ENERGY TRANSITION PARTNERSHIP

Powering Prosperity and Enabling Sustainability in South East Asia

Demand Side Management for the Philippines

DSM-Calc Program Analysis Software

By

IIEC
International Institute for Energy Conservation

October 2024

UNOPS
AFD Agence Française de Développement
Federal Ministry for Economic Affairs and Climate Action
Department for Energy Security & Net Zero
Environment and Climate Change Canada / Environnement et Changement climatique Canada
CIFF Children's Investment Fund Foundation
Sequoia Climate Foundation
Australian Government Department of Climate Change, Energy, the Environment and Water

Disclaimer

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DSM-Calc : Program Analysis Software

About this User Guide

This User Guide serves as the user manual for the DSM-Calc, an Excel-based modeling tool designed to support DSM Options Screening; DSM Program Design; and Benefit / Cost Analysis of DSM Programs. These three main steps are clearly highlighted in the DSM Planning and Implementation Guidebook which provides the overall understanding of the process for planning and implementation of DSM programs. Both DSM-Calc and the DSM Planning and Implementation Guidebook are the main components of the DSM Toolkit developed by the Demand Side Management for the Philippines Project to support Distribution Utilities (DUs) in the Philippines in developing and implementing their DSM plans.

DSM-Calc designed to provide engineering estimates of data as an introduction to the analysis of DSM technologies and benefit-to-cost ratios. This guide assumes that users have a basic understanding of the principles of DSM analysis and knows how to implement those principles using this tool. Along the way it seeks to reinforce and build on that understanding through the explanation of this estimation, calculation and analysis tool.

Introducing *DSM-Calc*

Idea behind *DSM-Calc*

The underlying components of a DSM analysis are not complex. *DSM-Calc* is based on the idea that a clear, simple calculation approach makes for better analysis. Focusing the analyst's attention on the important numbers and showing the relationships between all of the numbers and the significance of each reduces the chance of introducing errors, makes data errors easier to find and correct and allows the user to think actively about the DSM idea that they are analysing. This is contrasted with complex models, where users enter data into a 'black box' and then receive output results without seeing how the results were calculated.

DSM-Calc — which works in Microsoft Excel[1] — leads the user through the process of building up simple engineering estimates of data in a consistent way. Because it builds an understanding of the underlying principles of DSM, it is a good introduction to DSM analysis. *DSM-Calc* has been used in DSM training. It has been designed to be used easily for manual or pencil-and-paper calculation. *DSM-Calc* is also set up as a spreadsheet with all of the formulae built in so that only the input data needs to be entered. It is suggested that users, new to DSM analysis, perform one or two sample calculations by hand before using the spreadsheet version. A hand calculation will fully familiarize the user with the whole calculation process in a way that entering the input data and looking at the results does not.

[1] Version 6.3 was modified to be compatible with Microsoft 365

Structure of *DSM-Calc*

DSM-Calc Workbook Structure

Table 1 shows the sheet-level structure of the *DSM-Calc* workbook.

Table 1: DSM-Calc Workbook Sheets and Purpose

Sheet Tab Name	Full Name	Purpose
Discounting	Discounting Factor Lookup Table	for use in hand-calculation
PV Avoidable Costs & Tariffs	Discounted Present Value Calculation	for calculation of cumulative discounted present values
Guide	Guide to Main Economic Calculation	Notes to input and calculated cells
EconomicCalc	Main Economic Calculation	Technology-level economic calculation
Blank	Blank Economic Calculation sheet	for hand calculation
TechCompare	Technology Comparison Graphs	Technology-level economic tests
TechSummary	Technology Comparison Summary	Numbers for the graph above
Program&TariffImpact	Program and Tariff Impacts	Whole-program scale calculations
AnnualEffects	Discounted Annual Program Effects	Annual program results summary
Cost-Effectiveness	Program Cost-Effectiveness	Cost-effectiveness using economic tests at the program level
LoanCalc	DSM Loan Financial Calculation Sheet	For analysing loan-type DSM programs
CostRecovery	DSM Program Cost Recovery Calculation Sheet	For projected-to-actual program reconciliation

Structure of Main Sheet

"EconomicCalc" is the main sheet of *DSM-Calc*. This sheet performs a comparison between a unit of equipment for a base technology and a unit of equipment for a DSM technology in a particular application. An overview of the structure of this sheet is provided here. An explanation of how to use the sheet is given below, as well as an example.

Table 2: Structure of EconomicCalc

<table>
<tr><th>Title</th><th>Left-Hand Side: Customer Section</th><th>Right-Hand Side: Utility Section</th></tr>
<tr><td>Documentation</td><td colspan="2">Base Technology
DSM Technology
Service Life</td></tr>
<tr><td>Energy</td><td>Annual Energy Consumption</td><td>Annual Energy Consumption</td></tr>
</table>

	Tariff (discounted over service life) Bill Savings	Adjust for Losses Avoidable Costs (discounted over service life) Bill Savings
Demand	Demand Reduction Tariff (discounted over service life) Bill Savings (over service life)	Demand Reduction Adjust for Losses Avoidable Costs (discounted over service life) Bill Savings (over service life)
Equipment Cost	DSM equipment cost Base equipment cost Net (incremental) equipment cost	Net (incremental) equipment cost
Economic Tests	Participant NPV & BCR	Total Resource Cost (TRC)
	Participant Simple Payback	Rate Impact Measure (RIM)

In this sheet, labels and background are shaded, input and calculation values are in unshaded cells. Input data are in blue, bold italic type, results of formulae appear in black, non-italic type.

