Contents

6.0 Measuring the Value of Energy Conservation 116

6.1 Summary 116

6.2 Current Situation 117

6.2.1 Why Conserve? 117
6.2.2 Why is Government Action Needed? 117
6.2.3 What Conservation Initiatives Deserve Government Support? 118
6.2.4 How do We Define and Measure Cost-Effectiveness? 119
6.2.5 Are We Measuring the Right Things? 120
6.2.6 Which Conservation Programs are Required to be Cost-Effective? 122
6.2.7 What Do We Pay and What Do We Get? 125
6.2.8 Valuing Conservation of Different Energy Sources 127
6.2.9 Why Conserve Electricity if We Have More Than We Need? 127

6.3 A Detailed Analysis 128

6.3.1 Are We Correctly Measuring the Economic Value of Electricity Savings? 128
6.3.2 How does the IESO Calculate Avoided Costs? 129
6.3.3 Are We Using Program Evaluations to Measure Energy Savings and Cost-Effectiveness Accurately, and to Improve Program Performance? 131

6.4 Recommendations 133

Endnotes 134
6.0 Measuring the Value of Energy Conservation

6.1 Summary

In 2016, Ontario appears to be awash in energy. The fracking revolution is providing low-cost natural gas from the United States, and oil prices have plunged. Due to investments in new electricity generation, drops in industrial demand, and past conservation activities, Ontario also has an abundant supply of electricity. Does it make sense for Ontario to continue to invest in energy conservation?

In this article, we describe, through a set of questions and answers, how Ontario measures the value of energy conservation and determines which conservation actions are worth pursuing. We then examine, in more detail, two specific aspects of electricity conservation cost-benefit analysis:

1. how the economic value of electricity savings is estimated, and
2. whether third-party conservation program evaluations are accurately measuring electricity savings and being used to improve program performance.

The ECO concludes that Ontario has a rigorous method of valuing conservation delivered by electric and natural gas utilities and comparing it with energy supply. On the whole, Ontario ratepayers’ investments in electricity and natural gas conservation have been reasonable. However, there are special challenges in electricity conservation; because it is so difficult to store electricity, it must be generated when it is needed. In Ontario’s current electrical system, base load is provided by low-emission nuclear, hydro and renewable energy, much of which must be paid for whether we use it or not. Gas supplied nine per cent of Ontario’s electricity in 2014, but operated at the margin (and could be displaced by conservation) roughly one third of the time. Therefore, in the short term, lowering total electricity consumption has financial, air quality and climate benefits primarily in those hours when conservation displaces gas-fired generation.

In the short term, lowering total electricity consumption has financial, air quality and climate benefits primarily in those hours when conservation displaces gas-fired generation.
In the longer term, conservation also minimizes capital costs and the other impacts of building new infrastructure, and makes space on the grid for population growth and new uses of electricity such as electrification of transportation. The percentage of gas-fired generation is expected to increase in coming years, when nuclear plants are being refurbished or have been closed. A culture of conservation, and the necessary technology and expertise to implement conservation programs, must be built over time and cannot be easily turned on or off. To have enough conservation when we need it, a consistent pro-conservation policy is appropriate. However, Ontario should adjust electricity conservation incentives to focus them on times when conservation displaces gas-fired generation. Ontario should also reconsider why we spend so much less on conserving fossil fuels than on electricity conservation.

**Ontario should also reconsider why we spend so much less on conserving fossil fuels than on electricity conservation.**

The ECO makes some suggestions for improvements later in this chapter, to ensure that future evaluations of the costs and benefits of conservation are as accurate and transparent as possible, and continue to drive improvements in the cost-effectiveness of conservation programs.

### 6.2 Current Situation

#### 6.2.1 Why Conserve?

Why do individual households and businesses, energy utilities, or governments pursue energy conservation? In the simplest terms, each of these groups may choose to conserve when they believe the benefits of conservation are greater than the costs (assuming they have all relevant information and access to capital), although they may not actually assign a value to these costs and benefits in their decision-making process.

Individuals, energy utilities, and society will all have different viewpoints on the costs and benefits of conservation. Households and businesses may be most interested in reducing their energy bills, while energy utilities will care about the cost impact for all of their customers, operational challenges and shareholder return. Governments may have additional environmental or social priorities.

#### 6.2.2 Why is Government Action Needed?

If all of the benefits of conservation went to participating households and businesses, there might be little need for government action (beyond informational initiatives, such as energy labeling). However, this is not the case. For example,

- Improved air quality and reduced greenhouse gas emissions are public goods that benefit all of us. In addition, Ontario has made formal commitments to other jurisdictions to do our part to reduce greenhouse gas emissions.
• Split responsibilities for energy costs between builders and homebuyers or landlords and tenants can make it less appealing to invest in higher-efficiency products, a problem that product efficiency standards and Building Code requirements can address.

• The capital savings from not needing to build a new electric generating station are passed on to all existing and future Ontario electricity customers, not just those customers whose conservation actions made the station unnecessary. Utility conservation programs can transfer some of those savings to conservation participants, and thereby encourage more conservation.

Without the efforts of governments and energy utilities, our society would underinvest in energy conservation.

