**Ontario Energy Board** | **Commission de l'Énergie de l'Ontario**

Ontario

# TOTAL RESOURCE COST GUIDE

**September 8, 2005**

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## Overview

The *Total Resource Cost Guide* (the Guide) has been prepared to assist local distribution companies (LDCs) in meeting the filing requirements for 2005 conservation and demand management (CDM) plans approved by the Board. It should also be used for any applications for incremental CDM spending in 2006 distribution rates.

In its Decision of December 10, 2004, the Board approved the applications by certain LDCs to invest in CDM, conditional on, among other things, the applicants filing quarterly and annual reports on their CDM initiatives.[1] The annual report is to include a cost benefit analysis. This Guide outlines the required analysis and techniques for LDCs to perform the cost benefit analysis.

Similarly, in the *2006 Electricity Distribution Rate Handbook Repor*t, the Board stated that LDCs who plan to include additional expenditures on CDM in 2006 rates must file a cost benefit analysis in advance of Board approval.[2] This Guide is to be used for the purpose of preparing the cost benefit analysis.

The Guide consists of the minimum expectations of the Board. LDCs are free to use other testing techniques and incorporate other data where appropriate. Where a LDC uses other techniques and data, the LDC must provide evidence to justify the use of alternative techniques or data.

The Guide consists of two elements:

1. An explanatory document for undertaking TRC cost effectiveness analysis, including supporting information, specific direction on key issues, and the mathematical formulae and recommendations related to data requirements and collection techniques; and,

2. A detailed Assumptions and Measures List that provides all requisite TRC input data for a selection of over 100 measures. This list covers a range of typical CDM activities/technologies in residential, commercial and industrial applications. Furthermore:
   - all data is provided on a per unit basis and includes electricity savings, cost, equipment life and free rider estimates, where appropriate;
   - all the information is provided in comparison to a reference case and classified by the decision or installation type – new, retrofit, or replacement.

In combination these two elements provide users with the required information to undertake a TRC analysis.

[1] RP-2004-0203
[2] RP-2004-0188

The Guide is organized as follows:

**Section 1** provides a background on CDM and TRC analysis including the formulae used and a discussion of costs and benefits.[3]

**Section 2** focuses on a number of factors and adjustments that affect the TRC test. These include free riders, equipment life and persistence.

**Section 3** examines issues related to tracking, reporting and evaluating CDM programs.

**Section 4** builds on the issues identified in Section 3 and provides examples of how to perform a TRC test screening analysis at the technology, program and portfolio level.

**Section 5** consists of the Assumptions and Measures List which is the savings data and required assumptions for most residential, commercial and industrial measures.

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[3] A comprehensive history/overview of conservation in Ontario's electricity and gas sectors is available in Appendices A and B of the October 3, 2003 "Board Staff Discussion Paper on Demand Side Management and Demand Response in the Ontario Energy Sectors."

# 1.0 The Total Resource Cost Model

Conservation and demand management programs consist of a set of activities that a LDC undertakes in an attempt to alter the configuration or magnitude of a customer's load.

These activities can encompass a broad set of technologies, measures, market interventions and promotional efforts all aimed at lowering or shifting the customer's demand or energy use.

CDM initiatives can be evaluated on the basis of a cost effectiveness test known as the Total Resource Cost (TRC) test**.** The TRC test is defined as a test that *"measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participant's and the LDC's costs".*[4]

The TRC test measures the benefits and costs of CDM efforts from a societal perspective. Under the TRC test, benefits are driven by avoided resource costs. Costs in the TRC test are the costs of any equipment and program support costs associated with delivering that equipment to the marketplace.

| **Benefits** | **Costs**[5] |
|---|---|
| Avoided electrical supply costs | Equipment costs |
| Other avoided resource costs | LDC program costs |

### 1.1 TRC Calculation

Evaluating the cost effectiveness of CDM is done in stages at many different levels, including technology or measure, program, and portfolio. The TRC tests can be performed at each level.

At the most detailed level, a TRC test will be performed to evaluate the cost effectiveness of a measure or technology. Once a technology has proven to be cost effective, a program may be designed using that technology. Once the program costs have been assessed, the TRC test will be performed again to evaluate the cost effectiveness of the program. Finally, several programs are bundled together, further indirect costs are included and the TRC test is carried out once again to evaluate the cost effectiveness of the portfolio. This three layered structure; technology or measure, program and portfolio is key to performing TRC analyses.

The results of the TRC test should be expressed as a net present value (NPV). As a NPV assessment, the TRC test sums the streams of benefits and costs over

[4] California Public Utilities Commission. (2001) Standard Practice Manual: Economic Analysis of Demand-Side Management Programs and Projects.
[5] In the case of fuel switching measures, the costs of other fuels must be included.

the lifetime of the equipment/technology and uses a discount rate to express these streams as a single "current year" value. [6] Thus, the $NPV_{TRC}$ is the net discounted value of the benefits and costs over a specified period of time (usually dictated by the equipment life of the CDM technology).

The TRC test is a measure of the change in the total resource costs to society, excluding externalities, due to the CDM program. If the $NPV_{TRC}$ is positive, indicating that benefits exceed costs, the program is considered cost effective from a societal perspective.

### 1.1.1 Formula for Performing TRC Test

The TRC test examines streams of benefits and costs and uses discounting principles to express these future values as a single number. The benefits stem from the avoided resource costs, typically electricity. The costs are the cost of the equipment and the LDC program costs. Subtracting the costs from the benefits provides the net benefits. For a program to be considered cost effective, the net benefits must be greater than zero.

The $NPV_{TRC}$ formula is as follows:

Figure 1.1: Net Present $Value_{TRC}$ Formula

$$NPV_{TRC} = B_{TRC} - C_{TRC}$$

where;

$$B_{TRC} = \sum_{t=1}^{N} \frac{AC_t}{(1+d)^{t-1}}$$

$$C_{TRC} = \sum_{t=1}^{N} \frac{UC_t + PC_t}{(1+d)^{t-1}}$$

and,
$B_{trc}$ = the benefits of the program
$C_{trc}$ = the costs of the program[7]
$AC_t$ = avoided costs in year t
$UC_t$ = LDC program costs in year t
$PC_t$ = Participant cost in year t

[6] Discounting is a standard accounting principle which converts future monetary values into current values.
[7] Where a measure includes fuel switching for a given end use, the cost of the other fuel must be included in the cost component of the TRC formula.

N = Number of years for the analysis, (i.e. the equipment life of the CDM technology)
d = Discount rate[8]

### 1.2 Benefits: Avoided Costs

The TRC assesses CDM costs and benefits from a societal perspective. The benefits are defined as "avoided costs". This represents the benefit to society of not having to provide an extra unit of supply – typically expressed as kW and/or kWh. For electricity, supply costs include energy, generation, transmission and distribution capacity.

Certain CDM programs will have other benefits including other energy sources and water savings. While these savings are not the primary target of the program, the TRC test will accommodate the assessment of savings of other resources including natural gas, heating fuel oil, propane or water. In these cases, the benefits accrue from the avoided costs associated with these resources. LDCs wishing to assess resource savings stemming from other energy forms or water will need to use avoided cost estimates for those resources in the same manner that electricity avoided costs are used.
The TRC test requires an analysis over the life-cycle of the CDM measure. To accommodate this, long-term projections of avoided costs are required. Also, any CDM measures included in the analysis must have equipment life estimates along with estimates of savings and costs.

Not all of the avoided cost components and sub-components will be relevant for evaluating a particular CDM measure or program. For example, a program designed to shift load during peak hours may have little impact on annual energy use. Each potential CDM measure or program must be examined carefully to determine which types of loads will be avoided and which avoided costs apply.

Estimating the electrical avoided costs applicable to each customer class requires a number of analytical steps:

1. estimate marginal generation costs of capacity and energy;
2. estimate marginal transmission costs;
3. estimate marginal distribution costs;
4. determine the appropriate costing periods; and
5. attribute marginal costs to the costing periods.

Marginal costs studies typically involve detailed analyses starting with an understanding of the current costs for generation, transmission and distribution. Capacity costs accommodate the costs of building and maintaining new

[8] Consistent with the Electricity Distribution Rate Handbook and the Distribution System Code, for the purpose of calculating the net present value, LDCs must use a discount rate equal to the incremental after-tax cost of capital, based on the prospective capital mix, debt and preference share cost rates, and the latest approved rate of return on common equity.

generating plants, transmission and distribution systems to meet increases in peak demand. Energy costs measure the additional fuel and variable operating costs required to produce an extra kWh of energy. Energy costs can fluctuate on an hourly basis depending on the load level being served and the types of generating resources available in the market.

For Ontario, avoided costs have been developed for seasonal peak, mid-peak and off peak as well as for generation and transmission capacity. The report entitled "Avoided Cost Analysis for the Evaluation of CDM Measures" (Avoided Cost Study) filed with the Board by Hydro One Networks Inc. on June 15, 2005 provides the basis for avoided costs that are to be used in assessing CDM technologies, programs and portfolios for TRC analysis. Hydro One also submitted a preliminary evaluation of their distribution system capacity avoided costs. A copy of the submission is available on the Board's Web Site at: http://www.oeb.gov.on.ca/documents/dcdm_hydro_acar_170605.pdf

The data contained in Appendix C has been extracted from these studies and has been grossed up for inflation to provide the values that LDCs should use in assessing program benefits.

### 1.2.1 Instructions on Using the Avoided Costs

The avoided cost values include seasonal and time specific energy, generation, transmission and distribution capacity. Distributors should use the avoided cost values provided in Appendix C of this Guide for energy (columns B-I), generation capacity (column J), transmission capacity (column K) and distribution capacity (column L) for conservation and/or demand management measures. Where a distributor wishes to use a different value for the distribution system capacity avoided cost, they must provide evidence supporting the variation.

For measures which provide summer on-peak period demand response but no energy savings, distributors should use the avoided generation capacity values in column M only.

While all conservation and demand management measures will provide demand savings, only those measures which reduce load during peak seasons should apply capacity savings for generation, transmission and distribution. Since the Ontario load profile is summer peaking, only those measures which reduce load during the summer shall apply the avoided cost of system capacity. However, since some distribution areas are winter peaking, measures which reduce winter load in those areas should include the value of avoided distribution capacity costs as one of the benefits.

### 1.2.2 Losses on the Distribution System

While the Board recognizes that losses are a real part of the electrical system, at this time, losses on the distribution system should not be included in calculating the savings associated with a conservation or demand management measure.

### 1.2.3 Electrical Energy and Demand Savings

The benefits in the TRC test are driven by the annual energy (kWh/yr) and demand (kW) savings. Energy and demand savings are often calculated at the technology level and are commonly referred to as “prescriptive” savings estimates. For programs that rely on prescriptive savings estimates, savings are calculated by multiplying the per unit (i.e. single technology) savings with the number of units installed.

Savings and technology costs must be defined relative to a frame of reference or “base case”. To accurately specify the impacts of any given technology, the analyst must know what would have happened in the absence of the technology. This represents the base case for the analysis. In practice, specifying savings relative to a frame of reference can be simply characterized by the three general decision types:

- new;
- replacement; or
- retrofit.

Table1.1 shows how the frame of reference assumption can dramatically alter the energy savings estimates. The example assumes that a LDC may wish to offer a program targeting *replacement* of old primary refrigerators with Energy Star$^{TM}$ refrigerators, or may offer a program that targets the complete *removal* of old secondary refrigerators.

<u>Table 1.1: Example of Replacement and Removal Programs</u>

| | **Decision / Program** | **Existing Equipment** | **Base Case** | **Equipment** | **Savings** | **Measure Lives** |
|---|---|---|---|---|---|---|
| A | Replace old primary refrigerator with a new one | 1960’s vintage refrigerator using 1,500 kWh/yr | Standard refrigerator using 514 kWh/year | New Energy Star refrigerator using 440 kWh/yr | Base Case – Energy Star 514 – 440 = 74 kWh/yr | 19 years |
| B | Retire and remove old secondary refrigerator | 1960’s vintage refrigerator using 1200 kWh/yr | Keep using existing refrigerator | | 1200 kWh/yr | 6 years |

In this example, depending if the old refrigerator is the primary of secondary refrigerator in the home, and whether it is replaced or completely removed (i.e. different base cases), there is a significant difference in the savings estimates.

A) In the case of the replacement, the LDC must estimate the energy use for both the "base case" equipment (i.e. the standard refrigerator) and the Energy Star™ higher efficiency refrigerator. In this case, the base case refrigerator uses 514 kWh/yr while the energy efficient refrigerator uses 440 kWh/yr. Since the program targets the installation of an Energy Star™ refrigerator over the base case option, the difference of 74 kWh/yr is the appropriate savings estimate for the program.

B) For the removal program there is no replacement with either a base case or energy efficient model. Since the program encourages the removal of the old refrigerator, the appropriate savings estimate is 1200 kWh/year.

