening tool uses the levelized installed cost of new baseline equipment to capture the benefits of deferring this replacement to the end of the useful life of the efficient measure (in this example, for five years).

Further, these inputs are used to reflect changes in the level of savings over the life of a retrofit measure. The existing inefficient equipment that is replaced by a retrofit measure is likely to be less efficient than new baseline equipment. So, at the time when the existing equipment would have been naturally replaced, the savings attributable to the efficiency measure decline. In the above example, savings in the first 10 years of the measure's life might be higher than in the final five years. The screening tool can account only for a single change in savings over the life of the measure.

Note that if this section is being used for early replacement, full costs rather than incremental costs of efficient equipment should be used.

This section may also be used to represent other expected future changes in savings, such as from changes in production.

Full baseline equipment life

Standard existing or baseline equipment life, in whole years.

The useful lifetime of the existing or baseline equipment may or may not be the same as the lifetime of the efficient equipment. Even if it is the same, if this section is being used, this data should also be input, so that a blank is not interpreted as a zero.

If there is a value entered in this field then be sure to also enter values for the existing equipment age and savings adjustment fields, which will otherwise be assumed to be zero if left blank.

Existing equipment age

The age of the existing equipment, in whole years. This will be used with the baseline equipment life to calculate the remaining years of service that the existing equipment can provide.

Do not enter existing equipment age that is greater than the baseline equipment life above. If the existing equipment is older than its expected life, then usually the measure should be treated as time-of-replacement because the equipment is at the end of its useful life. Savings should then be calculated compared to new standard efficiency equipment and incremental measure cost should be used. This section would therefore not be needed.

If, however, the existing equipment is working well despite being older than its expected life, and is being replaced to improve energy efficiency, then enter an "existing equipment age" equal to the Full baseline equipment life minus the expected remaining life of the existing equipment. For example, if a water heater is normally expected to last 15 years, but the existing heater is 18 years old and still going strong, you may assume that it would continue operating for another 3 years before it needs to be replaced. In this case, you would enter 15 years as the baseline equipment life, and 12 years as the existing equipment age (instead of the actual 18) to show that it is expected to last another 3 years.

New baseline equipment installation cost

The installation cost of the new baseline equipment should be its full installed cost.

Electric Savings Adjustment (ultimate saved kWh/1st year kWh)

Enter the savings adjustment for electric savings, representing the ratio of future savings to first year savings. Enter the ratio of

(a) the expected future savings; for early replacement measures this would be the savings of the efficient equipment compared to new standard (baseline) equipment that would normally be installed at the end of the life of the existing equipment

divided by

(b) the first year savings from the efficient equipment; for early replacement measures this would be the savings relative to the existing equipment.

This value should normally be a percentage between 0% and 100%.

For example, if the new baseline equipment is expected to have the same efficiency as the existing equipment, then this input will be 100%. If the new baseline equipment is expected to have the same efficiency as the retrofit efficient equipment, then this input will be 0%.

Note that a blank entry in this field is treated as zero; if there are values entered in the Full baseline equipment life field then be sure to enter a value in this and the other savings adjustment fields as well to avoid unwanted adjustments.

Fuel Savings Adjustment (ultimate saved BTU/1st year BTU)

Enter the savings adjustment for fuel savings, calculated using the same methodology as the electric savings adjustment.

Water Savings Adjustment (ultimate saved CCF/1st year CCF)

Enter the savings adjustment for water savings, calculated using the same methodology as the electric savings adjustment.

1.1.4. Impact on Non-electric Fuels

Fuel Type

Input fuel type for measures that affect the end-use fuel consumption, whether positively or negatively. Only one fuel type may be selected for a single measure. If an energy efficiency measure affects more than one type of fuel, use separate lines for each fuel type.

Select the fuel type from the choices given in the drop-down box. The following options are currently defined.

INPUT:	FOR FUEL TYPE:
1	Residential Distillate (No. 2 oil)
2	Residential LPG (propane)
3	Space Heat Natural Gas
4	Commercial Distillate (No. 2 oil)
5	Commercial LPG (propane)
6	Flat/DHW Natural Gas
8	Kerosene
9	Wood
10	Wood Pellets
11	Wood Chips

Select Residential fuel types for smaller accounts that have relatively low usage and storage capacity; use Commercial fuel types for larger accounts.

For natural gas, select Space Heat Natural Gas for equipment that is used primarily in the winter; select Flat/DHW Natural Gas for equipment that uses natural gas year-round or primarily in the summer.

Select Commercial Distillate (No. 2 oil) also for other grades of fuel oil as well as for diesel fuel, coal, and other liquid fuels not listed.

Fossil Fuel Consumption Change (MMBty/yr)

Annual fuel use changes for the new equipment should be expressed in million Btus (MMBtus heat input). For measures that reduce end-use fuel consumption, annual fuel savings should be input as a *negative number*. Increases in fuel consumption should be input as a positive number.