6.2.3 What Conservation Initiatives Deserve Government Support?

Ontario’s stated policy in both electricity and natural gas conservation is to pursue as much cost-effective conservation as possible (subject to certain budget limits). In fact, Ontario is spending more than four times as much on electricity conservation as on natural gas conservation between 2015 and 2020, although natural gas provides nearly twice as much of Ontario’s energy. In 2014, the imbalance was even greater, with electricity conservation spending at six times the level of natural gas conservation spending. Ontario has no specific budget for conservation of transportation or other fuels.

Ontario is spending more than four times as much on electricity conservation as on natural gas conservation between 2015 and 2020, although natural gas provides nearly twice as much of Ontario’s energy.

Natural gas and electricity conservation programs in Ontario have been funded primarily from electricity or natural gas rates (i.e., by utility customers), not by the Ontario government. Most utility programs must pass a screening for cost-effectiveness (from multiple perspectives), before they can be offered to customers. If this analysis shows that a program is not likely to be cost-effective, it will not be approved. Programs are reviewed again, more thoroughly, for cost-effectiveness after they have been delivered, based on actual results, as part of a formal evaluation process.

There is no legal requirement for conservation initiatives delivered directly by government to be cost-effective. In practice, the government does undertake cost-benefit analyses for key initiatives such as energy efficiency standards and the Building Code amendments, although these are not always made public.
6.2.4 How do We Define and Measure Cost-Effectiveness?

Measuring the cost-effectiveness of conservation is simple in theory but complex in practice. The costs and benefits of a program are added up and compared, and programs with a benefit:cost ratio greater than one are considered cost-effective. Multiple cost-benefit tests can be used to determine whether a program is cost-effective, from the perspectives of different stakeholders, as shown in Table 6.1.

<table>
<thead>
<tr>
<th>Group</th>
<th>Benefits of Conservation include:</th>
<th>Costs of Conservation include:</th>
<th>Cost-Benefit Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Households/ Businesses</td>
<td>Lower energy bills; “Non-energy” benefits such as improved comfort; Satisfaction/reputational benefit from reducing environmental footprint; higher resale value</td>
<td>Incremental costs for high-efficiency products and services (net of incentive payments)</td>
<td>Participant Cost Test</td>
</tr>
<tr>
<td>Energy Utilities</td>
<td>Lower aggregate cost to provide energy services to customers, e.g. through reduced capital, operating, or fuel costs to produce and distribute energy; improved reliability (security of energy supply); reduced need for new infrastructure, for which approvals can be challenging to obtain</td>
<td>Administrative costs to deliver conservation programs; Incentive payments to participants in conservation programs</td>
<td>Program Administrator Cost Test</td>
</tr>
<tr>
<td>Government (representing the interests of all residents)</td>
<td>Lower aggregate cost of energy services; Reduced greenhouse gas emissions; Improved air quality; Social/environmental benefits from avoiding new energy infrastructure (e.g. pipelines, generating stations, transmission lines) and associated conflict</td>
<td>Administrative costs to deliver conservation programs; Incremental costs for high-efficiency products and services</td>
<td>Total Resource Cost Test</td>
</tr>
</tbody>
</table>

Note: Italics indicate benefits that are more difficult to quantify and may not be accurately accounted for in cost-benefit analysis.
These tests do not mean that a conservation project will necessarily make everyone better off. Many conservation programs pay some percentage of the cost of a conservation project (from taxpayers or ratepayer funds), with participants paying for the rest. This is a financial transfer from non-participants to participants, which can be justified as some of the benefits, including the environmental benefits, are shared by non-participants. To ensure fairness, electric and gas utilities offer conservation programs to all types of customers and attempt to achieve a high participation rate. They may also have budget limits imposed on their conservation spending to minimize the financial cost for non-participants.  

6.2.5 Are We Measuring the Right Things?  

In theory, cost-benefit analysis includes all of the costs and benefits of conservation. In reality, some costs and benefits are easier to quantify than others. Cost-benefit analyses of conservation programs devote most of their effort to measuring the energy savings (and the financial benefit of these savings) (see textbox How do We Measure and Value Energy Savings) and the hard costs of conservation programs. Other benefits of conservation that cannot easily be given a dollar value may be ignored, making it more difficult for programs to pass cost-effectiveness testing.  

Some costs and benefits are easier to quantify than others.  

A major step forward was taken in 2014 when the Minister of Energy required the Independent Electricity System Operator (IESO) to use a 15 per cent adder (an increase in the benefits proportional to the calculated benefits from energy savings) in its cost-effectiveness tests for electricity conservation programs, to capture additional “environmental, economic, and social benefits” of conservation. The Ontario Energy Board has recently adopted the same 15 per cent adder for natural gas conservation cost-benefit analysis.  

Greenhouse gas emissions reductions are not explicitly mentioned in the Minister’s directive, but may be one of the benefits the adder represents. As Ontario’s carbon cap and trade system becomes a reality, gas and electric utilities will be required to purchase allowances for the emissions associated with their products. It is not yet clear whether or how the adder will be amended as a result.
How do We Measure and Value Energy Savings?