Load impacts must be defined in a manner consistent with other assumptions in the CDM program assessments. Impacts must be calculated over the same time horizon used in the program design and for the same costing periods used in defining the marginal costs. Impacts must also be consistent with the base case option used to measure incremental costs (see 1.3.1 - Equipment Costs).

### 1.2.4 Equipment Life

In the TRC analysis, equipment life is used to determine the time period over which the net present value analysis is carried out. The benefits (i.e. energy and load savings) from an energy efficient piece of equipment are assumed to persist for the life of the equipment. Equipment life is estimated based on the nature of the equipment and an assumed usage pattern. The Assumptions and Measure List in this Guide provides a number of energy efficient equipment types and their estimated equipment lives, along with the energy, load savings and cost estimates.

An important consideration when assessing equipment life is the potential difference between the energy efficient equipment and the "base case" equipment that is being replaced. A simplifying assumption in the case of replacement programs, is that the energy efficient equipment lives are the same as the base case. However, there are some technologies (such as lighting) where the energy efficient equipment may have a much longer life than the base case equipment. For example, a compact fluorescent bulb has an equipment life of up to 10,000 hours and would replace an incandescent bulb which has an equipment life of 1,000 hours. To accommodate this difference in the TRC analysis, the savings are assumed to persist for the entire 10,000 hours and the incremental cost must be adjusted to reflect the avoided purchase of 10 incandescent bulbs. This has the effect of enhancing the cost effectiveness of the compact fluorescent bulb measure. The cost data provided in the Assumptions and Measures List reflect this adjustment for technologies where it is appropriate.

## 1.3 Costs

This section discusses how costs, such as those provided in the Assumptions and Measures List are derived.

The TRC includes two types of CDM costs:
(1) equipment costs; and,
(2) program costs.

### 1.3.1 Equipment Costs

Typically in CDM programs, equipment costs are paid by the participant/customer. Customer equipment costs (sometimes termed "Participant costs") are the costs to purchase the more efficient equipment. They include both capital and operating and maintenance (O&M) costs associated with the CDM program. It is important to note that the TRC test is not sensitive as to who (LDC or customer) pays the cost of the equipment.

Customer costs can be incremental or full cost depending upon the nature of the energy efficiency investment decision. Incremental equipment costs are defined as the cost of the energy efficient technology above the base case technology. In the same way that the base case is important for specifying the savings, it is also important for specifying the cost of the energy efficient equipment. For example, in a replacement scenario, the cost of the energy efficient technology is typically incremental. In a retrofit or discretionary investment case, the cost of the energy efficient technology would be the full cost of the equipment.

Equipment costs, whether paid by the customer or the LDC, including purchase and installation, must always be defined relative to a base case. It is not enough to know the installed cost associated with the energy efficient equipment used in the program. To calculate the impact of the program, the cost of the equipment that would have been purchased in the absence of the program, the base case, must also be known. The appropriate specification of incremental cost for use in the TRC analysis is the difference between the base case and the energy efficient purchase. Table 1.2 uses the same refrigerator example as in section 1.1 to show how the costs will vary depending upon the base case assumption.

As in the case of savings, there are typically three generic categories for specifying equipment costs, representing the type of investment decision:

- new;
- replacement; or,
- retrofit.

Table 1.2: Understanding Incremental Costs for TRC Analysis

| | Decision / Program | Baseline Equipment | Equipment Cost | Cost[9] |
|---|---|---|---|---|
| A | Replace old primary refrigerator | 1960's vintage refrigerator using 1200 kWh/yr | Base Case refrigerator: $1,000<br>Energy Star refrigerator: $1,070 | "Energy Star" + Removal Fee – Base Case fridge<br>$1,070 + 100 – $1,000 = $170 |
| B | Retire and remove old secondary refrigerator | 1960's vintage refrigerator using 1200 kWh/yr | $0 | Removal fee estimated to be $100 |

Table 1.2 shows two scenarios a) replacement and b) removal as in Table 1.1.

A) The replacement scenario requires knowledge about both the cost of the base case equipment, the energy efficient equipment and the cost of removal and disposal. The cost to be used in the TRC analysis is the difference between these.

B) For the refrigerator removal scenario the only costs of the program are those for removal and disposal.

The information sources for equipment costs will vary. For residential equipment, retail store prices are appropriate sources for many technologies including lighting, appliances and "do-it-yourself" water heater or thermal envelope upgrades. It is common practice to specify an average price based on a sample of retail prices. For commercial and industrial equipment, cost data can be more complicated to acquire due to limited access and confidentiality concerns. For larger "custom" projects, invoices or purchase orders may be necessary to support the cost estimate.

Equipment that requires O&M expenditures is often not incremental (i.e. those costs would have been incurred in the base case anyway). However, if the energy efficient equipment requires significantly more maintenance than its less energy efficient counterpart, the incremental O&M costs need to be factored into the TRC analysis. There will be exceptions and a proper TRC analysis should incorporate these.

### 1.3.2 CDM Program Costs

From the perspective of the TRC test, CDM program costs are those incurred by the LDC. These costs include the marketing and support costs associated with delivering the CDM activity. Participant or customer incentive costs, which are considered transfers in the TRC test, are <u>not</u> included in the analysis. This section also discusses the issue of customer incentives for CDM programs. LDC

[9] Costs are provided for illustrative purposes only. Actual costs for the equipment will vary.

costs typically cover a number of activities such as marketing and advertising, consulting, channel support, monitoring and evaluation.

There are five major categories of LDC costs:

i. development and startup;
ii. promotion;
iii. equipment and installation;
iv. monitoring and evaluation; and
v. administration.

In practice, all of these costs can be expected for programs that electric LDCs in Ontario might be considering.

i. Development and startup costs

Development and startup costs are different from on-going operating costs. For example, initial costs may be incurred to train LDC staff in the use of the equipment or techniques inherent in a program and usually occur at the early stages of the program's life. Costs of developing CDM plans and procedures are often concentrated in the early program years. In general, start-up costs are only a small component of the total costs in the life cycle of a CDM program.

ii. Promotion costs

Promotion costs may be incurred to educate the customer about a CDM program and will vary by program type and level of promotional effort. The cost of promotion depends on the method employed, the market segment and the CDM measures promoted. The best methods for program promotion involve trade-offs between increases in promotion costs and expected increases in participation.

Table 1.3 Some Methods of Promotion

| Type of Contact | Tactics |
|---|---|
| Personal contact with LDC representative | Telemarketing<br>Customer service campaign<br>Door-to-door campaign |
| Other direct LDC contact | Bill stuffers<br>Direct Mail |
| Mass media | Print/flyers<br>Television/Radio |
| Trade allies | Equipment vendors<br>Equipment installers |

***Note on LDC Costs for Incentives***

The appropriate costs to be included in the TRC analysis are the equipment and program delivery costs. Incentive payments from the LDC to a customer for participation in a program are not a component of the TRC analysis. The incentive merely represents a transfer payment between two parties involved in the program to support the purchase of energy efficient equipment.

The following formula illustrates why the incentive amount is not included in the TRC analysis:

As discussed in section 1.1 the costs of a program are LDC program costs ($UC_t$) plus participant cost ($PC_t$), while the benefits are the avoided costs ($AC_t$.). If the formula were to include the incentive amounts ($INC_t$), it could be re-written as:

$Costs = UC_t + PC_t + INC_t$
$Benefits = AC_t + INC_t$

Since the $INC_t$ term is the amount paid by the LDC for the benefit of some third party, it is both a cost and a benefit in the equation. Therefore, for simplicity it can be eliminated from the analysis.

The exclusions of incentives is only for the purposes of calculating the TRC value of a program and they are not excluded in developing the LDCs CDM budget. It is important to recognize that the only difference between the utility costs that get recorded in a LDCs TRC analysis and its complete CDM budget is the amount of incentives.

Many CDM programs involve some form of transfer payment (i.e. incentive) between LDCs and participants. They are generally characterized as follows:

- rebates;
- loans and leases;
- shared savings arrangements; or,
- participation fees.

While incentives primarily serve to improve the economic attractiveness of CDM investments for the customer, they also serve to increase customer awareness of the programs. As well, an incentive creates a specific paper trail that LDCs can use as part of their tracking and evaluation activities.

LDCs are free to design incentive schemes specific to their customers. Often, payback criteria or rebates are used in incentive design. This approach is often more important to commercial and industrial customers. For these customers, many utilities favour an approach that lowers the payback to a specific threshold, or ensures that incentives are only applied to projects with paybacks above a certain threshold.

An alternative approach is to gauge rebate levels relative to the incremental capital cost of the CDM technology compared to a standard technology that would have been installed in the absence of the program. Rebates are often set at some percentage of incremental cost. In practice, those percentages vary from a fraction of the incremental cost to completely off-setting incremental cost.

iii. LDC Equipment and Installation Costs

LDC equipment and installation costs include the costs of any LDC devices needed to operate the programs such as specialized software or tools as well as any CDM measures directly installed by the LDC such as load controllers.

iv. Monitoring and Evaluation Costs

This section focuses only on the cost to the LDC to monitor and evaluate a CDM portfolio. A detailed discussion on the nature of tracking, monitoring and evaluation is provided in Section 3.

There are two broad categories of evaluation activity: impact evaluation and process evaluation. Impact evaluation focuses on the specific impacts of the program – for example, savings and costs. Process evaluation focuses on the effectiveness of the program design – for example through the delivery channel approach. The costs associated with each of these activities are program costs that need to be included in the TRC analysis. Some of these costs will be assigned directly to a specific program or programs, while a portion of the costs are more appropriately assigned across all programs (i.e. at the CDM portfolio level).

Monitoring and evaluation costs are incurred for systems, equipment and studies necessary to track measurable levels of program success (participants, load impacts and costs) as well as to evaluate the features driving program success or failure. It is important to develop the necessary tracking systems at the time of program design. At a minimum, the tracking system must collect information on the key components that drive the TRC test, including:

- number of participants/installations;
- energy and seasonal demand savings;
- cost of equipment; and,
- LDC program and incentive costs.

Prescriptive load savings and cost values for most equipment are listed in the Assumptions and Measures List of this Guide.

To facilitate evaluations of CDM programs and results, LDCs must have clearly documented “paper trails” on the elements that drive a savings claim.

v. Administrative costs

Administrative costs are generally the costs of staff who work on CDM activities. These costs are often differentiated between support and operations staff. Support staff costs are considered fixed costs or “overhead” that occur regardless of the level of customer participation in the programs. Operations staff costs are variable, depending on the level of customer participation. LDCs must include all staff salaries that are attributable to CDM programs as part of the costs in the TRC analysis.

For an accurate TRC assessment, the LDC must ensure that all non-incentive costs associated with designing, operating and tracking the programs are accounted for in its TRC analysis.

### 1.3.3 Categorizing Costs

As a matter of practice and for ease of performing cost effectiveness testing, many LDCs categorize costs as either direct or indirect.

Direct costs are those that can be clearly allocated to a particular program and may include marketing, consulting and field staff costs among others. Direct costs factor into the program level cost effectiveness analysis. Indirect costs are those costs that can not easily be allocated to any particular program. These costs include overhead, administration and monitoring and evaluation. Indirect costs are typically incurred at the portfolio level and included in the portfolio cost effectiveness analysis.

# 2.0 Adjustment factors in the TRC Test

In performing a TRC analysis, several adjustments must be made to the benefits side of the equation. These adjustments include:

- free ridership of participants;
- attribution of the benefits, and
- persistence of the measures.

## 2.1 Free Riders

Free rider adjustments are one of the key components for the TRC test. The standard definition of a free rider is "a program participant who would have installed a measure on his or her own initiative even without the program."[10]

Costs and benefits associated with free ridership should be assessed as part of the TRC analysis. In determining overall savings, these participants are excluded from the benefits attributed to the program. The equipment costs associated with these participants is similarly excluded from cost side of the equation.[11] However, it should be noted that all program costs associated with free riders must be included in the analysis. As such, programs that have high free ridership are self-evident in the marketplace (i.e. they do not rely on a LDC promotion) and therefore are less cost effective for the LDC to pursue since the program costs are included in the TRC calculation while the benefits are not. Free rider estimates are established through market studies and initial values have been provided in the Assumptions and Measures List.

## 2.2 Attribution

A fundamental issue for the evaluation of CDM programs is whether the effects observed after the intervention occurs can be attributed to the intervention under evaluation (otherwise known as causality).

Since it can be expected that there will be multiple delivery points of CDM, including other electric LDCs, gas LDCs, electric retailers, gas marketers, the Ontario Power Authority and various levels of government, it is important to understand the Board's guidelines for the attribution of benefits especially in light of a potential claim for shareholder incentive.

This section outlines the guidelines for attributing benefits between OEB regulated CDM delivery LDCs and for savings associated with other resources.