Customer and Utility Sections

EconomicCalc is structured with two vertical sections side-by-side and several horizontal layers. Of the two vertical sections, the left-hand side (LHS) contains customer-level data and calculations and the right-hand side (RHS):contains utility-level data and calculations.

The **customer-level** section includes the energy and demand effects as measured as the customer's meter, the tariffs and effects on the customer's bill and the cost of the equipment that would be paid by the customer (no incentives or other program-related adjustments should be made at this stage).

The **utility-level** section includes the energy and demand effects as measured at the generator bus-bar – that is including the effect on the system network losses of the customer's equipment change – as well as the utility's avoidable costs of energy and demand (or capacity). There is more discussion of avoidable costs below.

Documentation Layer

The top layer spans the entire sheet. It contains **equipment descriptions** of the Base and DSM technologies, which document the measures. The descriptions used here should be as complete and self-explanatory as possible and indicate the use of the equipment.

This layer also contains the **equipment service life**. This number needs to be consistent with the assumed use of the equipment. If you have service life data in hours, then you should divide that number by the number of operating hours per year that are used in the annual energy estimation below. This is another reason why the equipment use should be stated. A lamp in the commercial sector will have a very different use profile from one in the residential sector, will be in use for a different number of hours per year and therefore have a very different service life in years.

The equipment service life is a very important number, as it determines the timespan for the economic analysis. The exact use of this number will be described below. Sometimes the Base technology and the DSM technology have different service lives. Using a very common example, incandescent lamps typically last for about 1,000h, while LED lamps could last for more than 10,000h.

Energy Layer

The next layer is the **Energy** calculation layer. It is done for a single unit of equipment, which should be indicated clearly in the documentation section above. The layer includes:

- estimation of annual energy consumption for both the Base and DSM technologies;
- calculation of the customer's annual energy saving by simple subtraction to calculate the difference between the annual energy consumption of the Base and DSM equipment;
- calculation of the utility generation energy saving by factoring in the marginal energy losses in the transmission and distribution network;
- calculation of the economic value of the customer's energy consumption savings; and
- calculation of the economic value of the utility's energy generation savings.

Annual Customer Energy Consumption and Saving

The annual energy consumption can be built up by an engineering estimation using readily available data. The calculation is:

Equation 1: Energy Consumption

$$\text{Equipment Annual Energy Consumption (kWh)} \\ = \text{Equipment Rating (kW)} \times \text{Average Loading (\%)} \times \text{Annual Use (h)}$$

The equipment rating is a readily available value for all equipment. The average loading for many types of equipment (e.g., undimmed lamps) is 100%, but is included because some equipment may be able to operate at part-load values. The average value *over the annual use (operating hours) used in the equation* should be used.

Sometimes actual measured data is available for a particular end use or type of equipment from load research work. If this is the case, the measured data should be used. However, some engineering estimation is usually also needed. For example, the annual operating hours may need to be back-calculated from the measured annual energy consumption values and the equipment rating and average loading to estimate the service life in years. Or the numbers for the DSM technology may not be available from the research and may need to be estimated (to be consistent with the measured data on operating hours, etc). Sometimes load research values will need to be used to estimate data for a specific technology analysis. For example, the total lighting consumption may have been measured for a household, but not lighting in specific rooms. Or the overall air conditioning energy consumption for office buildings may be available, but not the consumption of a particular component such as the chiller or ventilation fans. It is unusual to have all data in exactly the right format and not require at least some estimation.

The annual energy consumption is estimated for both the Base and DSM equipment and then the DSM value is subtracted from the Base value to calculate the annual energy savings.

Annual Utility Energy Saving

The annual utility energy generation saving is higher than the annual energy saving at the customer's meter because a reduction in customer energy consumption causes a reduction in the losses in the transmission and distribution network. The customer saving and the loss reduction added together give the generation energy saving.

Transmission and distribution network losses are usually calculated as a percentage of generation (sent-out energy). This approach suits the top-down approach of system planning. This allows the energy savings to be multiplied by 1+losses (or "1+overhead") to arrive at the energy saving at the power station.[2]

Box 1: Discounting

Money or capital has a "time value." Capital can be invested in productive uses which add value, providing a return on the investment. An investor may see this return as an interest rate on money deposited in a bank, or as a return on capital invested in a fund or as profit from investment in a business. The value of the return in the currency of the day is known as the "nominal" return. However, some of the value of the return may be lost to the effects of inflation. The remaining value — adjusted for the effects of inflation — is known as the "real" return.

An approach called "discounting" or "discounted present value analysis" is used to account for the time value of money. Under this approach future amounts are discounted by a specified percentage value for each year into the future. For example, using a 10% discount rate, a unit of currency one year from now would be discounted so that it is considered equivalent to 0.9 units today. In other words, its present value would be 0.9 units. Similarly, a unit two years from now would be considered equivalent to 0.81 units now: it would have a present value of 0.81.