Measuring and valuing the energy savings from conservation projects is a three-step process:

1. **Determining how much energy was saved, and when it occurred.**
   This can be done through estimates based on product technical specifications, metering of energy consumption, and/or field verification studies. As a rule of thumb, the larger and more unique a project is, the greater the amount of effort that will be devoted to accurately measuring the energy savings. Savings estimates for common conservation measures are collected and published, so that field studies of these measures do not need to be repeated every year. For electricity conservation, knowing the time of day and season when energy savings occur is important, because the economic and environmental value of saving electricity is different at different times. This is known as the load shape of a conservation measure. For example, an upgrade to a more efficient air conditioner or a more efficient refrigerator might save equal amounts of electricity, but the value of this saved energy would be very different. The refrigerator would have a flat load shape, saving almost the same amount of electricity in all hours of the year. In contrast, most of the energy savings from the high-efficiency air conditioner would be concentrated at times of high system demand and higher emissions, and thus its reduction in energy use would be more valuable.

Figure 6.1: Hourly patterns of Ontario electricity supply and energy use of selected products (hot summer day)

Note: Product electricity consumption and Ontario electricity supply curves are conceptual. The Ontario electricity supply curve assumes that contracts for older natural gas-fired generation (non-utility generation), which run around the clock, are not renewed.
2. **Converting gross energy savings to net energy savings.** The payment of a conservation incentive does not correspond exactly to the conservation impact of the incentive. In some cases, customers may have intended to undertake an efficiency measure with or without the incentive. If so, the program did not cause the recorded energy savings. Conversely, participation in an energy efficiency program may influence customers to undertake additional conservation measures that are not directly incented by the program, in which case some portion of these additional energy savings should be attributed to the program. Both of these adjustments are captured through the use of a net-to-gross ratio that converts gross energy savings to net energy savings.

3. **Placing an economic value on the net energy savings.** The economic value of reduced energy use (not including the environmental benefit of reduced greenhouse gas emissions, which is usually considered separately) should include any savings in fuel costs, plus any reductions in capital costs for the infrastructure needed to produce energy (e.g., generating stations) or distribute it (e.g., pipelines, transmission lines) to customers. Converting the net energy savings (from steps 1 and 2) into an economic value is not straightforward, particularly for electricity, and is discussed in section 6.3.

### 6.2.6 Which Conservation Programs are Required to be Cost-Effective?

Not all types of gas and electric conservation programs are required to pass cost-effectiveness tests (although the intent is still to deliver these programs as efficiently as possible). For good reasons, conservation programs for low-income and First Nations customers, pilot programs, and educational and market transformation programs are not required to be cost-effective:

- **All ratepayers subsidize conservation programs for low-income and First Nations customers.** These programs can be expensive to deliver, but have important social benefits such as "reduction in arrears management costs, increased home comfort, improved safety and health of residents, avoided homelessness and dislocation, and reductions in school dropouts from low-income families" which are difficult to quantify in cost-benefit analysis. Conservation in Aboriginal communities is discussed further in the text box *Aboriginal Energy Conservation*.

- **Pilot programs are useful small-scale tests to assess and improve program effectiveness, but may have higher administrative and transactional costs because of their novelty and small scale.**

- **For educational and market transformation programs,** it is often impossible to directly quantify the energy savings, making them less amenable to traditional cost-benefit analysis. Other metrics (e.g., number of builders trained to build higher-efficiency homes) are used to measure market transformation programs.
Success Story: Pursuing Energy Conservation in Finch, Ontario

The saveONenergy Home Assistance Program for low-income residents is one of many electricity conservation programs available across Ontario. The residents of Finchview Villa, a non-profit apartment complex for seniors located in Finch, Ontario, are participating in this program. The building applied to the Home Assistance Program and received the following free upgrades: more than 305 compact fluorescent light bulbs; 22 water saving measures, including tap aerators and low-flow shower heads; improvements to the building envelope through attic insulation and draft proofing; and 13 new ENERGY STAR® appliances, such as refrigerators, window air conditioners, and dehumidifiers. These upgrades helped conserve electricity and reduce utility bills (total annual electricity savings are over 28,000 kWh, and annual electricity bill savings for the co-op are more than $4,000).

Aboriginal Energy Conservation

For Ontario’s First Nations, like many other residents of the province, rising electricity costs and affordability are pressing concerns. Similarly, there are common health and environmental concerns like reducing the emissions from energy used in our communities. In addressing these concerns, there are unique socio-economic and geographic barriers for many Aboriginal communities that make delivery of conservation programs even more challenging than elsewhere in Ontario.

Unique Barriers Faced by Aboriginal Communities

First Nations face distinctive barriers to pursuing energy conservation, such as:

- Higher proportion of electrically heated homes than the Ontario average, which typically means higher bills;
- More common use of diesel generators to produce electricity which means higher bills;
- Higher proportion of poor quality housing stock that includes inefficient dwellings and houses in disrepair where installing energy efficiency measures could compromise health and safety;
- Colder weather and a longer heating season than southern zones of the province;
- Remote locations where providing energy efficiency technologies and services can only easily be achieved seasonally (i.e., by ice road during winter months) or by air (which is expensive); and,
Limited energy practitioner capacity in some regions (e.g., local contractors may not be available to service the large geographic areas).

Despite these barriers, energy conservation in aboriginal communities is valuable for its energy (avoided system/infrastructure costs), financial (lower customer bills for low income customers), employment and social equity benefits. It also helps to mitigate the health and environmental impacts associated with using diesel generators and heating oil in remote First Nation communities. For example, the IESO Aboriginal Conservation Program ran for three years delivering conservation to 45 Ontario First Nation communities. Final results are pending but the program yielded 6.3 million kilowatt-hour (kWh) of savings in its first two years. Savings per participant were higher than similar low-income programs for non-indigenous households – about four times higher, due largely to the opportunities to implement weatherization measures in electrically heated homes – with average savings of 2,760 kWh of energy and reduced peak demand of 0.5 kW in 2014.