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[10] Violette, Daniel M. (1995) Evaluation, Verification, and Performance Measurement of Energy Efficiency Programs. Report prepared for the International Energy Agency.
[11] Eto, J. (1998) Guidelines for Assessing the Value and Cost-effectiveness of Regional Market Transformation Initiatives. Northeast Energy Efficiency Partnership, Inc.

While attribution is not a true adjustment to the TRC test, this issue is important for those LDCs that plan on seeking a shareholder incentive. The Board advises LDCs that they are allowed to claim 100% of the benefits associated with a CDM program in which they jointly market and deliver the program with a non-rate regulated third party.

The following discussion addresses the issue of attribution of benefits of a CDM program with respect to the potential claim of a shareholder incentive from ratepayers. In the case that a shareholder incentive is recovered, it must be paid by those ratepayers who are receiving the benefits of the program, therefore, guidelines have been established to attribute the benefits of a program along geographic and industry boundaries.

### 2.3.1 Attribution Guidelines for CDM Programs

The formula for determining savings associated with a CDM program is:

Savings = (UATES) x (NUD) x (1-FRR)

where;

Savings – kWh/yr and/or other resource measure;

UATES – Unit Annual Total Energy Savings

NUD – Number of Units Delivered

FRR – Free Ridership Rate

In order to estimate the savings attributable to the LDC program an attribution rate is added to the previous formula to get:

Attributable Savings = (UATES) x (NUD) x (1-FRR) x (AR)

where;

AR – Attribution Rate

In most cases, the attribution rate will be 1.0, indicating that the LDC should claim in its TRC calculation all of the benefits associated with the CDM program.

The following discussion illustrates three cases where attribution may be an issue.

**Case 1-** Programs delivered jointly by LDCs with single energy savings (i.e. electricity):

In this case, several LDCs work together to market and deliver a CDM program. Each participating LDC is allowed to claim the benefits associated with the program (electricity and water) in their service area. The determining factors are the location of the participants and the benefits associated with the program. Therefore, in this case, the Attributable Savings would be:

Attributable Savings = (UATES) x ($NUD_{SA}$) x (1-FRR) x (AR)

$NUD_{SA}$ - number of units delivered in a LDC's service area.

AR = 1

**Case 2** – Multi energy savings in cross sector (gas and electricity) jointly delivered CDM program:

In this case, a gas and electric LDC jointly market and deliver a CDM program. Each participating LDC is allowed to claim all of the benefits associated with the energy type they distribute (i.e. gas LDCs would claim the gas savings and electricity LDCs would claim the electricity demand and energy savings). Other benefits, such as water savings, need to be allocated between the gas and electric LDC partners proportionally based on the dollar value of gas and electric TRC savings (i.e. where electricity savings represent 60% of the TRC savings of a program, the electric LDC will claim 60% of the water savings).

**Case 3** - Multi energy savings in an individually delivered DSM/CDM programs:

In this case, a LDC works independently to market and deliver a CDM program. The LDC's program may have energy savings additional to the primary energy savings targeted by the program. Common examples of these are Low Flow Shower Head and Programmable Thermostat programs. In these cases, the benefits of the programs will be electricity and other resource savings (i.e. gas and water). As in Case 1, the savings formula would be:

Attributable Savings = (UATES) x (NUD) x (1-FRR) x (AR)

Where UATES incorporate the savings of other energy sources.

### 2.4 Persistence

Persistence is a measure of how long a CDM measure is kept in place by the customer. Persistence is important for all energy efficiency interventions as a lack of persistence can have very significant effects on overall net program savings estimates. For example, if an energy efficient measure with a 15-year lifetime is removed after only two years, most of the savings thought to result from that installation will not materialize.

There is a compelling argument for accounting for persistence in the assessment of CDM cost effectiveness, especially for measures which are easily retrofitted such as compact fluorescent light bulbs. However, at this time, LDCs should assume 100% persistence in assessing CDM cost effectiveness unless otherwise updated by the Board.

## 3.0 Tracking and Measuring CDM Program Results

This section focuses on the requirements for tracking and measuring the effects of CDM programs.

Requirements for three types of programs are examined:

1. Direct acquisition programs are programs that have clear causality between LDC activity and energy savings.
2. Market support/outreach programs are programs in which the LDC supports outreach or educational efforts which generally promote the energy efficiency message, but where savings are indirect and it is difficult to see a clear cause and effect relationship.
3. Custom projects are programs that are generally large or complex in nature and often include a variety of individual measures and targeted at a specific customer.

### 3.1 Tracking of Direct Acquisition Programs

Direct acquisition programs are relatively straightforward to track and measure. Tracking requirements represent one of the administrative functions of program delivery. While the specifics will vary for each type of program, there is a need to show clear cause and effect between the LDC's activities and the customer's load reduction. In direct acquisition programs, this is often precipitated by the processing of a participant incentive. LDCs will need to have systems for collecting of relevant information for each program, including:

- technology type;
- number of installations;
- savings estimates;
- equipment cost estimates;
- customer address or location;
- delivery channel; and,
- incentive amount.

It may not be feasible to collect all information for all programs. For example, a program delivered by a retailer that relies on in-store coupons will likely not have the means to track who actually used the coupons and received the product(s). However, the retailer can be expected to track information about the number of coupons turned in, and the LDC's tracking system could then calculate the resulting cost to the LDC. With this information, the LDC can then calculate the savings and equipment cost and combine the information with equipment life, free rider estimates and program costs - resulting in both a tracking report and the requirements for the TRC analysis.

In the case of a program delivered by a third party, the tracking requirements will include reports that the delivery partner provides to the LDC. These reports should provide details on the customer visits, including address and equipment installed.

### 3.2 Tracking of Market Support Programs

Load reductions from CDM activities related to training, public outreach and the general provision of information on efficient energy use are difficult to track, measure and establish clear causality. Since market support programs typically do not result in direct demand or energy savings, other assessment criteria must be used to assess their validity. Table 3.1 provides a sample of potential tracking activities that might accompany the delivery of these programs. Each market support activity should attempt to have at least one metric.

Table 3.1 Sample Market Support Assessment Criteria

| Support | Metric | Additional Information |
|---|---|---|
| Web-site calculator | Number of hits | Survey re: usefulness of website |
| Training sessions for contractors | Number of sessions<br>Number of attendees | Survey re: specific activities undertaken by attendees |
| Home shows | Number of giveaways | Survey re: energy efficient appliances |
| Design workshops | Number of professional attendees | Surveys re: design activities |

### 3.3 Custom Projects

Custom projects are those projects where a LDC facilitates the implementation of specialized equipment and technology not identified in the Assumptions and Measures List. For a custom project, tracking requirements will include the type of equipment that was installed, the related savings and equipment cost and any LDC support costs. Since custom projects usually involve specialized equipment, savings estimates must be assessed accordingly. It is expected that each custom project will incorporate a professional engineering assessment of the savings. This assessment would serve as the primary documentation for a savings claim.

A special assessment program must be implemented for custom projects. The assessment should be conducted on a random sample consisting of 10% of the large custom projects; and the projects should represent at least 10% of the total volume savings of all custom projects. The minimum number of projects to assess would be 5 and the free rider rate for these projects would be 30%. Where less than 5 custom projects have been undertaken, all projects should be assessed. The assessment will focus on verifying the equipment installation and estimates of savings and equipment cost.

## 4.0 How to Calculate TRC

This section provides details of how to perform a TRC analysis with examples for a single technology calculation, a program calculation and an entire portfolio of programs.

As discussed earlier, a LDC's CDM portfolio is the highest level envelope incorporating all of the costs not captured at the technology and program level. Therefore, a CDM portfolio consists of set of cost effective CDM programs. Similarly, a CDM program is designed around a given cost effective measure or technology.[12] Cost effectiveness screening is assessed at each level of a LDC's CDM initiative.

The TRC calculation relies on estimates of:

- avoided cost;
- demand and energy savings;
- equipment cost;
- LDC program costs;
- equipment life;
- free ridership.

These estimates are used in a standard NPV calculation that relies on a discount rate to express a value for future streams of money and to determine a cost effectiveness result in current dollars.

### 4.1 Calculating the TRC for a Single Technology – Technology Screening Analysis

In its simplest form, the single technology screening analysis calculates the cost effectiveness of a single piece of equipment or technology based purely on its energy efficiency characteristics, its cost and equipment life. This screening analysis is the initial step in considering technologies for inclusion in a CDM program.

To perform the technology screening analysis, the required elements are:

- estimate of per unit savings (kW and kWh) by period;
- estimate of equipment cost; and
- expected equipment life.

This is a simple cost benefit analysis of the technology on a single unit basis.

**Calculating the benefits:** The benefits are expressed as the product of the per unit savings (in kW and/or kWh) and the avoided costs. This calculation is done

[12] An LDC may wish to undertake programming on non-cost effective technologies in the form of pilot programs or test efforts as part of a market support or market research activity. The rationale for these activities must be clearly identified.

for every year of the life of the equipment. These values are then discounted and summed to express the benefits as a single $NPV_{benefits}$.

**Calculating the costs:** The equipment cost is the cost of the technology, expressed as either its full or incremental cost. In most cases, the cost of the technology is incurred at the beginning of the initiative and no further costs are incurred over the life of the equipment (i.e. a CFL bulb). However, where the energy efficient equipment has ongoing maintenance costs incremental to the base case alternative, these costs should be included in the analysis and discounted appropriately. Once this calculation is performed, it is expressed as a single $NPV_{costs}$.

**Example 1: Technology Screening Analysis**

In this example, a compact fluorescent light bulb replaces a standard incandescent bulb in a residential application.

| | |
|---|---|
| Measure: | Replace 60 W incandescent bulb |
| Technology: | 15 W compact fluorescent bulb |
| Savings: | 104 kWh/yr |
| Equipment Cost: | $2.00 |
| Equipment Life: | 4 years |
| Discount rate: | 10% |

The calculations and tables in Appendix B show that the net present value per unit is $23.45.

The results of this technology screening analysis indicate that the proposed measure is cost effective and could be promoted to the program screening analysis for further evaluation.

**Example 2: Technology Screening Analysis**

In this example, a low flow showerhead replaces an inefficient showerhead in a standard residential application. There are both electricity and water savings that are assessed in the TRC analysis. The savings, equipment cost and equipment life are provided in the Assumptions and Measures List.

| | |
|---|---|
| Measure: | Install low flow showerhead |
| Technology: | 9.4 litre/minute low flow showerhead |
| Electricity Savings: | 545 kWh/yr |
| Water Savings: | 26,800 litres/year or 26.8 $m^3$/yr |
| Equipment Cost: | $7.00 |
| Equipment Life: | 12 years |
| Discount rate: | 10% |

The following TRC benefit calculation is identical to Example 1 except that the benefits associated with water savings are incorporated.

The calculations and tables in Appendix B show that the net present value per unit is $473.25

### 4.2 Calculating the TRC for a Program – Program Screening Analysis

Once a measure has passed the technology screening analysis, the analyst may wish to design a program that uses the technology. The program screening analysis combines the results of the individual technology analysis with the key program components, including number of participants, free ridership rates and direct LDC program costs. The program screening analysis repeats the same approach as defined in section 4.1 with the inclusion of the adjustment factors to assess the measure at the program level.

**Example: Program Screening Analysis**

Using the technology from Example 1 above, a program screening analysis would incorporate the following adjustments, given the following assumptions:

| | |
|---|---|
| Participant number: | 10,000 |
| Free rider rate: | 10% |
| Direct program cost: | $75,000* |
| Equipment cost | $20,000 |

Therefore, the $NPV_{Program}$ is as follows:

| | |
|---|---|
| NPV of Program Benefits | 254,500 |
| NPV of Program Benefits (net of free riders) | 229,050 |
| Direct Program Costs | (75,000) |
| Equipment Costs (net of free riders) | (18,000) |
| Program NPV | 136,050 |

Using the technology from Example 2 above, a program screening analysis would incorporate the following adjustments, given the following assumptions:

| | |
|---|---|
| Participant number: | 1,000 |
| Free rider rate: | 10% |
| Direct program cost: | $50,000* |
| Equipment cost: | $7,000 |

Therefore, the $NPV_{Program}$ is as follows:

* Costs are for illustrative purposes only.

| | |
|---|---|
| NPV of Program Benefits | 480,250 |
| NPV of Program Benefits (net of free riders) | 432,225 |
| Direct Program Costs | (50,000) |
| Equipment Costs (net of free riders) | (6,300) |
| Program NPV | 375,925 |

### 4.3 Calculating the TRC for a Portfolio - Portfolio Screening Analysis

Once the LDC has screened all of its programs and is comfortable with the program designs, the overall cost effectiveness of the portfolio needs to be tested. To do this, the LDC will sum the program TRC results and then allocate administrative and any market support costs (indirect costs) to the entire portfolio.  Administrative costs include overhead, monitoring and evaluation costs and administration costs associated with the delivery of the overall CDM portfolio. This roll-up value represents the TRC result for the entire CDM programming activity.