All of the analysis conducted in *DSM-Calc* is done in "real terms." That is, inflation is excluded from the analysis. The real return on the best alternative investment can be used as a real discount rate, as can the real cost of borrowing or the "weighted average cost of capital" (WACC).

DSM-Calc includes a look-up table showing the present value of one unit for 25 years into the future for a range of discount rates from 1% per annum to 20% per annum. If you are in doubt about what real discount rate to use, you should discuss the appropriate *real* discount rate for your utility with your DSM trainer, with your utility economist or chief financial executive, with development agency staff or with government economists or policy personnel. Many organisations have official or standard discount rates for use in economic analysis. Sometimes the sensitivity of the analysis to the discount rate is tested using discount rates above and below the standard rate.

[2] Losses as a percent of generation can be used, but the calculation is a little more cumbersome.

Remember, the relationship between the real discount rate, the nominal discount rate and inflation is:

Equation 2: Discount Rates

$$(1 + \text{nominal}) = (1 + \text{real})(1 + \text{inflation}) \text{ or}$$

$$(1 + n) = (1 + r)(1 + i) = 1 + r + i + ri$$

This is a quadratic expression. If the second order term ri is neglected, it reduces to:

Equation 3: First-Order Approximation of Discount Rates

$$n \approx r + i$$

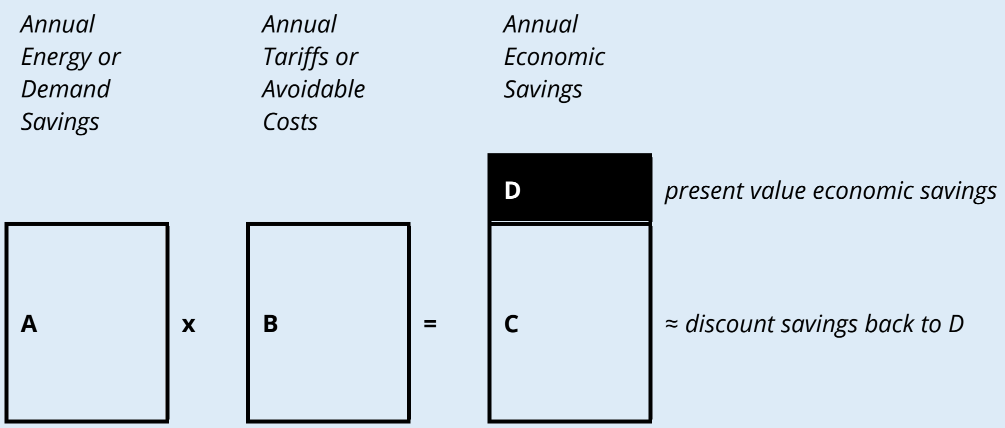
which is a common approximation. The approximation becomes less accurate at high inflation rates and high discount rates, as the second order term increases in size.

In calculating the losses, it is important to exclude from the network losses internal utility use and non-technical losses (e.g., any unaccounted consumption or electricity theft). Only genuine technical network losses should be included in the calculation of the percentage loss value, because it is only these losses that will be reduced by customer energy savings under DSM. Customer DSM savings have no effect on utility use or electricity theft.

Box 2: Streamlined DSM-Calc Present Value Calculations

DSM almost always involves some up-front investment, followed by savings spread over time. The usual way to analyse this is as follows:

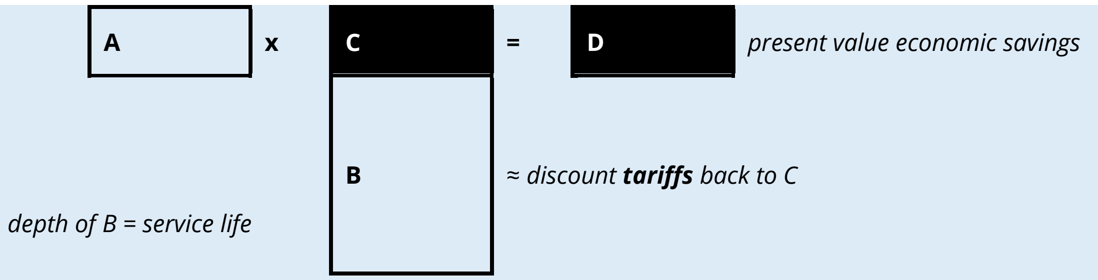
Figure 1: Usual Approach to Calculating Present Values



DSM-Calc offers an innovative approach to calculating discounted present values for the economic analysis at the unit equipment level that avoids the need to set up a large matrix for the calculation.

Figure 2: DSM-Calc Approach to Calculating Present Values

Annual Energy or Demand Savings *Annual Tariffs or Avoidable Costs* *Annual Economic Savings*



The benefit of this approach is that there is only one year-by-year data set so the discounting only needs to be done once for each tariff, not each time for the analysis of each technology idea, so the equipment-level analysis can be greatly simplified and done more quickly.