The table below highlights how key program delivery barriers were overcome.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Community buy-in:</strong> In some cases, there was reluctance towards outside delivery agents coming into communities and homes. There was a lack of trust as many felt the proposition of a free program too good to be true.</td>
<td>Local capacity building - project leads appointed from within the community to champion conservation, trained to communicate program benefits and explain specific efficiency measures.</td>
</tr>
<tr>
<td><strong>Geographic remoteness – transportation costs:</strong> Shipping equipment (e.g., efficient refrigerators) to remote communities is costly.</td>
<td>The IESO granted permission to set aside a portion of program budget to cover unforeseen costs related to community remoteness and transportation costs.</td>
</tr>
<tr>
<td><strong>Geographic remoteness – service repairs:</strong> In the event of appliance breakdowns, access to service technicians was limited with few service warranty providers having contractors available to go to remote locations.</td>
<td>New protocols negotiated with warranty service providers to serve communities involved in the project.</td>
</tr>
</tbody>
</table>
Cost-effectiveness of Aboriginal Conservation Programs

Taken together, there are good reasons why Aboriginal programs are more expensive to deliver. It is reasonable for the IESO and the Ontario Energy Board to exempt Aboriginal conservation programs from passing cost-effectiveness testing.

The 2015-2020 conservation framework governing electricity states that Aboriginal programs do not have to be cost-effective but should be administered as efficiently as possible. Currently, only four electricity distributors intend to offer conservation programs specifically targeted at First Nations communities: Hydro One and the Attawapiskat, Kashechewan and Fort Albany Power Corporations.

A distributor can receive approval for a conservation plan that is not cost-effective if it satisfies the IESO that it cannot develop a cost-effective plan due to its unique circumstances. Three Ontario distribution utilities that exclusively serve First Nations customers have attempted to do this, given the limited opportunities for them to develop cost-effective programs. The IESO has not yet approved their plans.

For natural gas utilities, the Ontario Energy Board has set a specific cost-effectiveness benchmark for low-income/Aboriginal programs. As with electricity, First Nations natural gas conservation programs do not have to be cost-effective (i.e., a benefit/cost ratio of >1.0) but, in aggregate, each utilities’ portfolio of low-income programs (which can include Aboriginal programs) must score >0.7 to be approved. Union Gas will offer gas conservation programs among First Nations.

6.2.7 What Do We Pay and What Do We Get?

Final cost-effectiveness data based on actual electricity and natural gas conservation program results are published each year (see online Appendices A and B of this report). Both gas and electricity conservation programs have consistently proven to be cost-effective when measured by appropriate post-implementation cost-effectiveness tests.

Electricity conservation utility program spending in 2014 was $421 million. The portfolio of electricity conservation programs delivered in 2014 had a benefit:cost ratio of 1.40 from a societal perspective, delivering a net benefit of approximately $250 million dollars, over the lifetime of the conservation measures.

Natural gas conservation utility program spending in 2014 was $66 million. The portfolio of gas conservation programs delivered by Union Gas in 2014 had a benefit:cost ratio of 1.75 from a societal perspective, while Enbridge’s portfolio had a benefit-cost ratio of 2.67.

These cost-benefit analyses and results encompass the entire portfolio of 2014 conservation programs, with the exception of a small amount of spending (less than 10 per cent of utility budgets) for programs that are not subject to cost-effectiveness testing.
Costs paid by all utility customers (approx.)

Electricity conservation programs

$421 MILLION

$203 MILLION

Additional costs paid by conservation participants (approx.)

Natural gas conservation programs

$132 MILLION

$66 MILLION

Life-cycle benefits (shared between participants and utility customers)

$396 MILLION

$874 MILLION

Figure 6.2: The costs and benefits to society of 2014 energy conservation programs

Note: Total costs and benefits are shown from a societal perspective, using the Total Resource Cost test. The primary costs are incremental costs of higher-efficiency equipment (paid for in part by program incentives), and program administration costs. Costs are largely incurred immediately, in 2014. The primary benefits are reductions in overall energy spending, which are realized over the lifetime of a conservation measure (benefits in future years are discounted, to allow for a valid economic comparison with costs). The split between participant and utility costs is approximate, using 2014 utility spending. It is not possible to estimate the split of benefits in the same way; however, the majority of benefits will go to conservation participants. The benefits of reduced greenhouse gas emissions are not included in this figure, as they were not considered in cost-effectiveness testing until 2015.

Source: Independent Electricity System Operator, Enbridge Gas Distribution, Union Gas

Gas and electricity conservation programs have consistently proven to be cost-effective.

Not all individual conservation initiatives that were tested proved to be cost-effective. For natural gas conservation, only Union’s program for low-income households, which accounted for $8.5 million in spending, was not cost-effective. For electricity, a number of individual initiatives were not cost-effective (from a societal perspective); however, these initiatives accounted for only about one-quarter of overall electricity conservation spending from 2011 to 2014. Some of these initiatives were not expected to be cost-effective, such as the program for low-income households, while other programs, such as the Industrial Accelerator program for large industrial customers, were not cost-effective because some of the assumptions in the original cost-benefit analysis were not accurate (e.g., the programs have not (yet) delivered the energy savings expected). In cases like this, the IESO is expected to take steps to improve program cost-effectiveness, or discontinue the program.
Funding for electricity conservation programs is recovered through the Global Adjustment, which is also used to recover electricity costs associated with electricity supply resources that cannot be recovered through the electricity market price. As shown in Figure 6.3, conservation funding only accounted for approximately 4 per cent of the Global Adjustment in 2014.