**Example: Portfolio Screening Analysis**

Assuming a LDC planned to deliver only the two programs discussed above; the following consists of a theoretical portfolio screening analysis.

Assuming a LDC has indirect costs of administration, market support, overhead and monitoring and evaluation of $200,000.[*]  The NPV of the portfolio would be as follows:

| | |
|---|---|
| Program 1 NPV Program: | 136,050 |
| Program 2 NPV Program: | 375,925 |
| Total Indirect Costs: | (200,000) |
| $NPV_{TRC}$ | 311,975 |

Therefore, the $NPV_{TRC}$ of this portfolio is $311,975.

### 4.4 Using TRC Analysis for Post Program Evaluation

The TRC calculation done at the end of a program year follows exactly the same approach using the “actual” information collected as part of the tracking and reporting exercises as opposed to estimates.

* Costs are for illustrative purposes only.

# 5.0 Assumptions and Measures List

The Assumptions and Measures List data were developed using secondary research, augmented by expert input as required. All data points were cross-referenced with a minimum of two sources. Where possible, recent Canadian experience and data was used. All savings data were based on an understanding of average electricity loads in typical applications in each sector. Cost data were collected from a variety of sources including retailers and distributors. Free rider values are also provided for all measures.[13]

[13] While it is recognized that free ridership is appropriately applied at the program level, the Assumptions and Measures List provides an estimate to facilitate cost effectiveness analysis.

## Assumptions and Measures List: Residential

| | | | | | | | | | Demand Reduction | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Efficient Equipment & Technologies | Base Equipment & Technologies | Load Type (Base, Weather Winter, Weather Summer, Load shifting) | Decision Type | Annual Operating Time, hrs/yr | Base Annual Energy Usage (kWh/yr) | Energy Efficient Technology Annual Energy Usage (kWh/yr) | Annual Energy Savings with Upgrade (kWh/yr) | Winter On Peak (kW) | Summer On Peak (kW) | Annual Water Savings Litres/yr | Alternative Fuel Increase m3/yr | EE Technology Life | Incremental Equipment Cost, $ | Lifespan Hours | Free Ridership | Energy Savings Winter Peak (kW.h) | Energy Savings Winter Mid (kW.h) | Energy Savings Winter Off Peak (kW.h) | Energy Savings Summer Peak (kW.h) | Energy Savings Summer Mid (kW.h) | Energy Savings Summer Off Peak (kW.h) | Energy Savings Shoulder Mid (kW.h) | Energy Savings Shoulder Off (kW.h) |
| | **Refrigerators** | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | Recycling Program | Average existing stock | Base | Removal | - | 1,200 | 0 | 1,200 | 0.288 | 0.272 | - | - | 6 | $100.00 | - | 10% | 82 | 94 | 221 | 72 | 107 | 222 | 179 | 222 |
| 2 | Energy Star Refrigerators | Current standard for refridgerator | Base | New/Repl | - | 514 | 440 | 74 | 0.018 | 0.017 | - | - | 19 | $70.00 | - | 10% | 5 | 6 | 14 | 4 | 7 | 14 | 11 | 14 |
| | **Freezers** | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Recycling Program | Average existing stock | Base | Removal | - | 900 | 0 | 900 | 0.216 | 0.204 | - | - | 6 | $100.00 | - | 10% | 62 | 71 | 166 | 54 | 80 | 167 | 134 | 167 |
| 4 | Energy Star Freezer | Current standard for freezer | Base | New/Repl | - | 368 | 331 | 37 | 0.009 | 0.008 | - | - | 21 | $200.00 | - | 10% | 3 | 3 | 7 | 2 | 3 | 7 | 5 | 7 |
| | **Clothes Dryers** | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | High Efficiency Clothes Dryer | Current standard for clothes dryer | Base | New/Repl | - | 916 | 824 | 92 | 0.005 | 0.004 | - | - | 18 | $100.00 | - | 10% | 6 | 7 | 17 | 5 | 8 | 17 | 14 | 17 |
| 6 | Fuel Switching - Gas Clothes Dryer | Average existing stock | Base | New/Repl | - | 916 | 0 | 916 | 0.047 | 0.040 | - | 112.00 | 18 | $0.00 | - | 10% | 63 | 72 | 169 | 55 | 82 | 170 | 136 | 170 |
| | **Range/Ovens and EE Cooking and Food Preparation** | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | High Efficiency Range/Oven | Current standard range/oven | Base | New/Repl | - | 550 | 495 | 55 | 0.001 | 0.000 | - | - | 18 | $60.00 | - | 10% | 4 | 4 | 10 | 3 | 5 | 10 | 8 | 10 |
| 8 | Fuel Switching - Gas Range | Average existing stock | Base | New/Repl | - | 735 | 0 | 735 | 0.017 | 0.000 | - | 81.00 | 18 | $400.00 | - | 10% | 51 | 58 | 135 | 44 | 66 | 136 | 109 | 136 |
| 9 | Microwave Oven as Alternative Food Preparation | Average existing stock | Base | New/Repl | - | 735 | 625 | 110 | 0.003 | 0.000 | - | - | 5 | $120.00 | - | 10% | 8 | 9 | 20 | 7 | 10 | 20 | 16 | 20 |
| 10 | Toaster Oven as Alternative Food Preparation | Average existing stock | Base | New/Repl | - | 735 | 625 | 110 | 0.003 | 0.000 | - | - | 5 | $140.00 | - | 10% | 8 | 9 | 20 | 7 | 10 | 20 | 16 | 20 |
| | **Dishwashers** | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | Energy Star Dishwasher | Current standard dishwasher | Base | New/Repl | - | 592 | 492 | 100 | 0.002 | 0.000 | - | - | 13 | $100.00 | - | 10% | 7 | 8 | 18 | 6 | 9 | 19 | 15 | 19 |
| | **Clothes Washers** | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Energy Star Front Loading Clothes Washer | Current standard for clothes washer | Base | New/Repl | - | 779 | 299 | 480 | 0.019 | 0.016 | 20000 | - | 14 | $200.00 | - | 10% | 33 | 38 | 88 | 29 | 43 | 89 | 72 | 89 |
| 13 | Energy Star Top Loading Clothes Washers | Current standard for clothes washer | Base | New/Repl | - | 779 | 701 | 78 | 0.003 | 0.003 | - | - | 14 | $100.00 | - | 10% | 5 | 6 | 14 | 5 | 7 | 14 | 12 | 14 |
| 14 | Cold Water Washing (Detergent) | Average existing stock | Base | New/Repl | - | 779 | 156 | 623 | 0.024 | 0.021 | - | - | 1 | $10.00 | - | 25% | 43 | 49 | 115 | 37 | 56 | 115 | 93 | 115 |
| | **Indoor Lighting** | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | CFL Screw-in 11W | 40W Incandescent | Lightng | Ret./Repl. | 2,320 | 93 | 26 | 67 | 0.015 | 0.000 | - | - | 3 | $2.25 | 8,000 | 10% | 10 | 5 | 13 | 0 | 8 | 9 | 11 | 11 |
| 16 | CFL Screw-in 15W | 60W Incandescent | Lightng | Ret./Repl. | 2,320 | 139 | 35 | 104 | 0.023 | 0.000 | - | - | 4 | $2.00 | 10,000 | 10% | 15 | 8 | 20 | 0 | 12 | 14 | 17 | 18 |
| 17 | CFL Screw-in 20W | 75W Incandescent | Lightng | Ret./Repl. | 2,320 | 174 | 46 | 128 | 0.028 | 0.000 | - | - | 4 | $3.50 | 10,000 | 10% | 19 | 9 | 25 | 0 | 14 | 17 | 21 | 22 |
| 18 | CFL Screw-in 25W | 100W Incandescent | Lightng | Ret./Repl. | 2,320 | 232 | 58 | 174 | 0.038 | 0.000 | - | - | 4 | $4.00 | 10,000 | 10% | 26 | 13 | 34 | 0 | 20 | 23 | 29 | 29 |
| 19 | CFL Screw-in 27W | 100W Incandescent | Lightng | Ret./Repl. | 2,320 | 232 | 63 | 169 | 0.037 | 0.000 | - | - | 3 | $5.00 | 8,000 | 10% | 25 | 13 | 33 | 0 | 19 | 23 | 28 | 29 |
| | **Outdoor Lighting** | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | Flood Light, 26W Fluorescent | Flood Light, 100W Incandescent PAR | Base | Ret./Repl. | 1,825 | 183 | 58 | 124 | 0.013 | 0.000 | - | - | 5 | $6.00 | 10,000 | 5% | 3 | 16 | 23 | 0 | 11 | 30 | 18 | 23 |
| 21 | Metal Halide Fixture 39W CMH PAR | Flood Light, 150W Incandescent PAR | Base | Ret./Repl. | 1,825 | 274 | 100 | 173 | 0.017 | 0.000 | - | - | 5 | $100.00 | 10,000 | 5% | 4 | 22 | 32 | 0 | 15 | 42 | 26 | 32 |
| 22 | LED Christmas Lights (indoor or outdoor) | 5 WATT Christmas lights C-7(25 lights) | Base Winter | Ret./Repl. | 155 | 19 | 1 | 19 | 0.008 | 0.000 | - | - | 30 | $2.00 | 200,000 | 5% | 6 | 4 | 9 | 0 | 0 | 0 | 0 | 0 |
| 23 | LED Christmas Lights (indoor or outdoor) | Incandescent Mini Lights | Base Winter | Ret./Repl. | 155 | 8 | 1 | 7 | 0.003 | 0.000 | - | - | 30 | $2.00 | 200,000 | 5% | 2 | 1 | 4 | 0 | 0 | 0 | 0 | 0 |
| | **Lighting Controls** | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Timer - Outdoor Light | 2 Flood Lights, 75W Incandescent, on 50% time | Base | New | 4,380 | 876 | 584 | 292 | 0.189 | 0.000 | - | - | 20 | $20.00 | - | 10% | 43 | 22 | 57 | 0 | 33 | 39 | 49 | 49 |
| 23 | Dimmer Switch | 2 100 Watt Incandescent bulbs | Base | New | - | 464 | 325 | 139 | 0.090 | 0.000 | - | - | 10 | $5.00 | - | 10% | 21 | 10 | 27 | 0 | 16 | 19 | 23 | 24 |
| 24 | Motion Detector | 3 100 Watt Incandescent bulbs | Base | New | - | 696 | 487 | 209 | 0.135 | 0.000 | - | - | 10 | $25.00 | - | 10% | 31 | 15 | 41 | 0 | 23 | 28 | 35 | 35 |
| | **Water Heating - Average Residential Home** | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | Efficient Showerhead | Average existing stock | Base | Ret./Repl. | - | 5,000 | 4,455 | 545 | 0.096 | 0.039 | 26,800 | - | 12 | $7.00 | - | 10% | 37 | 43 | 100 | 33 | 49 | 101 | 81 | 101 |
| 26 | Faucet Aerator | Average existing stock | Base | Ret./Repl. | - | 5,000 | 4,966 | 34 | 0.006 | 0.002 | 3,269 | - | 12 | $6.00 | - | 10% | 2 | 3 | 6 | 2 | 3 | 6 | 5 | 6 |
| 27 | Faucet Washers | Average existing stock | Base | Ret./Repl. | - | 5,000 | 4,980 | 20 | 0.004 | 0.001 | - | - | 6 | $0.28 | - | 10% | 1 | 2 | 4 | 1 | 2 | 4 | 3 | 4 |
| 28 | Tank Wrap | Average existing stock | Base | Ret./Repl. | - | 5,000 | 4,730 | 270 | 0.047 | 0.019 | - | - | 6 | $25.00 | - | 5% | 19 | 21 | 50 | 16 | 24 | 50 | 40 | 50 |
| 30 | Pipe Insulation (6-10') | Average existing stock | Base | Ret./Repl. | - | 5,000 | 4,924 | 76 | 0.013 | 0.005 | - | - | 6 | $0.50 | - | 10% | 5 | 6 | 14 | 5 | 7 | 14 | 11 | 14 |