The first step required is to calculate the discounted present value of the annual tariffs. The values used in each future year should be the real tariff values. So, if tariffs will be adjusted to keep pace with inflation, then in real terms they will remain constant. If tariffs are expected to rise less rapidly than inflation (sometimes, for example, governments make this a promise), then tariffs in real terms should be shown as decreasing in real terms by the difference between the tariff increase and the inflation increase. If tariffs are expected to rise by more than inflation, this should be shown. If a nominal value tariff projection is available, then the effects of inflation will need to be removed from those numbers.

The discounted present values represented schematically by "C" in *Figure 2* are calculated in the sheet "PV Avoidable Costs & Tariffs." *It is very important that the period over which the present values are calculated is equal to the service life for the equipment being analysed*.

Economic Value to the Customer of Energy Savings

Once the annual energy savings have been calculated, the economic value needs to be calculated. This requires an explanation of discounting (provided in *Box 1*) and the innovative approach of *DSM-Calc* to present value calculation (provided in *Box* 2).

The annual energy saving in kWh is multiplied by the present value of 1 kWh of energy saved discounted over the service life of the equipment.

Note that some tariffs have several blocks or price steps. It is always the marginal block or price step that will yield the savings. For this reason, it is not necessary to enter the full complex tariff structure into the spreadsheet, but only the marginal tariff value. In these cases it is necessary to know the magnitude of the customer bills in question, to know what is the marginal tariff.

Economic Value to the Utility of Energy Savings

The annual utility energy savings (including the reduction in network losses) in kWh is multiplied by the present value of 1 kWh of avoided energy generation discounted over the service life of the DSM equipment. Avoidable costs, marginal costs and incremental costs are discussed in below.

Box 3: Avoidable Costs

Avoidable costs are simply those costs that a utility could avoid by DSM. The economic analysis of DSM compares the incremental costs of a DSM technology over a Base technology with the costs in the utility system that can be avoided by the adoption of the DSM technology in place of the Base technology. The system costs (fuel and operating and maintenance costs, generation capacity costs and transmission and distribution network capacity costs) that can be avoided are always those "at the margin." That is why the terms avoidable costs and marginal costs are sometimes used interchangeably.

Box 4: What is the "margin"

The term "margin" occurs often in DSM analysis, particularly in the aspects of DSM planning that involve economic analysis. So, what is the margin?

The word "margin" refers to the edge, the boundary or the periphery of something. Economics often involves marginal analysis, which is "the study of variables in terms of the effects that would occur if they were changed by a small amount."[3]

So, in DSM, we study the effect of relatively small changes — the marginal effect — in energy consumption and demand for capacity.

- How much would network energy losses change if energy consumption changed by 1 MWh/y?
- How much would energy purchase costs change if energy consumption changed by 1 MWh/y?
- How much would generation capacity purchase costs change if peak demand changed by 1 kW each month for a year?
- How much would revenue change if energy consumption changed by 1 MWh/y?
- How much would revenue change if peak demand changed by 1 kW each month for a year?

Demand Layer

The next layer working downwards in the economic calculation sheet is concerned with **Demand** and capacity effects.

Customer Demand Effect

The equipment maximum demand at the customer meter is given by the equipment rating:

Equation 4: Estimating Customer Demand Effects

$$\text{Equipment Demand at Customer Meter (kW)} = \text{Equipment Rating (kW)}$$

[3] Graham Bannock, R E Baxter and Evan Davis, *Dictionary of Economics*, 5th edition, 1992, Penguin.

Utility Peak Demand Effect

The estimation of the peak demand effects for the utility of the change from the Base to the DSM technology is made in a very similar way to the estimation of the energy effects.

Equation 5: Estimating Utility Peak-Coincident Demand Effects

$$\text{Coincident Demand Impact (kW)} = \text{Total Equipment Rating (kW)} \times \text{Coincidence (\%)}$$

In making this estimation it is important to understand the coincidence factor. Refer to *Box 5*.

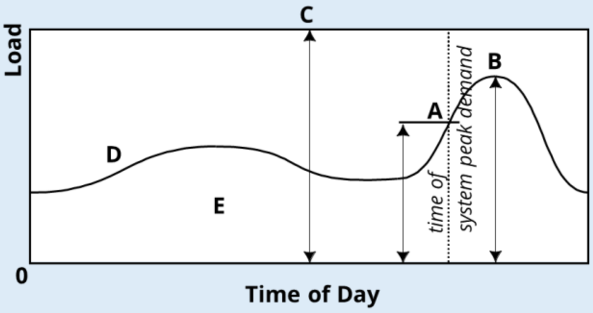
Box 5: What is the Coincidence Factor?

The term "coincidence" factor is related to the time-of-use or load shape characteristics of the particular end use equipment in question and are used for calculating the demand effects on the electricity system.

It is important to remember that the technology-level economic calculations apply to an imaginary 'average' unit of technology from a population of similar units. For most types of electrical equipment, individual units may be either on or off at any instant. However, the load from an entire population of such units tends to vary continuously as individual units are switched on and off throughout the day. This gives rise to a load shape or load profile, as in the example shown here.

The average demand of the various pieces of end use equipment represented by the curve *D* fluctuates throughout the day, consuming energy represented by the area under the curve, *E*. If all of the equipment in the population represented by the curve *D* was turned on at once, the curve would reach the maximum capacity, *C*. In other words, the value of the curve *D* represents the proportion of load in the population that is operating at any given instant.