Fuel consumption changes should be input consistent with savings and costs. That is, this input should be incremental to the fuel use of the same baseline used for measure electric savings and costs.

Water Savings (CCF)

Enter any impact on annual water consumption here in hundreds of Cubic Feet (CCF). Savings are entered as a positive number and increased use is entered as a negative number. This input should be consistent with the other savings and cost inputs, compared to the same baseline condition.

1.1.5. Maintenance and Component Costs

Use these inputs to account for recurring costs over the life of the measure. These costs could be for replacing a component or for maintenance. Up to two shorter-lived separate components can be modeled. Inputs are necessary in this section only if there is a significant difference in operation and maintenance costs between the efficient and baseline equipment.

Efficient measure components are those shorter-lived components or maintenance visits associated with the efficient equipment that is being screened for cost-effectiveness.

Baseline measure components are those shorter-lived components or maintenance visits associated with the baseline equipment that would have been installed if the efficient equipment were not.

The inputs under *Efficient measure components* will result in additional measure costs. The inputs under *Baseline measure components* will result in a reduction in the net measure costs. The net annual levelized maintenance or component cost from these inputs is shown at the bottom right of this input section. A negative number means that the baseline equipment would have cost more to maintain than the efficient equipment.

Component Life

Input the life of the component that will need to be replaced or the time between required maintenance visits before the end of the full measure life. The component life should be a positive number less than the Measure Life.

Component Replacement Cost

Input the cost of the shorter-lived equipment component or the cost for the scheduled maintenance visit.

Note that the original measure cost should have been the entire measure cost (incorporating both the cost of the short- and long-lived components.)

1.1.6. Custom Load Profile Data

If the measure has a load profile that does not follow any of the end-use selection choices, then the user may modify any one of the variables. The custom inputs override the standard profile assumptions. If nothing is entered in any of these fields, then the values from the selected load profile are used.

% of annual kWh (custom)

Annual energy savings (kWh) will be divided between the four rating periods according to the percentages in this input. The rating periods are:

Winter Peak: October to May, 6am-10pm M-F

Winter Off Peak: October to May, all other hours

Summer Peak: June to September, 6am-10pm M-F

Summer Off Peak: June to September, all other hours

Entry of a value in any one of these four fields will result in the standard kWh distribution values from the selected load profile being overridden. It is therefore important to enter values for all four periods if a custom load profile is desired. The sum of these inputs must equal 100%.

The standard distribution values for the selected load profile are shown in columns AV-BA.

% of connected load kW (custom)

Enter the coincident peak reductions, for Winter and Summer respectively, as a percent of the connected kW load peak reduction. The coincident peak reduction is the average reduction across the hours in the defined period. The ISO-NE defined coincident peak period hours are defined as:

Winter December-January, 5pm-7pm M-F, non-holiday

Summer June-August, 1pm-5pm M-F, non-holiday

Full load hours (custom)

This input may be used to modify the assumed full load operating hours. In most cases it is preferred to leave the Full Load Hours blank, unless the selected load profile does not include a default Full Load hours assumption.

If the **kW connected load** savings input is left blank and only the **kWh** savings input has a value, then the kW connected load savings will be automatically calculated by dividing the **kWh** savings by the full load hours. In this case increasing the full load hours will decrease the kW connected load savings, while decreasing the full load hours will increase the kW connected load savings.

1.2. OUTPUT

1.2.1. Measure Cost Effectiveness

The left portion of the input sheet shows the societal cost-effectiveness screening results for the measures. The present value of the measure societal benefits, costs and net benefits, and the benefit-to-cost ratio (BCR) are included in these results. In addition to the direct resource benefits and costs, these account for the value of other non-energy impacts such as avoided carbon and other emissions, operation and maintenance impacts, low-income benefits, health and safety, etc. By having the screening results with the inputs, the user may observe how changing a single input will affect the cost effectiveness.

The primary means of comparing competing measures should be the PV of Net Benefits. The measure with the largest positive societal net benefits – the most value to society – should be the measure that is promoted as economically optimal. If competing measures are compared only by the BCR, then a suboptimal measure with less net benefits might be chosen, thereby foregoing some benefits to society.

The Present values of Fuel benefits, Water benefits, Gross electric are also shown next to the societal screening results. These are included as an indication of the benefits to the electric system and the relative values of the various benefits. These do not include the values of measure costs or non-energy impacts that are included in the PV of Net Benefits. Total Resource Benefits is the sum of the fuel, water, and electric benefits.

PV of Measure Benefits includes the present value of electric and water savings or penalties and associated non-energy impacts, plus fuel savings and associated non-energy benefits. PV of Measure Benefits includes the present value of measure costs, net operation and maintenance costs, and avoided replacement costs, as well as fuel penalties and associated non-energy impacts. Net operation and maintenance savings are represented as negative costs, and may in some cases be greater than measure costs, thus resulting in a negative PV of Measure Costs.