| | | | | | | | | | Demand Reduction | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Efficient Equipment & Technologies | Base Equipment & Technologies | Load Type (Base, Weather Winter, Weather Summer, Load shifting) | Decision Type | Annual Operating Time, hrs/yr | Base Annual Energy Usage (kWh/yr) | Energy Efficient Technology Annual Energy Usage (kWh/yr) | Annual Energy Savings with Upgrade (kWh/yr) | Winter On Peak (kW) | Summer On Peak (kW) | Annual Water Savings Litres/yr | Alternative Fuel Increase m3/yr | EE Technology Life | Incremental Equipment Cost, $ | Lifespan Hours | Free Ridership | Energy Savings Winter Peak (kW.h) | Energy Savings Winter Mid (kW.h) | Energy Savings Winter Off Peak (kW.h) | Energy Savings Summer Peak (kW.h) | Energy Savings Summer Mid (kW.h) | Energy Savings Summer Off Peak (kW.h) | Energy Savings Shoulder Mid (kW.h) | Energy Savings Shoulder Off (kW.h) |
| | **Water Heater Load Shifting** | | | | | | | | | | | | | | | | | | | | | | | |
| 31 | Utility Controlled Relay | Average existing stock | Load Shifting | Retrofit | - | 5,000 | 5,000 | 0 | 2.892 | 0.777 | - | - | 12 | $50.00 | - | 0% | 1134 | -1134 | 0 | 648 | -427 | -220 | 0 | 0 |
| 32 | Water Heater Clock Thermostat | Average existing stock | Load Shifting | Retrofit | - | 5,000 | 5,000 | 0 | 2.892 | 0.777 | - | - | 12 | $150.00 | - | 0% | 1134 | -1134 | 0 | 648 | -427 | -220 | 0 | 0 |
| | **Alternative Water Heating** | | | | | | | | | | | | | | | | | | | | | | | |
| 33 | Tankless Instantaneous Electric Water Heater | Current standard electrical water heater | Base | New/Retro | - | 5,000 | 4,250 | 750 | 0.131 | 0.054 | - | - | 18 | $600.00 | - | 0% | 52 | 59 | 138 | 45 | 67 | 139 | 112 | 139 |
| 34 | Solar Assisted Water Heater | Current standard electrical water heater | Base | New | - | 5,000 | 3,020 | 1,980 | 0.347 | 0.142 | - | - | 18 | $2,000.00 | - | 0% | 136 | 156 | 365 | 118 | 177 | 367 | 296 | 367 |
| 35 | Fuel Switching - Gas Water Heater | Current standard electrical water heater | Base | New | - | 5,000 | 0 | 5,000 | 0.876 | 0.357 | - | 680.00 | 18 | $600.00 | - | 0% | 344 | 393 | 921 | 298 | 447 | 926 | 745 | 926 |
| | **Thermal Envelope Improvements - Existing Homes, Single Family Detached** | | | | | | | | | | | | | | | | | | | | | | | |
| 36 | Caulking Products | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,741 | 362 | 0.290 | 0.000 | - | - | 25 | $100.00 | - | 10% | 50 | 57 | 134 | 0 | 0 | 0 | 54 | 67 |
| 37 | Weatherstripping | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $30.00 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| 38 | Air Vapour Barrier Upgrade | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 16,836 | 1,267 | 1.015 | 0.000 | - | - | 25 | $405 | - | 10% | 175 | 200 | 468 | 0 | 0 | 0 | 189 | 235 |
| 39 | Attic Insulation (R-11 to R-38) | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 15,388 | 2,715 | 2.176 | 0.000 | - | - | 25 | $2,253 | - | 10% | 374 | 428 | 1003 | 0 | 0 | 0 | 406 | 504 |
| 40 | Duct Insulation and Sealing | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 15,388 | 2,715 | 2.176 | 0.000 | - | - | 25 | $540 | - | 10% | 374 | 428 | 1003 | 0 | 0 | 0 | 406 | 504 |
| 41 | Wall Insulation | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $2,004 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| 42 | Ceiling/Floor Insulation | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $2,253 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| 43 | Basement Insulation | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $1,379 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| 44 | Door Upgrade | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $335 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| 45 | Window Upgrade | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 17,560 | 543 | 0.435 | 0.000 | - | - | 25 | $3,520 | - | 10% | 75 | 86 | 201 | 0 | 0 | 0 | 81 | 101 |
| | **Thermal Envelope Improvements - New Homes, Single Family Detached** | | | | | | | | | | | | | | | | | | | | | | | |
| 46 | R-2000+ Lrg 2 story new house | Current Ontario Building Code | Weather/Winter | New | - | 23,647 | 9,223 | 14,424 | 11.558 | 0.000 | - | - | 25 | $12,800 | - | 5% | 1988 | 2272 | 5330 | 0 | 0 | 0 | 2155 | 2680 |
| 47 | R-2000+ Sm 2 story new house | Current Ontario Building Code | Weather/Winter | New | - | 19,229 | 7,076 | 12,153 | 9.738 | 0.000 | - | - | 25 | $9,701 | - | 5% | 1675 | 1914 | 4491 | 0 | 0 | 0 | 1815 | 2258 |
| 48 | R-2000+ Interior Row new house | Current Ontario Building Code | Weather/Winter | New | - | 9,462 | 3,482 | 5,980 | 4.792 | 0.000 | - | - | 25 | $5,802 | - | 5% | 824 | 942 | 2210 | 0 | 0 | 0 | 893 | 1111 |
| 49 | R-2000+ Exterior Row new house | Current Ontario Building Code | Weather/Winter | New | - | 12,630 | 4,648 | 7,982 | 6.396 | 0.000 | - | - | 25 | $7,057 | - | 5% | 1100 | 1257 | 2949 | 0 | 0 | 0 | 1192 | 1483 |
| | **Space Cooling** | | | | | | | | | | | | | | | | | | | | | | | |
| 50 | Energy Star Room Air Conditioner | Current standard for room air conditioner | Weaten/Summer | Ret./Repl. | - | 880 | 792 | 88 | 0.000 | 0.090 | - | - | 12 | $36.00 | - | 10% | 0 | 0 | 0 | 16 | 24 | 49 | 0 | 0 |
| 51 | Utility Controlled Relay | Average existing stock | Weaten/Summer | Ret./Repl. | - | 1,964 | | 0 | 0.000 | 0.500 | - | - | 18 | $150.00 | - | 0% | 0 | 0 | 0 | 255 | -170 | -85 | 0 | 0 |
| 52 | Contractor service (charge/air flow fix) | Average existing stock | Weaten/Summer | Ret./Repl. | - | 1,964 | 1,595 | 369 | 0.000 | 0.378 | - | - | 8 | $420.00 | - | 0% | 0 | 0 | 0 | 66 | 99 | 205 | 0 | 0 |
| 53 | Contractor service (Duct Sealing) | Average existing stock | Weaten/Summer | Ret./Repl. | - | 1,964 | 1,747 | 217 | 0.000 | 0.222 | - | - | 15 | $540.00 | - | 0% | 0 | 0 | 0 | 39 | 58 | 120 | 0 | 0 |
| 54 | Energy Star Central Air Conditioner | Current standard for central air conditioner | Weaten/Summer | Ret./Repl. | - | 1,403 | 1,052 | 351 | 0.000 | 0.359 | - | - | 14 | $480.00 | - | 10% | 0 | 0 | 0 | 63 | 94 | 194 | 0 | 0 |
| 55 | Programmable Thermostat | Average existing stock | Weaten/Summer | Ret./Repl. | - | 1,964 | 1,805 | 159 | 0.000 | 0.163 | - | - | 18 | $60.00 | - | 10% | 0 | 0 | 0 | 28 | 43 | 88 | 0 | 0 |
| | **Space Heating Measures- Existing Homes, Single Family Detached** | | | | | | | | | | | | | | | | | | | | | | | |
| 56 | Programmable Thermostat | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 16,637 | 1,466 | 1.175 | 0.000 | - | - | 18 | $60.00 | - | 10% | 202 | 231 | 542 | 0 | 0 | 0 | 219 | 272 |
| 57 | Energy Star Air Source Heat Pump | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 13,577 | 4,526 | 3.626 | 0.000 | - | - | 18 | $5,760.00 | - | 0% | 624 | 713 | 1672 | 0 | 0 | 0 | 676 | 841 |
| 58 | Electric Storage Furnace | Average existing stock | Weather/Winter | Ret./Repl. | - | 18,103 | 16,293 | 1,810 | 1.451 | 0.000 | - | - | 18 | $3,000.00 | - | 0% | 249 | 285 | 669 | 0 | 0 | 0 | 270 | 336 |
| | **Apartments/Condos - Various end uses** | | | | | | | | | | | | | | | | | | | | | | | |
| 59 | Programmable Thermostat (space heating and cooling) | Average existing stock | Weather/Winter | Ret/Repl. | - | 3,000 | 2,757 | 243 | 0.097 | 0.083 | - | - | 18 | $60.00 | - | 10% | 17 | 19 | 45 | 14 | 22 | 45 | 36 | 45 |
| 60 | Individul Metering | Average existing stock | Weather/Winter | Ret/Repl. | - | 6,000 | 5,400 | 600 | 0.240 | 0.205 | - | - | 20 | $400.00 | - | 0% | 41 | 47 | 111 | 36 | 54 | 111 | 89 | 111 |
| | **Miscellaneous** | | | | | | | | | | | | | | | | | | | | | | | |
| 61 | Clothes Line Kit | Average existing stock | Base | New | - | 916 | 687 | 229 | 0.000 | 0.023 | - | - | 10 | $65.00 | - | 10% | 0 | 0 | 0 | 41 | 61 | 127 | 0 | 0 |