Figure 3: Typical Load Profile



A: System-coincident demand (kW)
B: End-use equipment peak demand (kW)
C: Total capacity of the equipment (kW)
D: Demand (kW) fluctuating throughout the day
E: Energy (kWh) consumed over the course of the day

In the economic cost-effectiveness calculation, the system demand impact is calculated as the product of the equipment rating, the coincidence factor, which is equivalent to ***A/C***. This number is the answer to the question: *at the time of the system peak, what proportion of the end use load in question is turned on?*

Economic Value to the Customer of Demand Savings

The economic value to the customer of demand savings is calculated in a similar way to that described above for energy savings. There will only be an economic value to the customer if there is a demand component to the customer's tariff. If this is the case, the present value of saving 1 kW each year for the service life of the equipment is calculated in exactly the same way as the present value of saving 1 kWh each year for the service life of the equipment, as described in *Box* 2. Usually only the tariffs of larger customers have a demand component. This is usually determined on the customer's own peak demand and does not take into account the time of day so coincidence with the utility peak is not considered.[4]

Economic Value to the Utility of Peak Demand Savings

The economic value of demand savings to the utility are calculated in much the same way as for energy savings. The marginal losses are factored in to calculate the effect on system peak demand and hence on the capacity requirements, and the result is multiplied by the present value of avoiding 1 kW of peak demand over the life of the equipment.[5]

Cost Layer

The final layer with input data is the equipment **Cost** layer. This simply calculates the difference between the Base and DSM equipment to calculate the incremental cost of the DSM technology.

Note that if the two equipment types have different service lives, it is necessary to take a time period at least equal to the longer of the two, and to express in present value terms the on-going costs of the equipment with the shorter service life over the period of time equal to the equipment with the longer life.

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[4] Note that the method in the worksheet assumes that the end use equipment is operating fully during the customer's own peak time. In other words, it is assumed to be 100% coincident with the customer's load profile, and hence to be fully available to contribute to a reduction in the customer's own peak demand. If this is not the case, and the customer is on a demand tariff, it would be necessary to estimate the coincidence with the customers' own peak. If the customer has many units of the equipment in question, it would also be necessary to estimate the customer's diversity for the end use.

[5] Note that the analysis is designed to be conservative in several ways. Firstly, system losses at peak time are the highest of all, due to the I^2 relationship. Secondly, all systems must carry reserve plant to serve peak loads reliably. Reduction in peak loads (and near-peak loads) tends to reduce the reserve capacity requirement. This means that the effect on capacity requirements is higher than that expressed in the calculations in the economic calculation sheet. The analysis can be said to be conservative — in the sense that it tends to underestimate the economic benefits — in this respect.

Box 6: Incremental Costs

The idea of incremental costs is important in DSM analysis. Incremental costs are the difference or "increment" between two costs. The incremental cost of a DSM measure is the cost of the DSM measure minus the cost that would have been incurred anyway without the DSM measure. At the time equipment is being replaced, the incremental cost is the difference between the cost of the DSM equipment and the Base equipment. At other times, the incremental cost is the cost of the DSM measure *minus* the cost of the existing equipment *plus* the remaining (or undepreciated) value of the existing equipment that would be discarded.

Economic Results Layer

The final layer, where all of the inputs and calculations come together is the economic results layer. This contains three economic tests:

- the participant test;
- the total resource cost (TRC) test; and
- the rate impact measure (RIM) test.

Each of these tests contains benefits and costs in present value terms as calculated above. The difference between these is shown as the net present value of the DSM technology idea against that perspective. The ratio is shown as the benefit/cost ratio.

Box 7: Summary of the Three Key Economic Perspectives

The main terms used in the calculation of the three key economic perspectives in the Economic Calculation sheet are:

- reduced supply costs
- customer bill savings
- equipment costs; and

The table summarises how each of these terms appear in each of the main benefit-cost tests that describe each of the three main economic perspectives.

Perspective Item	***Total Resource Cost***	***Rate Impact Measure***	***Participant***
Reduced Supply Costs	+	+	
Customer Bill Savings		–	+
Equipment Costs	–		–

The TRC measures the *overall economic efficiency of investment in the DSM program*. The benefits from one unit of the technology must be greater than the costs on this test or calculating the cost-effectiveness for the full program is not worthwhile. The Philippine DSM Framework requires that utilities undertake programs that are cost-effective when measured against the societal test. The

TRC is the same as the societal test, except that it does not include effects of the DSM program external to the customers and the utility.[6]

The participant test measures the *economic (but* **not** *total) attractiveness of the DSM program to customers.* The benefits to the customer should be greater than the costs, otherwise customers could not be expected to participate in the program. Even though the benefits are greater than the costs, a carefully designed program is required to get customers to participate.

The RIM test measures the *overall impact of the DSM program on the utility's revenue needs*. If the RIM returns a negative result, a small increase in tariffs would be required to restore the utility's financial position.

The simple payback period refers to the time required to recover an initial investment through savings and is a widely used, easy-to-understand measure of when an investment will break even.

Simple Payback = Investment Cost / Annual Savings

Using *DSM-Calc* to Assess a DSM Technology Idea

An example is provided in DSM-Calc. Follow through this, using the descriptive notes above. Then set up your own examples.