### 6.2.8 Valuing Conservation of Different Energy Sources

Ontario has focussed heavily, and with considerable success, on conservation programs for electricity and (to a lesser extent) natural gas, which are delivered by utility monopolies and funded by ratepayers. Other energy sources, such as transportation fuels and other petroleum products, have been largely ignored and are not included in the province’s Long-Term Energy Plan.

### 6.2.9 Why Conserve Electricity if We Have More Than We Need?

Few now remember our precarious supply situation in the mid-2000s, when brownouts (power reductions) were occasionally needed to keep the lights on. The situation is now reversed, with Ontario occasionally needing to curtail off-peak renewable or nuclear electricity production because sometimes we cannot use all of the power we have agreed to pay for.

However, most conservation measures will deliver savings for a decade or more. We cannot assess the value of electricity conservation by looking only at the situation today, but must look over the full life-cycle of a conservation measure. Ontario is currently in a very unusual situation with all nuclear units operating. This will change beginning later in 2016, as first Darlington and then Bruce nuclear units are shut down for refurbishment, and the Pickering nuclear station closes permanently in the 2020s. Meanwhile, we can anticipate additional electrical demand from population growth and electrification of transportation. Both will reduce the problem of surplus electricity, but could also lead to gas-fired generation operating more frequently. This, in turn, will increase the
economic and environmental value of electricity conservation, which is higher when it displaces gas-fired generation, providing savings on fuel costs and reductions in greenhouse gas emissions. Finally, a culture of conservation, and the expertise and innovation to support it, takes a long time to build, and cannot be simply turned on and off.

6.3 A Detailed Analysis

The ECO undertook two studies in 2015 on technical aspects of the cost-effectiveness analysis of conservation:

- An examination of how the IESO calculates the “avoided costs” used in electricity conservation cost-effectiveness testing, to determine whether these avoided costs are accurate; and,

- A review of the program evaluations done between 2011 and 2013 of the IESO’s Retrofit Program, to assess whether energy savings were estimated properly, among other factors.

6.3.1 Are We Correctly Measuring the Economic Value of Electricity Savings?

As noted above, in electricity, the timing of energy savings is very important. There is great environmental and financial benefit in conserving electricity in some hours of the day and year, and much less benefit at other times. This affects which electricity conservation projects are worth funding.

ECO studied the avoided costs that IESO uses in its cost-benefit analysis for electricity conservation programs, including how the avoided costs varied between on- and off-peak periods (as shown in Table 6.2).

This bland table of numbers is very important. It is the IESO’s best estimate as to how much each unit of energy saved through conservation is worth to electricity customers, in terms of reduced electricity system costs. It is the single most important variable the IESO uses to determine whether a conservation program is cost-effective and should be funded and delivered for the 2015-2020 period.

### Table 6.2: Avoided Energy Costs

<table>
<thead>
<tr>
<th>Year</th>
<th>Avoided Cost of Energy Production 2014 $/MWh by TOU Period</th>
<th>Avoided Capacity Costs 2014 $/kW-yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter On-Peak</td>
<td>Mid-Peak</td>
</tr>
<tr>
<td>2015</td>
<td>$46.53</td>
<td>$43.38</td>
</tr>
<tr>
<td>2016</td>
<td>$36.08</td>
<td>$31.88</td>
</tr>
<tr>
<td>2017</td>
<td>$40.97</td>
<td>$34.96</td>
</tr>
<tr>
<td>2018</td>
<td>$41.97</td>
<td>$35.82</td>
</tr>
</tbody>
</table>

Source: Ontario Power Authority
The avoided costs are split into two components: an avoided cost of energy production, and an avoided capacity cost.

- **The avoided cost of energy production** is the cost savings from each unit of reduced electricity consumption, due to reduced fuel and operating costs from electricity generating stations. This avoided cost depends greatly on what type of electricity generator will be powered down due to conservation measures – known as the marginal generating unit. For example, if production from a natural gas-fired generating station is reduced, less fuel is burned, and there are real cost savings that are passed on to electricity customers. However, if production from a nuclear unit or a solar or wind generator is reduced, the cost savings are much lower (fuel has low or no cost and the generator is usually under contract to be paid for the electricity regardless), and the electricity that would have been produced cannot be saved and used later (unless the generator is coupled with storage capacity). The IESO estimates avoided costs of energy production for eight different time periods of the year (e.g., winter off-peak), with different values in each period, based on which type of generation is expected to be at the margin.

- The **avoided capacity cost** places a value on the savings that conservation can provide by avoiding future capital investments in generation, transmission, or distribution infrastructure. In the table above, the value for avoided capacity costs for 2015 and 2016 is zero. This is because, by 2013, Ontario already had sufficient energy supply to meet its energy needs in 2015 and 2016. Additional reductions from conservation in these years would not deliver any capital savings. However (at the time these calculations were made), in the absence of continued conservation program activity, Ontario was expected to need new supply by 2017 to meet peak demand. Therefore, new conservation measures that can reduce peak demand in 2017 and later years have value if they can defer or eliminate the need for this new supply.