## Assumptions and Measures List: Commercial

| | | | | | | | | Demand Reduction | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Efficient Equipment & Technologies | Base Equipment & Technologies | Decision Type | Annual Operating Time (hrs/yr) | Base Annual Energy (kWh/yr) | Efficient Energy Use (kWh/yr) | Annual Energy Savings with Upgrade (kWh/yr) | Winter On Peak (kW) | Summer On Peak (kW) | EE Technology Life (yrs) | Incremental Equipment Cost | Lifespan (hrs) | Free Ridership | Energy Savings Winter Peak (kW.h) | Energy Savings Winter Mid (kW.h) | Energy Savings Winter Off Peak (kW.h) | Energy Savings Summer Peak (kW.h) | Energy Savings Summer Mid (kW.h) | Energy Savings Summer Off Peak (kW.h) | Energy Savings Shoulder Mid (kW.h) | Energy Savings Shoulder Off (kW.h) |
| | **Interior Lighting - Fluorescent** | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 - T8 32W (58 W) reflectorized w/EL ballast | 4 - T12 34W (156W) 4' Lamps w/2 magnetic ballasts | Ret./Repl. | 4000 | 624 | 232 | 392 | 0.088 | 0.084 | 5 | $53 | 20000 | 10% | 45 | 49 | 36 | 42 | 53 | 36 | 96 | 36 |
| 2 | 4 - T8 32W (112W) 4' Lamps w/EL ballast | 2 - T12 75W (184W) 8' HO Lamps w/1 magnetic ballast | Ret./Repl. | 4000 | 736 | 448 | 288 | 0.065 | 0.062 | 5 | $65 | 20000 | 10% | 33 | 36 | 27 | 31 | 39 | 27 | 70 | 27 |
| 3 | 1- T8 32W (38W) w/EL HBF ballast | 2 - T12 34W (78W) 4' lamps pendant mount, 1 EM ballast | Ret./Repl. | 4000 | 312 | 152 | 160 | 0.036 | 0.034 | 5 | $36 | 20000 | 10% | 18 | 20 | 15 | 17 | 22 | 15 | 39 | 15 |
| | **Interior Lighting - Compact Fluorescent** | | | | | | | | | | | | | | | | | | | | |
| 4 | 11W Screw-in CFL | 40W Incandescent | Ret./Repl. | 4000 | 160 | 50 | 110 | 0.025 | 0.023 | 2 | $5 | 8000 | 10% | 13 | 14 | 11 | 12 | 16 | 11 | 28 | 11 |
| 5 | 15W Screw-in CFL | 60W Incandescent | Ret./Repl. | 4000 | 240 | 68 | 172 | 0.038 | 0.037 | 2 | $4 | 8000 | 10% | 21 | 22 | 17 | 19 | 24 | 17 | 43 | 17 |
| 6 | 13W CFL fixture w/EM ballast | 60W Incandescent | Ret./Repl. | 4000 | 240 | 74 | 166 | 0.041 | 0.039 | 2.5 | $7 | 10000 | 10% | 20 | 22 | 16 | 19 | 24 | 16 | 43 | 16 |
| 7 | 18W CFL fixture w/EM ballast | 75W Incandescent | Ret./Repl. | 4000 | 300 | 83 | 217 | 0.049 | 0.046 | 2.5 | $8 | 10000 | 10% | 23 | 25 | 18 | 21 | 27 | 19 | 48 | 19 |
| 8 | 26W CFL fixture w/EM ballast | 100W Incandescent | Ret./Repl. | 4000 | 400 | 120 | 280 | 0.063 | 0.060 | 2.5 | $10 | 10000 | 10% | 33 | 36 | 27 | 31 | 39 | 27 | 70 | 27 |
| 9 | 2 - 26W CFL fixture w/EM ballast | 150W Incandescent | Ret./Repl. | 4000 | 600 | 218 | 382 | 0.084 | 0.080 | 2.5 | $75 | 10000 | 10% | 46 | 50 | 37 | 42 | 54 | 37 | 97 | 37 |
| | **Interior Lighting - Exit Sign** | | | | | | | | | | | | | | | | | | | | |
| 10 | 3W LED EXIT sign | 2 - 15W (30W) Incandescent EXIT Sign | Ret./Repl. | 8760 | 263 | 26 | 237 | 0.027 | 0.026 | 25 | $95 | 220000 | 10% | 27 | 29 | 22 | 25 | 32 | 22 | 57 | 22 |
| | **Interior Lighting - Metal Halide** | | | | | | | | | | | | | | | | | | | | |
| 11 | 100W Metal Halide fixture | 4 - T12 34W (156W) 4' lamps, 2 EM ballasts | Ret./Repl. | 4000 | 624 | 516 | 108 | 0.056 | 0.053 | 3 | $175 | 12500 | 10% | 12 | 13 | 10 | 11 | 15 | 10 | 26 | 10 |
| | **Interior Lighting - Warehouse & Workshop[** | | | | | | | | | | | | | | | | | | | | |
| 12 | 250W Metal Halide Lamp, PS | 400W Mercury Vapor | Ret./Repl. | 4000 | 1816 | 1168 | 648 | 0.135 | 0.128 | 4 | $245 | 15,000 | 10% | 74 | 81 | 60 | 69 | 88 | 60 | 157 | 60 |
| 13 | 175W Metal Halide Lamp, PS | 250W Mercury Vapor | Ret./Repl. | 4000 | 1140 | 832 | 308 | 0.068 | 0.064 | 4 | $245 | 15,000 | 10% | 35 | 38 | 28 | 33 | 42 | 29 | 74 | 29 |
| 14 | 200W High Pressure Sodium | 400W Mercury Vapor | Ret./Repl. | 4000 | 1816 | 960 | 856 | 0.180 | 0.171 | 6 | $245 | 24,000 | 10% | 98 | 107 | 79 | 91 | 116 | 79 | 207 | 79 |
| 15 | 6 - T5 HO Lamps in new High Bay fixture (372W) | 400W Metal Halide PS High Bay | Ret./Repl. | 4000 | 1816 | 1488 | 328 | 0.025 | 0.024 | 5 | $436 | 20,000 | 10% | 38 | 41 | 30 | 35 | 45 | 30 | 79 | 30 |
| | **Occupancy & Timing Control** | | | | | | | | | | | | | | | | | | | | |
| 16 | Timer Control - Outdoor light (300 W controlled) | On/Off Switch Control - Outdoor light | New/Retro. | | 1500 | 1200 | 300 | 0.030 | 0.013 | 10 | $275 | | 10% | 34 | 37 | 28 | 32 | 41 | 28 | 72 | 28 |
| 17 | Occupancy Sensor Control (private office - 1200 W controlled) | On/Off Switch Control | New/Retro. | | 5400 | 3780 | 1620 | 0.518 | 0.437 | 10 | $550 | | 10% | 186 | 202 | 149 | 172 | 220 | 150 | 391 | 150 |
| 18 | Daylight Sensing Control (general office - 3000 W controlled) | On/Off Switch Control | New/Retro. | | 13500 | 9450 | 4050 | 1.355 | 1.595 | 10 | $1,800 | | 10% | 465 | 505 | 373 | 429 | 550 | 375 | 979 | 375 |
| | **Water Heater - Heat Loss Reduction** | | | | | | | | | | | | | | | | | | | | |
| 19 | Upgrade tank insulation | Water Heater (119 USG) Tank Insulation Blanket R-24.9 | New/Retro. | | 770 | 366 | 404 | 0.323 | 0.277 | 10 | $400 | | 10% | 46 | 50 | 37 | 43 | 55 | 37 | 98 | 37 |
| 20 | Install pipe insulation - 6 - 10 ft. | Pipe insulation (10 ft each on inlet & outlet of tank) | New/Retro. | | 40000 | 39400 | 600 | 0.479 | 0.411 | 10 | $2 | | 10% | 69 | 75 | 55 | 64 | 81 | 56 | 145 | 56 |
| | **Cooking** | | | | | | | | | | | | | | | | | | | | |
| 21 | EE Fryer | Deep Fryer - fast food restaurant | Ret./Repl. | per fryer | 13424 | 12082 | 1342 | 0.194 | 0.167 | 15 | $7,000 | | 10% | 154 | 167 | 124 | 142 | 182 | 124 | 324 | 124 |
| | **Reduced Infiltration** | | | | | | | | | | | | | | | | | | | | |
| 22 | Air Sealing (non-profit housing) | Caulking | Ret./Repl. | per hsng unit | 6600 | 6270 | 330 | 0.171 | 0.000 | 25 | $700 | | 10% | 38 | 41 | 30 | 35 | 45 | 31 | 80 | 31 |
| | **Occupancy Control (Hotel/Motel)** | | | | | | | | | | | | | | | | | | | | |
| 23 | Manual switches/controls | Occupancy Sensors | Ret./Repl. | per hotel room | 2877 | 1530 | 1347 | 1.08 | 0.92 | 15 | $850 | | 10% | 155 | 168 | 124 | 143 | 183 | 125 | 325 | 125 |
| | **Free Cooling** | | | | | | | | | | | | | | | | | | | | |
| 24 | No economizer | Outside Air Economizer | Ret./Repl. | 5 ton cooling | 5000 | 3750 | 1250 | 1.00 | 0.86 | 12 | $2,500 | | 10% | 143 | 156 | 115 | 132 | 170 | 116 | 302 | 116 |
| 25 | Base Case (30,000 sq ft, 1 storey office) | Winter Free Cooling (water side economizer) | Ret./Repl. | per building | 1913898 | 1368323 | 545575 | 436 | 374 | 20 | $5,500 | | 10% | 62623 | 67979 | 50260 | 57781 | 74036 | 50540 | 131816 | 50540 |
| | **Commercial Refrigeration** | | | | | | | | | | | | | | | | | | | | |
| 26 | Floating Head Pressure Control | Fixed Head Pressure | Ret./Repl. | per 12 ft case | 50000 | 46000 | 4000 | 1.90 | 1.63 | 15 | $2,345 | | 10% | 459 | 498 | 368 | 424 | 543 | 371 | 966 | 371 |
| 27 | EE Evaporator Fan Motors | Standard Motors | Ret./Repl. | per 12 ft case | 50000 | 48400 | 1600 | 0.76 | 0.65 | 10 | $1,675 | | 10% | 184 | 199 | 147 | 169 | 217 | 148 | 387 | 148 |
| 28 | Humidistat Anti-sweat heater Control | Continuous operation | Ret./Repl. | per 12 ft case | 50000 | 47500 | 2500 | 1.19 | 1.02 | 15 | $1,250 | | 10% | 287 | 312 | 230 | 265 | 339 | 232 | 604 | 232 |
| | **EE Electric Heating/Cooling** | | | | | | | | | | | | | | | | | | | | |
| 26 | Elec. Res. Heating, DX cooling | Air-to-air heat pumps (5 ton capacity | Ret./Repl. | 5 ton unit | 46250 | 32375 | 13875 | 4.16 | 0.00 | 15 | $7,000 | | 10% | 1593 | 1729 | 1278 | 1469 | 1883 | 1285 | 3352 | 1285 |
| 27 | Elec. Res. Heating, DX cooling | Ground Source Heat Pumps (5 ton capacity) | Ret./Repl. | 5 ton unit | 46250 | 25438 | 20813 | 16.63 | 14.26 | 20 | $14,000 | | 10% | 2389 | 2593 | 1917 | 2204 | 2824 | 1928 | 5028 | 1928 |
| | **Dishwasher Retrofit** | | | | | | | | | | | | | | | | | | | | |
| 28 | Low temperature - Hopsital (chemical dishwasher rinse) | High Temperature Dishwasher | Ret./Repl. | per dishwasher | 16320 | 3264 | 13056 | 1.96 | 1.68 | 10 | $0 | | 10% | 1499 | 1627 | 1203 | 1383 | 1772 | 1209 | 3154 | 1209 |
| 29 | Low Temperature - Sit-down Restaurant (chemical dishwasher rinse) | | Ret./Repl. | per dishwasher | 11021 | 2204 | 8817 | 0.92 | 0.79 | 10 | $0 | | 10% | 1012 | 1099 | 812 | 934 | 1196 | 817 | 2130 | 817 |
| | **Clothes Dryer Replacement** | | | | | | | | | | | | | | | | | | | | |
| 30 | Moisture Sensor Dryer | Clothes Dryer - Hospital | Ret./Repl. | per dryer | 42840 | 37271 | 5569 | 1.47 | 1.26 | 11 | $550 | | 10% | 639 | 694 | 513 | 590 | 756 | 516 | 1346 | 516 |
| 31 | Moisture Sensor Dryer | Clothes Dryer - Laundromat | Ret./Repl. | per dryer | 43643 | 37969 | 5674 | 3.12 | 2.65 | 11 | $550 | | 10% | 651 | 707 | 523 | 601 | 770 | 526 | 1371 | 526 |

## Assumptions and Measures List: Industrial

| | | | | | | | | Demand Reduction | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Efficient Equipment & Technologies | Base Equipment & Technologies | Decision Type | Annual Operating Time hrs/yr | Base Annual Energy (kWh/yr) | Efficient Energy Use (kWh/yr) | Annual Energy Savings with Upgrade (kWh/yr) | Winter On Peak (kW) | Summer On Peak (kW) | EE Technology Life | Incremental Equipment Cost $ | Lifespan, hrs | Free Ridership | Energy Savings Winter Peak (kW.h) | Energy Savings Winter Mid (kW.h) | Energy Savings Winter Off Peak (kW.h) | Energy Savings Summer Peak (kW.h) | Energy Savings Summer Mid (kW.h) | Energy Savings Summer Off Peak (kW.h) | Energy Savings Shoulder Mid (kW.h) | Energy Savings Shoulder Off (kW.h) |
| | **Interior Lighting - Fluorescent** | | | | | | | | | | | | | | | | | | | | |
| 1 | 2 - T8 32W (58 W) reflectorized w/EL ballast | 4 - T12 34W (156W) 4' Lamps w/2 magnetic ballasts | Ret./Repl. | 6500 | 1014 | 377 | 637 | 0.088 | 0.084 | 3 | $93 | 20000 | 10% | 73 | 79 | 59 | 67 | 86 | 59 | 154 | 59 |
| 2 | 4 - T8 32W (112W) 4' Lamps w/EL ballast | 2 - T12 75W (184W) 8' HO Lamps w/1 magnetic ballast | Ret./Repl. | 6500 | 1196 | 728 | 468 | 0.065 | 0.062 | 3 | $99 | 20000 | 10% | 54 | 58 | 43 | 50 | 64 | 43 | 113 | 43 |
| 3 | 1- T8 32W (38W) w/EL HBF ballast | 2 - T12 34W (78W) 4' lamps pendant mount, 1 EM ballast | Ret./Repl. | 6500 | 507 | 247 | 260 | 0.036 | 0.034 | 3 | $75 | 20000 | 10% | 30 | 32 | 24 | 28 | 35 | 24 | 63 | 24 |
| | **Interior Lighting - Warehouse & Plant** | | | | | | | | | | | | | | | | | | | | |
| 3 | 250W Metal Halide Lamp, PS | 400W Mercury Vapor | Ret./Repl. | 6000 | 1816 | 1752 | 64 | 0.135 | 0.128 | 3 | $245 | 15,000 | 10% | 7 | 8 | 6 | 7 | 9 | 6 | 15 | 6 |
| 4 | 175W Metal Halide Lamp, PS | 250W Mercury Vapor | Ret./Repl. | 6000 | 1710 | 832 | 878 | 0.068 | 0.064 | 3 | $245 | 15,000 | 10% | 101 | 109 | 81 | 93 | 119 | 81 | 212 | 81 |
| 5 | 200W High Pressure Sodium | 400W Mercury Vapor | Ret./Repl. | 6000 | 1816 | 960 | 856 | 0.180 | 0.171 | 4 | $245 | 24,000 | 10% | 98 | 107 | 79 | 91 | 116 | 79 | 207 | 79 |
| 6 | 6 - T5 HO Lamps in new High Bay fixture (372W) | 400W Metal Halide PS High Bay | Ret./Repl. | 6000 | 1816 | 1488 | 328 | 0.072 | 0.068 | 3 | $436 | 20,000 | 10% | 38 | 41 | 30 | 35 | 45 | 30 | 79 | 30 |
| 7 | 100W Metal Halide fixture | 4 - T12 34W (156W) 4' lamps, 2 EM ballasts | Ret./Repl. | 4000 | 624 | 516 | 108 | 0.050 | 0.048 | 3 | $250 | 12500 | 10% | 12 | 13 | 10 | 11 | 15 | 10 | 26 | 10 |
| | **Interior Lighting - Exit Sign** | | | | | | | | | | | | | | | | | | | | |
| 8 | 3W LED EXIT sign | 2 - 15W (30W) Incandescent EXIT Sign | Ret./Repl. | 8760 | 263 | 26 | 237 | 0.027 | 0.027 | 25 | $95 | 220000 | 10% | 27 | 29 | 22 | 25 | 32 | 22 | 57 | 22 |
| | **Compressed Air System (100 hp)** | | | | | | | | | | | | | | | | | | | | |
| 9 | Dessicant Dryer Control Upgrades | Fixed Interval Dessicant Regeneration | Ret./Repl. | 1280 | 95488 | 81165 | 14323 | 3.65 | 3.07 | 15 | $8,000 | | 10% | 1644 | 1785 | 1319 | 1517 | 1944 | 1327 | 3461 | 1327 |
| 10 | Convert to On/Off Controls | Bypass or Inlet Throttle Controls | Ret./Repl. | 1280 | 95488 | 57293 | 38195 | 9.73 | 8.18 | 15 | $6,500 | | 10% | 4384 | 4759 | 3519 | 4045 | 5183 | 3538 | 9228 | 3538 |

# Appendix A: Glossary of Terms and Symbols

### Avoided Equipment Costs

The avoided equipment cost or base case equipment cost refers to the cost of the equipment that the customer would have installed in absence of the program. These costs cover all the out of pocket expenses that the customer would have incurred for the standard equipment as compared to the high efficiency equipment.