Present-Value Avoidable Costs & Tariffs

The first step is to set up the "PV Avoidable Costs & Tariffs" sheet. This requires:

- the entry of the currency name and symbol (e.g., Dollar, $; Yen, ¥; Pound, £; Peso, ₱, Rupiah, Rp; Rupee, Rp, etc.) in cells C1 and C2 respectively. The symbol will flow throughout the sheet to wherever there is a currency label. Only one unit is included, and this should be the major unit of currency (e.g., dollar, not cents). All currency values should be entered in major currency units (e.g., 10 Cents should be entered as $0.10).

- the entry of the real discount rate to be used in cell C6;

- the entry in cell A7 of the "zeroth" year (the year before year 1 of the analysis, which should be the anticipated first year of actual implementation; and

- the entry of year-by-year avoidable energy and demand costs and energy and demand components of each tariff.

In the paper version, the discounting factors from the lookup table need to be entered in column C, then multiplied by the annual avoidable cost and tariff values to produce a present value stream of these. This can then be cumulatively summed to produce the cumulative present values for use in the economic calculation sheet. In the electronic version discounted and cumulative values should calculate automatically.

6 Such as environmental externalities.

Update Tariff Index Sheet

The tariff index sheet should be updated to show the names of the various tariffs against the column numbers for lookup of energy and demand component values.

Complete the Economic Calculation Sheet

The economic calculation sheet should then be completed using the principles described above. The paper version requires the entry and calculation of all values. As mentioned above, it is highly recommended that a hand calculation exercise be undertaken with a pencil and paper (using the manual lookup tables and a calculator) first, before the electronic version is used. This will produce a much deeper familiarity with the process and the calculation tool itself, than is possible by launching straight into the electronic version where all of the calculations and lookups are done instantaneously for the user.

It is suggested that several colleagues define a simple example (discount rate, avoidable costs, tariffs, base and DSM technology) and then *individually* work through the example by hand on paper. Once complete, the results, the estimation of energy and demand values and the costs should be compared, as well as the results. This will quickly build familiarity in the use of the tool and confidence in data estimation.

In the electronic version, documentation and data needs to be entered in the clear cells with bold italic blue text. All other values then calculate automatically.

Be innovative with your DSM program ideas. After looking at simple lighting programs, look at an air conditioning program, then branch out into something a little different: perhaps an interruptible municipal pumping program, or a program to use existing standby generators or rooftop solar Photo Voltaic systems to clip the peak. Think about how the input data need to be used in the spreadsheet.

Box 8: Visualising and Understanding the Technology Cost-Effectiveness Tests

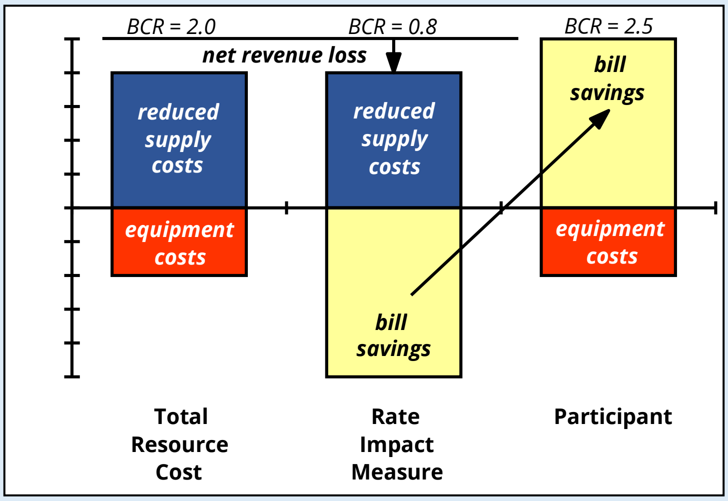
The technology cost-effectiveness calculations (as in the "Quick Calculation" sheet of the spreadsheet) measure the costs and benefits of *one individual unit of the DSM technology* from several perspectives. There are ***three*** main terms in the technology cost-effectiveness calculations:[7]

- Reduced Supply Costs;
- Customer Bill Savings; and
- Equipment Costs.

Each of the three economic perspectives includes ***two*** of these terms. So each of these three perspectives is inter-related to the other two. The Total Resource Cost perspective is related to the Rate Impact Measure perspective through Reduced Supply Costs. The Rate Impact Measure perspective is related to the Participant perspective through the transfer of Customer Bill Savings. The Participant perspective is related to the Total Resource Cost perspective through equipment costs.

In the graphical example shown, the "Total Resource" experiences benefits from the technology of 2 times the costs, the participant experiences benefits of 2.5 times the costs and the "rate impact" is described by benefits of just 0.8 of the costs. The arrow indicates the transfer of revenues from the utility to the customer as bill savings.

Figure 4: Technology Comparison Graphs



The economic perspectives — from most important to least important — to use when assessing the economic viability of a DSM technology idea under the Philippine DSM Framework , are:

- Total Resource Cost (TRC);
- Participant; and
- Rate Impact Measure (RIM)

Remember: if the DSM idea is not cost-effective at the level of an individual unit of technology, then it will never be cost-effective at the overall program level. This is why the economic calculation sheet is considered the core of *DSM-Calc* and can be used as a screening device for technology cost-effectiveness. If a technology is cost-effective, a cost-effective program may be

[7] Program costs and incentives are included in the full program calculation shown below.

able to be designed using it, although the costs of the program will reduce somewhat the net present value of the DSM idea at the technology level.