Once the table of avoided costs is developed, it is used in the cost-benefit analysis of all electricity conservation programs, along with program-specific information on costs, energy savings, and load shape. This approach delivers a quantitative answer – which is unique to each potential conservation program – about whether or not this program makes sense in a period of abundant electricity supply. Programs that deliver energy savings when they are needed most will have higher avoided costs and will be more likely to pass cost-effectiveness testing. Programs that deliver energy savings at times when they are worth less will need to offset that negative with other advantages (higher overall energy savings, lower cost structure, etc.) in order to pass the screening process.

### 6.3.2 How does the IESO Calculate Avoided Costs?

While these general principles on avoided costs are public, the IESO’s methodology for calculating the specific numerical values is not. The ECO’s discussion with the IESO was illuminating in revealing many, but not all of the details of this analysis.

The IESO developed the table of avoided costs as an output of its power system planning work for the 2013 Long Term Energy Plan. The IESO estimated the avoided costs by developing two electricity supply mix portfolios, one with no ratepayer-funded conservation programs after 2014, and one with the amount of conservation needed to reach the LTEP’s conservation targets. Both scenarios were modeled over all 8760 hours in the year, determining which generation
resources would run in each hour, and the costs of this generation. The difference in costs between the two scenarios, divided by the amount of conservation savings, was used to determine the avoided cost values.

The IESO’s analysis showed that conservation has somewhat less value in the near-term due to Ontario’s strong supply position. Conservation savings in 2015 and 2016 had an average value of about 4¢/kWh, increasing to 7¢/kWh by 2020. As most conservation measures have a lifetime of a decade or more, if installed today, these measures will still be delivering savings in the future periods when these savings are more valuable.

One of the reasons for the increased value of conservation after 2016 is its potential to defer capital investments. Another is that the type of generation that will be at the margin, and therefore can be powered down due to conservation activities, is projected to change over time. The IESO estimates that between 2014 and 2020, about 50 per cent of the electricity production avoided by conservation programs will be renewables (with the remainder being gas-fired generation). Beyond 2020, however, about 90 per cent of the energy production avoided by conservation programs will be from natural gas-fired generation. Consequently, the value of reducing total electricity consumed (in terms of both fuel cost savings and avoided greenhouse gas emissions) increases after 2020, as shown in Figure 6.4.

Figure 6.4: Avoided energy production due to utility-funded energy efficiency programs, 2014 -2032 (TWh)

Between 2014-2020, about 50% of the energy production avoided by energy efficiency programs is from renewables. Beyond 2020, about 90% of the energy production avoided by energy efficiency programs is from natural gas-fired energy production.

Bars represent energy production from available generation resources displaced by planned energy efficiency programs

Source: Independent Electricity System Operator

Displaced Natural Gas-Fired Production
Displaced Non-Hydro Renewables Production
Displaced Hydro
Renewables that would be curtailed
Following this discussion with the IESO, the ECO was satisfied that the procedure for calculating avoided costs is methodologically sound in principle and should yield reasonably accurate values. Unfortunately, the IESO was not able to provide the ECO with the full details as to how the avoided costs associated with each type of generation and energy supply contract were calculated. This left the ECO unable to determine why the IESO’s analysis shows so little difference in avoided costs between peak and off-peak hours in the near-term (one would expect that avoided costs in off-peak hours in the near term would be quite low, as there is limited opportunity to reduce the use of expensive gas-fired generation).

In addition, the methodology is very sensitive to Ontario supply and demand conditions. This analysis was conducted as part of the 2013 LTEP, so it told us what conservation programs were worth delivering based on the best available information at that time, not necessarily what programs are worth delivering today. Several major changes to Ontario’s supply mix have been announced in subsequent years, in particular, changes to the timing of planned nuclear refurbishments and the shut-down of the Pickering nuclear station, that will affect the value of conservation programs.

It is expected that avoided costs will be updated again as part of the next LTEP, in 2016 or 2017. The ECO suggests that this updated version of avoided costs should be used going forward in conservation program cost-effectiveness testing. The ECO also encourages the IESO to publish its updated analysis of avoided costs to allow public consideration of whether any changes to the IESO’s methodology should be made.

In particular, the ECO notes that one specific variable – the type of electricity generation at the margin in each hour – has a large influence on whether it is good public policy (considering both costs and greenhouse gas emissions) to attempt to reduce electricity consumption in that hour. To generalize, lowering total electricity consumption has financial, air quality and climate benefits primarily in those hours when conservation displaces gas-fired generation.

It would be valuable for energy policy discussion in general if the IESO could publish historical statistics on what type of electricity generation has been at the margin in each hour (recognizing that there may be some market confidentiality issues to overcome), and projections as to what type is expected to be at the margin in the future, given different planning assumptions. This would be useful not only in assessing the costs and benefits of conservation, but also in assessing the costs and benefits of other measures that might increase or reduce electricity use by switching between electricity and another fuel (e.g., electric vehicles, behind-the-meter generation and combined heat and power generation, and electric heat pumps). The ECO will expect to see this type of scenario analysis used in the next LTEP.

6.3.3 Are We Using Program Evaluations to Measure Energy Savings and Cost-Effectiveness Accurately, and to Improve Program Performance?