### Base Case Technology

Energy impacts must always be defined relative to some frame of reference. The base case technology variable represents the piece of equipment or technology that is being replaced by a more efficient technology. The application of a base case technology can vary, for example, in the case of a CDM program consisting of a residential programmable thermostat; the base technology would be a manual thermostat. In the example of a program consisting of a high efficiency furnace, the base case equipment would be the homeowner's current furnace. At a minimum, the base case technology must be equal to or more efficient than the technology benchmarks mandated in energy efficiency standards.

### Base Annual Energy Usage

Energy impacts are what drive the calculations for the supply cost savings and revenue impacts. The base case technology energy usages are used to determine the level of energy savings relative to the more efficient technology. It is important to note that the energy usage is expressed in terms that relate to the system supply costs. For example, there are typically several costing periods at the system supply level; winter vs. summer, peak vs. off-peak.

### Base Year

The base year refers to the first year of the program analysis. This year is typically set to the current calendar year or the year of the LDC's CDM portfolio.

### Discount Rates used for CDM Cost Effectiveness Analysis

Discount rate refers to the economic rate of interest that is used to convert a future stream of dollars into current dollars. The resulting value is often termed Net Present Value or NPV. In terms of a conservation or demand management program, the discount rate is used to compare current and future demand and energy savings with the costs of a CDM program investment.

### Efficient Technology

The efficient technology variable refers to the more energy efficient technology being used to replace the base case technology.

### Efficiency Technology Energy Usage

The efficient technology energy usage represents the level of energy consumption being used by the more efficient technology. As in the case of the base case technology, the consumption must be expressed in terms that relate to the system supply costs. For example, there are typically several costing periods at the system supply level; winter vs. summer, peak vs. off-peak.

### Equipment Costs

Equipment costs refer to all out of pocket expenses incurred, typically by the customer, to purchase the high efficiency equipment. These costs are before any incentive has been applied. Cost categories include:

- Equipment costs, including provincial sales tax and G.S.T. and installation.
- Operation and maintenance costs
- Any removal costs (less salvage value)
- Any other costs directly related to the customer's equipment choice (i.e. engineering consultation).

### Equipment Life

The equipment life variable represents the number of years that the more efficient equipment installed is assumed to produce energy savings. In most cases, the full life of the efficient equipment is applied; however, there may be cases in which the efficient equipment may be installed prior to the end of the useful life of the base case equipment. In such cases, using a number different from the manufacturers' equipment life expectancy is appropriate.

### Free-rider

A free rider is a program participant who would have installed a measure on his or her own without the CDM program. This participant simply uses the program to offset the cost of installing or undertaking the energy efficient initiative.

**Incentives**

Incentives are any form of financial transfer from the LDC to encourage program participation. The most common form of incentives is a rebate which is designed to help off set the cost of purchasing a more expensive piece of equipment.

**Avoided Costs**

Avoided costs are the marginal costs that are avoided by not producing and delivering the next unit of energy to the customer. Marginal costs (or avoided costs) include energy, generation, transmission and distribution costs. They measure the expected change in the systems total costs due to a decrease or increase in load and are calculated using either a short-run or long run perspective.

**Measure**

CDM programs are most often concerned with the use of equipment (i.e. particular types of water heaters, appliances), technologies (i.e. cycling, timing, heated water storing) or processes / procedures (i.e. equipment servicing / maintenance / tune up) for the purpose of promoting energy efficiency. The terms 'equipment' and 'technology' often can be used interchangeably.

When the application of a technology, type of equipment, or procedure is used to replace another technology or type of equipment, or procedure it is referred to as a 'measure'. A measure is therefore, an action to change one piece of equipment for another.

**Program Participants**

The number of participants or installations expected for the program. Typically specified on an annual basis, this value is multiplied by the per unit impacts and the free ridership level to generate the total savings for the program.

**Third Party Rebates**

This variable refers to any dollar discounts or rebates offered to the customer by any other party other than the LDC (i.e. government or manufacturer) for the purchase of an energy efficient technology. Third party rebates are not considered in the Total Resource Cost Test, as it is considered a benefit to the customer and a cost to the third party and therefore, cancel each other out.

**LDC Costs**

There are some broad categories of expenditure that must be considered when developing a CDM portfolio of programs. These categories include:

- Program development and start up costs
- Program administration
- Promotion and advertising
- Capital Equipment
- Monitoring and tracking
- Evaluation

**SYMBOLS:**

| | |
|---|---|
| NPV | = net present value |
| $NPV_{TRC}$ | = net present value of total resource cost calculation |
| $B_{TRC}$ | = present value of total resource cost benefits |
| $C_{TRC}$ | = present value of total resource cost costs |
| $AC_t$ | = avoided resource costs in year t |
| $UC_t$ | = LDC program costs in year t |
| $PC_t$ | = participant costs in year t |
| N | = number of years use in the analysis |
| d | = discount rate used in the analysis |
| $INC_t$ | = incentive amount provided by the LDC in year t |
| UATES | = unit annual total energy savings |
| NUD | = number of units delivered or installed |
| $NUD_{sa}$ | = number of units delivered or installed in an LDCs service area |
| FRR | = free rider rate |
| AR | = attribution rate |
| AS | = attributable savings |
| $NPV_{technology}$ | = net present value of the technology at the technology screening level |
| $NPV_{program}$ | = net present value of the program |

# Appendix B: Sample Calculations and Tables

Example 1: Technology Screening Analysis

Table A. Measure Savings

| Year | Measure Energy Savings (kWh) | | | | | | | | Measure Demand Savings |
|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | On Peak (kW) |
| 1 | 15.48 | 7.74 | 20.34 | 0 | 11.75 | 13.95 | 17.46 | 17.685 | 0 |
| 2 | 15.48 | 7.74 | 20.34 | 0 | 11.75 | 13.95 | 17.46 | 17.685 | 0 |
| 3 | 15.48 | 7.74 | 20.34 | 0 | 11.75 | 13.95 | 17.46 | 17.685 | 0 |
| 4 | 15.48 | 7.74 | 20.34 | 0 | 11.75 | 13.95 | 17.46 | 17.685 | 0 |

Table B. Avoided Electricity Costs

| Year | Ontario Seasonal Average Avoided Energy Cost (CAD$/kWh) | | | | | | | | Avoided Capacity (CAD$/KW-yr) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Generation | Transmission | Distribution |
| | 602 | 688 | 1,614 | 522 | 783 | 1,623 | 1,305 | 1,623 | N/A | N/A | N/A |
| 1 | 120.8 | 83.9 | 45.4 | 112.9 | 81.4 | 47.5 | 84.2 | 42.3 | 0.00 | 0.00 | 0.00 |
| 2 | 124.6 | 84.3 | 45.2 | 111.5 | 79.6 | 45.9 | 81.4 | 40.8 | 0.00 | 0.00 | 0.00 |
| 3 | 115.4 | 86.8 | 48.9 | 110.6 | 83.6 | 50.1 | 90.4 | 44.9 | 74.65 | 5.62 | 0.00 |
| 4 | 111.9 | 77.1 | 48.9 | 104.5 | 79.5 | 47.6 | 85.8 | 43.4 | 83.57 | 5.76 | 7.17 |

Table C. Avoided Electricity Cost Savings

| Year | Nominal Savings ($) | | | | | | | | Nominal Savings ($) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | Avoided Capacity Costs | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Generation | Transmission | Distribution |
| 1 | $1.87 | $0.65 | $0.92 | $0.00 | $0.96 | $0.66 | $1.47 | $0.75 | $0.00 | $0.00 | $0.00 |
| 2 | $1.93 | $0.65 | $0.92 | $0.00 | $0.93 | $0.64 | $1.42 | $0.72 | $0.00 | $0.00 | $0.00 |
| 3 | $1.79 | $0.67 | $0.99 | $0.00 | $0.98 | $0.70 | $1.58 | $0.79 | $0.00 | $0.00 | $0.00 |
| 4 | $1.73 | $0.60 | $0.99 | $0.00 | $0.93 | $0.66 | $1.50 | $0.77 | $0.00 | $0.00 | $0.00 |

Table D. Discounted Avoided Electricity Cost Savings

| | Discount Rate Factor | Discounted Savings ($) | | | | | | | | Discounted Savings ($) | | | Total Savings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Winter | | | Summer | | | Shoulder | | Avoided Capacity Costs | | | |
| | | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Gen | Tx | Dx | |
| 1 | 1.00 | $1.8700 | $0.6494 | $0.9234 | $0 | $0.9560 | $0.6626 | $1.4701 | $0.7481 | $0 | $0 | $0 | 7.28 |
| 2 | 1.10 | $1.7535 | $0.5932 | $0.8358 | $0 | $0.8499 | $0.5821 | $1.2920 | $0.6560 | $0 | $0 | $0 | 6.56 |
| 3 | 1.21 | $1.4764 | $0.5552 | $0.8220 | $0 | $0.8115 | $0.5776 | $1.3044 | $0.6562 | $0 | $0 | $0 | 6.20 |
| 4 | 1.33 | $1.3014 | $0.4484 | $0.7473 | $0 | $0.7015 | $0.4989 | $1.1255 | $0.5767 | $0 | $0 | $0 | 5.40 |

Table E. Measure Costs and Benefits

| | Measure Benefits | Measure Costs |
|---|---|---|
| | 25.45 | 2.00 |

Example 2: Technology Screening Analysis

Table A. Measure Savings

| Year | Measure Energy Savings (kWh) | | | | | | | | Demand Savings On Peak (KW) | Annual Water Savings litres/yr |
|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | | |
| 2006 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2007 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2008 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2009 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2010 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2011 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2012 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2013 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2014 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2015 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2016 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |
| 2017 | 37.48 | 42.84 | 100.50 | 32.50 | 48.75 | 101.06 | 81.26 | 101.06 | 0.04 | 26,800 |

Table B. Avoided Electricity & Water Costs

| Year | Ontario Seasonal Average Avoided Energy Cost (CAD$/kWh) | | | | | | | | Avoided Capacity Costs (CAD$/KW-yr) | | | Avoided Cost of Water (CAD$/m3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | | | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Generation | Transmission | Distribution | |
| | 602 | 688 | 1,614 | 522 | 783 | 1,623 | 1,305 | 1,623 | N/A | N/A | N/A | N/A |
| 2006 | 120.8 | 83.9 | 45.4 | 112.9 | 81.4 | 47.5 | 84.2 | 42.3 | 0.00 | 0.00 | 0.000 | 0.766 |
| 2007 | 124.6 | 84.3 | 45.2 | 111.5 | 79.6 | 45.9 | 81.4 | 40.8 | 0.00 | 0.00 | 0.000 | 0.785 |
| 2008 | 115.4 | 86.8 | 48.9 | 110.6 | 83.6 | 50.1 | 90.4 | 44.9 | 74.65 | 5.62 | 0.000 | 0.804 |
| 2009 | 111.9 | 77.1 | 48.9 | 104.5 | 79.5 | 47.6 | 85.8 | 43.4 | 83.57 | 5.76 | 7.175 | 0.825 |
| 2010 | 113.5 | 77.4 | 52.1 | 107.0 | 80.5 | 48.2 | 83.5 | 43.4 | 71.49 | 5.90 | 7.354 | 0.845 |
| 2011 | 110.2 | 77.3 | 52.7 | 103.2 | 81.3 | 48.5 | 84.2 | 43.0 | 85.42 | 6.05 | 7.538 | 0.866 |
| 2012 | 112.4 | 78.9 | 53.3 | 113.1 | 84.6 | 51.2 | 88.5 | 47.8 | 81.20 | 6.20 | 7.726 | 0.888 |
| 2013 | 125.2 | 86.4 | 59.9 | 116.9 | 91.3 | 54.0 | 92.5 | 51.9 | 61.60 | 6.36 | 7.920 | 0.910 |
| 2014 | 125.7 | 92.4 | 62.8 | 127.9 | 96.8 | 56.7 | 98.9 | 54.4 | 46.63 | 6.52 | 8.118 | 0.933 |
| 2015 | 127.4 | 94.7 | 69.6 | 151.6 | 106.7 | 62.5 | 102.8 | 59.9 | 23.16 | 6.68 | 8.321 | 0.956 |
| 2016 | 131.7 | 97.3 | 70.9 | 152.5 | 108.1 | 63.9 | 104.5 | 61.4 | 26.88 | 6.85 | 8.529 | 0.980 |
| 2017 | 136.0 | 100.0 | 72.1 | 153.5 | 109.5 | 65.3 | 106.2 | 62.8 | 29.94 | 7.02 | 8.742 | 1.005 |

Table C. Avoided Electricity & Water Cost Savings

| Year | Savings ($) | | | | | | | | Savings ($) | | | Savings ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Winter | | | Summer | | | Shoulder | | Avoided Capacity | | | |
| | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Generation | Transmission | Distribution | Water |
| 2006 | $4.53 | $3.59 | $4.56 | $3.67 | $3.97 | $4.80 | $6.84 | $4.27 | $0.00 | $0.00 | $0.00 | $20.52 |
| 2007 | $4.67 | $3.61 | $4.54 | $3.62 | $3.88 | $4.64 | $6.61 | $4.12 | $0.00 | $0.00 | $0.00 | $21.03 |
| 2008 | $4.33 | $3.72 | $4.91 | $3.59 | $4.08 | $5.06 | $7.35 | $4.54 | $2.91 | $0.22 | $0.00 | $21.56 |
| 2009 | $4.19 | $3.30 | $4.91 | $3.40 | $3.88 | $4.81 | $6.97 | $4.39 | $3.26 | $0.22 | $0.28 | $22.10 |
| 2010 | $4.25 | $3.32 | $5.24 | $3.48 | $3.92 | $4.87 | $6.79 | $4.39 | $2.79 | $0.23 | $0.29 | $22.65 |
| 2011 | $4.13 | $3.31 | $5.30 | $3.35 | $3.96 | $4.90 | $6.84 | $4.35 | $3.33 | $0.24 | $0.29 | $23.22 |
| 2012 | $4.21 | $3.38 | $5.36 | $3.68 | $4.12 | $5.17 | $7.19 | $4.83 | $3.17 | $0.24 | $0.30 | $23.80 |
| 2013 | $4.69 | $3.70 | $6.02 | $3.80 | $4.45 | $5.46 | $7.52 | $5.24 | $2.40 | $0.25 | $0.31 | $24.39 |
| 2014 | $4.71 | $3.96 | $6.31 | $4.16 | $4.72 | $5.73 | $8.04 | $5.50 | $1.82 | $0.25 | $0.32 | $25.00 |
| 2015 | $4.78 | $4.06 | $6.99 | $4.93 | $5.20 | $6.32 | $8.35 | $6.05 | $0.90 | $0.26 | $0.32 | $25.63 |
| 2016 | $4.94 | $4.17 | $7.13 | $4.96 | $5.27 | $6.46 | $8.49 | $6.20 | $1.05 | $0.27 | $0.33 | $26.27 |
| 2017 | $5.10 | $4.28 | $7.25 | $4.99 | $5.34 | $6.60 | $8.63 | $6.35 | $1.17 | $0.27 | $0.34 | $26.92 |

Table D. Discounted Avoided Electricity & Water Cost Savings

| Year | Discounted Savings ($) | | | | | | | | | Discounted Savings ($) | | | Discounted Savings ($) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Discount Rate Factor | Winter | | | Summer | | | Shoulder | | Avoided Capacity | | | | |
| | | On Peak | Mid-Peak | Off Peak | On Peak | Mid-Peak | Off Peak | Mid-Peak | Off Peak | Generation | Transmission | Distribution | Water | Savings |
| 2006 | 1.0000 | $4.53 | $3.59 | $4.56 | $3.67 | $3.97 | $4.80 | $6.84 | $4.27 | $0.00 | $0.00 | $0.00 | $20.52 | $56.76 |
| 2007 | 1.1000 | $4.25 | $3.28 | $4.13 | $3.29 | $3.53 | $4.22 | $6.01 | $3.75 | $0.00 | $0.00 | $0.00 | $19.12 | $51.58 |
| 2008 | 1.2100 | $3.57 | $3.07 | $4.06 | $2.97 | $3.37 | $4.18 | $6.07 | $3.75 | $2.41 | $0.18 | $0.00 | $17.82 | $51.46 |
| 2009 | 1.3310 | $3.15 | $2.48 | $3.69 | $2.55 | $2.91 | $3.61 | $5.24 | $3.30 | $2.45 | $0.17 | $0.21 | $16.60 | $46.37 |
| 2010 | 1.4641 | $2.91 | $2.26 | $3.58 | $2.38 | $2.68 | $3.33 | $4.63 | $3.00 | $1.90 | $0.16 | $0.20 | $15.47 | $42.49 |
| 2011 | 1.6105 | $2.56 | $2.06 | $3.29 | $2.08 | $2.46 | $3.04 | $4.25 | $2.70 | $2.07 | $0.15 | $0.18 | $14.42 | $39.26 |
| 2012 | 1.7716 | $2.38 | $1.91 | $3.02 | $2.08 | $2.33 | $2.92 | $4.06 | $2.73 | $1.79 | $0.14 | $0.17 | $13.43 | $36.95 |
| 2013 | 1.9487 | $2.41 | $1.90 | $3.09 | $1.95 | $2.28 | $2.80 | $3.86 | $2.69 | $1.23 | $0.13 | $0.16 | $12.52 | $35.02 |
| 2014 | 2.1436 | $2.20 | $1.85 | $2.94 | $1.94 | $2.20 | $2.67 | $3.75 | $2.56 | $0.85 | $0.12 | $0.15 | $11.66 | $32.89 |
| 2015 | 2.3579 | $2.03 | $1.72 | $2.97 | $2.09 | $2.21 | $2.68 | $3.54 | $2.57 | $0.38 | $0.11 | $0.14 | $10.87 | $31.30 |
| 2016 | 2.5937 | $1.90 | $1.61 | $2.75 | $1.91 | $2.03 | $2.49 | $3.27 | $2.39 | $0.40 | $0.10 | $0.13 | $10.13 | $29.12 |
| 2017 | 2.8531 | $1.79 | $1.50 | $2.54 | $1.75 | $1.87 | $2.31 | $3.02 | $2.22 | $0.41 | $0.10 | $0.12 | $9.44 | $27.07 |

Table E. Measure Costs and Benefits

| Year | Electricity Benefits | Water Benefits | Measure Costs |
|---|---|---|---|
| 1 | $36.24 | $20.52 | $7.00 |
| 2 | $32.46 | $19.12 | |
| 3 | $33.64 | $17.82 | |
| 4 | $29.76 | $16.60 | |
| 5 | $27.02 | $15.47 | |
| 6 | $24.84 | $14.42 | |
| 7 | $23.51 | $13.43 | |
| 8 | $22.50 | $12.52 | |
| 9 | $21.23 | $11.66 | |
| 10 | $20.43 | $10.87 | |
| 11 | $18.99 | $10.13 | |
| 12 | $17.63 | $9.44 | |
| | $308.26 | $171.99 | |
| | $480.25 | | $7.00 |

# Appendix C: Avoided Cost of Energy, Generation, Transmission and Distribution Capacity[14]

| A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Ontario Seasonal Average Avoided Energy Cost (CAD$/MWh) | | | | | | | | Avoided Generation Capacity Costs (CAD$/kw-yr) | Avoided Transmission Capacity Costs (CAD$/kw-year) | Avoided Distribution Capacity Cost (CAD$/kw-year) | Avoided Generation Capacity Costs for Demand Response (CAD$/KW-yr) |
| | Winter | | | Summer | | | Shoulder | | | | | |
| | On Peak | Mid-Peak | Off-Peak | On Peak | Mid-Peak | Off-Peak | Mid-Peak | Off Peak | | | | |
| Hours/Period | 602 | 688 | 1614 | 522 | 783 | 1623 | 1305 | 1623 | n/a | n/a | na | na |
| 2006 | 120.8 | 83.9 | 45.4 | 112.9 | 81.4 | 47.5 | 84.2 | 42.3 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2007 | 124.6 | 84.3 | 45.2 | 111.5 | 79.6 | 45.9 | 81.4 | 40.8 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2008 | 115.4 | 86.8 | 48.9 | 110.6 | 83.6 | 50.1 | 90.4 | 44.9 | 74.65 | 5.62 | 0.00 | 144.84 |
| 2009 | 111.9 | 77.1 | 48.9 | 104.5 | 79.5 | 47.6 | 85.8 | 43.4 | 83.57 | 5.76 | 7.17 | 146.70 |
| 2010 | 113.5 | 77.4 | 52.1 | 107.0 | 80.5 | 48.2 | 83.5 | 43.4 | 71.49 | 5.90 | 7.35 | 148.55 |
| 2011 | 110.2 | 77.3 | 52.7 | 103.2 | 81.3 | 48.5 | 84.2 | 43.0 | 85.42 | 6.05 | 7.54 | 150.41 |
| 2012 | 112.4 | 78.9 | 53.3 | 113.1 | 84.6 | 51.2 | 88.5 | 47.8 | 81.20 | 6.20 | 7.73 | 152.27 |
| 2013 | 125.2 | 86.4 | 59.9 | 116.9 | 91.3 | 54.0 | 92.5 | 51.9 | 61.60 | 6.36 | 7.92 | 154.25 |
| 2014 | 125.7 | 92.4 | 62.8 | 127.9 | 96.8 | 56.7 | 98.9 | 54.4 | 46.63 | 6.52 | 8.12 | 156.23 |
| 2015 | 127.4 | 94.7 | 69.6 | 151.6 | 106.7 | 62.5 | 102.8 | 59.9 | 23.16 | 6.68 | 8.32 | 158.22 |
| 2016 | 131.7 | 97.3 | 70.9 | 152.5 | 108.1 | 63.9 | 104.5 | 61.4 | 26.88 | 6.85 | 8.53 | 160.21 |
| 2017 | 136.0 | 100.0 | 72.1 | 153.5 | 109.5 | 65.3 | 106.2 | 62.8 | 29.94 | 7.02 | 8.74 | 162.33 |
| 2018 | 140.3 | 102.7 | 73.4 | 154.4 | 110.9 | 66.8 | 108.0 | 64.3 | 31.66 | 7.19 | 8.96 | 164.32 |
| 2019 | 144.6 | 105.4 | 74.6 | 155.3 | 112.3 | 68.2 | 109.7 | 65.7 | 32.41 | 7.37 | 9.18 | 166.59 |
| 2020 | 148.9 | 108.1 | 75.9 | 156.3 | 113.6 | 69.6 | 111.4 | 67.2 | 31.85 | 7.56 | 9.41 | 168.73 |
| 2021 | 152.4 | 110.4 | 78.0 | 157.1 | 116.5 | 71.5 | 114.7 | 69.1 | 38.27 | 7.74 | 9.65 | 170.87 |
| 2022 | 155.8 | 112.7 | 80.0 | 157.9 | 119.4 | 73.4 | 117.9 | 71.0 | 41.97 | 7.94 | 9.89 | 173.16 |
| 2023 | 159.3 | 115.0 | 82.1 | 158.7 | 122.4 | 75.3 | 121.1 | 72.9 | 44.22 | 8.14 | 10.14 | 175.46 |
| 2024 | 162.7 | 117.3 | 84.2 | 159.5 | 125.3 | 77.2 | 124.3 | 74.8 | 44.56 | 8.34 | 10.39 | 177.77 |
| 2025 | 166.1 | 119.7 | 86.3 | 160.3 | 128.2 | 79.1 | 127.5 | 76.7 | 42.02 | 8.55 | 10.65 | 180.08 |

[14] Navigant Consulting Ltd. on behalf of Hydro One Network Inc. "Avoided Cost Study for the Evaluation of CDM Measures" June 14, 2005 inflated at 2.5% and Hydro One Networks Inc. "Preliminary Distribution Cost Assessment for Hydro One" June 14, 2005 inflated at 2.5%.