Using *DSM-Calc* to Assess a DSM Program

Once a cost-effective DSM technology idea has been found, it needs to be developed into a full-scale program. This involves estimating market size and take-up and program costs. This is done in the sheet “Program&TariffImpact.” The program name should be entered in cell **C3**.

Full Program Analysis

Take-up should always be estimated in the context of the total market size. This data is entered in column C. If the program is targeted at the residential sector, and there is one unit of the equipment that could be installed in each household, then the number of residential households projected for each year would be entered here. Note that sometimes more than one unit of equipment could be installed per household. If this is the case, more than one unit can be analyzed in the economic calculation sheet (e.g., 2 or 3 lamps per household), or the market size can be factored up accordingly. It is usually clearer and less confusing to adopt the former approach.

Table 3: Program Effects and Stock Turnover

Year No.	*Total Market Size*	*Eligible Market Size*	*Program Market Size*	*1st Year*	*2nd Year*	*3rd Year*	*4th Year*	*5th Year*	*New & replace*
0	**31,926**								
1	**34,700**	24,290	***1,000***	**1 000**					**1 000**
2	**37,703**	26,392	***5,000***	1 000	**4 000**				**4 000**
3	**41,210**	28,847	***9,000***	1 000	4 000	**4 000**			**4 000**
4	**45,086**	31,560	***13,000***	**1 000**	4 000	4 000	**4 000**		**5 000**
5	**48,936**	34,255	***17,000***	1 000	**4 000**	4 000	4 000	**4 000**	**8 000**
6	**52,112**	36,478	***13,000***	1 000	4 000		4 000	4 000	0
7	**54,998**	38,499	***8,000***		4 000			4 000	0
8	**57,535**	40,275	***0***						0
9	**59,897**	41,928	***0***						0
10	**64,231**	44,962	***0***						0

Often not all of a particular market is eligible for the DSM idea either because they have it installed already, or there are some technical limitations to its installation, or because the use pattern does not justify the investment among all customers, or because there are some program rules concerning participation. The eligible proportion in cell **D4** should be entered to reflect these considerations. The program market take-up should be estimated and entered into column E.

The method is up to the user, but should take into account that it usually takes some years to come up to maximum participation in a program, and that this value must be less than or equal to the eligible market size in all years. *DSM-Calc* comes with an example calculation for a program that runs for five years with a six year equipment service life and assumes a zero re-purchase rate (to avoid over-estimating the economic benefits).

An example is provided in *Table* 3 to illustrate the effects of stock turnover for a five year program promoting equipment with a three year service life, 100% re-purchase during the program and 0% re-purchase assumed after the program.[8] A simple table like this can be created and the values entered directly into *DSM-Calc*, or some custom-entered formulae of the type in the example can be used to make the process more automated.

Table 4: Full Program Cost-Effectiveness Calculation

Column Calculations	***Explanation***
	Program & Tariff Impacts
C	Total Market Size — customers in group to whom program is offered
C × d = D	Eligible Market Size — customers who could participate in the program[9]
E	Program Market Size — estimate of ***cumulative*** program participation levels, year by year
E × f = F	Program Market Size × Annual Customer Unit kWh Impacts = Annual Customer kWh Impacts
F × G = H	Annual Customer kWh Impacts × Discounted kWh Tariff = Discounted Bill Savings on kWh
E × i = I	Program Market Size × Annual Customer Unit kW Impacts = Annual Customer kW Impacts
I × J = K	Annual Customer kW Impacts × Discounted kW Tariff = Discounted Bill Savings on kW
H + K = L	Discounted Bill Savings on kWh + Discounted Bill Savings on kW = Total Discounted Bill Savings
E × m = M	Program Market Size × Annual System Unit kWh Impacts = Annual System kWh Impacts
M × N = O	Annual System kWh Impacts × Discounted Avoidable kWh Cost = Discounted Reduced kWh Supply Savings
E × p = P	Program Market Size × Annual System Unit kW Impacts = Annual System kW Impacts

8 The program should of course be designed in practice to maximize re-purchase after the program to create lasting effects. It is just that the analysis does not count this benefit, in order to be on the safe side and avoid padding up the economic benefits.

9 Must satisfy program criteria, if there are any. For existing customers to be eligible, they must have the Base technology, and be technically able to install the DSM technology.

P × Q = R	Annual System kWh Impacts × Discounted Avoidable kW Cost = Discounted Reduced kW Supply Savings
O + R = S	Discounted Reduced kWh Supply Savings + Discounted Reduced kW Supply Savings = Discounted Total Reduced Supply Savings
S - L = T	Total Discounted Reduced Supply Savings - Total Discounted Bill Savings = Net Discounted Revenue Reduction
U × v = V	New & Repeat Participants × Incremental Unit Equipment Cost = Total Equipment Cost
V × W = X	Total Equipment Cost × Discount Factor = Discounted Total Equipment Cost
(U × y) +Z = AA	(New & Repeat Participants × Unit Variable Program Costs) + Annual Fixed Costs = Total Variable Program Costs
AA × AB = AC	Total Variable Program Costs × Discount Factor = Total Discounted Variable Program Costs

Program unit costs need to be entered into cell Y4 and fixed costs need to be entered into column Z. Entering into column AD the projected energy sales for the group of customers from whom revenue needs to be recovered then allows the tariff adjustment associated with the rate impact to be calculated. This can be done iteratively, by entering values into cell AF3, or if the Solver add-in in Excel is installed, can be done automatically by using Solver Function on the Data tab.

Iterative Calculation of One-Time Tariff Adjustment Calculation

Columns AD to AI are used to calculate the one-time tariff adjustment that would provide a revenue stream with a discounted present value equal and opposite to the discounted present value of the revenue impact stream.

The discounted present value of the Rate Impact Measure (RIM) in cell AI2 is equal to the utility cost reductions minus customer bill savings minus program costs.

The discounted present value of the recovered revenue is equal to:

- the one-time tariff adjustment;
- multiplied by
- the energy consumption forecast ***for those customers from whom revenue is to be recovered*** minus the DSM program energy savings for that customer group.

This needs to be solved iteratively — put in a value for the one-time tariff adjustment, if it is too high then try a lower value; if it is too low then try a higher value. Iteration involves doing this until the correct answer is arrived at. Cell AG4 has the difference between the discounted present value of the Rate Impact Measure stream and the discounted present value of the Recovered Revenue stream. A difference of zero occurs when the one-time tariff adjustment is correct.

The Excel Solver Add-in may be used to automatically calculate the one-time tariff adjustment. This needs to be installed with Excel. If it is not installed:

- In Excel 2010 and later, go to File > Options
- Click Add-Ins, and then in the Manage box, select Excel Add-ins.
- Click Go.
- In the Add-Ins available box, select the Solver Add-in check box, and then click OK.
- After load the Solver Add-in, the Solver command is available in the Analysis group on the Data tab.

The worksheet "**Read This First!**", it shows a screenshot of how to add Solver add-in in Excel and config the required parameters in Solver function.

The Solver function will process to get the results automatically.

The annual program effects are summarised in the next sheet and the five economic test results are shown in the sheet after that.

Box 9: Interpreting the Results of the Calculation Spreadsheet — DSM Programs from several Economic Perspectives

The main terms[10] used in the calculation of the economic perspectives are:

- Reduced Supply Costs
- Customer Bill Savings
- Equipment Costs
- Financial Incentives to Customers; and
- Program Costs

The table summarises how each of these terms appear in each of the main benefit-cost tests that describe each of the three main economic perspectives.

Summary of Economic Perspectives

Perspective Item	***Total Resource Cost***	***Rate Impact Measure***	***Participant***
Reduced Supply Costs	+	+	
Customer Bill Savings		–	+
Equipment Costs	–		–
Incentives		–	+
Program Costs	–	–	

10 The full list of terms and their use in the cost-effectiveness tests for energy conservation, peak clipping and load-shifting programs is included in the appendix to this document.

The TRC measures the *overall economic efficiency of investment in the DSM program*. The benefits from one unit of the technology must be greater than the costs on this test or calculating the cost-effectiveness for the full program is not worthwhile. The Philippine DSM Framework requires that utilities undertake programs that are cost-effective when measured against the societal test. The TRC is the same as the societal test, except that it does not include effects of the DSM program external to the customers and the utility.[11]

The participant test measures the *economic (but* **not** *total) attractiveness of the DSM program to customers.* The benefits to the customer should be greater than the costs, otherwise customers could not be expected to participate in the program. Even though the benefits are greater than the costs, a carefully designed program is required to get customers to participate.

The RIM test measures the *overall impact of the DSM program on the utility's revenue needs*. If the RIM returns a negative result, a small increase in tariffs would be required to restore the utility's financial position.

Loans

A sheet is provided to allow the calculations for DSM loan programs to be done easily. Loan programs can work well where:

- a technology is quite cost-effective to the customer;
- but the customer is not prepared or not able to spend the necessary up-front capital; and
- the utility is in a position to keep administration costs for mini-loans low, by using the existing billing system (with some small, relatively low-cost programming modifications) and by using existing counter/service facilities such as payment centres, utility appliance retail outlets or partnerships with existing retail suppliers.

DSM program loans can be designed to:

- break even on the principal, interest and administration costs;
- re-coup less than the principal, interest and administration costs, which means that part of the loan is in fact a rebate to the customer; or
- return a profit to the utility over and above the principal, interest and administration costs.

The second option would be expected to increase participation levels and the third option to reduce them.

The calculation is set up assuming that the program borrows the funds to finance the loan either internally within the utility or externally. A fixed periodic repayment, such as on each bill, is assumed for the customers. The number of payments per year for the customer should be set to the number of bills that they receive per year.

[11] Such as environmental externalities.

Cost Recovery

The final sheet allows for reconciliation between planned cost recovery and actual cost recovery. It contains links to the calculations of costs, participation and revenue losses, and allows for adjustments to be made year-by-year after program implementation.