Post-implementation conservation program evaluations almost always measure energy savings and cost-effectiveness (impact evaluation), and may also look at how to improve program performance (process evaluation). The IESO has published a detailed guide of protocols for evaluation, measurement and verification (EMV), to be used for evaluating all electricity conservation programs. These protocols are also used to evaluate natural gas conservation programs, where appropriate. The IESO’s EMV protocols draw heavily upon the International Performance Measurement & Verification Protocol, and methods used in California to evaluate conservation programs. The IESO’s
protocols are consistent with industry-standard best practices.

In the electricity sector, the IESO is responsible for program evaluation (of both province-wide and custom LDC programs). Third parties are hired by the IESO to perform these evaluations (in early years, some evaluations were done internally and were not made public), and most programs are evaluated every year.\textsuperscript{38} In the natural gas sector, the OEB has final oversight over evaluation of utility programs, with the assistance of an evaluation advisory group of utility representatives and stakeholders (the ECO sits as an observer on this group).\textsuperscript{39}

There is some potential for conflict of interest in the electricity sector – the IESO hires and manages the program evaluators, yet it is also accountable (jointly with LDCs) for the performance of programs that are being evaluated. In the gas sector, the functions of program operation and program evaluation are separated.

With this concern in mind, the ECO contracted for a time-series review of the program evaluations done over the years of the IESO’s Retrofit Program.\textsuperscript{40} This program funds electricity conservation measures (e.g., lighting improvements) in existing buildings in the commercial and institutional sector, and is the largest electricity conservation program in terms of both dollars spent and energy savings.

The purpose of the ECO review was to assess the strengths and weaknesses of these evaluation reports and to perform a reality check that the evaluation framework was functioning as intended. The results of this review were generally positive. The ECO found that the methods used to assess energy savings were credible and in-line with best practices used in the evaluation community. No evidence was found that the evaluations made improper assumptions that led to overstated program energy savings.

However, the review identified several concerns of a procedural nature with the conservation program evaluations:

- **The linkage between program evaluation and program operation was weak.** Many recommendations made by the evaluator to improve program results were not acted on by the IESO, and were often repeated in evaluation reports year after year. The IESO did not publicly respond to the evaluator’s recommendations, nor did it indicate what action it intended to take in response to the recommendations.

- **Little or no details of the cost-effectiveness analysis were included in the public evaluation reports.** For example, the IESO’s evaluation reports included no discussion of how the additional customer costs for conservation projects were determined, or how the funds for program administration were spent. Perhaps more important, there was no analysis of how to drive down costs and improve program cost-effectiveness. The IESO’s published *Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide* is an excellent resource for the IESO’s general methodology for cost-effectiveness testing. However, the program evaluator must rely on his or her professional judgment to apply these guidelines to actual programs. Key issues and concerns with cost-effectiveness that the evaluator identifies should be discussed in the evaluation reports.\textsuperscript{41} Instead, the published evaluation reports are silent on cost-effectiveness, while the IESO publishes (separately) the overall cost-benefit results for its programs, with no supporting details. The review conducted for the ECO flagged this lack of transparency regarding cost-effectiveness analysis as being far outside the norm in comparison with other jurisdictions.
The ECO finds both of these concerns to be valid. While the IESO has indicated that it does review and prioritize recommendations made by the program evaluators, there is value and accountability in requiring a formal response to evaluator recommendations, as is done in natural gas conservation. Concerning cost-effectiveness, there is no indication in the IESO’s EMV Protocols that consideration of cost-effectiveness should be treated any differently from other aspects of program evaluation and kept out of public view. More detail as to how the IESO is measuring and seeking to improve program cost-effectiveness can only be a good thing.

In the ECO’s view, these and other concerns could also be addressed by opening up the evaluation process to provide a role for other interested parties, such as representatives of different classes of electricity customers. This change would also help address the perception of conflict of interest. The IESO’s original EMV protocols did include plans for an evaluation stakeholder advisory committee, but this proposal was never acted on.

### 6.4 Recommendations

**Ontario should focus electricity conservation on times of higher demand, when conservation displaces natural gas-fired generation.**

**The Independent Electricity System Operator should improve public participation in conservation planning by providing greater transparency about marginal hourly generation and how it is implementing recommendations for conservation program improvements.**
Endnotes


For the gas sector, the Minister’s direction is to “enable the achievement of all cost-effective DSM”.


2. This could change if the Ontario government continues to make new investments in conservation using its Green Investment Fund.

3. Programs must usually pass the Total Resource Cost test and the Program Administrator Cost test. The Participant Cost Test is not usually used – because of the voluntary nature of conservation programs, it can usually be implied that any participant in a conservation program has determined (implicitly or explicitly) that the benefits of participation outweigh the costs.

4. For example, the OEB recently rejected funding for a Home Energy Report program proposed by Union and Enbridge, on the grounds that the program did not appear likely to be cost-effective.

5. This is a very brief overview. For more details, see Ontario Power Authority, report, Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide, July 2014.

6. For example, one of the Ontario Energy Board’s criteria in determining conservation budgets for natural gas utilities was limiting the rate impact to approximately $2 per month for residential customers, to minimize the impact on customers who do not participate in conservation programs.


For natural gas measures, no comprehensive single source of measures is available at this time, but a Technical Reference Manual is under development.

9. In natural gas conservation, programs for low-income consumers are subject to cost-benefit analysis, but must pass a lower threshold (benefit:cost ratio of 0.7 or higher, instead of 1.0)


11. Market transformation programs are only offered by gas utilities and focus on facilitating fundamental changes that lead to greater market shares of energy-efficient products and services.


13. According to the program evaluation, common health and safety issues include considerable amounts of mould at prospective participant homes. In these cases, adding additional insulation or air sealing measures could pose serious health threats to their occupants. In other cases, homes were in such a state of disrepair that adding more insulation was an ineffective solution to a much more extensive problem. Opinion Dynamics, report, 2014 Evaluation Report for the Aboriginal Conservation Program, October 29, 2015.

15. The Aboriginal Conservation Program was originally intended to be a 2-year program offered to up to approximately 20 First Nation electrically heated communities. However, over subscription led to OPA expansion of the program. The program was delivered by First Nations Engineering Services Ltd and focussed on improving home energy efficiency. Selected communities received basic conservation measures such as smart power bars and efficient shower heads, and in some cases, additional weatherization measures (e.g., draft proofing), new ENERGY STAR appliances, or programmable thermostats.

16. Savings per project for Aboriginal Conservation Program (ACP) participants were considerably higher compared to similar low-income programs (Home Assistance Program), and participation grew steadily between 2013 and 2015. ACP participants saved on average 2,760 kWh of energy and reduced peak demand by 0.5 kW in 2014, compared with 770 kWh and 0.10 kW in savings for Home Assistance Program customers over the same period. The success of the ACP has been attributed to a higher proportion of ACP participants who received weatherization measures (e.g., insulation and draft proofing), 22 per cent of ACP received weatherization versus 3 per cent of Home Assistance Program participants. 

Supra, note 13.

17. Training was initially done remotely in each community, but over the 3 program years evolved to all champions being brought to Toronto and trained over two days. According to the IESO, having a local champion with enhanced training was directly reflected in savings results. The same type of capacity building with centralised training is expected to occur under the Hydro One First Nation program.

Supra, note 1.

18. Hydro One is the only non-First Nations LDC that has submitted a custom conservation program targeting Aboriginal customers. Hydro One serves 21,700 First Nation customers from 102 of Ontario’s 133 First Nation communities and in 2013 and 2014, the utility provided conservation measures to 1,600 homes under the Aboriginal Conservation Program (ACP). Hydro One’s custom First Nations Conservation Program began in January 2016 and mirrors its low-income Home Assistance program, similar to the ACP.

19. There is a very limited industrial and commercial customer base, and little use of air conditioning, eliminating many of the energy conservation opportunities that are most cost-effective in other regions.

20. The reason for revisions was given as “significant revisions to original submission to maximize cost-effectiveness – currently with LDC”.

Independent Electricity System Operator, information provided to the ECO in response to ECO inquiry, October 16, 2015.

21. For electricity conservation, capability-building initiatives and the Conservation Fund (accounting for about two per cent of 2011-2014 electricity conservation program spending) were not tested for cost-effectiveness and are not included in cost-effectiveness results. For natural gas conservation, market transformation programs are not subject to cost-effectiveness testing and accounted for 9 per cent ($5.7 million) of natural gas conservation program spending ($4.4 million for Enbridge, and $1.3 million (Optimum Home) for Union).


25. These costs are published in appendix A of the Conservation & Demand Management Energy Efficiency Cost Effectiveness Guide (supra, note 5).
29. Short-term reductions in nuclear power production (at Bruce Power stations only) are achieved by running the reactors at full power, but allowing some of the steam produced bypass the turbine, so there are no savings from reduced fuel (uranium) consumption.

30. The time periods used by the IESO for cost-effectiveness testing are similar, but not identical, to the time-of-use periods that the Ontario Energy Board uses for setting electricity TOU rates.

31. The value assigned for avoided capacity cost is proportional to the IESO’s estimated capital cost of procuring a new gas-fired peaking (simple-cycle) generating station, as this is generally considered the least expensive supply-side resource to meet peak demand needs. For example, the IESO estimates that the capital cost of 1 MW (1000 kW) of new gas-fired generation would work out to $162,150 per year. A conservation measure that reduced system peak demand by 1 kW would save 1/1000 of this cost, so the avoided capacity cost would be valued at $162.15 per year.

32. The avoided energy and capacity costs for all years in the lifetime of the conservation measure are summed together (the value of savings in future years is discounted, by 4 per cent per year).


34. Ibid, slide 20.

35. Historical data on the type of generation at the margin (setting the real-time market clearing price) is published in the OEB’s biannual Market Surveillance Panel reports, but only quarterly averages are shown, not hour-by-hour data.


38. Final evaluation reports are made public by the IESO.

39. The Ontario Energy Board is taking a more hands-on role in directly co-ordinating program evaluation for the 2015-2020 DSM Framework. Previously, each gas utility, in collaboration with a technical group of stakeholders, jointly oversaw an independent audit. Final results were submitted to the OEB for approval.

39. The Ontario Energy Board is taking a more hands-on role in directly co-ordinating program evaluation for the 2015-2020 DSM Framework. Previously, each gas utility, in collaboration with a technical group of stakeholders, jointly oversaw an independent audit. Final results were submitted to the OEB for approval.


41. The IESO has confirmed that the cost-effectiveness calculations are performed by the third-party evaluation firms, not by the IESO itself.

42. Ibid.

43. See for example, how auditor recommendations are treated in:
