Achievable Potential Study: Short Term Analysis

Submitted to IESO

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1 Executive Summary

The achievable potential analysis study was required through a direction from Ontario's Minister of Energy and was a condition of the Energy Conservation Agreement (ECA) between the Independent Electricity System Operator (IESO) and Ontario's local distribution companies (LDCs), which governs the *2015–2020 Conservation First Framework*. The IESO is required to coordinate, support, and fund the delivery of conservation and demand management (CDM) programs by LDCs to achieve a total of 7 terawatt-hours (TWh) of persistent reductions in electricity consumption between January 1, 2015, and December 31, 2020.

The potential analysis included both a short term analysis from 2015 to 2020 and a long term analysis from 2015 to 2035. This report addresses the short term analysis; the long term analysis is addressed in a separate report. The timeframe of the short term analysis is from 2015 to 2020 and the scope included the following main items:

- Distribution-connected customers within each LDC's service area.
- All commercially available technology-based and energy management/behaviour-based energy efficiency measures applicable to the Ontario market.[1]

The main outputs of the short term analysis included:

- Annual province-wide (LDC aggregate) and LDC specific achievable, cost-effective electricity savings and associated costs between 2015 and 2020 under a budget constrained scenario and an unconstrained scenario.
- Identification of opportunities and insights for conservation program enhancements and new program offerings to realize this potential.
- Analysis to identify the most sensitive inputs to the results.
- Recommendations to direct future work.

The main differences between the methodology used in this study, compared to previous potential analysis studies completed for Ontario, included:

- Unique energy use profiles were developed for each LDC.
- The analysis of potential electricity savings was modelled and determined at the LDC level for each LDC.
- The potential savings were determined and modelled at the program-level.

[1] Behind-the-meter-generation or embedded load displacement, demand response, and pricing mechanisms are not included as eligible measures. The potential savings from eligible behind-the-meter generation will be analyzed in a separate study.

- The potential savings were estimated for each LDC under a budget constrained and an unconstrained achievable potential scenario.

Measures

A list of energy efficiency measures were developed and researched. A workbook was developed for each measure and the number of measures per sector was:

- 138 measures for the residential sector
- 219 measures for the commercial sector
- 188 measures for the industrial sector.

The list of all the measures is included in an Excel workbook, which accompanies this report and includes for each measure:

- Name of measure
- Measure type
- Baseline technology
- Applicable end use.

Archetype Programs

Archetype programs were broad categories meant to indicate the program delivery mechanism, approach, or target sector. The study's program archetypes were general enough to provide flexibility when needed, but contained enough definition to serve as a logical, cohesive program offering that will help IESO and LDCs achieve their energy savings goals.

Archetype programs were developed with input from the IESO working group and expert panel. In developing the archetype programs, the existing and planned Ontario programs were reviewed and assessed, a gap analysis was completed, and programs in North America were researched. The following archetype programs were identified and developed:

Residential:

- Consumer
- Systems and equipment
- Audit and direct install
- Whole-home
- Behavioural
- Low income
- Aboriginal
- New construction

Commercial and Industrial:

- Audit and energy partners
- Retrofit
- Small business
- New construction

The descriptions of the archetype programs included a review of the status of associated Ontario programs, program evaluation findings, the main elements of the archetype program, best practices, and reference programs in other North American jurisdictions.

LDC Profiles

One of the main objectives of the achievable potential study was to develop the potential from the bottom-up for each LDC. To estimate the savings potential for each LDC, it was necessary to develop a unique profile for each LDC. This profile defined the LDC's customer segmentation and its energy use by sector and subsector. The bottom-up analysis approach captured market differences between LDCs and provided an energy efficiency potential that was a more accurate reflection of the opportunities within each specific LDC, when compared to a top-down approach.

To develop the sector and subsector energy load profiles for each LDC, both primary and secondary data was used. Of the 75 LDCs, 32 LDCs (accounting for 82% of the base year electricity load) submitted primary data to inform the 2014 energy consumption profiles by rate class, and twenty LDCs submitted segmentation data by North American Industry Classification System (NAICS) code. The draft profiles were submitted to the LDCs for review and to obtain additional input and data. During the review process, 45 LDCs participated in meetings or conference calls and 64 LDCs (accounting for 98% of the base year electricity load) provided feedback, which included comments or revised data.

As part of the LDC load profile development, the availability of natural gas to residential customers in each of the 75 LDC service territories was researched. The LDC profiles were also segmented by mapping the LDCs to a climate region. The climate regions were based on International Climate Zones from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2007. Ontario includes Climate Zones 5, 6 and 7. Because Hydro One customers are located across the province, a weighted average approach was applied in the development of Hydro One's segmentation and load profiles.

Nexant consulted with IESO and its stakeholders to understand how projected customer composition was incorporated into each LDC's energy forecast. LDC load forecasts were adjusted to capture annual changes in total customers and customer mix that were expected to occur between 2015 and 2020. Each LDC's energy profile was provided to the respective LDC. Because of the confidentiality of LDC information, only aggregated provincial data is provided in this report.

Base Year and Reference Case Forecast

In the 2014 base year, the largest portion of electricity was consumed by the commercial sector (57,031 gigawatt-hours (GWh) per year, or 48% of the total electricity use), followed by the residential sector (39,461 GWh or 33%). The industrial sector used the smallest portion of electricity (21,951 GWh or 19%). The residential single family subsector accounted for the largest electricity use by subsector, with 29,974 GWh per year. The end use with the largest electricity use was general interior lighting in the commercial sector, with 17,882 GWh per year.

The load forecast for 2015 to 2020 estimated a total increase in electricity use of 0.9% from 118,426 GWh in 2014 to 119,515 GWh in 2020, with the commercial sector expected to provide the largest increase in electricity use of 2,451 GWh from 2014 to 2020 (a 4.3% increase). The residential sector electricity use was expected to decrease by 5.5% to 37,296 GWh in 2020, while the industrial sector electricity use was expected to increase by 3.6% to 22,738 GWh in 2020. In absolute terms, the largest decrease in electricity consumption by subsector was expected to occur in the residential single family, industrial paper, and non-metallic mineral manufacturing subsectors. The largest increases in electricity were expected to occur in most of the commercial subsectors.

Savings Potential

The comparison of the technical, economic, and achievable potential scenarios with the baseline and reference case forecast are illustrated in Figure 1-1, and the estimated persistent savings potential in 2020 are summarized in Table 1-1. The persistent savings in 2020 ranged from 28% for the technical potential to 5% for the budget constrained achievable potential, relative to the reference case. The achievable potential in 2020 was estimated to be an annual persistent savings of 6,373 GWh for the budget constrained scenario. The largest portion of the savings was from the commercial sector, which accounted for 73% of the savings, as illustrated in Figure 1-2.

Table 1-1: Persistent Savings by Scenario in 2020 (GWh/year)

Scenario	2020
Technical potential	33,614
Economic potential	23,381
Achievable potential: unconstrained	6,760
Achievable potential: budget constrained	6,373

Figure 1-1: Potential Scenarios Compared with Baseline and Reference Case

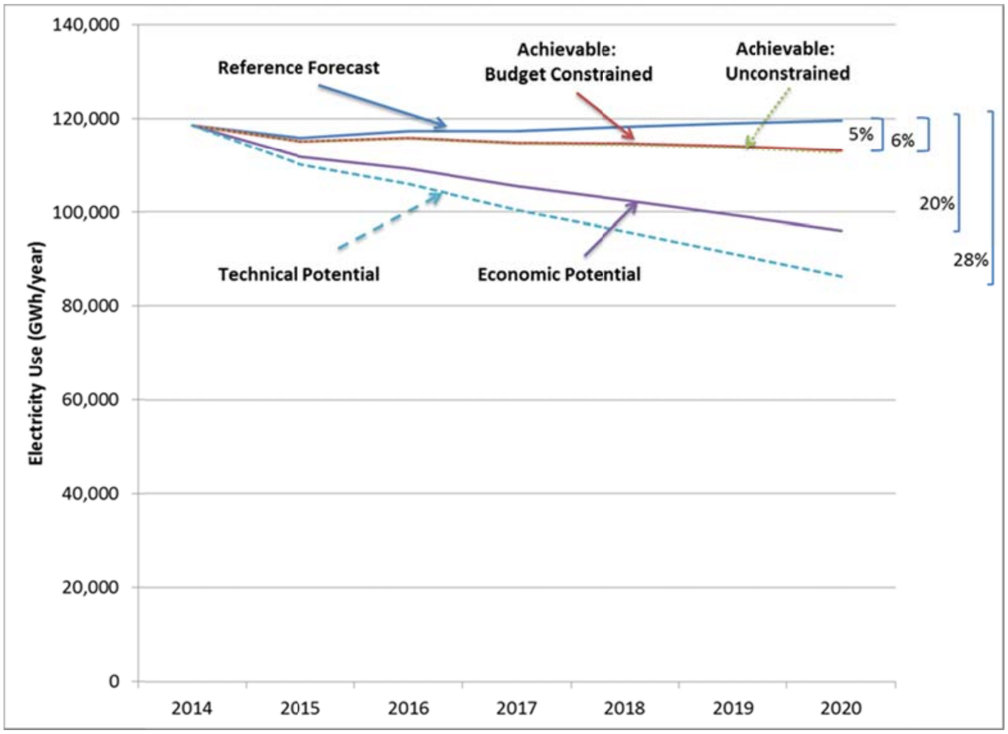
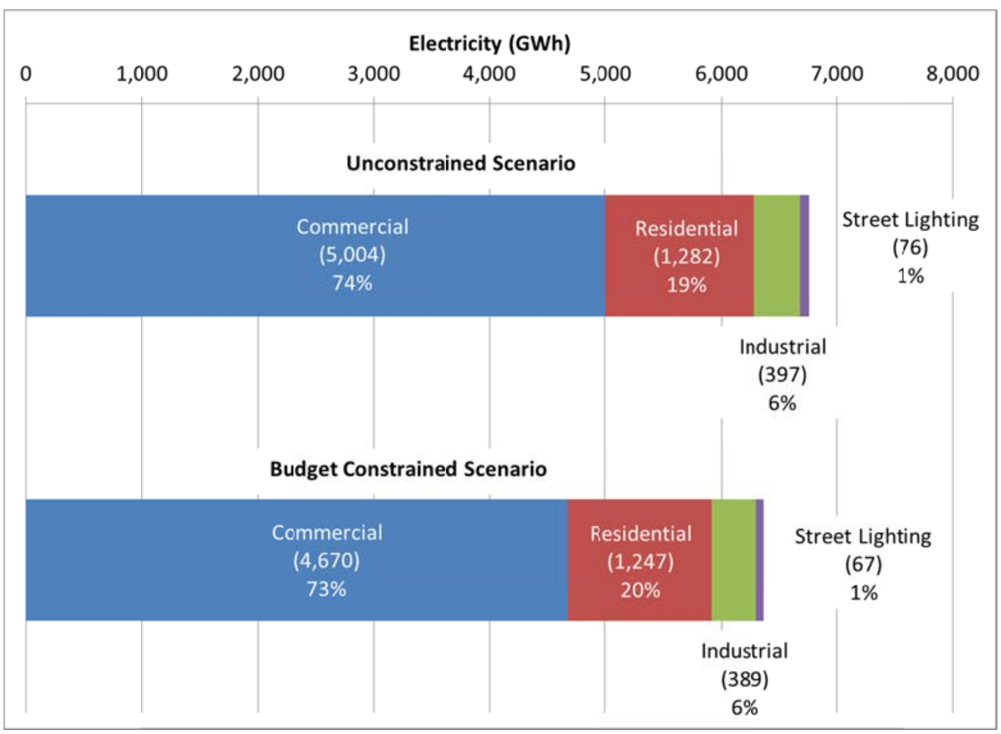
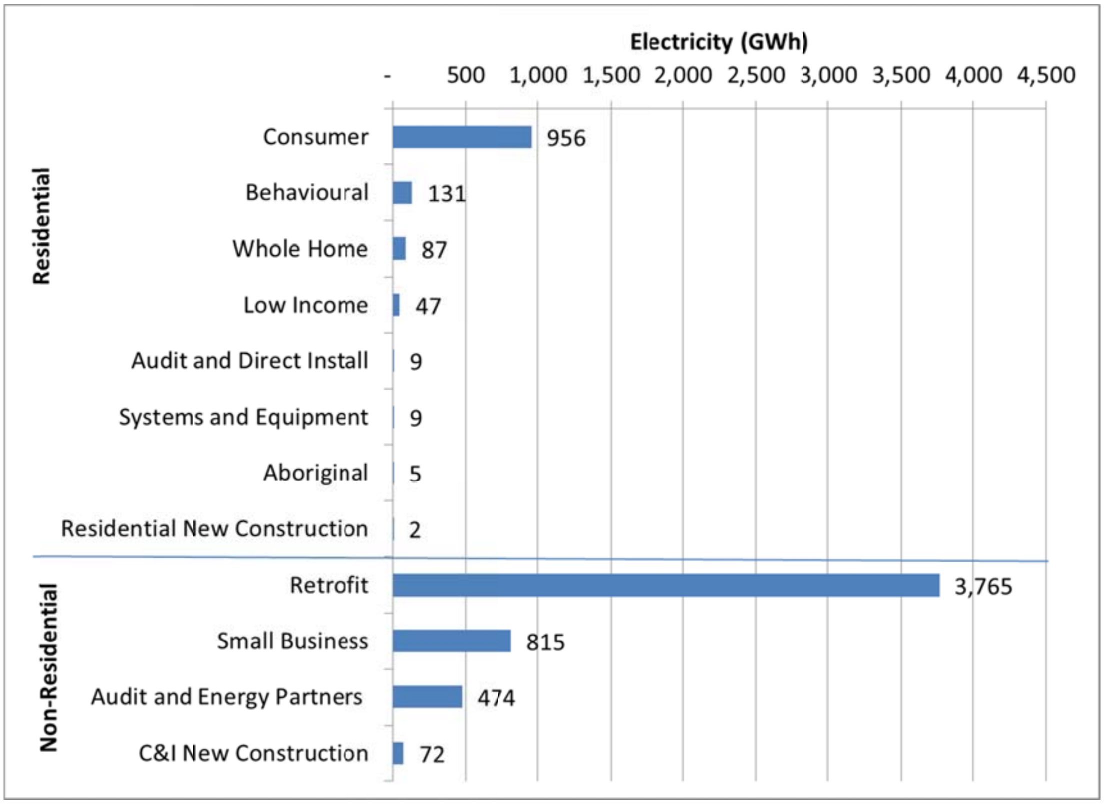


Figure 1-2: Achievable Potential Persistent Savings by Sector in 2020



The potential savings from the archetype programs indicated that the largest budget constrained achievable potential was estimated to be obtained from the Retrofit (close to 60% of total persistent achievable potential savings in 2020) and Consumer (close to 15% of savings) archetype programs.

Figure 1-3: Budget Constrained Achievable Potential Persistent Savings by Archetype Program in 2020



The archetype programs with the highest total resource cost (TRC) values in the budget constrained achievable potential scenario were the Audit and Direct Install (TRC of 23.9) and Small Business (TRC of 3.5) archetype programs. Similarly, the highest program administrative cost (PAC) values in the budget constrained achievable potential scenario was observed for the Audit and Direct Install Programs (PAC of 22.3), while the Retrofit (PAC of 5.5) archetype program had the second highest PAC.

The portfolio acquisition cost was estimated to be $ 311 per megawatt-hour (MWh) for the budget constrained scenario. In the budget constrained scenario, the highest acquisition costs were associated with the Aboriginal ($1,282/MWh) and Whole Home ($1,241/MWh) archetype programs, while the lowest acquisition costs were associated with the Audit and Energy Partners ($191/MWh each) and Retrofit ($191/MWh) archetype programs.

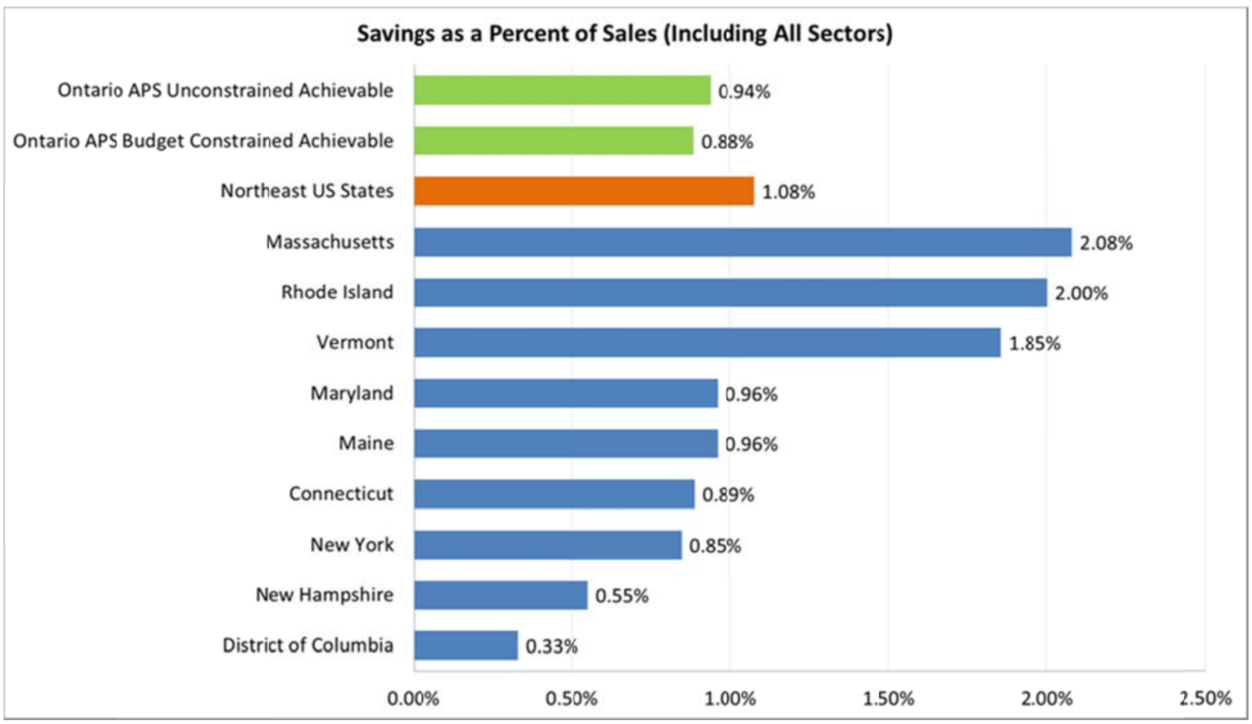
Additional Analyses

Comparison with Other Jurisdictions

The main objective of the comparison of the Ontario achievable potential scenario savings with other comparable states in the United States was to assess the feasibility and practicality of the potential savings estimates. Ontario's achievable potential results were compared with the actual savings achieved over 4 years, from 2011 to 2014, in nine Northeast American states: New York, Massachusetts, Maryland, Connecticut, New Hampshire, the District of Columbia, Rhode Island, Vermont, and Maine.

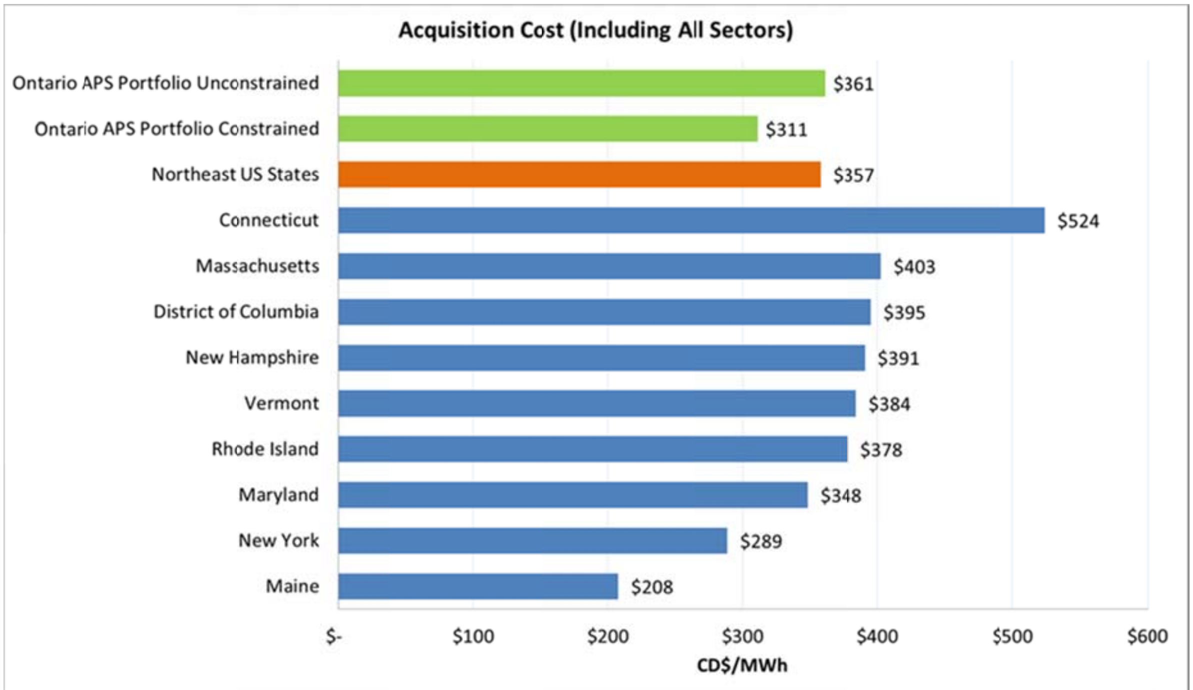
The average annual savings under a budget constrained scenario were estimated to be 0.88% of total sales for Ontario. The annual average actual savings for the nine American states ranged from 0.33% to 2.08% of total sales, and the average for all nine states was 1.08%. Based on the comparative analysis, it appeared that Ontario's achievable potential savings estimate was within the feasible range of actual savings achieved by these states, and some states achieved significantly higher percentage savings of sales than estimated for Ontario, as illustrated in Figure 1-4.

Figure 1-4: Comparison of Savings as Percentage of Total Sales



Because the budget constrained scenario was based on an optimized TRC ranking approach, one would expect the acquisition cost to be somewhat optimized. Having the Ontario estimated acquisition cost for the unconstrained and budget constrained scenarios, be higher and lower, respectively, than the average actual acquisition cost of several American states (see Figure 1-5), suggested that the Ontario estimate is in a practically achievable range.

Figure 1-5: Comparison of Acquisition Costs



Sensitivity Analysis

The objective of the sensitivity analysis was to assess the impact on the achievable potential savings if key input parameters were changed. The key input parameters that were assessed in the sensitivity analysis were:

- Incentive rates
- Adoption curves
- Avoided cost.

The budget constrained scenario indicated that the portion of residential load affected the impact of increasing or decreasing the incentive rates. Due to the lower price elasticity for the residential sector, for an LDC with a relatively larger portion of residential load, more money allocated to incentives did not result in incrementally more savings.

For both the unconstrained and the budget constrained scenarios, the increase or decrease in savings was relatively proportional to the changes in adoption rates. Increased adoption rates in the budget constrained scenario did have a significantly lower impact on increased savings, compared to the unconstrained scenario. A 25% increase in adoption rates resulted in an increase savings of between 6% and 8% in the budget constrained achievable potential scenario; this compared to 23% to 24% for the unconstrained achievable potential scenario.

A small correlated impact was observed for the unconstrained potential: a 25% increase in avoided costs led to 3% of additional potential. The sensitivity analysis indicated that the residential sector was more sensitive to changes in avoided costs. For the budget constrained, achievable potential scenario, there did not seem to be any direct correlation with an increase or decrease of avoided cost.

Conservation First Framework (CFF) and Behind-the-Meter Generation (BMG)

The potential for electricity reduction resulting from BMG was assessed in a separate study and the methodology and results were presented in a separate report published by IESO. The results from the BMG study were used to determine the total achievable potential for electricity reduction. The total budget constrained, achievable potential for both energy efficiency (EE) and BMG was 7,349 GWh in 2020, which was 5% more than the 7,000 GWh provincial target set by the CFF for 2020. The budget associated with the achievable potential was $ 2,213 million.

Recommendations

Table 1-2 summarizes the observations and recommendations to improve data and accuracy, address gaps, and enhance the process for future potential analyses.

Table 1-2: Observations and Recommendations

Overall Process, Methodology, and Schedule
It is anticipated that updating the LDC profiles will require less time in the next study, but this step is time-consuming to ensure adequate review by all LDCs, and sufficient time needs to be allocated to this step.
Sufficient time needs to be allocated to generate and review draft results. It is recommended that IESO conduct test model runs to review the draft results prior to undertaking a full model run.
Methodologies and approaches were reviewed and adjusted as needed throughout the study. In future studies, it may be beneficial to identify key methodologies and plan extra time for reviewing these methodologies and the implications of the results.
The study used an optimized TRC ranking approach to estimate the budget constrained achievable potential. Depending on the objectives of future potential studies, it may be beneficial to review additional approaches to develop budget constrained achievable potential.
This was the first time that both EE and BMG potential was assessed and integrated to derive the potential savings. Combining the two studies into one study would assist in a more effective alignment of the methodologies and the schedule of the integration.
The study was completed in mid-2016 and used 2014 as the base year; close to the completion of the project, program evaluation data became available for 2015. It is recommended that IESO consider the timing of the program evaluation results when scheduling the achievable potential study and when selecting the base year.
Data Collection
Since the study followed a bottom-up approach that was LDC- and program-focused, it was important to obtain as much LDC and program primary data as possible.
Obtaining LDC data prior to the formal kick-off of the study assisted in optimizing the time required to conduct the study and it is recommended to follow a similar approach for future studies.
Program performance data provided important input for the study, especially in terms of understanding participation rates and measure adoption. Accurately tracking this information and being able to access the information for the study, would help to increase the accuracy of future studies. It is recommended that IESO identify internal program data at the measure level that can be leveraged for future potential studies.

LDC Profiles
The LDC Profiles provided a significant benefit to the study by defining the segmentation and load share for each LDC. The LDC profiles were one of the key inputs in the model, and updating the profiles would be a critical component to include in future studies.
The larger LDCs were able to provide data to develop the LDC profiles, while many of the smaller LDCs had difficulty submitting the data. Most often, smaller LDCs did not have the necessary resources or did not track and collect data that was easy to compile in the format requested for the study. It is recommended that IESO take the lead in collecting data from the smaller LDCs and provide assistance to the smaller LDCs in the data collection step.
Mapping the billing data to NAICS was very beneficial to segmenting the LDC data and developing more accurate LDC profiles. It is recommended that IESO promote the mapping of billing data to NAICS when it can be done cost-effectively and when it also provides additional benefits to the LDC.
The accuracy of the achievable potential analysis would be improved by having primary data and information to inform, for example, energy intensity values according to building type and end use saturation. It is recommended that IESO identify two to three critical subsectors and evaluate the cost-benefit of the studies to determine if these studies should be commissioned. Collaborating with the gas utilities on the initiative could potentially result in cost sharing and could also optimize the efficiency in reaching out to customers to participate in the study.
Measures
The incentive rate was a significant driver in the acquisition costs (typically representing the majority of the program delivery costs). While fairly good records were kept on the incentive costs, information on the average measure incremental costs was not as well organized. A provincial-wide database that tracks measure incremental costs would be useful for the accurate estimation of incentive rates.
The IESO's measures and assumptions (M&A) list and measure database were important information sources for the achievable potential studies. It is recommended that IESO expand the measure database to address: baseline information, incremental cost data, 8760 avoided energy cost, and deemed savings and costs for key parameters.
Working Group
The working group functioned very well throughout the study and was a critical element in the success of the study. It is recommended that IESO continue including a working group and working subgroups in future studies, to assist with guidance, input, review of draft and final project material, and communication with the LDCs.
Due to the size and complexity of the study, providing both underlying (i.e. assumptions) data and results data to working group members in an expedited manner and in an understandable format proved challenging. For future studies, it is recommended that IESO build this into the process early on to provide information to LDCs in a meaningful and digestible format with more comfortable lead-time.
To manage the project and ensure effective communication and interaction with the working group, it is recommended that IESO ensure adequate staffing dedicated to the project. Having a full-time IESO project manager on the project is seen as a very important element of success.
Coordination with Natural Gas DSM Programs
A few measures were applicable to both CDM and DSM programs. It is recommended that IESO share data relevant to the adoption of these measures to inform future potential studies.
The shared data could also assist in program design and program delivery to minimize duplication of efforts between the LDCs and the gas utilities.

2 Introduction

The achievable potential study (APS) was required through a direction (*2015–2020 Conservation First Framework*, dated March 31, 2014) from Ontario's Minister of Energy. The study was a condition of the Energy Conservation Agreement (ECA) between the IESO and Ontario's LDCs, which governs the *2015–2020 Conservation First Framework*. The IESO is required to coordinate, support, and fund the delivery of CDM programs delivered by LDCs to achieve a total of 7 TWh of persistent reductions in electricity consumption between January 1, 2015, and December 31, 2020.

There are two major needs for developing a new estimate of the achievable electricity conservation potential in Ontario:

- Develop an estimate of LDC specific and province-wide (LDC aggregate) achievable potential between 2015 and 2020 to inform the mid-term review of the 2015–2020 CFF and to provide insights to assist LDCs with program planning and design. This is referred to as the *short term analysis* in this report.
- Develop a 20-year provincial achievable potential forecast to inform long term resource planning and energy efficiency program design. This is referred to as the *long term analysis* in this report.

Nexant was retained by IESO to undertake the APS and to deliver results and reports for the two analyses. This report addresses the short term analysis, while the long term analysis is addressed in a separate report. The timeframe of the short term analysis was from 2015 to 2020 and the scope included the following main items:

- Distribution-connected customers within each LDC's service area
- All commercially available technology-based and energy management/behaviour-based energy efficiency measures applicable to the Ontario market.[1]

The main outputs of the short term analysis included:

- Annual province-wide (LDC aggregate) and LDC specific, achievable, cost-effective electricity savings and associated costs between 2015 and 2020 under a budget constrained and unconstrained scenario.
- Identification of opportunities and insights for conservation program enhancements and new program offerings to realize this potential.
- Analysis to identify the most sensitive inputs to the results.
- Recommendations to direct future work.

[1] Behind-the-meter-generation, embedded load displacement, demand response, and pricing mechanisms were included as eligible measures. The potential savings from eligible behind-the-meter generation was analyzed in a separate study.

3 Methodology

The main differences between the methodology used in this study compared to previous potential analysis studies completed for Ontario included:

- *Unique energy use profiles were developed for each LDC* to reflect the composition of the LDC's load. These LDC load profiles provided the breakdown of energy use by residential, commercial (including institutional), and industrial sectors for each LDC. The data sources used to inform the development of the LDC profiles are discussed in Section 6.1.1.
- The analysis of *potential electricity savings was modelled and determined at the LDC level for each LDC*. This provided each LDC with an estimate of what the LDC's potential savings were over the six years through the end of 2020.
- The *potential savings were determined and modelled at the program-level*. Energy efficiency opportunities (or measures) were mapped to programs, and the potential savings of the programs that were applicable to a particular LDC were estimated for each LDC. This provided each LDC with an indication of what the savings potential of applicable programs was, and what programs could potentially be used to assist the LDC in achieving its 2020 targets under the Conservation First Framework.
- The potential savings were estimated *for each LDC, under a budget constrained and unconstrained achievable potential scenario*. This provided each LDC with an estimate of the potential savings that could be achieved at the current approved budget, as well as without any budget constraints.

Since this study was focused on modelling at the LDC and program levels, the analysis and results benefited greatly from LDC data and input. In cases where there was a lack of LDC data, secondary data and assumptions were used and are highlighted in this report.

The study's approach relied on best practices[1] in potential analysis, as well as collaboration and transparency between Nexant, IESO, and IESO's stakeholders. Nexant shared all major analysis spreadsheets and assumptions with IESO and the working group. Table 3-1 provides a summary of tasks for the short term analysis and the associated report sections where the methodology, results, and discussions are presented. In each of the report sections, the associated methodology is described at the beginning of the section.

The development of the deliverables and reports were completed with continuous collaboration and input from IESO and the working group. The working group consisted of representatives from IESO, twelve LDCs, the Ministry of Energy, the Electricity Distributors Association, the Ontario Energy Board, the Environmental Commissioner of Ontario, Enbridge Gas Distribution,

[1] The best practices were based on Nexant's experience conducting more than 35 potential studies, Nexant's familiarity with potential studies conducted by other consultants and input provided by the expert panel.

and Union Gas. Monthly meetings were held to inform the working group about progress, and to present and discuss methodologies, assumptions, and draft and final deliverables.

Table 3-1 Tasks and Associated Report Sections

Task	Report Section
Task 1: Identify measures and develop archetype programs	Sections 4 and 5
Task 2: Develop LDC profiles	Section 6
Task 3: Develop participation and potential savings estimates	Sections 7 through 10
Task 4: Conduct sensitivity analysis	Section 11
Task 5: Compare potential to baseline and reference forecast	Section 11
Task 6: Program enhancements and new program recommendations	Section 12
Task 7: Future work and continuous improvement recommendations	Section 12
Task 8: Develop report and deliverables	Section 3

Sub-working groups were formed specifically to provide input in developing the archetype programs, and the methodology to develop the achievable potential.

The remainder of the report provides detailed methodologies for each step in the potential analysis process, together with the results and analyses, according to the following sections:

- Measures
- LDC profiles
- Archetype programs
- Base year and reference case forecasts
- Technical potential
- Economic potential
- Achievable potential
- Additional analyses
- Recommendations

4 Measures

An important research task of the potential study was a review of energy efficiency measures and programs. The objective of the research was to develop a comprehensive list of measures and archetype programs applicable to Ontario, which included both technology and non-technology measures. The research obtained information about measures and programs, such as savings, costs, and measure lifetimes. The information from this research provided the necessary input to assess cost-effectiveness during the development of archetype programs applicable to Ontario.

4.1 Methodology

Measures included in IESO's M&A list formed the basis for the measure research and was used to populate an initial measure list. This list was supplemented by Nexant's extensive internal measure library, as well as by measures from technical reference manuals (TRMs) in North America. For the short term analysis, only commercially available measures in Ontario were included. Relevant measures that were under development at the time of the study and that are expected to become commercially available during the next 20 years were considered in the long term analysis. Once a draft set of energy efficiency measures was compiled, it was reviewed with the IESO before the list was finalized. Once finalized, the potential measure impacts were determined by collecting data on energy savings, cost, lifetime, and technical applicability. This work involved a five step process.

1. Define market classes and develop end use, subsector, and sector profiles.
2. Screen measure eligibility and applicability.
3. Develop base case measure consumption and costs.
4. Develop efficient case measure impacts and costs.
5. Collaborate with IESO and APS working group to gather measure feedback and refine parameters.

The methodology included an assessment of measures in terms of cost-effectiveness, competition, and interactive effects. Further details on the research and methodology applied in the five steps are provided below.

Step 1: Define Market Classes and Develop End use, Subsector, and Sector Profiles

Each measure was defined according to its applicability to: sector, subsector, end use, climate region, and vintage (for example, existing buildings or new construction). Table 4-1 summarizes the sectors and subsectors used in the study, which were aligned with the IESO's End use Forecasting (EUF) model for long term planning purposes.

To align the measures with end uses, subsectors, and sectors, it was necessary to develop end use profiles for each subsector and sector. These profiles also provided the framework for the subsequent modelling of savings potential.

Table 4-1 Sectors and Subsectors

Sector	Residential	Commercial	Industrial
Subsector	Single family Row house Multi-unit residential building (MURB) low rise Multi-unit residential building (MURB) high rise Other residential	Large office Small office Non-food retail Food retail Restaurant Lodging Hospitals Nursing homes Schools Universities Warehouse wholesale Data centers Transportation, Communication, Utilities (TCU) Other commercial buildings	Primary metals Paper manufacturing Auto-parts manufacturing Chemical manufacturing Plastic and rubber manufacturing Food and beverage manufacturing Fabricated metals Non-metallic minerals Wood products manufacturing Petroleum refineries Electronics manufacturing Mining Agriculture Miscellaneous industrial

End use profiles were developed by climate region for each subsector to provide a profile template of energy end use. End use profiles from the IESO's End Use Forecaster (EUF) model were used and an example is provided in Figure 4-1 for the single family subsector. The figure shows that the profile consists of the contribution of each end use to the total energy use (i.e. 100%) of the subsector.

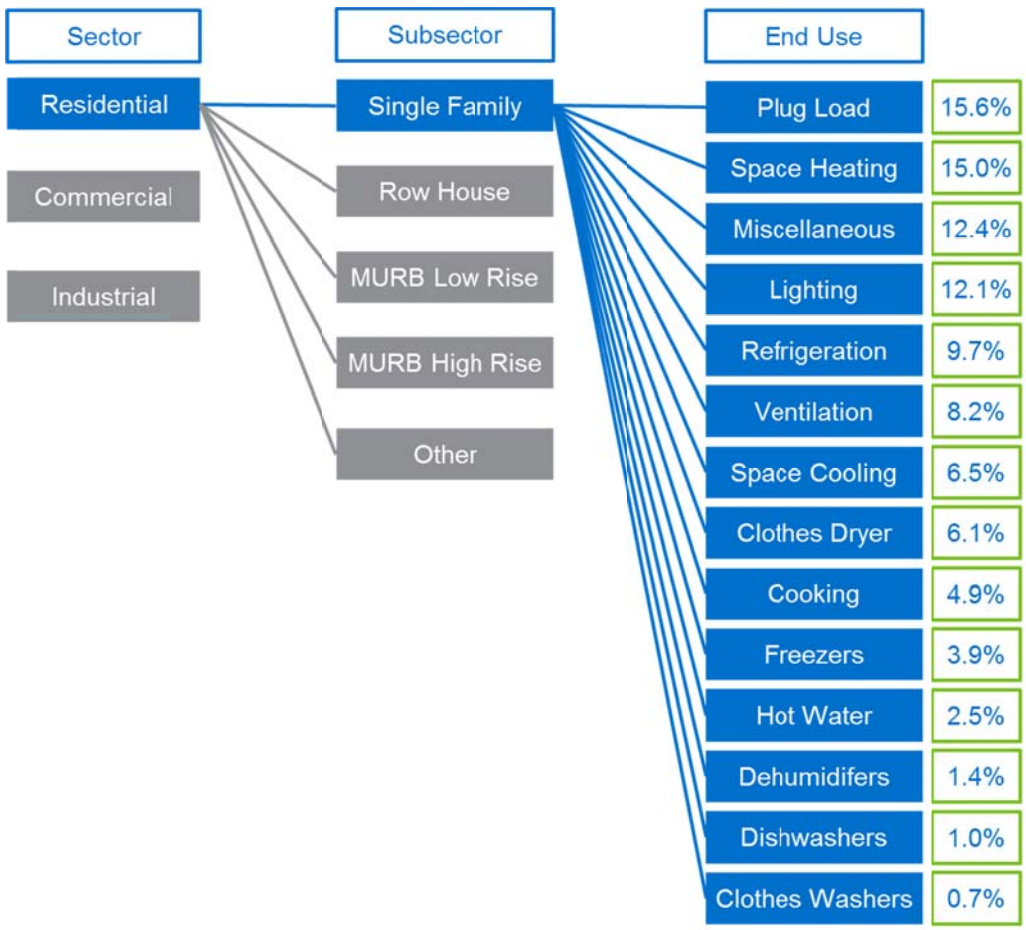
Step 2: Screen Measure Eligibility and Applicability

Measures were screened to ensure that only measures that were eligible, per the CFF requirements, were included in the measure list and archetype programs. Measures were further screened to ensure that only measures applicable to Ontario were included. The measure list was developed primarily from the IESO's M&A list for Ontario, with additional measures added from Nexant's internal library. A review of the measures resulted in excluding standard compact fluorescent lightbulbs (CFLs), since it was determined they were no longer an EE measure in Ontario. The hot water reset measure was also removed because it was considered a liability in Ontario.

Step 3: Develop Base Case Measure Consumption and Costs

Each measure provided an energy savings compared to a base case equipment or measure. The base case equipment or measure was determined along with its annual energy consumption and efficiency. A description of all base case equipment, efficiencies, and practices were documented. Information to determine annual energy consumption was obtained as part of the development of the LDC profiles, which is described in Section 6.

Figure 4-1: Example of End use Profile



Step 4: Develop Efficient Case Measure Impacts and Costs

For each of the energy efficiency measures, savings and cost impacts were determined. Savings and cost data were necessary to determine the cost-effectiveness of measures and programs. In general, the cost of a replacement measure was based on the incremental cost, while the cost of a retrofit measure was the full measure cost. The main sources of information were IESO's M&A list, Nexant's measure library, TRMs, measure databases across North America, and research that included cost databases (such as RSMeans) and vendor data.

For both measure costs and base case consumption, Nexant also accounted for: the varying permutations of turnover (i.e. replace on burnout) by measure and vintage, early replacement, new construction, and existing (i.e. retrofit). Depending on the vintage permutation for each measure, the assumed base case consumption was aligned with either code minimum or market baseline (i.e. baseline of existing stock of equipment), while the assumed measure cost was either the incremental cost of the measure over the baseline or the full cost of the measure. Table 4-2 below shows the varying baseline/cost assumptions that Nexant used in the measure research.

Table 4-2: Measure Vintage Table

Measure Type	Vintage	Description	Savings Baseline	Cost
Equipment	Turnover	Replace equipment at end of life	Code	Incremental cost
	Early replacement	Replace equipment before end of life	Existing stock	Full cost
	New	Install equipment in new construction	Code	Incremental cost
Non-equipment	Existing	Retrofit existing condition (e.g. add insulation)	Existing stock	Full cost
	New	Install measure in new construction	Code	Incremental cost

Step 5: Collaborate with IESO to Gather Measure Feedback and Refine Parameters

The measure assumptions and data were reviewed with IESO staff before the development of the archetype programs used for estimating short term potential.

4.2 Measures

The complete measure list included:

- 138 measures for the residential sector
- 219 measures for the commercial sector
- 188 measures for the industrial sector

Many additional measures were included in the final measure list that were not part of the IESO's M&A list, but all of the high-impact typical EE measures were already part of the M&A list. To assist with determining the cost-effectiveness of measures in the future, it would be beneficial to have a provincial incremental measure cost database.

The list of all the measures is included in an Excel workbook that accompanies this report, which includes the information listed below:

- Name of measure
- Measure type
- Baseline technology
- Applicable end use

A sample of the measure list is provided in Table 4-3.

For each measure, a workbook was developed, which included the following information:

- Classification of measure by type, end use, and subsector
- Measure life
- Description of the base case scenario, and the primary and secondary efficiency cases
- Variable inputs
- Savings algorithms and calculations per subsector, taking weather zones and subsectors into consideration
- Cost algorithms and calculations
- Sources and supporting information
- Output to be used as input in Nexant's potential analysis model

An example of a measure workbook is provided in Figure 4-2, Figure 4-3, and Figure 4-4.

Table 4-3: Sample of Measure List for Residential Sector

Measure Name	Measure Type	Base Technology	End Use
Residential new construction, Tier 1 (10% more efficient)	Non-equipment	Standard residential new construction building	All
Residential new construction, Tier 2 (20% more efficient)	Non-equipment	Standard residential new construction building	All
Residential new construction, Tier 3 (30% more efficient)	Non-equipment	Standard residential new construction building	All
Behaviour modification: home energy reports	Non-equipment	No report provided to customer	All
Clotheslines	Non-equipment	Clothes dryer (141 loads per year	Clothes dryers
ENERGY STAR® dryers	Equipment	Standard dryer	Clothes dryers
Clothes washers, Consortium for Energy Efficiency (CEE) Tier 1/ ENERGY STAR®	Equipment	Standard clothes washer	Clothes washers
Clothes washers CEE, Tier 2	Equipment	Standard clothes washer	Clothes washers
Clothes washers CEE, Tier 3	Equipment	Standard clothes washer	Clothes washers
ENERGY STAR® dehumidifier: replace with new	Equipment	Non-ENERGY STAR® Dehumidifier	Dehumidifiers
ENERGY STAR® dishwashers (electric water heating)	Equipment	Standard dishwasher	Dishwashers

Figure 4-2: Example of Measure Workbook – Classification

Summary Table	Fields
Name	ECM MOTORS FOR HVAC APPLICATION (FAN-POWERED VAV BOX) - VAV Units
Number	34
Sector	Industrial
End Use	HVAC
Type	Equipment
Equipment Type 1	HVAC
Equipment Type 2	
Equipment Type 3	
Equipment Type 4	
Equipment Type 5	
Competition Group	
Efficient Case Description	ECM Motor on VAV Fan,1/15 HP
Primary Base Case Description	PSC motor on VAV Fan, 1/15 HP
Secondary Base Case Description	PSC motor on VAV Fan, 1/15 HP
Tertiary Base Case Description	n/a
Codes, Standards, & Regulations	
Measure Unit	Per Unit
Premise Unit	Per Building
Savings Units	kWh
Measure Life (yrs)	15
Estimated Measure Savings Impact	High
Notes	

Figure 4-3: Example of Measure Workbook – Inputs, Savings, and Sources

Inputs

Category	Parameter	Attribute	Units	Source
Variable Inputs	ECM motor power (Wattsee)	75	Watts	2015 PA TRM Page 315
	SP motor power (Watts-sp-base)	120	Watts	2015 PA TRM Page 315
	Load Factor	0.9	%	2015 PA TRM Page 314
	Demand Interactive Factor (IFkW)	0.3	%	2015 PA TRM Page 314
	CF	0.99	unitless	2011 quasi-prescriptive release v1, table 3, pg 324, CF2, summer
	SESP	42.0%		2011 quasi-prescriptive release v1, table 2, pg 323, com space cooling, summer peak
	Hperiod	528	hours	2011 quasi-prescriptive release v1, table 1, pg 322, summer peak hours
Global Inputs (automatically loaded)	Segment 1	Primary Metals		
	Segment 2	Paper Mfg		
	Segment 3	Auto Parts Manufacturing		
	Segment 4	Chemical Mfg		
	Segment 5	Plastic And Rubber Mfg		
	Segment 6	Food And Beverage		
	Segment 7	Fabricated Metals		
	Segment 8	Non Metallic Minerals		
	Segment 9	Wood Products		
	Segment 10	Petroleum Refineries		
	Segment 11	Mining		
	Segment 12	Miscellaneous Industrial		
	Segment 13	Agricultural		
	Segment 14	Electronic Manufacturing		
Conversion Factors	W per kW	1,000		

Savings Algorithms & Calculations

Algorithms (from 2014 Pennsylvania TRM)

Delta kWh = kWhbase - kWhee

kWhee= ((Wattsee/1000) x LF x EFLHcool x (1+IFkwh))

kWhbase= ((Wattsbasee/1000) x LF x EFLHcool x (1+IFkwh))

Ifkwh = Ifkw x (1-(EFLHheat/(EFLHheat + EFLHcool)) x 13/11.3

2011 Quasi-Prescriptive Release v1, Appendix A, pg 323

Average demand savings (ΔP_{AVG}) is estimated as follows:

$$\Delta P_{AVG} = \frac{AES\ (kWh) \times \%\ SESP}{H_{PERIOD}}$$

where:

AES (kWh) Annual energy savings

Figure 4-4: Example of Measure Workbook – Costs

Costs Algorithms & Calculations

Algorithms

	Turnover	Early Replacement	New
ECM MOTORS FOR HVAC APPLICATION (FAN-POWERED VAV BOX) - VAV Units	$134	$262	$134

Supporting Documents

1	
Baseline Cost	
$127.83	Grainger Industrial Supplies Cost Data
2	
Efficient Case Cost	
$262.23	Grainger Industrial Supplies Cost Data

5 Archetype Programs

A key characteristic of the achievable potential study was the approach to modelling at the archetype program level and estimating achievable potential at the LDC level. The archetype programs addressed all the subsectors and end uses. Existing and planned programs in Ontario, and best practices in CDM programs, were taken into consideration. The archetype programs defined the potential programs that were applicable to Ontario, and were used as the basis for the achievable potential modelling. The archetype programs are not prescriptive in their guidance of programs to be implemented in Ontario. The archetype programs provide guidance in terms of savings potential that would be available in Ontario if best practice programs were applied.

The following section provides an overview of the methodology that was used to develop the archetype programs, followed by an overview of the archetype programs, themselves.

5.1 Methodology

The methodology to develop the archetype programs included the following main steps:

- Develop a draft list of archetype programs:
  - The starting point was the existing and planned Ontario programs.
  - Gap analysis to define the gaps in existing and planned programs.
  - Research and add additional archetype programs to address gaps.
- Review and finalize the list with IESO and the sub-working group.
- Survey expert representatives from LDCs, IESO, the expert panel, and Nexant to define the most appropriate non-incentive attributes for each archetype program.
- Develop draft and final descriptions of archetype programs through a review process with IESO and the sub-working group.

The survey of expert representatives to inform the most appropriate non-incentive attributes for each archetype program provided input in developing the adoption curves, which were used in the achievable potential scenario. The survey methodology and development of adoption curves covering the achievable potential are described in Section 10. The archetype programs are described in this section and define the non-incentive attributes included in the archetype programs. The definition of each attribute appears in Table 5-1.

Table 5-1 Non-Incentive Program Attributes

Category	Description
Marketing approach Approach to making customers aware of utility programs, energy efficiency, and associated utility-sponsored programs. Options for a marketing strategy have a range of influence and cost.	Target customer segment This marketing strategy relies on analysis to identify customer groups or customer profiles and generates tailored messages. The resulting marketing materials are more likely to influence customers, but require additional effort to develop and align with customer preferences.
	Mass marketing This marketing strategy is designed to cast a wide net and reach the largest number of customers. Since all customers receive the same marketing messages, the message may not apply to some customers. The investment in this strategy is concentrated on developing the product message, and no additional costs are incurred to target specific customers.
	Joint marketing and co-branding This marketing approach is designed to enhance existing efforts by market channel allies, including, for example, a utility seal of approval for contractors, a preferred contractor database, or enhanced in-store displays for retail partners. This approach is designed to encourage customers who are “already in the market” to adopt more energy efficient measures. The additional costs of this approach may include enforcement of brand standards.
Customer experience Addresses how customers acquire energy savings. The ease of participation, or mechanism of participation, can influence customer adoption of energy efficiency.	Technical assistance Customers receive advice and recommendations for measures that can save them energy. This may include design assistance for major renovations or new construction, for example, recommendations for the type of heating, ventilation, and air conditioning (HVAC) configuration that saves the most energy given a home’s construction and the occupants’ habits as determined by channel partners.
	Direct install This approach is designed to minimize customer involvement and routine disruption while providing clear benefits to the customer.
	Self-directed The customer identifies energy efficiency opportunities and programs that are most beneficial to them, without providing utility interventions beyond marketing for program awareness or customer rebates for purchase of energy efficiency equipment.
	Behaviour A behavioural experience educates customers about how their energy consumption compares to peer groups. It also educates customers about their existing energy consumption in an effort to help them identify alternative behaviours or investments that can save energy.
Type of incentive This attribute addresses barriers to energy efficiency,	Customer rebate Customer rebates focus on barriers related to the up-front cost of energy efficiency measures. Utility-sponsored programs can encourage more program participation by lowering the incremental costs of energy efficiency measures included in the program, relative to baseline efficiency measures.

Category	Description
such as the lack of knowledge about energy efficiency benefits, the low availability of energy efficient products, or the capital expenses associated with energy efficiency equipment.	Sales incentive (rewards channel partners or trade allies) Incentives are designed to reward channel partners or trade allies for sales of energy efficiency measures. In the case of consumer-facing measures, this may include incentives to salespeople who work in retail outlets, or it may include spiffs or bonuses for sales of higher-efficiency measures typically installed by contractors. Sales incentives are designed to overcome barriers related to lack of knowledge about energy efficiency benefits, or lack of familiarity with new products.
	Upstream incentives and mark-downs Incentives are designed to reduce point-of-sale costs or to encourage distributors and retailers to increase the share of energy efficiency product offered. This strategy is designed to overcome barriers associated with lack of product availability.

5.2 Review of Ontario Programs

The existing CDM programs offered in Ontario were reviewed to understand the participation and electricity trends of the programs, as well as the challenges and barriers the programs were experiencing. Table 5-2 summarizes Ontario's existing programs, together with the observed trends, challenges, and barriers. The review of the programs was informed by the annual program evaluation reports.[1] The archetype programs that were developed for the study, and which were described in Section 5.3, were informed by the review and assessment of the existing Ontario programs.

[1] IESO program evaluation reports are posted online: http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

Table 5-2: Summary of Existing Ontario Programs[2]

Program	Description	Program Evaluation Trends	Challenges and Barriers to Overcome
Residential			
Coupon Initiatives (Bi-Annual Retailer Event and Annual Coupon Initiative)	Encourages households to reduce their energy use by offering participants discounts on energy efficient products	▪ After a decline in participation and savings from 2012 to 2013, net savings in 2014 increased six-fold over 2013 ▪ Increasing baseline efficiency ▪ Program dominated by lighting measures	▪ Increasing baseline efficiency of lighting products ▪ Perceived increasing saturation of efficient lighting products ▪ Changing baseline measures for lighting (e.g. more free-riders over time) ▪ Lack of customer knowledge and familiarity with efficient lighting options ▪ Technology maturation for efficient lighting options ▪ Time required to educate consumers about "do-it-yourself" energy savings products and efficiency measures
HVAC Incentive	Encourages individuals and businesses with residential-type systems to replace existing heating systems with high-efficiency furnaces equipped with and electronically commutated motor (ECM), and to replace existing central air conditioning (CAC) systems with, or install new, ENERGY STAR® - qualified CAC systems.	▪ After a decrease in overall participation in 2012, participation has increased in 2013 and 2014 ▪ Program is dominated by ECM furnaces ▪ Contractors are the driving force of the initiative and are responsible for virtually every aspect of the participation process	▪ Very few participants replaced well-functioning existing equipment simply to save energy ▪ Increasing product baseline efficiency for CAC systems ▪ Limited cooling-season opportunities for HVAC savings ▪ Perceived market saturation for ECM motors ▪ ECM is code requirement for new construction in 2015 ▪ Market technology diffusion for more efficient furnace/HVAC blower motors ▪ Relatively modest cost increases for Tier II, 15 Seasonal Energy Efficiency Ratio (SEER) CAC units vs. Tier I, 14.5 SEER CAC units

[2] Program evaluation trends are based on published program evaluation reports. The latest reports available at the time of the study addressed the program evaluation up to 2014.

Program	Description	Program Evaluation Trends	Challenges and Barriers to Overcome
Appliance Retirement	The primary focus of the initiative is the removal of secondary units and the replacement of full-sized refrigerators or freezers; a secondary focus is the removal of room air conditioners (RACs) and dehumidifiers	▪ Participation has declined annually between 2011 to 2013, and increased in 2014 ▪ Refrigerators and freezers account for at least 90% of the total retired units	▪ Declining program savings opportunities and perceived program saturation ▪ Lack of knowledge about the energy and capacity costs for operating seldom-used, inefficient refrigeration and home climate control products
Appliance Exchange	The initiative is offered semi-annually through “exchange events” at participating retailers and targets the retirement of older, inefficient dehumidifiers	▪ Participation has increased since 2011 ▪ Primarily focused on replacing old, inefficient dehumidifiers	None identified
Home Assistance	Improve home electricity efficiency for low income customers	▪ Program participants were primarily residents of social housing ▪ A decrease in energy savings over the last two years was due to a proportionate decrease in program participation	▪ Difficult to identify and market to low income participants outside of social housing communities ▪ Baseline lighting efficiency is increasing
Aboriginal	The program provides customized conservation services to First Nations communities, including distant northern communities, to reduce their electricity use and lower their monthly utility bills	▪ Verified savings per project were considerably higher than similar income-qualified programs ▪ Weatherization measures account for the largest share of kW savings, followed by lighting measures ▪ Program participation has grown steadily over the program’s two-year history	▪ Program faces challenges associated with the compressed timelines that implementation staff has had to operate within ▪ Program faces a challenge, particularly regarding the installation of weatherization measures, due to the range and quality of housing stock present in First Nations communities

Program	Description	Program Evaluation Trends	Challenges and Barriers to Overcome
Residential New Construction	The initiative is designed to encourage the construction of energy efficient buildings that are more efficient than the Ontario Building Code by allowing commercial customers to participate in three incentive tracks: prescriptive, engineered, and custom	▪ In 2014, savings was driven primarily by the prescriptive track	▪ Baseline lighting efficiency is increasing ▪ Relatively low participation ▪ ECM is a code requirement for new construction in 2015 ▪ Increasing product baseline efficiency for CAC systems
Commercial and Industrial			
Audit Funding	Educate commercial and industrial customers about energy savings opportunities and generate energy savings opportunities that drive customers to the retrofit program	▪ Participants primarily learn of the program from past retrofit participation, LDC contacts, and professional affiliations ▪ The facilities in the initiative were typically larger commercial buildings with an average annual electricity consumption of 5.5 GWh	▪ Lack of data available for identifying potential retrofit opportunities ▪ Tracking system difficulties may lead to “lost” savings opportunities
Existing Building Commissioning	Provides funding for projects comprised of commissioning phases and the installation of measures to reduce electricity consumption associated with chilled water systems in existing industrial, commercial, institutional, and multi-family residential buildings	▪ In 2014, the first five projects completed all stages since the program started in 2011 ▪ In 2014, 31 participants have completed at least one phase of the program	Only applicable to chilled water systems
Small Business Lighting	Encourages the installation of efficient lighting through an easy process and minimal transaction effort by the customer	After annual decreasing participation from 2009 to 2013, an increase occurred in 2014	▪ Perception of market saturation and program maturity ▪ Forthcoming increase in baseline lighting efficiency has potential to reduce savings

Program	Description	Program Evaluation Trends	Challenges and Barriers to Overcome
Retrofit	Promotes the installation of more efficient equipment in businesses, including incentives; participants can participate in three tracks: prescriptive, engineered and custom tracks	▪ In 2014, results in the prescriptive and engineered measure-tracks were driven by lighting projects; in the custom track, 77% of energy savings came from non-lighting projects ▪ Savings and participation are increasing annually	▪ Inertia and awareness of financial benefits of energy savings ▪ Intensive savings application process
Process and System Upgrade Initiative (PSUI)	Support for the development and implementation of energy efficiency projects and system optimization projects for facilities that are intrinsically complex and capital intensive	In 2014, 10 projects were completed under the Capital Incentive, 379 under Energy Manager, and 2 under the Measurement and Targeting initiatives	▪ Challenges with participation process, for example, the contract's complexity, rigid and strict contract terms, and slow approval process ▪ Perception of lack of internal project funding for customers who want to complete capital incentive projects
High Performance New Construction	Encourages designers and builders to incorporate energy-efficient measures to reduce electricity consumption in newly constructed or renovated facilities	▪ In 2014, savings were driven primarily by the custom track	▪ Baseline lighting efficiency is increasing ▪ Relatively low participation ▪ ECM is a code requirement for new construction in 2015 ▪ Increasing product baseline efficiency for CAC systems

5.3 Archetype Programs

Archetype programs were used as broad categories meant to indicate the program delivery mechanism, approach, or target sector. The program archetypes were general enough to provide flexibility when needed, but had enough definition to serve as a logical, cohesive program offering to help IESO and LDCs achieve their energy savings goals. The archetype programs were informed by the review and assessment of the existing Ontario programs, which are discussed in Section 5.2. The archetype programs aimed to address and overcome the challenges and barriers identified for the existing programs, and were informed by best practices researched from North American CDM programs. The archetype programs for the residential sector, and the commercial and industrial sectors, are described in the following two sub-sections.

5.3.1 Residential Sector

Table 5-3, below, presents a summary of the residential program archetypes, along with target end uses, market segments, and observations and recommendations to enhance programs.

Table 5-3: Summary of Residential Program Archetypes

<table>
<tr><th>Program Archetype</th><th>End Uses</th><th>Subsectors</th><th>Notes</th></tr>
<tr><td rowspan="3">Consumer archetype program</td><td>Space heating
Space cooling
Ventilation and circulation
Lighting
Plug load</td><td>All subsectors</td><td>Archetype addresses need for consumer self-installed measures</td></tr>
<tr><td colspan="3">Observation and Recommendations</td></tr>
<tr><td colspan="3">The current Ontario program delivery approach is consistent with other successful programs. The bi-annual events represent an upstream incentive type, while in-store displays employ joint-marketing approaches to build on existing advertising and sales efforts by retail channel partners.
Focus on diversifying the source of savings in the program by expanding to new end uses and product types.
Include offering multiple avenues for redeeming coupons, including the promotion of program measures through mail-order catalogs or online retail.
Include information technology that supports real-time product tracking, which could be used by LDCs or IESO to engage retail channel partners to reward successes or encourage additional efforts.</td></tr>
<tr><td rowspan="3">Systems and equipment</td><td>Space heating
Space cooling
Ventilation and circulation
Domestic hot water</td><td>All subsectors
(Note: decision-maker varies by building type)</td><td>Archetype is a contractor-driven program addressing the need for residential equipment measures that require outside contractors to install</td></tr>
<tr><td colspan="3">Observation and Recommendations</td></tr>
<tr><td colspan="3">Past program successes and current energy structure with Ontario's relatively high penetration of natural gas-fueled appliances may potentially limit electricity savings available for this program archetype.
Focus on trade ally network development. Include active LDC engagement and communication with trade allies to provide support and training in sales techniques, equipment education, rewards, and recognition.
Identify additional opportunities to continue its trend of market transformation, for example, consider offering additional incentives to increase savings of the HVAC system</td></tr>
<tr><td rowspan="3">Audit and direct install</td><td>All residential end uses (with a focus on settings and peripherals)</td><td>All subsectors
(Note: decision-maker varies by building type)</td><td>Educate customers
Install highly cost-effective measures
Direct to other programs</td></tr>
<tr><td colspan="3">Observation and Recommendations</td></tr>
<tr><td colspan="3">In-home audit is likely to increase costs but may also provide technical assistance, education, and additional feedback about potential energy efficiency retrofits to existing homes. Include low cost measures while directing participants towards other programs.
Identify cost-effective means for completing audit component, for example, identify cost-effective contractors.
Generate marketing materials and leave-behinds that will encourage participation in larger, more comprehensive programs.</td></tr>
</table>

Program Archetype	End Uses	Subsectors	Notes
Whole-home	▪ Space heating ▪ Space cooling ▪ Ventilation and circulation ▪ Domestic hot water	All subsectors (Note: decision-maker varies by building type)	▪ Implement shell/envelope measures ▪ Energy efficiency upgrades that are not “plug and play”
	Observation and Recommendations		
	▪ Consider advertising in multiple media and channels, as well as cooperatively with retailers. ▪ Provide technical assistance in the form of contractors or LDC and IESO websites.		
Behavioural	All end uses	Single family	Drives behavioural changes and conservation
	Observation and Recommendations		
	▪ Best practices for the program include the fundamental need for a randomized, controlled trial approach to program delivery and educational and messaging materials about how to save energy, and cross-promoting other utility programs in behavioural product messaging.		
Low income	All end uses (with a focus on health and safety measures)	All subsectors	Approach centralized management and existing resources for low income community to support energy and health and safety benefits
	Observation and Recommendations		
	▪ Consider additional avenues for offering the program, such as other social organizations that may have a large degree of contact with income-qualifying households. ▪ Engage other government agencies to identify and market the program as a delivery channel and partner. ▪ Utilize community events to raise awareness of the program and deliver educational components of the program. ▪ Consider geographic approaches for targeting potential qualifying participants. ▪ Consider neighborhood-based approaches that may limit overhead costs related to diffuse project sites.		
Aboriginal	All end uses	All subsectors	Approach centralized management and existing resources for aboriginal community to support energy, health, and safety benefits
	Observation and Recommendations		
	▪ The existing program frequently encountered homes that were not ready for retrofit measures due to structural deficiencies. Such deficiencies may be overcome by working with other services and programs to enhance efforts associated with public housing support. ▪ Evaluation results of the existing program indicate that some lag time is created by the project application review process. An option to consider is transitioning the program to a biannual model that would allow one project selection period, with a longer implementation period and biannual review/evaluation.		
New construction	All end uses	All subsectors	▪ Target highly cost-effective measures

Program Archetype	End Uses	Subsectors	Notes
			▪ Perhaps offer additional tier for green building market
	Observation and Recommendations		
	▪ Program participants indicate a steep learning curve regarding program requirements and processes that could be enhanced by LDC outreach, training, and engagement.		

The remainder of this section describes the logic behind the program archetypes. For each program archetype, the current Ontario programs that are similar to the archetype program are described. The current status and significant findings from the 2014 evaluations of the programs are summarized. A description of the archetype program is provided, which expresses the program logic and strategy. Recommendations for enhancements or changes are included and, in the last subsection, best practices and examples of similar programs in North America are provided.

5.3.1.1 Residential Consumer Archetype Program

Status of Ontario Program

The existing Ontario Consumer Programs include the following:

- Bi-Annual Retailer Event
- Annual Coupon Initiatives
- Appliance Retirement and Appliance Exchange Initiatives
- HVAC Incentive Initiative.

These coupon programs are designed to address energy efficiency measures that can be readily installed by consumers after purchase from a participating retailer. The current program is prescriptive and lighting rebates focus on LED measures. Domestic hot water heater pipe wrap has been removed from the program. The program has successfully demonstrated that many energy efficiency upgrades are available and easy to implement by consumers.

The following end uses are addressed by the programs:

- Space heating (one measure)
- Ventilation and circulation (one measure)
- Lighting (seven measures)
- Plug load (three measures)
- Domestic hot water peripheral (one measure).

Evaluation Findings

The evaluation of the 2014 coupon programs highlighted the following[3] items to take into consideration for the archetype program:

- The annual net savings of the coupon initiatives in 2014 was 155.7 GWh. The savings were primarily from lighting end use, which accounted for 95% of program savings in 2014.
- The program has successfully overcome market barriers associated with historical, entrenched, and inefficient lighting products.
- As energy efficiency codes and product standards evolve, the program faces the reality of increased baseline efficiency for the residential lighting end use.
- The program benefitted in 2014 by adding more popular, higher-efficiency LED lighting products. Participating retailers pointed to this addition as the explanation for large increases in program participation between 2013 and 2014.

Archetype Program Description

In this potential analysis, the Consumer Archetype Program addressed the need for consumer self-installed measures. Only the two coupon programs, the Bi-annual Retailer Event and the Conservation Instant Coupon Booklet, which are also known as the Annual Coupon Initiatives, were included in the archetype program. The residential Consumer Archetype Program is designed to offer rebates or incentives at point-of-purchase. Retail outlets are recruited into the program and receive incentives to reduce the costs of easy-to-install energy efficiency measures, such as efficient lamp (light bulb) products. Cost savings are only available to consumer participants who present coupons for purchase. It is recommended that coupons are available year-round from a program website, and LDCs can also distribute coupons to their customers directly. Table 5-4 summarizes the key elements of the archetype program.

[3] Research Into Action (2015). 2014 Consumer Program Evaluation. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

Table 5-4: Residential Consumer Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All residential subsectors and all building types	
General program marketing strategy	Mass marketing and joint marketing	
Customer experience	Self-directed	
Incentive type	Rebate	

Measures included	**Existing measures:**
	▪ LED
	▪ CFL
	▪ Fixtures
	▪ Ceiling fans
	▪ Lighting control products
	▪ Hot water pipe wraps
	▪ Electric water heater blankets
	▪ Weather-stripping
	▪ Heavy duty outdoor timers
	▪ Advanced power bars or power strips
	▪ Outdoor clothesline stands and kits
	▪ Electric baseboard programmable thermostats
		New and revised measures:
		▪ ENERGY STAR® appliances such as refrigerators, dryers, dehumidifiers, etc. (currently part of the appliance retirement and exchange program)
		▪ Appliance recycling coupons:
		  ▪ Freezer recycling (with or without replacement)
		  ▪ Refrigerator recycling (with or without replacement)
		▪ Other home electronics, such as air purifiers (exchange) and ENERGY STAR® electronics:
		  ▪ Printers
		  ▪ Audio amplifiers
		  ▪ Optical disc players
		  ▪ Desktop computers
		  ▪ Notebook computers
		  ▪ Computer monitors
		  ▪ Game consoles
		  ▪ Set-top boxes
		▪ Domestic hot water peripheral measures (electric use only):
		  ▪ Faucet aerators
		  ▪ Low flow shower heads

Best Practices and Reference Programs

Research of similar North American programs indicated that other jurisdictions commonly offer appliance rebates for ENERGY STAR® certified products. Specific examples included the MASS Save Lighting and Appliances program in Massachusetts, the Efficiency Maine and Efficiency Vermont ENERGY STAR® Product programs, and the BC Hydro Appliance Rebate program. Best practices from the Efficiency Vermont and Efficiency Maine programs include offering multiple avenues for redeeming coupons, including the promotion of program measures through mail-order catalogs or online retail.

In addition to multiple pathways for participation, best practices include information technology that supports real-time product tracking, which could be used by LDCs or IESO to engage retail channel partners to reward successes or encourage additional efforts. Likewise, under-performing locations could be scheduled for in-store checkups to ensure that promotional materials and product displays are in line with program marketing strategies.

The current Ontario program delivery approach is consistent with other successful programs. The bi-annual events represent an upstream incentive type, while in-store displays employ joint-marketing approaches to build on existing advertising and sales efforts by retail channel partners. A main focus for expanding savings from the residential Consumer Archetype Program is to focus on diversifying the source of savings in the program by expanding to new end uses and product types. Based on observations of similar programs in other jurisdictions, it is recommended that the existing Coupon Initiatives be enhanced by offering additional measures. Offering additional measures would increase the number of end uses for which the archetype program generates savings and keep pace with evolving consumer product efficiency and controls. By broadening the measures, the archetype program also captures additional self-install opportunities for consumers and evolving home automation and controls products.

5.3.1.2 Residential Systems and Equipment Archetype Program

Status of Ontario Program

The heating, ventilation, and air conditioning (HVAC) Incentives Initiative is the only current residential systems and equipment program in Ontario. The program works with residential HVAC contractors (trade allies) as the primary delivery channel for three measures: (1) Consortium for Energy Efficiency (CEE) Tier-1 central air conditioning (CAC) systems, (2) CEE Tier-2 CAC systems, and (3) electronically commutated motor (ECM) replacements for HVAC fan systems.

The following end uses are addressed by the programs:

- Space heating (one measure)
- Space cooling (two measures).

Evaluation Findings

The evaluation of the 2014 coupon programs highlighted the following[4] items to take into consideration for the archetype program:

- The majority of savings in the program were achieved by ECM retrofits. The two CAC units garnered 66 kWh and 94 kWh per year per participant for Tier-1 and Tier-2 systems, respectively. The ECM retrofit to furnace fans generated 261–2,803 kWh per year savings, depending on participants' residential system configuration and operation characteristics.
- Most of these ECM retrofits occurred on systems with non-electric furnaces.

[4] Research Into Action (2015). 2014 Consumer Program Evaluation. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

- The primary opportunity for adoption of these measures resulted from equipment failure. Contractors appeared to be successful in educating customers about the benefits of higher efficiency equipment.
- Contractors also educated customers about additional measures that could save energy, such as: adding insulation, weatherizing, and duct sealing.

Archetype Program Description

The residential System and Equipment Archetype Program delivers energy efficiency upgrades that are not typically installed by residential occupants. Complex home systems and equipment, such as HVAC systems and domestic hot-water systems, are typically the purview of third party contractors. Residents hire them to make repairs or install equipment that requires contractors with specialized knowledge and skills. Program delivery generally focuses on trade ally (third party contractor) partnerships that take advantage of the face-to-face interactions between residential dwelling occupants/owners and trade allies. Typical partnerships may include trade ally training on program offerings and incentives, eligibility requirements, equipment sales, or other strategic enhancements to program delivery. Table 5-5 summarizes the key elements of the archetype program.

Table 5-5: Residential System and Equipment Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All residential subsectors and all building types	
General program marketing strategy	Targeted marketing	
Customer experience	Technical assistance	
Incentive type	Sales incentive	
Measures included	**Existing measures:** ▪ Tier 1 and 2 CAC ▪ ECM	**New and revised measures:** ▪ Ductless mini-split heat pump 15 SEER*, replacing central air conditioning (AC) and forced-air furnace ▪ Ductless mini-split heat pump 15 SEER*, replacing electric boiler and room AC ▪ Ground source heat pump 17 EER/3.6 COP with desuperheater ▪ Ground source heat pump 17 EER/3.6 COP ▪ Heat pump water heaters (50- and 80-gallon units) ▪ Basement and wall insulation for homes with little or no existing insulation (R-5 or lower) ▪ Ceiling insulation for homes with little or no existing insulation (R-4 or lower) ▪ Air sealing

Best Practices and Reference Programs

Best practices for the residential Equipment and Systems Archetype Program focus on trade ally network development. Outside of the current, popular ECM motor measure, the measures included in this program may not be widely known to residential customers. Program success therefore depends on the level of trade ally engagement and the quality of technical assistance provided by trade allies. Typical best practices for developing strong trade ally networks include active LDC engagement and communication with trade allies to provide support and training in sales techniques, equipment education, rewards, and recognition. Example programs relevant to the Ontario climate region include the MASS Save Deep Energy Retrofits (pilot) Program, the Wisconsin Focus on Energy Residential Rewards and Enhanced Renewable Rewards Program, the Pacific Gas & Electric (PG&E) Appliances program, and the Efficiency Maine Water Heater Rebate program and Heating System Projects program.

Past program successes and current energy structure with Ontario's relatively high penetration of natural gas–fueled appliances may potentially limit electricity savings available for this program archetype. In Ontario, natural gas systems occupy the majority share of residential space heating and domestic hot water end uses. Furthermore, the current HVAC Initiative savings are dominated by the ECM motor measure, installed on furnace fan equipment, which will soon become the code/product standard requirement for this equipment. All of these factors suggest that the residential Systems and Equipment Archetype Program would benefit from identifying additional opportunities to continue its trend of market transformation. Potential enhancements to programs that align with this archetype program include:

- Engage contractors with the training and education necessary to market additional cost-effective measures, in addition to the current ECM motor, which will become a code requirement and which appears to already have wide acceptance.
- Consider offering additional incentives to increase the savings of the HVAC system, such as shell and envelope measures or duct sealing.
- Continue to push for gains in residential HVAC efficiency by adding other HVAC heating and ventilation system controls for the Ontario market. For example, equipment that allows heating zone controls may achieve additional savings by limiting the operation of residential HVAC equipment to areas of the home that are in use.

5.3.1.3 Residential Audit and Direct Install Archetype Program

Status of Ontario Program

Some LDCs are currently conducting a pilot program for residential direct mail energy efficiency kits. The following end uses are addressed by the programs:

- Lighting (one measure)
- Shell and building envelope (three measures)
- Domestic hot water (six measures)
- Cooking (one measure)

- Plug load (two measures).

Evaluation Findings

No program evaluations are available, since only pilot programs are currently being delivered.

Archetype Program Description

The residential Audit and Direct Install Archetype Program is designed to educate consumers about electricity consumption:

- The major home characteristics that determine the magnitude of home energy consumption
- Simple tips to reduce costs and consumption
- Recommendations of larger energy savings retrofits that might be accomplished in the home.

The direct install component allows immediate savings by installing highly cost-effective measures that have the added benefit, in many cases, of demonstrating to customers the range of energy efficiency products available. This archetype program also fits well with a whole-home approach that markets larger efficiency retrofit projects, such as adding attic insulation or duct sealing. Essentially, this archetype program serves as a demonstration platform for marketing additional savings and programs. Table 5-6 summarizes the key elements of the archetype program.

Table 5-6: Residential Audit and Direct Install Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All residential subsectors and building types	
General program marketing strategy	Mass marketing	
Customer experience	Direct install	
Incentive type	Behavioural	
Measures included	**Existing measures:** Measures included in the pilot programs address the following end uses: ▪ Lighting ▪ Shell and building envelope ▪ Domestic hot water ▪ Cooking ▪ Plug load	**New and revised measures:** ▪ Furnace whistle ▪ Hot water pipe wrap ▪ Water heater temperature setback

Best Practices and Reference Programs

Many jurisdictions offer home energy savings kits that are often classified as direct install because the utility pays the full cost of the measures included. BC Hydro offers free energy savings kits for income-qualifying accounts. Manitoba Hydro has a PowerSmart Water and

Energy Savings program that offers similar measures to customers free of charge. The concept of an in-home audit is likely to increase costs but may also provide technical assistance, education, and additional feedback about potential energy efficiency retrofits to existing homes. Keeping home audit programs cost-effective can be difficult, and many jurisdictions combine home audit efforts with energy efficiency financing. This combination is beneficial for ensuring that high-impact measures are included to offset the cost of providing in-home audits. The goal of these programs is to include low cost measures while directing participants towards other programs. This is effective if there is a mechanism for cross-program attributes that allows direct install programs to claim a share of the energy savings credit from audit recipients that “follow the audit prescription,” and install measures offered by other programs. New York State Energy Research and Development Authority (NYSERDA), MASS Save of Massachusetts, and Efficiency Maine offer audit-to-loan programs for installing energy efficiency measures.

Potential elements to consider for programs that align with this archetype program include:

- Identify cost-effective means for completing the audit component (e.g. identify cost-effective contractors)
- Generate marketing materials and leave-behinds that will encourage participation in larger, more comprehensive programs
- Use the residential audit and direct install program as a complementary platform for pushing potential energy savings to higher impact programs.

5.3.1.4 Residential Whole-Home Archetype Program

Status of Ontario Program

No approved programs existed.

Evaluation Findings

No program evaluations were available, since only pilot programs are currently being delivered.

Archetype Program Description

The residential Whole-Home Archetype Program focused primarily on contractor-installed measures that enhance the building envelope or shell of residential buildings such that weather conditions have less influence on occupants’ electricity consumption. The archetype program is a logical complement to the residential Audit and Direct Install Archetype Program.

The residential Whole-Home Archetype Program concept is highly applicable in markets where HVAC electricity load shares are substantial. Based on previous evaluation findings, the residential whole-home model has been suggested by LDCs as a potential avenue to access additional savings. Overcoming the low electric load share for building and envelope measures to also offer measures that generate electricity savings is a critical program design element for the Whole-Home Archetype Program, as is the need for low cost implementation approaches. Potential interactions between this program and other archetype programs are an important factor for ensuring the success of this archetype program. The archetype program is limited by a small number of cost-effective measures that address building shell and envelope efficiency in the Ontario market. Table 5-7 summarizes the key elements of the archetype program.

Table 5-7: Residential Whole-Home Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All residential subsectors and all building types	
General program marketing strategy	Targeted marketing	
Customer experience	Technical assistance	
Incentive type	Sales incentive	
Measures included	**Existing measures:** None	**New and revised measures:** ▪ Basement wall insulation ▪ Central AC maintenance, tune-up ▪ Heat pump maintenance, tune-up ▪ Wall insulation ▪ Air sealing

Best Practices and Reference Programs

PG&E includes Home Improvement measures in its portfolio by offering $0.15 in rebates per square foot of installed insulation. The program advertises via multiple media and channels, as well as cooperatively with retailers. Program staff track application data and leading indicators. Technical assistance is available in the form of contractors or the utility website. FortisBC also includes home efficiency and shell measures, such as insulation.

5.3.1.5 Residential Behavioural Archetype Program

Status of Ontario Program

Some LDCs have proposed pilot behavioural measures or programs in their CDM plans for the 2015–2020 CFF. The pilots address both opt-in and opt-out approaches.

Evaluation Findings

No program evaluations were available, since only pilot programs are currently being delivered.

Archetype Program Description

The residential Behavioural Archetype Program draws on social normative theory to generate changes to customer behaviour that lead to energy conservation. Customers are compared to each other with the goal of generating a sense of competition or awareness around households that are either driven to seek additional energy savings or reduce their consumption, in the case where they are on the higher end of the range of household energy consumption. The energy consumption reports that customers receive as a consequence of the Behavioural Archetype Program also make household energy consumption data readily available in an accessible format. Table 5-8 summarizes the key elements of the archetype program.

Table 5-8: Residential Behavioural Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All residential subsectors and all building types	
General program marketing strategy	Not applicable (opt-out program)	
Customer experience	Behavioural	
Incentive type	Customer rebate (for applicable measures promoted in the program)	
Measures included	**Existing measures:** All measures	**New and revised measures:** None

Best Practices and Reference Programs

Behavioural programs have now been implemented throughout North America. These programs consistently save 1% to 3% of annual energy savings for single family residential homes. The higher end of this range is typically associated with high electricity fuel shares for residential HVAC systems. While program savings appear consistent and reliable, the exact mechanism by which such programs generate savings is not yet fully understood.

A number of utilities offer behavioural programs and products. National Grid, Sand Diego Gas & Electric (SDG&E), and American Electric Power (AEP) Ohio are some examples of utilities with behavioural programs. Best practices for the program include the fundamental need for a randomized, controlled trial approach to program delivery, educational and messaging materials about how to save energy, and cross-promoting other utility programs in behavioural product messaging.

5.3.1.6 Low Income Archetype Programs

Status of Ontario Program

The Ontario Home Assistance Program generates savings to low income customers using a whole-home approach. The program consists of weatherization measures installed by delivery agents. The program makes use of diagnostic tools that estimate post-retrofit savings on the basis of the home's initial condition. The program's participation is primarily composed of social housing occupants, and 40% of program participants indicate their landlord or building manager initiated program activities at their home.

Evaluation Findings

The evaluation of the 2014 Home Assistance program highlighted the following[5] items to take into consideration for the archetype program:

- The 2014 program evaluation indicates average savings per home is 766 kWh per year
- Identifying eligible customers is a sensitive topic
- Weatherization measures accounted for 42% of program savings, although only 3% of projects included weatherization.

[5] Opinion Dynamics (2015). 2014 Evaluation Report for the Home Assistance Program. Website: http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/report

Archetype Program Description

The residential Low Income Archetype Program focuses on increasing access to energy savings; improving home comfort; and reducing health and safety concerns associated with home weatherization, building shell, or home system inefficiencies that may be present in certain geographies, communities, or building types. The archetype program focuses on community benefits by engaging organizations that have existing relationships with low income or underserved communities. Table 5-9 summarizes the key elements of the archetype program.

Table 5-9: Residential Low Income Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	Low income residential sector (all building types)	
General program marketing strategy	Joint marketing	
Customer experience	Direct install	
Incentive type	Customer rebate	
Measures included	**Existing measures:** All measures	**New and revised measures:** None

Best Practices and Reference Programs

Based on best practices and the 2014 evaluation of the Home Assistance Program, potential elements to consider for programs that align with this archetype program include:

- Consider additional avenues for offering the program, such as other social organizations that may have a large degree of contact with income-qualifying households
- Engage other government agencies to identify and market the program as a delivery channel and partner
- Use community events to raise awareness of the program and deliver educational components of the program
- Consider neighborhood-based approaches that may limit overhead costs related to diffuse project sites; such an approach would combine well with modifications to the education component that may also reduce costs associated with individual project education
- Consider geographic approaches for targeting potential qualifying participants.

5.3.1.7 Aboriginal Archetype Program

Status of Ontario Program

The Aboriginal Conservation Program (ACP) provides conservation services to First Nations communities to reduce electricity use. The measures include the same set of energy conservation measures provided as part of the Home Assistance program, which is described in the previous section. The program was launched in 2013.

Evaluation Findings

The evaluation of the 2014 ACP highlights the following[6] items to take into consideration for the archetype program:

- The ACP achieved 3.1 MWh of savings in 2014
- The evaluation findings indicate that the savings per project are slightly higher for the ACP than for the Home Assistance program, at 770 kWh per home per year on average.
- The ACP program participants typically receive more weatherization measures, consisting of insulation and draft-proofing, when compared to the Home Assistance Program.
- Twenty-three percent of all First Nations communities have had the opportunity to participate in the ACP.
- The program is delivered by First Nations Engineering Services, Ltd., and the evaluation finding suggests this single-agent delivery strategy has been effective in Ontario.

Archetype Program Description

The Aboriginal Archetype Program addresses energy conservation in First Nations communities. Table 5-10 summarizes the key elements of the archetype program.

Table 5-10: Aboriginal Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	Aboriginal community (all building types)	
General program marketing strategy	Not applicable (communities apply and participation is determined by government or agencies)	
Customer experience	Direct install	
Incentive type	Sales incentive (contractor is paid for completed projects)	
Measures included	**Existing measures:** All measures	**New and revised measures:** None

Best Practices and Reference Programs

Based on best practices and the 2014 evaluation of the ACP, potential elements to consider for programs that align with this archetype program include:

- The existing program frequently encountered homes that were not ready for retrofit measures due to structural deficiencies. Such deficiencies may be overcome by working with other services and programs to enhance efforts associated with public housing support.
- Evaluation results of the existing program indicated that some lag time is created by the project application review process. An option to consider is transitioning the program to a

[6] Opinion Dymanics (2015). 2014 Evaluation Report for the Aboriginal Conservation Program. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

biannual model that would allow one project selection period, with a longer implementation and biannual review/evaluation period.

5.3.1.8 Residential New Construction Archetype Program

Status of Ontario Program

The Ontario Residential New Construction program encourages residential homebuilders to construct energy efficient homes. There are three tracks for participation in the program:

- The *prescriptive track* includes incentives for pre-approved technologies
- The *performance track* offers incentives that are tied to EnerGuide energy efficiency performance ratings
- The *custom track* consists of site-specific savings and incentives that are based on standard calculation worksheets that estimate savings achieved.

The following measures are included in the program:

- Prescriptive track:
  - Gas furnace with ECM
  - 15 SEER central air conditioner
  - Electric furnace with ECM
  - ENERGY STAR® lighting
  - Timers, switches, and motion sensors
- Performance track:
  - EnerGuide rating of 83 or better
  - ENERGY STAR® new homes.

Evaluation Findings

The evaluation of the 2014 Residential New Construction Program highlighted the following[7] items to take into consideration for the archetype program:

- The residential new construction program has completed 2,685 projects since 2011, equating to approximately 48 GWh savings
- The prescriptive track has achieved the most electricity savings: 63% of the program total
- Prescriptive measures include lighting and ECM motors for gas and electric furnace fans; the ECM measure is no longer a viable measure for the program, as it has become part of baseline building codes and standards

[7] Frontier Associates (2015). *Final Evaluation Report: High Performance New Construction and Residential New Construction Initiatives*. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

- The majority of program savings from the prescriptive track are generated by lighting measures, but ECM motors make significant contributions
- Program participants have indicated that prescriptive incentives are low and some participants indicated they received additional incentives from another source
- Some process evaluation results indicated it may be worthwhile to consider new construction programs that target buyers, rather than builders
- The program depends on a small number of residential home builders: 11 builders participated in the 2011–2012 programs, with only 8 participating in 2013; only 3 of the 11 builders from 2011–2012 were still participating in 2013.

Archetype Program Description

The residential New Construction Archetype Program is similar to “upstream” consumer programs in that it targets the supply side of the new construction market to increase the efficiency of offered products. The archetype program provides set incentives for common energy efficiency opportunities, such as lighting, that have relatively standard use and savings values. Other measures that may be more site-specific can be rebated through a custom, energy modelling approach. Finally, whole-home performance can be used to apply for incentives by producing homes that meet the minimum EnerGuide or ENERGY STAR® ratings accepted by the program. Table 5-11 summarizes the key elements of the archetype program.

Table 5-11: Residential New Construction Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All subsectors, with a focus on new construction	
General program marketing strategy	Joint marketing	
Customer experience	Technical assistance	
Incentive type	Customer rebate	
Measures included	**Existing measures:** All measures	**New and revised measures:** None

Best Practices and Reference Programs

Based on best practices and the 2014 evaluation of the Residential New Construction Program, potential elements to consider for programs that align with this archetype program include:

- Program participants indicate a steep learning curve regarding program requirements and processes; LDC outreach, training, and engagement could help participants.

5.3.2 Commercial and Industrial Sector

Table 5-12 summarizes the C&I program archetypes along with target end uses and subsectors.

Table 5-12: Summary of Commercial and Industrial (C&I) Program Archetypes

Program Archetype	End Uses	Subsectors	Notes
Audit and Energy Partners	All end uses	All commercial and industrial subsectors (with a focus on medium to large customers)	▪ Identify operational and control measures ▪ Direct to retrofit program ▪ Engage in behavioural, strategic energy management
	Observations and Recommendations		
	▪ Develop a web-based, behavioural component to the program that increases customer awareness and engagement around energy efficiency. ▪ Consider rebranding the program to showcase enhancements. ▪ Make use of the data collected by an audit program and develop a follow-up procedure that cross-promotes other commercial programs. ▪ Consider third party direct installation, where "bundled" audit recommendations suggest the potential for economies of scale. ▪ Make a strong business case for long term, strategic investment in energy efficiency based on the site-specific data collected during the audit. ▪ Establish technical and financial planning assistance to integrate energy savings potential with capital project planning. ▪ The program provides a platform for LDCs that wish to market themselves to medium and large customers as a trusted energy management partner.		
Retrofit	All end uses	All commercial and industrial subsectors	Addresses need to overcome cost barriers and increase efficiency of commercial equipment
	Observations and Recommendations		
	▪ Commercial and industrial energy efficiency retrofit programs are nearly universal among utility-sponsored market interventions. Some jurisdictions focus on specific subsectors or segments to offer energy savings that are tailored or targeted for relevant building or facility types. ▪ Best practices indicate the need for constant and consistent engagement across multiple platforms. In addition, LDCs may want to consider how they can best provide support with in-kind services for training, marketing, conference, web tools, and partnerships with other organizations. ▪ The segmentation strategy and approach should be flexible to align with LDC market characteristics. ▪ Engage trade allies in a manner consistent with residential approaches. ▪ Examine the potential to reward participants with non-rebate incentives, such as public recognition and marketing support. ▪ Review the performance of existing measures and measure the portfolio relative to cost-effectiveness. ▪ Continue offering variable speed drive (VSD) motor control rebates, but consider additional HVAC periphery measures, such as zone controls that may supplement the savings from VSD systems. ▪ Target additional national accounts for non-lighting HVAC and plug load savings.		

<table>
<tr><th>Program Archetype</th><th>End Uses</th><th>Subsectors</th><th>Notes</th></tr>
<tr><td rowspan="3">Small Business</td><td>Lighting
Space heating
Space cooling
Ventilation and circulation
Domestic hot water
Plug load</td><td>Commercial and industrial businesses with <50 kW average annual demand</td><td>Archetype is direct install approach to implement fast, cost-effective CDM measures where energy management is not a major cost</td></tr>
<tr><td colspan="3">Observations and Recommendations</td></tr>
<tr><td colspan="3">Most of the small business programs focus on engaging channel allies to help implement efficiency opportunities. Utility engagement includes training for channel allies, promotional materials, conferences, and workshops. Real-time data on channel ally performance allow utility sponsors to apply motivation and encouragement directly to participating channel partners.
Consider the business case for the continued shift away from CFL measures towards LEDs.
Add additional energy savings measures that can be installed along with lighting.
Offer discounts on measures that are not cost-effective when offered solely as direct install, but may become cost-effective with some limited customer cost sharing.</td></tr>
<tr><td rowspan="3">New Construction</td><td>All end uses</td><td>All commercial and industrial subsectors</td><td>Supply-chain program that engages design and construction upstream</td></tr>
<tr><td colspan="3">Observations and Recommendations</td></tr>
<tr><td colspan="3">Review program allowances against program cost-effectiveness thresholds to ensure alignment between savings and incentives.
A potential program strategy may be developed around the viewpoint of design/build firms as channel allies for LDCs in implementing the program.
Nearly all the existing High Performance New Construction program evaluation recommendations focus on data management and program processes, such as a consistent methodology for calculating savings across LDCs, reporting additional details on engineering track projects, monitoring project documentation, and including the assumptions used when calculating simulated energy savings from proposed projects.
Evaluate the possibility of increasing program incentives from the standpoint of program cost-effectiveness and net-to-gross implications.</td></tr>
</table>

Similar to the previous section, which addresses the residential archetype programs, the remainder of this section describes the logic behind the commercial and industrial program archetypes. For each program archetype, the current Ontario programs that are similar to the archetype program are described. The current status and significant findings from the 2014 evaluation of the programs are summarized. A description of the archetype program is provided, which expresses the program logic and strategy. Recommendations for enhancements or changes are included and, in the last subsection, best practices and examples of similar programs in North America are provided.

5.3.2.1 C&I Audit and Energy Partners Archetype Program

Status of Ontario Program

The Ontario programs relevant to this archetype program include:

- *Audit Funding Initiative.* The current audit funding program offers a 50% discount for energy audits. The result of the audit is a list of recommendations for energy efficiency improvements. The audit program increases awareness and education around the savings opportunities available through the commercial retrofit program.
- *Building Commissioning Initiative*. The Existing Building Commissioning Program provides funding for projects comprised of commissioning phases and the installation of measures to reduce electricity consumption associated with chilled water systems in existing commercial, institutional, and multi-family residential buildings.
- *Process and System Upgrade Initiative (PSUI) – Engineering Studies.* Engineering Studies offers 100% of the study costs (up to $10,000) in incentive funding for completing a Preliminary Engineering Study (PES), while a Detailed Engineering Study (DES) for viable energy projects is funded up to $50,000.
- *PSUI – Opportunity Accelerator.* The initiative is a free service that provides a preliminary analysis and report on the potential electrical efficiency opportunities in a facility. These opportunities may be eligible for capital incentives projects.
- *PSUI – Energy Managers*. This program offers funding for hiring the services of an energy manager who serves either: (1) an eligible participant with one or more facilities and is employed by the eligible participant (embedded energy manager), or (2) multiple industrial facilities, when employed by the LDC or a group of LDCs (roving energy manager). An energy manager funded through the PSUI must identify 0.3 MW of potential savings per year. Among these opportunities, some projects may benefit from capital incentives, but a minimum of 30% of the savings must be achieved through non-incentivized projects.

Evaluation Findings

The evaluation of the 2014 programs[8,9] highlights the following items to take into consideration for the archetype program:

- The energy savings generated by the commercial audit program are poorly understood. Audit Funding Initiatives are captured in a database that only provides a list of completed projects, without any information about the recommended measures and their associated estimated savings.

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[8] Nexant (2015). Evaluation of 2014 Business Incentive Programs. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

[9] Econoler and Cadmus (2015). 2014 Evaluation of Industrial Energy Efficiency Programs. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

- Approximately 12% of the recommendations generated by the audit program since 2011 have been implemented.
- Five Existing Building Commissioning Incentive Initiative (EBCII) projects reached the Hand-off Stage in 2014. These were the first five projects to have completed all stages since the program started in 2011.
- In 2014, 379 projects were completed under the Energy Managers initiative.
- Trade allies are willing to play a bigger role in promoting the PSUI initiatives. Currently, trade allies are not actively encouraged to work with the PSUI program.
- Inefficiency in the process to participate in the PSUI was identified as a barrier to participate, which included the complicated terms and conditions, and the data tracking systems.

Archetype Program Description

The commercial Audit Funding and Energy Partners Archetype Program presents an opportunity to provide technical assistance that enables deeper energy savings in medium to large businesses. In addition, the archetype program can also be used to collect baseline data for a heterogeneous group of business that may not be otherwise easily classified or segmented. In other words, facilities requesting the audit are expected to be more specialized in their business processes and associated energy consumption. In contrast to some commercial and industrial segments, which may exhibit similar energy consumption patterns, the load profiles and consumption of audit participants may be different, making the archetype program an excellent opportunity to gain additional insight into potential energy savings. The archetype program also provides opportunities for businesses to engage with LDCs for longer-term, strategic energy management.

Table 5-13 summarizes the key elements of the archetype program.

Table 5-13: Commercial Audit and Energy Partners Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All commercial and industrial subsectors	
General program marketing strategy	Targeted marketing	
Customer experience	Self-directed	
Incentive type	Customer rebate	
Measures included	**Existing measures:** All measures are included as potential opportunities in the audit; the building commissioning initiative focuses on chilled water systems	**New and revised measures:** Expand the building commissioning initiative to include all building systems

Best Practices and Reference Programs

Based on the evaluation of the existing programs and the research of best practices, potential enhancements recommended to be included in programs based in the archetype program include:

- Develop a web-based, behavioural component to the program that increases customer awareness and engagement around energy efficiency.
- Consider rebranding the program to showcase enhancements.
- Collect additional data on recommended measures and record them in an electronic database that enables comparison of standardized audit findings against other customer characteristics. Make use of the data collected by an audit program.
- Develop a follow-up procedure that cross-promotes other commercial programs.
- Follow-up should also maintain tracking of audit recommendations that are implemented by participants.
- Consider third party direct installation, enabling “bundled” audit recommendations and the potential for economies of scale.
- Make a strong business case for long term, strategic investment in energy efficiency based on site-specific data collected during the audit.
- Establish technical and financial planning assistance to integrate energy savings potential with capital project planning.
- Provide a platform for LDCs that wish to market themselves to medium and large customers as a trusted energy management partner.

Examples of similar programs in North America include:

- BC Hydro offers customer site investigation, audits, and end use assessment through its Energy Studies and Audits Program.
- FortisBC has a similar Custom Business Efficiency program that offers no-cost walkthroughs, as well as energy modelling studies. FortisBC also offers the Partners in Efficiency Program to engage customers with ongoing technical support and energy efficiency planning.
- Similar models have also successfully achieved energy savings by helping customers integrate energy efficiency with existing capital improvement plans (e.g. National Grid Energy Initiative).

5.3.2.2 C&I Retrofit Archetype Program

Status of Ontario Program

The current Commercial Retrofit Initiative provides participants with incentives to upgrade facilities and measures to reduce electricity consumption. The program has three tracks: prescriptive, custom, and engineered. The prescriptive program offers deemed energy savings values and set rebates, each based on the number of equipment units installed per facility. The engineered track consists of pre-qualified efficiency measures, but applicants have the opportunity to adjust estimated savings on the basis of their facility's characteristics. The custom track addresses eligible measures that are not included in the prescriptive and engineered track.

Almost all commercial and industrial end uses are included in the prescriptive and engineered tracks, and the custom track allows for energy efficiency savings and measure installations that are not captured by either of the other available tracks. This means that all end uses are addressed by the three tracks.

Evaluation Findings

The evaluation of the 2014 Retrofit program highlighted the following[10] items to take into consideration for the archetype program:

- A total of 10,925 projects were completed under the Retrofit Initiative in 2014, up 12% from 2013.
- Results in the prescriptive and engineered tracks were driven by lighting projects, which represented 94% of the total reported energy savings for the two tracks. In the custom track, 77% of energy savings came from non-lighting projects. The custom track accounted for about 38% of the gross Retrofit program savings in 2014.

The share of program savings achieved by the engineered track has grown since 2011. The amount of custom non-lighting savings has also grown over time since 2011.

Archetype Program Description

The commercial Retrofit Archetype Program offers incentives to businesses for installing energy efficiency equipment. As energy costs are not a major cost center for the majority of small to medium sized business, it is recommended that energy efficiency program managers leverage data-driven approaches to solicit participants that are most likely to benefit from energy efficiency retrofits. In combination with strong trade ally partnerships that parallel those in the residential sector, utilities can apply strategic marketing approaches on the basis of their local market composition. Monies traditionally spent on participant-level rebates may yield additional value through the consideration of how such funds can be spent to cross-market the role of the utility in providing low cost, responsible energy management as a quasi-public service.

Table 5-14 summarizes the key elements of the archetype program.

[10] Nexant (2015). Evaluation of 2014 Business Incentive Programs. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

Table 5-14: Commercial Retrofit Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All commercial and industrial subsectors	
General program marketing strategy	Targeted marketing	
Customer experience	Technical assistance	
Incentive type	Customer rebate	
Measures included	**Existing measures:** All commercially feasible measures are included	**New and revised measures:** Place a larger focus on measures and end uses that had low uptake, but are cost-effective

Best Practices and Reference Programs

Commercial and industrial energy efficiency retrofit programs are nearly universal among utility-sponsored market interventions. Some jurisdictions focus on specific subsectors or segments to offer energy savings that are tailored or targeted for relevant building or facility types. For example, MASS Save has a Sustainable Office Design program that offers high performance lighting solutions or custom lighting systems. PG&E also organizes the prescriptive program measures according to typical building types to help improve customer experience when seeking energy efficiency advice, or when evaluating opportunities and rebate offers.

NYSERDA offers a prescriptive and custom (performance-based) pathway for commercial retrofits. NYSERDA also offers the FlexTech program, which engages retired people or volunteers to provide technical assistance with energy efficiency project design. Likewise, NYSERDA operates an HVAC Business Partners program to engage HVAC channel allies in commercial energy efficiency. This program offers training and incentives for the purchase of diagnostic equipment that can be used during commercial retrofit consultations or project scoping and design.

Best practices indicate the need for constant and consistent engagement across multiple platforms. In addition, LDCs may want to consider how it can best provide support with in-kind services for training, marketing, conference, web-tools, and partnerships with other organizations. PG&E and other California programs are examples of situations in which these strategies are being used, and National Grid maintains similar degrees of ongoing engagement in Massachusetts.

Best practices and potential enhancements to include in programs that align with the archetype program, include:

- Determine the role of customer segmentation analysis in targeting facilities that may benefit from the program.
- Segmentation strategy and approach should be flexible to align with LDC market characteristics. In some cases, segmentation may be valuable for identifying

homogenous commercial and industrial segments, whereas geographic segmentation may be most valued for identifying groups of building and facility types likely to have unitary or rooftop AC equipment, for example.

- Engage trade allies in a manner consistent with residential approaches.
- Examine the potential to reward participants with non-rebate incentives, such as public recognition and marketing support.
- Review the performance of existing measures and the measure portfolio relative to cost-effectiveness. For example, avoid focusing administrative resources on low performing prescriptive measures, or ensure administrative costs are commensurate with relative measure performance. Based on the review outcome, it may also be beneficial to include a focus on plug load and refrigeration savings, to add quick-service restaurant equipment, and to market opportunities for savings to national account representatives.
- Continue offering VSD motor control rebates, but consider additional HVAC periphery measures, such as zone controls that may supplement the savings from VSD systems.
- Target additional national accounts for non-lighting HVAC and plug load savings.

5.3.2.3 C&I Small Business Archetype Program

Status of Ontario Program

Ontario currently offers a SBL program. The program historically focused on the compact fluorescent light bulb (CFL) lighting measure, but has now shifted to a light-emitting diode (LED) focus, and mainly addresses the interior lighting end use.

Evaluation Findings

The evaluation of the 2014 SBL program highlighted the following[11] items to take into consideration for the archetype program:

- Increased share of participants from small, rural communities
- Increased share of LED measures among participants
- 68% percent increase in lifetime savings due to shift from away from CFL to LED
- 2014 energy savings exceeded all previous years.

This program has been successful by applying a direct install approach for basic lighting upgrades (CFLs and other cost-effective measures such as T8 lighting or ballasts). The introduction of LED measures vastly increased the savings in 2014 and developed new opportunities for a program that is perceived by IESO stakeholders as having reached market saturation. The shift to LED measures represents a new opportunity for the program to gain additional savings. This opportunity may be mitigated by the additional cost of LED measures relative to CFLs, which may affect program cost-effectiveness.

[11] Nexant (2015). Evaluation of 2014 Business Incentive Programs. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

Archetype Program Description

The Small Business Archetype program focuses on installing highly cost-effective measures while minimizing customers' participation burden with a direct install approach. Businesses in this sector are not often able to redirect resources from critical business operations to examine energy efficiency opportunities. The program offers direct contractor installation of energy efficiency measures. Some measures are free of charge, but businesses also have the option to elect additional measures for installation at a reduced cost.

Table 5-15 summarizes the key elements of the archetype program.

Table 5-15: Commercial Small Business Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All commercial and industrial subsectors, with a focus on small businesses	
General program marketing strategy	Targeted marketing	
Customer experience	Direct install	
Incentive type	Upstream incentive and mark-down	

Measures included	**Existing measures:**
	CFLs and LEDs
		New and revised measures:
		▪ Faucet aerators
		▪ Smart strips, plug load controllers, and occupancy sensors
		▪ LEDs
		▪ Lighting controls
		▪ Water heater pipe wrap
		▪ Water heater blanket
		▪ Rebates for other measures that take advantage of rapid install while people are onsite:
		  ▪ Smart thermostats
		  ▪ Ecobees or other smart controllers for items such as room ACs and dehumidifiers

Best Practices and Reference Programs

Most of the small business programs focus on engaging channel allies to help implement efficiency opportunities. Utility engagement includes training for channel allies, promotional materials, conferences, and workshops. Real-time data on channel ally performance allows utility sponsors to apply motivation and encouragement directly to participating channel partners. Likewise, recognition for leadership and outstanding performance can also benefit the program and channel allies. Most utilities also employ random sampling to verify channel allies' completed projects. Small business programs at PG&E focus on low cost measures, while MASS Save small business programs include an audit and options to facilitate comprehensive retrofits. Some small business programs, such as that of FortisBC, offer small business retrofit kits.

Based on best practices and the 2014 evaluation of the Ontario SBL program, potential enhancements to include in programs aligned with the archetype program, include:

- Consider the business case for the continued shift away from CFL measures towards LEDs
- Add additional energy savings measures that can be installed along with lighting
- Offer discounts on measures that are not cost-effective when offered solely as direct install, but may become cost-effective with some limited customer cost sharing.

5.3.2.4 C&I New Construction Archetype Program

Status of Ontario Program

The High Performance New Construction program (HPNC) has been offered in Ontario since 2011. Like the retrofit initiative, the HPNC has three tracks: prescriptive, engineered, and custom. HPNC encourages efficient construction for new buildings and addresses mainly the building envelope end uses. Participants are facility managers or owners.

Evaluation Findings

The evaluation of the 2014 HPNC program highlighted the following[12] items to take into consideration for the archetype program:

- Through 2014, 489 buildings have been produced in conjunction with the program
- The total savings achieved during this period are approximately 85 GWh
- The custom track is generating the highest annual savings on average
- Top measures from the prescriptive track are lighting; high-volume, low-speed (HVLS) fans; and ENERGY STAR® appliances
- The engineered track benefits most from the installation of lighting measures and unitary air conditioning systems.

Archetype Program Description

The commercial New Construction Archetype Program seeks to influence the design and construction phase of the commercial real estate market. To influence the design of a building, it is important to approach new construction projects at the correct phase. Typically, owners may not learn of the program during the initial consultation and design phase unless their technical consultants for design introduce them to the program. One approach is to view design-and-build firms as channel allies that may influence their customers' decisions around energy efficiency opportunities at an earlier stage in the project. Table 5-16 summarizes the key elements of the archetype program.

[12] Frontier Associates (2015). Final Evaluation Report: High Performance New Construction and Residential New Construction Initiatives. http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification/reports.

Table 5-16: Commercial New Construction Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	All commercial and industrial subsectors, with a focus on new construction	
General program marketing strategy	Targeted marketing	
Customer experience	Technical assistance	
Incentive type	Customer rebate	
Measures included	**Existing measures:** Building envelope	**New and revised measures:** None

Best Practices and Reference Programs

Commercial new construction programs often focus on multi-family residential construction projects. Examples of programs in similar jurisdictions include:

- NYSERDA has a specific program focused on the multi-family residential sector, in addition to its standard commercial offerings, which includes the Flex-Tech design assistance program. NYSERDA also offers design assistance in the form of its zero net and deep-savings technical support initiatives. NYSERDA offers a design team support incentive of $25 to $90 per peak kW saved, depending on the degree of savings over baseline, and a financial incentive for incremental design costs for higher efficiency building designs.
- MASS Save has a new construction program that also incorporates major renovation projects. The prescriptive path of this program has incentives for most commercial end uses and associated measures.
- Eversource Energy (formerly NSTAR Gas & Electric) pursues high efficiency, new commercial construction through aggressive outreach to the engineering and design community. This program also includes tracking infrastructure that helps project future demand for the program.

Based on best practices and the 2014 evaluation of the Ontario HPNC program, the following are potential enhancements to consider for programs that align with the archetype program:

- The current HPNC program design, which allows variances in design as long as the resulting changes to performance do not exceed 30%, is likely necessary for a program that approves building designs (construction design variances often occur). It is recommended to review this allowance against program cost-effectiveness thresholds to ensure alignment between savings and incentives.
- Current participants are mainly building owners or managers, but this may not be the most efficient approach to HPNC participation. An alternative program strategy may be developed around the viewpoint of design-and-build firms as channel allies for LDCs in implementing the program. For example, sales incentives could be offered to design-and-build firms for educating clients about energy efficiency benefits and acquiring approval for higher efficiency building designs.

- Nearly all the HPNC program evaluation recommendations focus on data management and program processes, such as consistent methodology for calculating savings across LDCs, reporting additional details on engineering track projects, monitoring project documentations, and including the assumptions used when calculating simulated energy savings from proposed projects.
- Archetype program staff should evaluate the possibility of increasing program incentives from the standpoint of program cost-effectiveness and net-to-gross implications.

5.3.2.5 Street Lighting

Status of Ontario Program

Street lighting is currently included as a measure in the commercial Retrofit program.

Evaluation Findings

Street lighting projects have not been singled out in program evaluations of the commercial Retrofit program.

Archetype Program Description

For the purpose of modelling the achievable potential, street lighting was defined as a subsector since it is a unique end use in terms of energy use metering and reporting, as well as ownership and operation. This archetype program focuses on investigating and identifying street lighting retrofit opportunities and educating municipalities about potential benefits from street lighting retrofits. Street lighting infrastructure may be improved by new control and lighting technology that is significantly more efficient than historical street lighting technologies and controls.

Table 5-17 summarizes the key elements of the archetype program.

Table 5-17: Street Lighting Archetype Program Summary

Program Archetype Element	Description	
Target sector and segments	Street lighting	
General program marketing strategy	Targeted marketing	
Customer experience	Technical assistance	
Incentive type	Customer rebate	
Measures included	**Existing measures:** Street lighting	**New and revised measures:** None

Best Practices and Reference Programs

Street lighting projects are a relatively new trend in municipal and commercial retrofits, largely due to the maturation of LED technology and smart grid technology. Additional data on instantaneous street light demand can be combined with new control and lamp technology to implement smart lighting systems for public safety and aesthetics. Example projects include networked street lighting projects by Florida Power & Light, Baltimore Gas & Electric, ComEd, and Pepco that were initiated in early 2015. Also in 2015, the Northeast Energy Efficiency

Partnership has published white papers that explore the potential for street lighting savings opportunities.

Potential enhancements to consider for programs that align with this archetype program include:

- Municipal street lighting project may represent a cost-effective source of efficiency for LDCs. There are fewer potential participants, which can reduce marketing and outreach costs; nevertheless, a smaller market also increases risks associated with not meeting targets due to low participation.
- Participation in street lighting retrofit projects depends on municipal government budget priorities and the availability of funding, and may make estimating participation difficult. LDCs could engage in a form of project pipeline surveillance to track and identify opportunities for assisting municipalities with such projects as appropriate. In fact, many LDCs are municipal public enterprises and may implement street lighting retrofits to reduce operating costs, without soliciting other parties for participation.

6 LDC Profiles

One of the main objectives of the achievable potential study was to develop the potential from the bottom-up for each LDC. To estimate the savings potential for each LDC, it was necessary to develop each LDC's unique profile. Each profile defined the LDC's customer segmentation and its energy use by sector and subsector. When compared to a top-down approach, the bottom-up analysis captured market differences between LDCs, and provided an energy efficiency potential that was a more accurate reflection of the opportunities within each specific LDC. This section describes the methodology of how these LDC profiles were developed, and presents an example of an LDC profile. Recommendations for future studies are included in Section 12.

6.1 Methodology

The approach to developing the 75 LDC profiles included the following subtasks:

- Segment LDC customers by sector, by subsector, by access to natural gas, by climate region, and by end use.
- Adjust and calibrate LDC profiles to changes in sales and customer forecasts.

6.1.1 Segment LDC Customers by Sector and by Subsector

The first step in developing a bottom-up LDC profile was to determine energy share distributions for the residential, commercial/institutional, and industrial sectors and then segment each sector by subsector (i.e. building type). The sectors and subsectors are summarized in Table 6-1. The definition of each subsector is provided in Appendix A: Subsector Definitions.

To develop the sector and subsector energy load profiles for each LDC, both primary and secondary data were used. Of the 75 LDCs, 32 LDCs (accounting for 82% of the base year electricity load) submitted primary data to inform the 2014 energy consumption profiles by rate class; 20 LDCs submitted segmentation data by NAICS code. The secondary data sources used in developing the LCD profiles are summarized in Table 6-2.

Table 6-1: Sectors and Subsectors

Sector	Residential	Commercial	Industrial
Subsector	Single family Row house Multi-unit residential building (MURB) low rise Multi-unit residential building (MURB) high rise Other residential	Large office Small office Non-food retail Food retail Restaurant Lodging Hospitals Nursing homes Schools Universities Warehouses (wholesale) Data centers TCU Other commercial buildings	Primary metals Paper manufacturing Auto-parts manufacturing Chemical manufacturing Plastic and rubber manufacturing Food and beverage manufacturing Fabricated metals Non-metallic minerals Wood products manufacturing Petroleum refineries Electronics manufacturing Mining Agriculture Miscellaneous industrial

Table 6-2: Secondary Data Sources Used in Developing LDC Profiles

Source	Notes	Web Link (if available)
2014 Ontario Energy Board (OEB) Yearbook	Used to derive top-line energy consumption by rate class, and residential customer counts	http://www.ontarioenergyboard.ca/OEB
2014 MPAC data	Used to derive square footage and premise count data by residential and commercial building type	https://www.mpac.ca/ (IESO purchased dataset)
Hemson study	Used to derive square footage data for office, retail, and food retail building types	Not applicable (IESO commissioned study on office and retail commercial floor space)
2014 Dun & Bradstreet data	Used to derive square footage and premise counts by commercial building type	http://www.dnb.com/ (IESO purchased dataset)
Public-sector database	Used to derive total energy consumption for schools, universities, hospitals, and TCU	http://www.ontario.ca/data/energy-use-and-greenhouse-gas-emissions-broader-public-sector
Nexant analysis	Used to derive average annual energy consumption by industrial subsector by facility size	Not applicable
NRCan 2009 Commercial Building SCIEU Database	Used to establish commercial subsector EUIs for office, school, university, warehouse, nursing home, lodging, food retail, and non-food retail subsectors	http://oee.nrcan.gc.ca/corporate/ statistics/neud/dpa/menus/scieu/2009/tables.cfm
2003 United States EIA Commercial Buildings Energy Consumption Survey (CBECS)	Used to establish EUIs for remaining commercial subsectors (not included in NRCan data)	http://www.eia.gov/consumption/ commercial/data/2003/
NRCan 2011 Residential Building SCEU Database	Used to establish residential subsector building type EUIs	http://oee.nrcan.gc.ca/corporate/ statistics/neud/dpa/menus/sheu/2011/tables.cfm
United States EPA & Lawrence Berkeley Lab, 2001 Data Center Report	Used to establish data center building EUI	http://eetd.lbl.gov/sites/all/files/ lbnl_version_procieee_embargoed-1-1.pdf
Statistics Canada: 2006 Census (E1561, Defined Household Income Status)	Used to establish low income households	http://www12.statcan.ca/census-recensement/2006/dp-pd/hlt/97-563/Index-eng.cfm
ANSI/ASHRAE/IESNA Standard 90.1-2007	Used ASHRAE *Appendix B – Building Envelope Climate Criteria* to identify international climate zones and establish mapping of LDCs to climate zones; Tables B-2 and B-3	Not applicable

The following steps were used to develop LDC profile segmentation by sector and subsector:

- Develop LDC bottom-up kWh estimate using secondary sources, which are summarized in Table 6-2. The bottom-up methodology is summarized in Table 6-3.
- Compare the bottom-up calculated energy use data with data provided by the LDC (when applicable) to derive a final LDC energy load distribution by sector and subsector.
- Sum up LDC totals to derive provincial calculated total.
- Determine each LDC's 2014 annual energy use for residential and non-residential sectors from reported data in the 2014 OEB Yearbook.
- Compare bottom-up calculated LDC totals and calculated provincial total with 2014 OEB Yearbook reported data. Review the calculated results against OEB-reported data to identify significant differences. Significant difference was defined as:
    - Bottom-up LDC calculated total was not within ± 20% of the OEB Yearbook reported total for the LDC
    - Provincial calculated total was not within ± 5% of OEB Yearbook reported total.
- Calibrate the LDC bottom-up calculated profile to the top-line reported 2014 OEB Yearbook energy sales. This was accomplished by applying the LDC energy load distribution (in percentage terms) by sector and subsector to top-line reported 2014 OEB Yearbook energy sales. This meant that the total energy use per residential and non-residential sectors by LDC was equal to the 2014 OEB Yearbook data, while the energy use profile by subsector was based on the LDC data and supplemented with secondary data to fill the gaps.
- Review the draft profiles with each LDC to obtain additional input and data. During the review process, 45 LDCs participated in meetings or conference calls and 64 LDCs provided feedback, which included comments or revised data.
- Adjust the LDC profiles with revised LDC data when applicable.

Table 6-3: Bottom-up Methodology to Define Subsector Energy Use

Profile Element	Description and Calculation Step	Sources
Residential sector		
kWh per premise	Energy use intensity (annual kWh consumption/premise) by subsector, climate zone, and electric heating saturation	▪ 2014 MPAC Database ▪ NRCan 2011 Residential Building SCEU Database ▪ 2014 OEB Yearbook
Number of premises per subsector	Number of residential premises by subsector	
Total kWh per subsector	Within each subsector, multiply energy use intensity by number of premises to derive total electricity consumption within each subsector	
Non-residential MURB	Identify the share of multi-unit residential building (MURB) load that is part of the non-residential rate class; subtract and move associated load to commercial load profile	
LDC total kWh per subsector	Sum total electricity consumption by subsector to derive total residential electricity consumption bottom-up estimate by LDC	
Percent profile per LDC	Sum total electricity consumption by subsector and calculate percentage contributed by each subsector to derive percentage profile	
Commercial sector		
kWh per square foot	Establish energy use intensity (annual kWh/square foot) by subsectors by climate zone	▪ Hemson Data ▪ NRCan 2009 ▪ Commercial Building SCIEU Database ▪ 2014 Dun & Bradstreet Database ▪ 2003 CBECS Database ▪ 2014 MPAC Database ▪ RECS Data ▪ 2014 OEB Reporting ▪ NIBS
Square foot per subsector	Determine the total amount of floor space area (square footage) within each of the subsectors	
Total kWh per subsector	Within each subsector, multiply energy use intensity by total amount of floor space area to derive total electricity consumption within each subsector	
Non-residential MURB	Add in share of MURB load that is within the commercial sector	

Profile Element	Description and Calculation Step	Sources
kWh per public sector	For commercial subsectors which are predominantly public-sector facilities, identify total electricity consumption in kilowatt-hours (kWh) reported from facilities in Public Sector database by LDC	▪ Public Sector Database
LDC Total kWh per subsector	After adding in share of MURB load and public sector facilities in commercial sector, sum total electricity consumption by subsector to derive total commercial electricity consumption bottom-up estimate by LDC	
Percent profile per LDC	Sum total electricity consumption by subsector and calculate percentage contributed by each subsector to derive percentage profile	
Industrial sector		
kWh per premise	Establish energy use intensity (annual kWh consumption / premise) by facility size (small / medium / large) by subsector	▪ 2014 Dun & Bradstreet Data ▪ Primary data from LDCs
Number of premises per subsector	Determine the number of premises by subsector and size (using number of employees as a proxy for size)	
Total kWh per subsector	Within each subsector, multiply energy use intensity for each facility size by number of premises within that facility size bin to derive total energy consumption within each subsector	
LDC total kWh per subsector	Sum total energy consumption by subsector to derive total industrial energy consumption by LDC.	
Percent profile per LDC	Sum total electricity consumption by subsector and calculate percentage contributed by each subsector, to derive percentage profile.	

The development of the energy use profile for the residential and commercial sectors using the bottom-up approach relied on energy intensity and premise counts. Due to the significant variation in energy use in industrial facilities, an approach was used that took into consideration the size of the facilities and the associated energy use. The following steps outline the approach that was used to develop the bottom-up estimate of electricity use for the industrial sector.

Step 1: Define Energy Use by Size

Small, medium, and large facilities were defined for three types of energy intensive industrial subsectors:

- A: Low energy intensity subsectors
- B: Medium energy intensity subsectors
- C: High energy intensity subsectors

The facility sizes were defined by the annual MWh per facility, which was based on the average annual hours of operation and average MW demand, as summarized in Table 6-4.

Table 6-4: Industrial Energy Use per Facility Size

	A: Low Energy Intensity			B - Medium Energy Intensity			C - High Energy Intensity		
	Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
Annual hours	1,013	2,700	8,064	1,013	3,150	8,400	1,920	3,840	8,400
Average MW	0.08	0.8	1.5	0.1	1.0	2.5	0.1	1.0	3.0
Annual MWh per Facility	81	2,160	12,096	101	3,150	21,000	192	3,840	25,200

Step 2: Classify Subsectors by Energy Intensity

Each of the subsectors was classified according to one of three types of energy intensity, as summarized in Table 6-5.

Table 6-5: Industrial Subsector Energy Intensity Classification

Type of Energy Intensity Subsector	Subsector
A: Low energy intensity	Fabricated metals
	Miscellaneous industrial
	Electronic manufacturing
	Paper manufacturing
B: Medium energy intensity	Food and beverage manufacturing
	Auto-parts manufacturing
	Wood products manufacturing
	Agricultural
C: High energy intensity	Primary metals
	Non-metallic minerals
	Plastic and rubber manufacturing
	Chemical manufacturing
	Petroleum refineries
	Mining

The definition of facility sizes and the classification of the industrial subsectors by energy intensity were based on an analysis of data provided by LDCs and assessments of Ontario's industrial sector, completed in previous studies.

Step 3: Determine Number of Facilities by Size

To determine the number of small, medium, and large facilities in each subsector, data from Dunn and Bradstreet were used. This data provided facility sizes by number of employees and square feet. The definition in Table 6-6 was used to define small, medium, and large facilities based on the number of employees.

Table 6-6: Industrial Facility Size by Number of Employees

Size	Number of Employees
Small	≤25
Medium	26–250
Large	>250

The data was screened to ensure that the size of the facilities in terms of square feet was reasonable in terms of the number of employees.

Step 4: Determine Annual Electricity Use by Subsector per LDC Region

To derive the estimated annual electricity use by subsector, the appropriate annual electricity use (i.e. small, medium, or large defined by energy intensity) was multiplied by the number of facilities per subsector by size. For example, for the fabricated metal subsector in an LDC region, the total annual electricity use was the sum-product of the annual electricity use for low energy intensity, small, medium, and large facilities, and the number of small, medium, and large facilities in the LDC's fabricated metal subsector (based on the Dunn and Bradstreet data analysis).

6.1.2 Segment LDC Customers by Access to Natural Gas

As part of the LDC load profile development, the availability of natural gas to residential customers in each of the 75 LDC service territories was researched. This was important because the customers with access to natural gas tended to have gas-fueled space heating and water heating equipment, which significantly reduced their electricity load when compared with customers who used electrically-fueled space heating equipment. Data from the MPAC database identified the counts of space heating equipment and fuel-type within each LDC service territory. These counts were used to calculate an electric space heat saturation value (i.e. the percentage of homes that used electrically fueled equipment to heat their homes). The LDCs were grouped into three categories to identify their service territories as either having low, moderate, or high saturations of electric space heat (see table below). These categories were used to adjust the researched average household space heating electric energy consumption within each subsector up or down. That is, LDCs with high electric heat saturation had their space heating consumption adjusted up, while LDCs with low electric heat saturation had their space heating consumption adjusted down.

6.1.3 Segment LDC Customers by Climate Region

The LDC profiles were further segmented by mapping the LDCs to a climate region. This enabled the identification of variances in measure savings due to weather impacts, thereby allowing a more accurate estimation of the specific savings opportunity for each LDC. The climate regions were based on International Climate Zones from ASHRAE Standard 90.1-2007. Ontario includes Climate Zones 5, 6 and 7, as illustrated in Figure 6-1. Since Hydro One customers are located across the province, a weighted average approach was applied in the development of Hydro One's segmentation and load profiles.

Figure 6-1: Ontario Climate Zones

6.1.4 Segment LDC Customers by End Use

End use profiles were developed for each sector and Table 6-7 provides a summary of the end uses for the residential, commercial, and industrial sectors. End use profiles from the IESO's End Use Forecaster (EUF) model were used to develop the end use profiles for this study.

Table 6-7: End Uses per Sector

Residential Sector	Commercial Sector	Industrial Sector
Lighting	Lighting interior general	Motors pumps
Plug load	Lighting interior high bay	Motors fans blowers
Space heating	Lighting exterior	Motors other
Space cooling	Cooling direct expansion (DX)	Compressed air
Ventilation and circulation	Cooling chillers	Process heating
Domestic hot water	HVAC ventilation	Process cooling
Refrigerators	Heating	Process specific
Freezers	Domestic hot water	Electrochemical
Dishwashers	Cooking	HVAC
Clothes dryers	Refrigeration	Lighting
Clothes washers	Computer equipment	Other
Cooking	Other plug loads	
Dehumidifiers	Miscellaneous	
Miscellaneous		

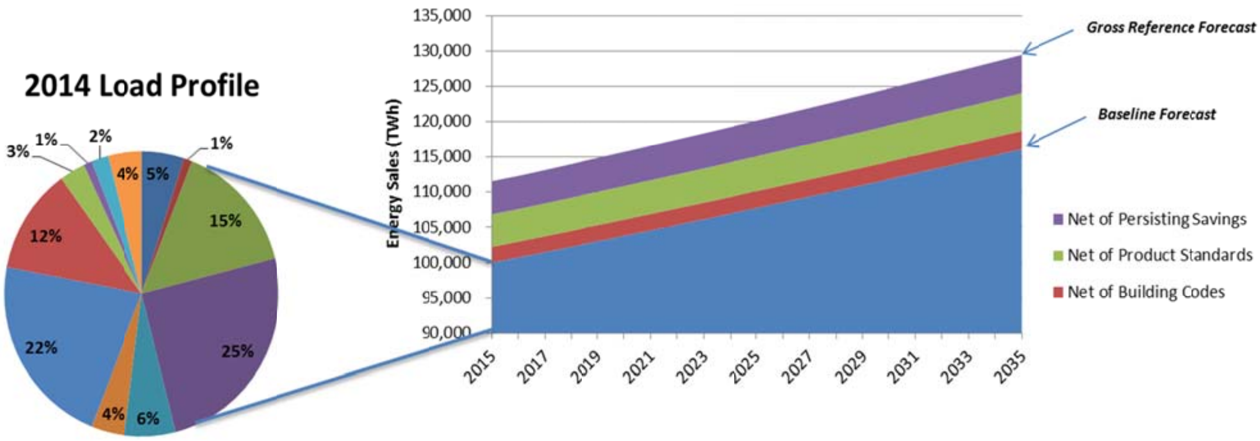
6.1.5 Adjust LDC Profiles to Changes in Sales and Customer Forecasts

Nexant consulted with IESO and its stakeholders to understand how projected customer composition was incorporated into each LDC's energy forecast. LDC load forecasts were adjusted to capture annual changes in total customers and customer mix that were expected to occur between 2015 and 2020. The load forecasts were informed by:

- LDC load forecast data, including the impact of significant load loss due to the closure of customer facilities since 2014.
- IESO Gross Load Forecast.

Figure 6-2 shows a simplified example of how the baseline load forecast was established for each LDC.

Figure 6-2: Simplified Illustration of Baseline Load Forecast Development by LDC



The following steps were followed to develop the baseline forecast:

- Disaggregate base year load by sector and subsector: This step is described in Section 3.1.
- Disaggregate base year load by end use: This step is described in Section 3.4.
- Apply IESO's gross reference forecast: Nexant applied IESO's sector and subsector drivers, including sector energy sales growth rates, to develop a gross reference forecast (2015 to 2035) consistent with the IESO EUF model's gross reference forecast. The IESO gross reference case forecast included consideration of natural conservation, which was the improvement of energy efficiency that would occur in the absence of energy efficiency programs.
- Apply base year load profiles to LDC base year top line gross sales: Nexant applied each LDC's base year load profile (energy sales distribution *percentages* by sector, by subsector, and by end use) to the top-line energy sales for the base year (2014).
- Subtract codes and standards and persisting savings from gross forecast: Nexant worked with IESO's staff to obtain the respective energy savings through the long term study horizon anticipated by end use due to the adoption of more stringent building codes (e.g. HVAC and lighting) and the adoption of more efficient product standards (e.g. appliances). Data provided by IESO summarized the persistent savings by measure from 2015, and Nexant allocated the appropriate persistent savings by LDC, by sector, and by end use and subtracted the savings from the gross reference forecast. These codes and standards, and persistent savings were subtracted from the top-line gross reference forecast to establish the baseline forecast.
- Adjust end use and subsector load shares by year (as appropriate): To account for changes to the end use and customer subsector mix over time, compound annual growth rates (CAGR) for end use energy intensity estimates from the EUF reference forecast were reviewed and applied to the base year IESO zone load profiles so that changes in the end use shares of energy load over time could be captured. Additionally,

changes in the total annual customers by IESO zone were researched from IESO's gross load forecast and from office and retail space forecasts so that adjustments to the customer mix (sales distributions by sector by subsector) over time could be accounted for by IESO zone.

By properly accounting for these factors, the short term potential study estimated the electricity use from 2015 to 2020, in the absence of the impact from CDM programs and from the persistence of savings from programs delivered prior to 2015; standards and codes; and other conservation programs.

6.2 LDC Profiles and Sector End Use Profiles

Each LDC's energy use profile was provided to the respective LDC. Due to the commercial sensitivity of LDC information, only aggregated provincial data is provided in this report. An example of an LDC profile is provided in Figure 6-3, while an example end use profile is provide in Table 6-8. The definitions of the subsectors are provided in Appendix A: Subsector Definitions.

The LDC profiles were used to develop the baseline and reference forecast for the potential analysis, which is discussed in Section 7.

Figure 6-3: Example of LDC Profile Summary

Version	Version 2			
LDC Name	LDC			Source
Climate Zone	5			ANSI/ASHRAE/IESNA Standard 90.1-2007 (12)
Rate Class Profile	Rate Class	2014 Sales (%)	2014 kWh Sales	
	Residential	**29.4%**	**150,516,625**	*2014 OEB RRR Reporting (1)*
	Non-Residential	**66.7%**	**340,880,292**	*2014 OEB RRR Reporting (1)*
	General Service < 50 kW	9.4%	47,965,405	*2014 OEB RRR Reporting (1)*
	General Service >= 50 kW	36.7%	187,466,920	*2014 OEB RRR Reporting (1)*
	Large User	19.3%	98,447,967	*2014 OEB RRR Reporting (1)*
	Street Lighting	0.4%	2,236,000	*2014 OEB RRR Reporting (1)*
	Other	3.4%	17,622,083	*2014 OEB RRR Reporting (1)*
	Total	**100.0%**	**511,255,001**	

Sector Profile	Residential - 2014 kWh	Non-Residential - 2014 kWh		Source
	150,516,625	340,880,292		*2014 OEB RRR Reporting (1)*
		Commercial	Industrial	
	Sales Distribution (%)	50%	50%	*LDC Segmentation Data*
	Total Sales (kWh)	170,538,127	170,342,165	*Calculated*

		Final Segmentation (applied to 2014 OEB Consumption)		
Subsector Profiles	Residential Subsectors	2014 (%)	2014 (kWh)	Source
	Single Family	87%	131,451,013	*2014 MPAC Database (2), NRCan Res Data (9)*
	Row House	6%	9,492,721	*2014 MPAC Database (2), NRCan Res Data (9)*
	Other Residential	1%	1,309,975	*2014 MPAC Database (2), NRCan Res Data (9)*
	Multi-Res Low Rise	5%	8,262,916	*2014 MPAC Database (2), NRCan Res Data (9), 2014 OEB RRR Reporting (1)*
	Multi-Res High Rise	0%	0	*2014 MPAC Database (2), NRCan Res Data (9), 2014 OEB RRR Reporting (1)*
	Total	**100%**	**150,516,625**	

Industrial Subsectors	Final Segmentation (applied to 2014 OEB Consumption) 2014 (%)	2014 (kWh)	Source
Primary Metals	1%	1,622,559	*LDC Segmentation Data*
Paper Mfg	1%	1,710,802	*LDC Segmentation Data*
Auto Parts Mfg	51%	86,117,792	*LDC Segmentation Data*
Chemical Mfg	5%	9,069,492	*LDC Segmentation Data*
Plastic & Rubber Mfg	5%	8,761,742	*LDC Segmentation Data*
Food & Beverage Mfg	17%	28,386,011	*LDC Segmentation Data*
Fabricated Metals	18%	30,112,539	*LDC Segmentation Data*
Non-Metallic Minerals	0%	778,632	*LDC Segmentation Data*
Wood Products Mfg	1%	2,512,856	*LDC Segmentation Data*
Petroleum Refineries	0%	0	*LDC Segmentation Data*
Electronic Mfg	0%	0	*LDC Segmentation Data*
Mining	0%	0	*LDC Segmentation Data*
Agricultural	0%	746,703	*LDC Segmentation Data*
Miscellaneous Industrial	0%	523,037	*LDC Segmentation Data*
Total	**100%**	**170,342,165**	

Table 6-8: Example of End Use Profile for Residential Sector in Climate Zone 5

	Space Heating	Space Cooling	Domestic Hot Water	Ventilation and Circulation	Lighting	Cooking	Refrigerators	Freezers	Clothes Washers	Clothes Dryers	Dishwashers	Plug Load	Miscellaneous	Dehumidifiers
Single family	14.2%	11.5%	17.5%	1.6%	18.6%	4.5%	7.0%	1.5%	0.6%	4.6%	2.0%	13.4%	2.6%	0.3%
Row house	18.9%	8.8%	19.8%	1.2%	16.9%	4.1%	7.2%	1.5%	0.6%	4.2%	1.9%	12.2%	2.4%	0.3%
MURB low rise	24.8%	7.1%	21.9%	1.0%	14.2%	3.5%	7.7%	1.6%	0.5%	3.5%	1.6%	10.3%	2.0%	0.2%
MURB high rise	27.1%	8.6%	21.5%	1.2%	12.7%	3.1%	8.0%	1.7%	0.4%	3.1%	1.4%	9.2%	1.8%	0.2%
Low income	19.7%	10.0%	19.8%	1.4%	16.4%	4.0%	6.6%	1.4%	0.6%	4.0%	1.8%	11.8%	2.3%	0.3%
Other residential buildings	19.7%	10.0%	19.8%	1.4%	16.4%	4.0%	6.6%	1.4%	0.6%	4.0%	1.8%	11.8%	2.3%	0.3%

7 Base Year Energy Use and Reference Case Forecast

The previous section described the process used to develop the 2014 base year energy use and 2015–2020 energy use load forecasts for each LDC. The individual LDC energy use, for the base year and load forecast, was aggregated to derive the provincial energy 2014 base year use and 2015–2020 reference case forecast. The results are presented and discussed in this section.

The base year electricity use and reference case forecast provide the reference point to determine the potential savings. The estimated technical, economic, and achievable potential scenarios, and the comparison with the base year and reference case, are discussed in the subsequent sections (Section 8 to Section 11).

7.1 Methodology

The 2014 base year electricity loads and 2015–2020 load forecasts were developed for each LDC, as described in Section 6. The provincial electricity 2014 base year loads and 2015–2020 load forecasts were derived from aggregating the loads of the LDCs.

7.2 Base Year: 2014

Figure 7-1 illustrates the portion of electricity use contributed by each of the three sectors in the 2014 base year. The largest portion of electricity was consumed by the commercial sector (57,031 GWh/year, or 48% of the total electricity use), followed by the residential sector (39,461 GWh/year, or 33%) and the industrial sector (21,951 GWh/year, or 19%).

The breakdown of electricity use in the base year by subsector and end use are summarized in Figure 7-2 through Figure 7-7.

In the residential sector:

- The single family subsector accounted for close to 76% of the total electricity use.
- Three end uses account for 45% of the electricity use in the residential sector: space heating, lighting, and plug loads. Nexant utilized the end use profiles from the IESO EUF model (which estimated electric space heating as the largest share of residential load). This aligned with other data sources, including U.S. EIA data and NRCan.

In the commercial sector:

- Slightly more than 52% of the total electricity load was used by small offices, multi-unit residential common areas, other (miscellaneous) commercial buildings, and non-food retail.
- General interior lighting used about 31% of the total electricity, while an additional 20% was used by HVAC ventilation and miscellaneous equipment.

In the industrial sector:

- Nine of the 15 subsectors each used between 5% and 15% of the total electricity use, with the largest amounts used by the miscellaneous industrial and auto-parts manufacturing subsectors.
- Other motors, pump motors, and compressed air used 55% of the electricity.

Figure 7-1: Ontario Base Year (2014) Electricity Use by Sector

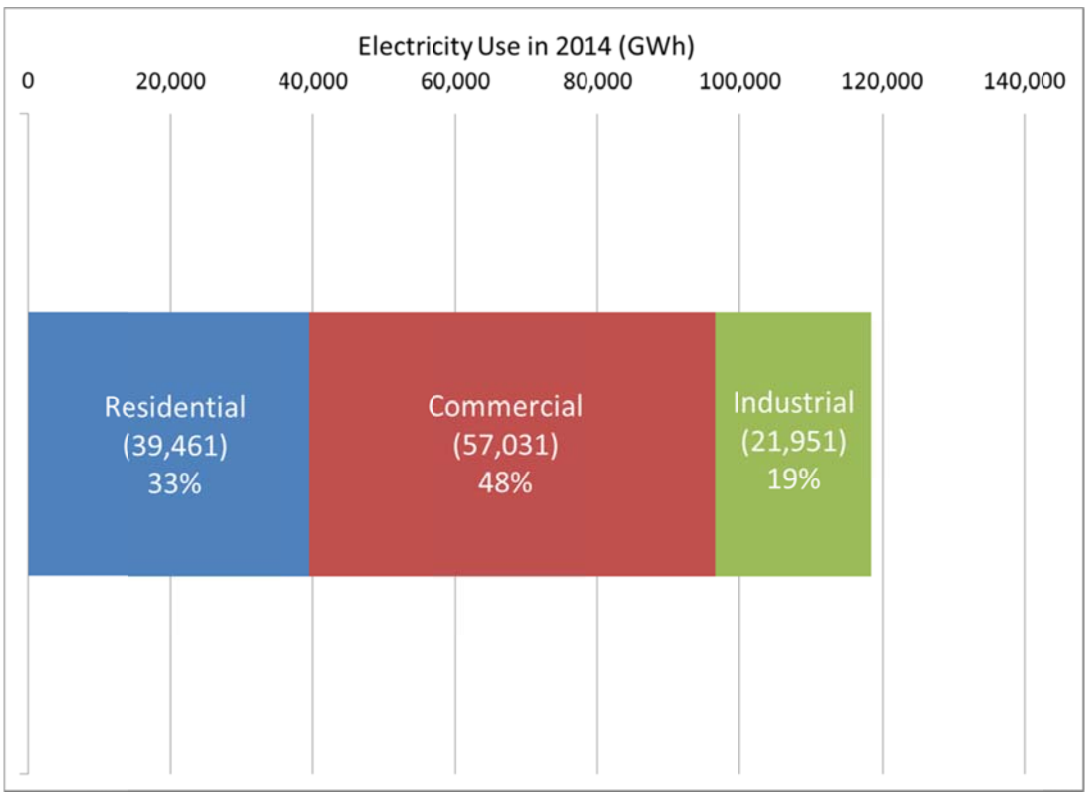


Figure 7-2: Residential Sector Base Year (2014) Electricity Use by Subsector (GWh/year)

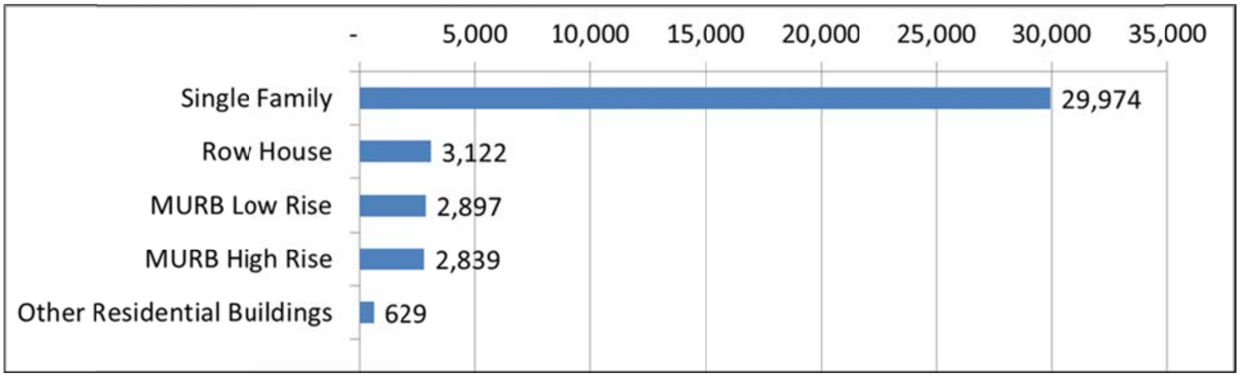


Figure 7-3: Residential Sector Base Year (2014) Electricity Use by End Use (GWh/year)

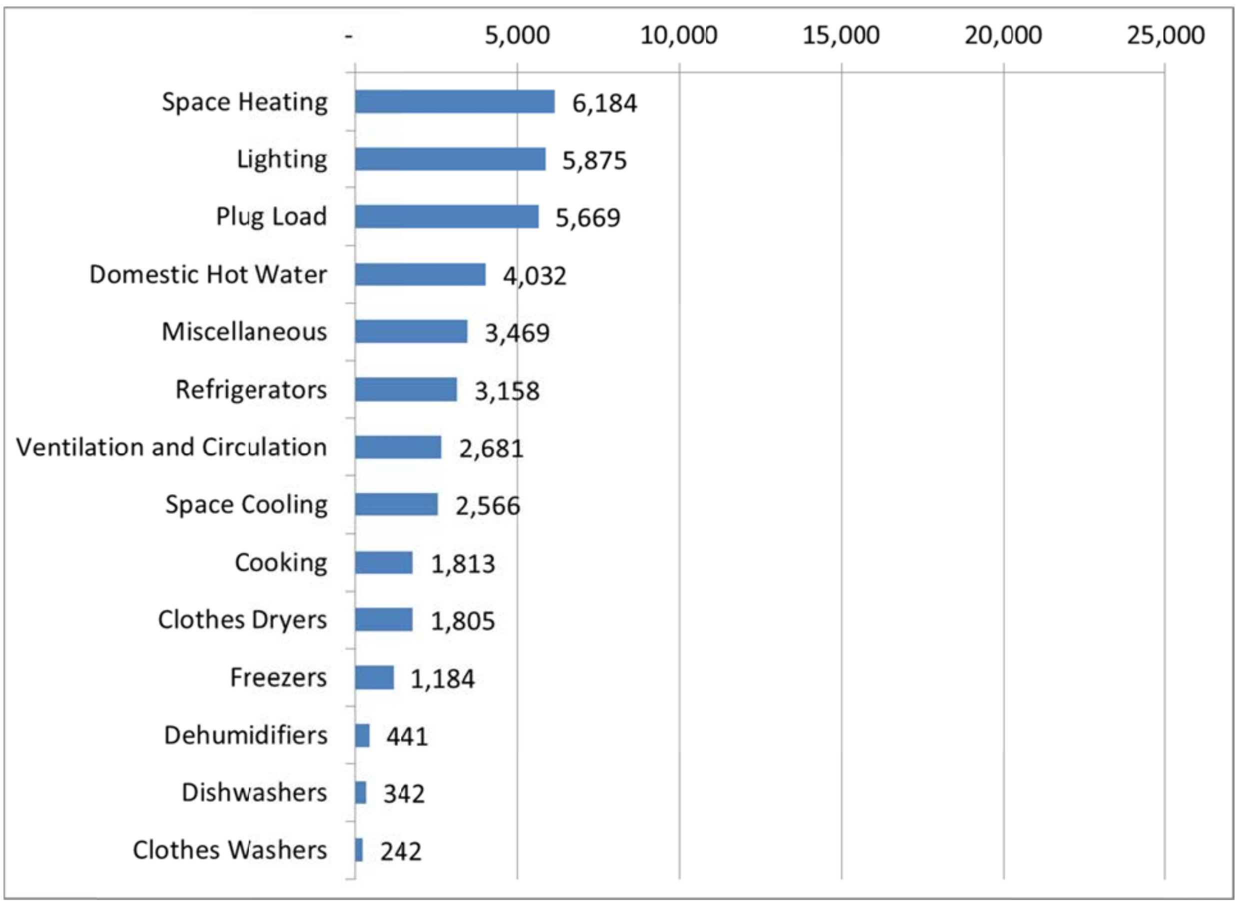


Figure 7-4: Commercial Sector Base Year (2014) Electricity Use by Subsector (GWh/year)

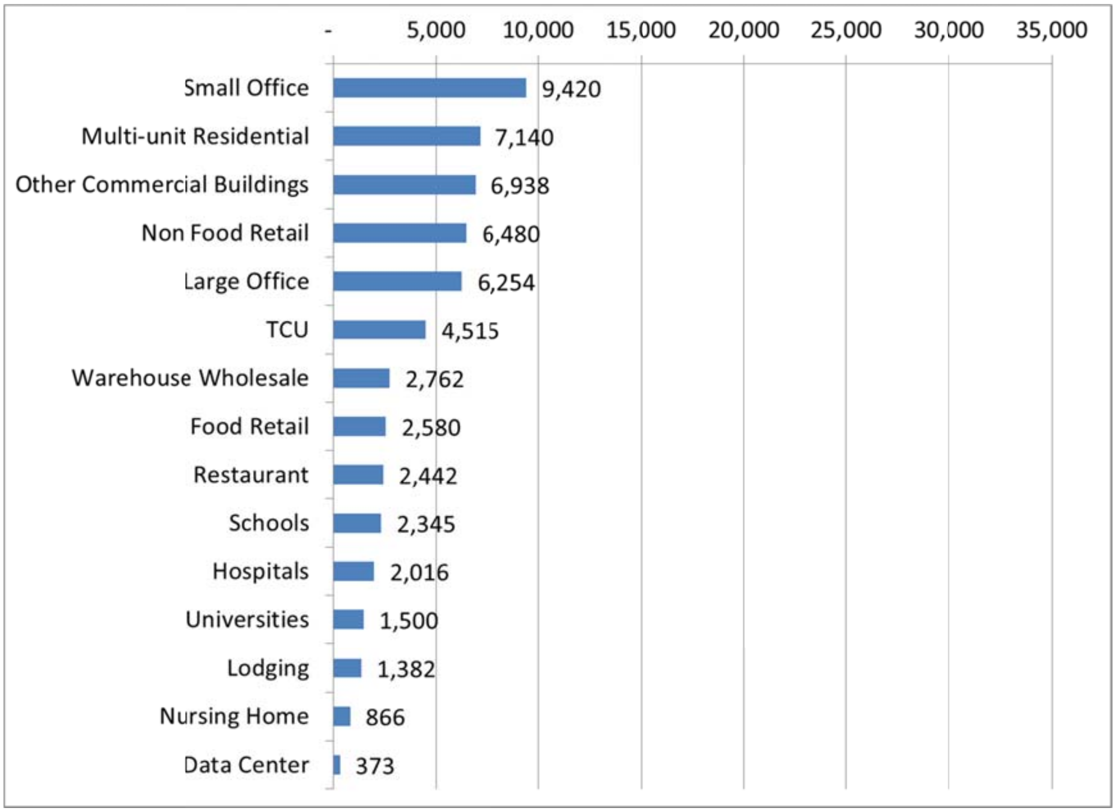


Figure 7-5: Commercial Sector Base Year (2014) Electricity Use by End Use (GWh/year)

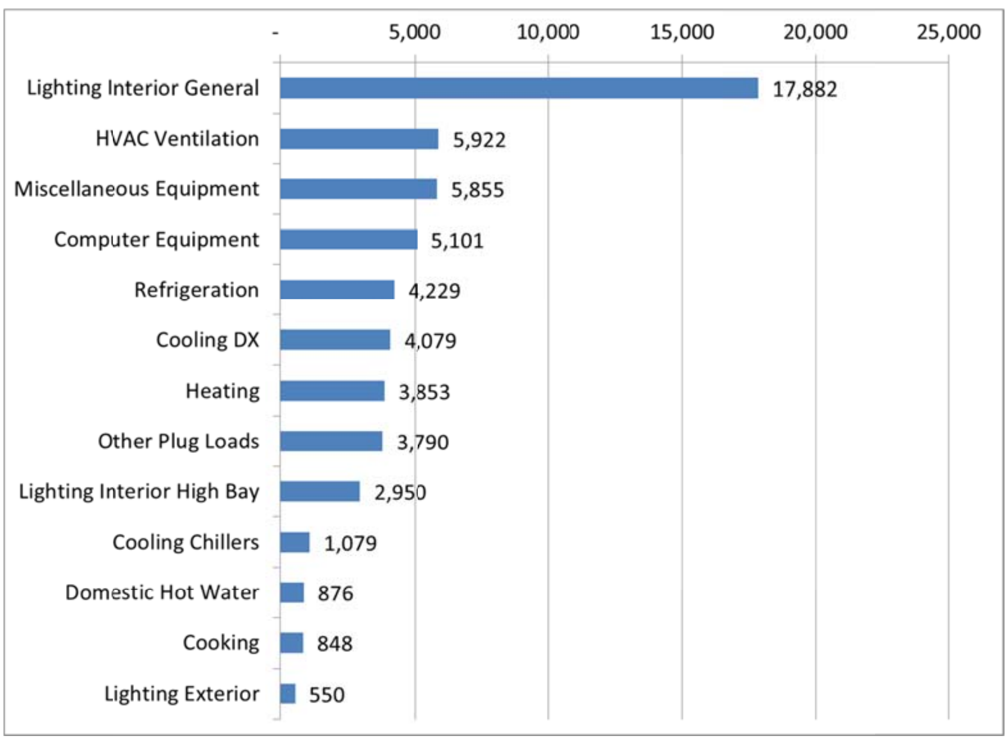


Figure 7-6: Industrial Sector Base Year (2014) Electricity Use by Subsector (GWh/year)

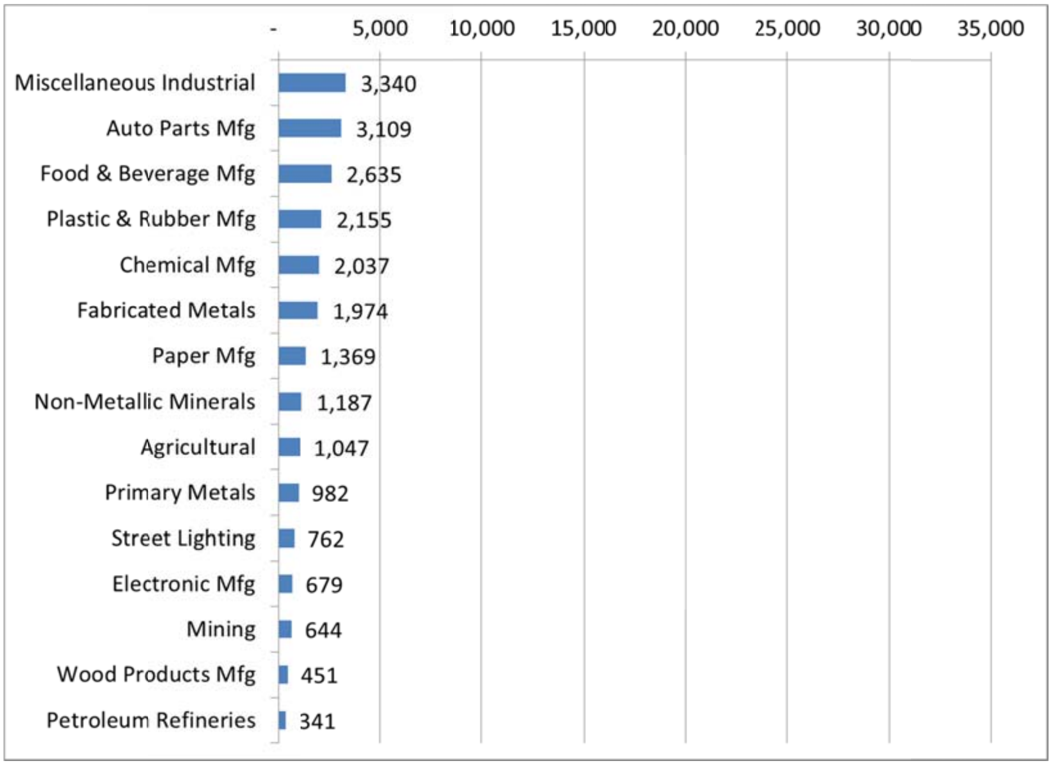
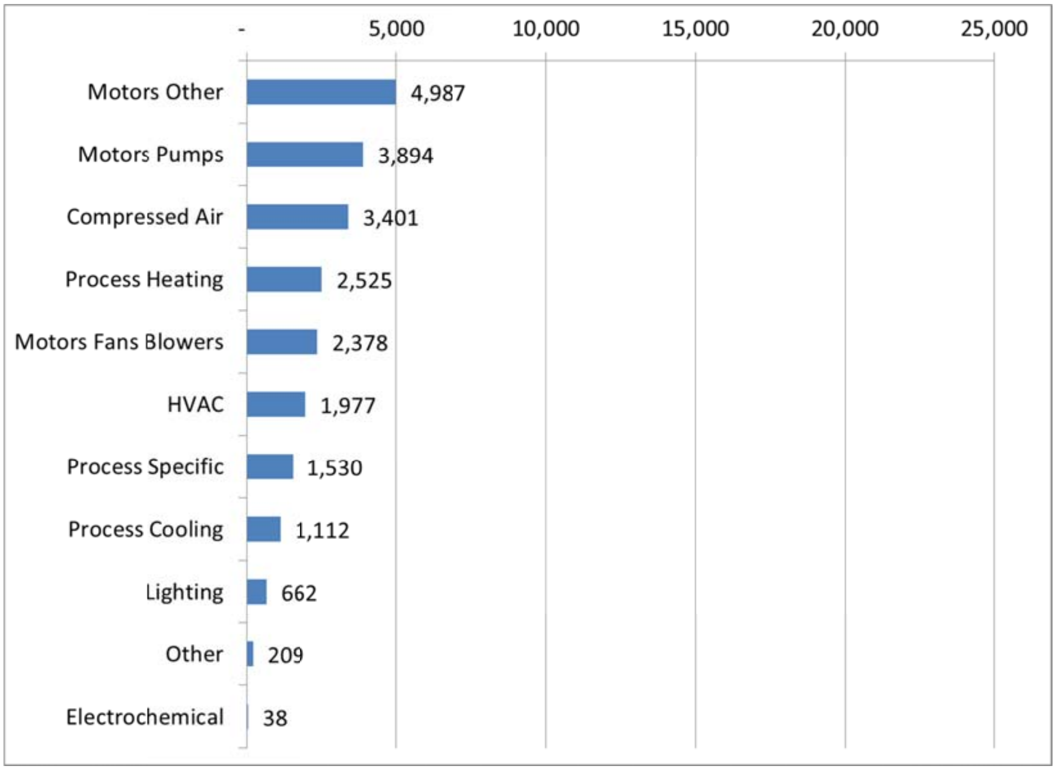


Figure 7-7: Industrial Sector Base Year (2014) Electricity Use by End Use (GWh/year)



7.3 Reference Case Forecast: 2015–2020

The load forecast for 2015 to 2020 estimated a total increase in electricity use of 0.9% from 118,443 GWh in 2014 to 119,515 GWh in 2020, as illustrated in Figure 7-8. The commercial sector is expected to account for the largest increase in electricity use: 2,451 GWh from 2014 to 2020 (4.3% increase). Total commercial floor space will likely grow from 3,205 million square feet in the year 2015 to 3,456 million square feet by 2020. This will result in the growth of electricity consumption in the commercial sector. Efficiency improvement in lighting technologies and heat pumps are anticipated. These improvements will offset some growth in the electricity usage.

The residential sector electricity use is expected to decrease by 5.5% to 37,296 GWh in 2020. Household numbers in Ontario are projected to grow from 5.4 million in 2015 to 5.83 million in the year 2020. However in parallel, several factors are expected to result in decreased intensity. Some of the reasons why electricity consumption growth rate is projected to decrease are:

- More efficient lighting (CFLs and LEDs)
- Continued conversion of space heating and water heating fuel share
- Rising share of multi-residential dwellings
- More efficient household appliances

The industrial sector electricity use is expected to increase by 3.6% to 22,738 GWh in 2020. Industrial output will continue to recover from the global economic crises of 2008/2009 and the Ontario economy will likely undergo significant economic restructuring. It is not expected that the industrial sector will grow to pre-recessionary levels.

The 2015–2020 provincial load forecasts by subsector and end use are summarized in Figure 7-9 to Figure 7-14. The following can be observed from the forecast:

- In absolute terms, the largest decrease in electricity consumption in the residential sector is expected to occur in the single family subsector. At the end use level, space heating and lighting show the largest reductions in electricity use, while plug loads are expected to increase the most.
- Increased electricity usage are expected for all commercial subsectors, except for non-food retail and food retail, which are expected to decrease in electricity use, and hospitals and nursing homes, which are expected to remain relatively unchanged from 2014 to 2020.
- In the industrial sector, the largest increase in electricity use is expected in the miscellaneous industrial subsector, followed by the food and beverage manufacturing subsector. The most significant decreases in electricity use are expected in the paper manufacturing and non-metallic mineral subsectors. Increased electricity consumption is expected to occur in all end uses.

Figure 7-8: Ontario Forecast (2015 – 2020) Electricity Use by Sector

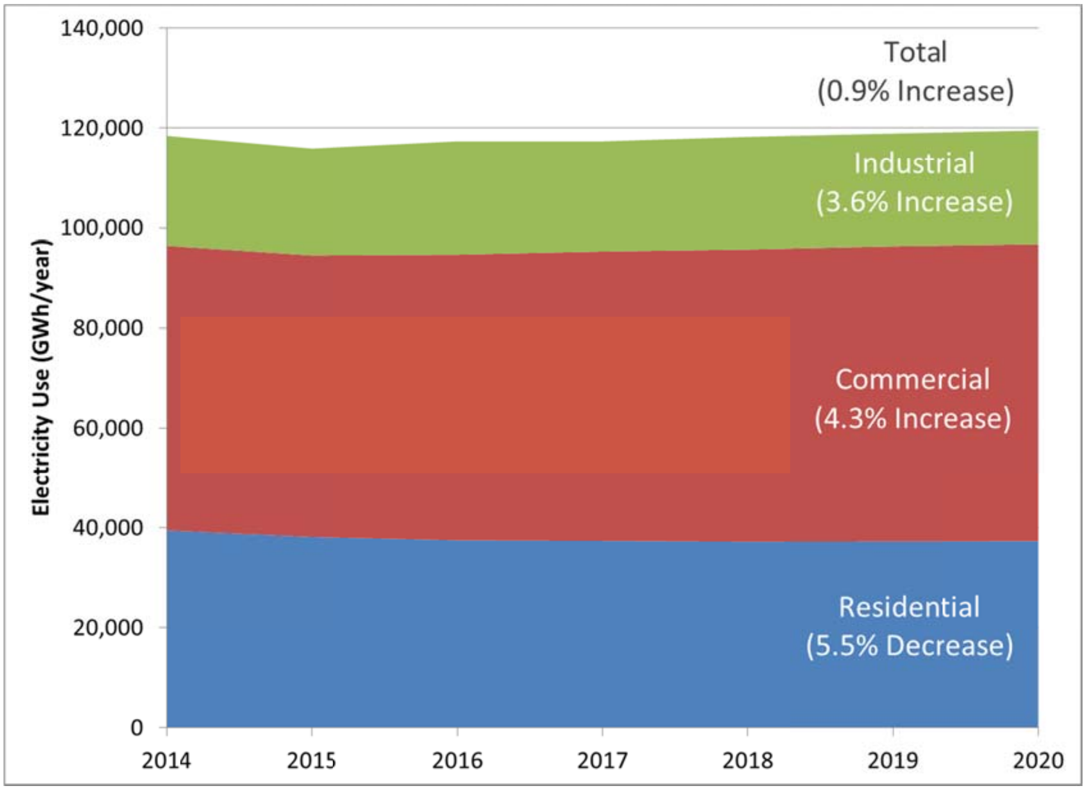


Figure 7-9: Residential Sector Load Forecast (2015 to 2020) by Subsector

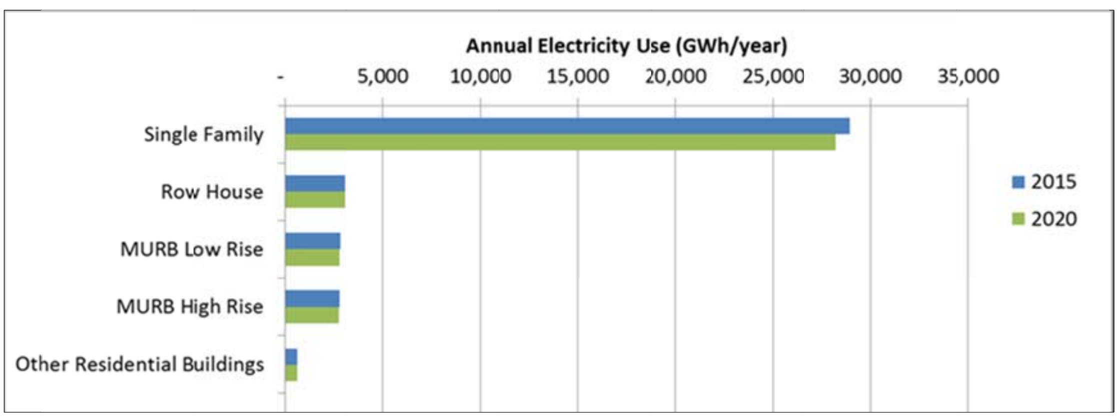


Figure 7-10: Residential Sector Load Forecast (2015 to 2020) by End Use

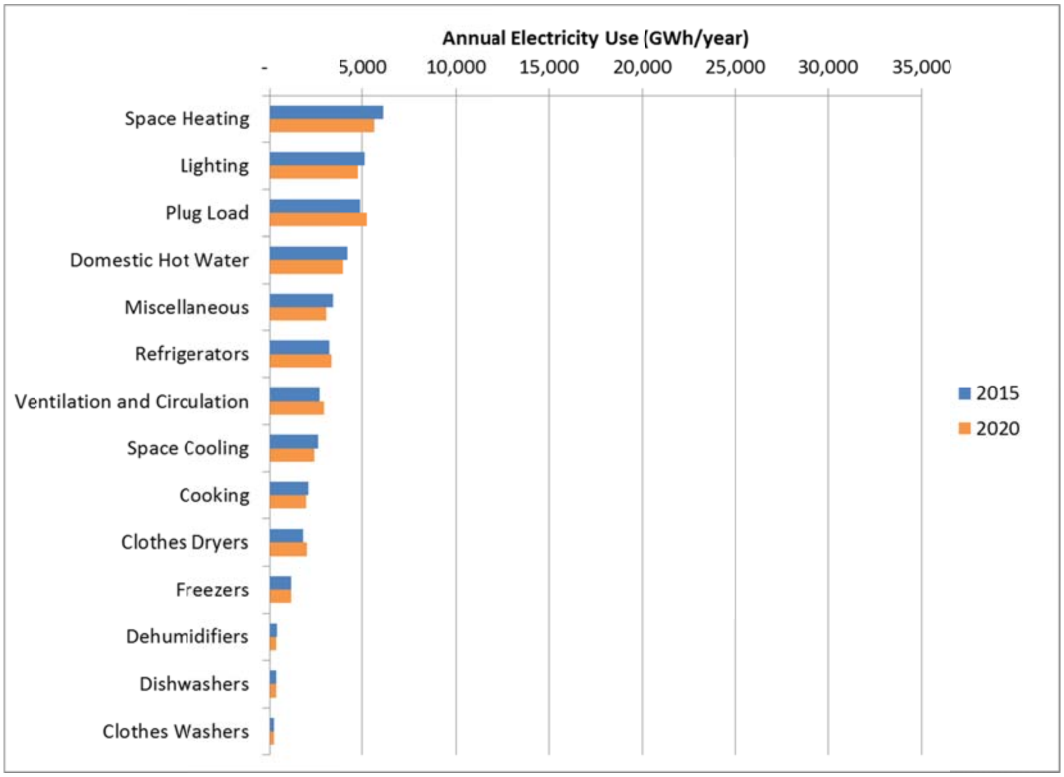


Figure 7-11: Commercial Sector Load Forecast (2015 to 2020) by Subsector

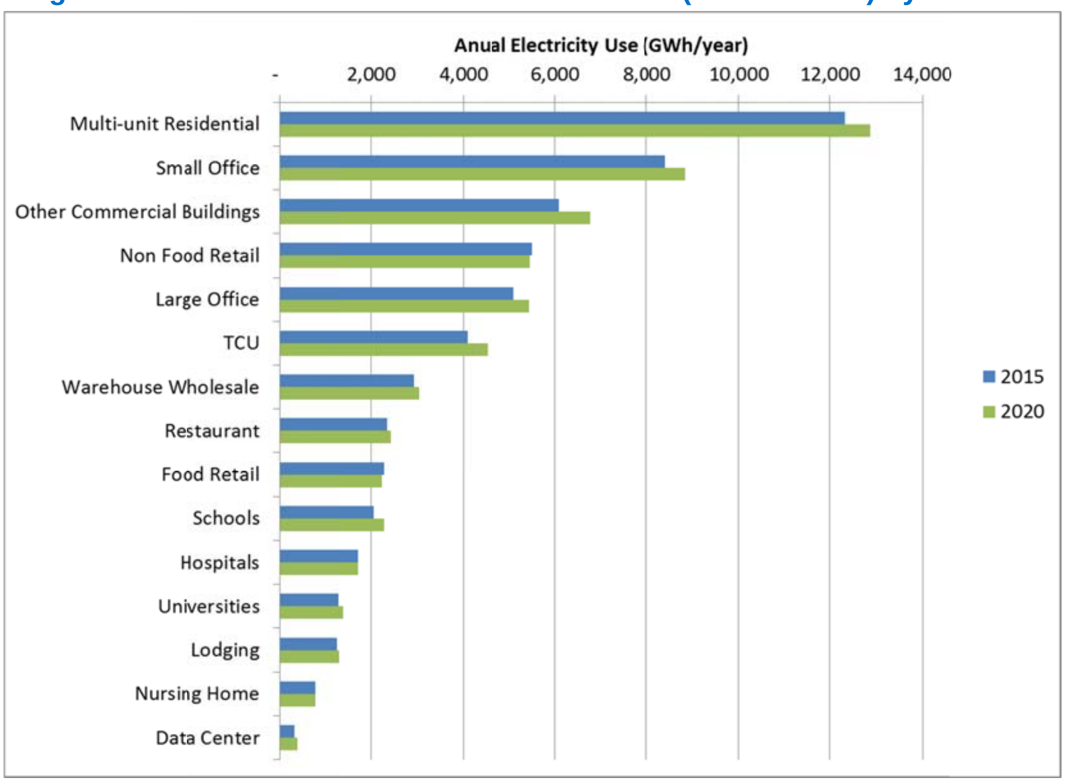


Figure 7-12: Commercial Sector Load Forecast (2015 to 2020) by End Use

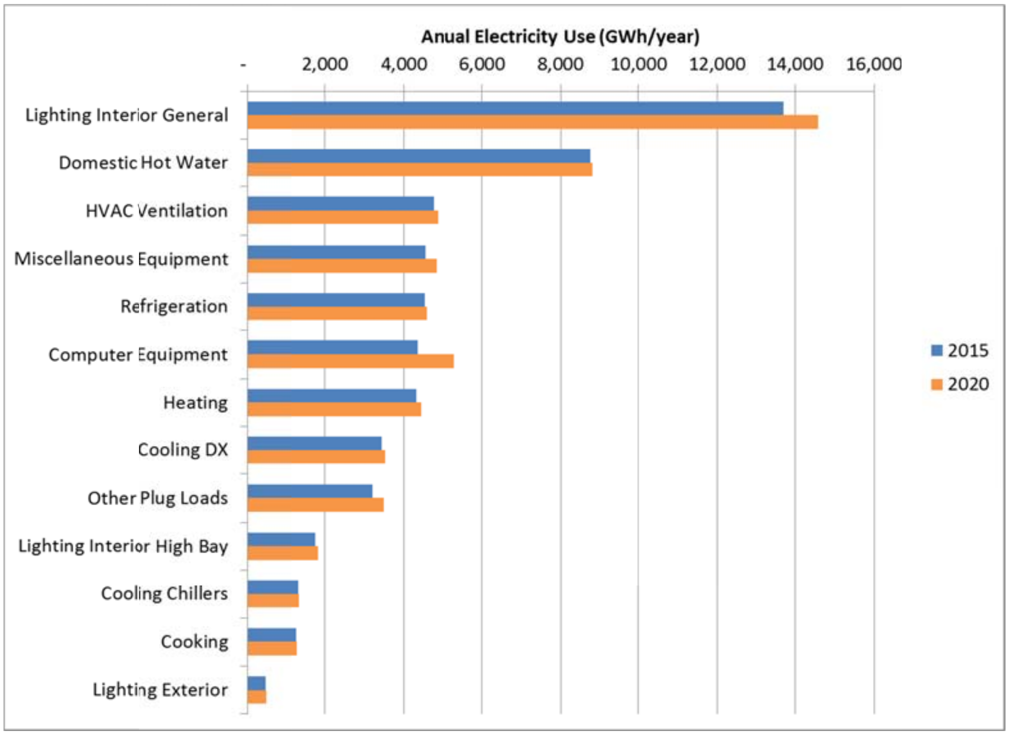


Figure 7-13: Industrial Sector Load Forecast (2015 to 2020) by Subsector

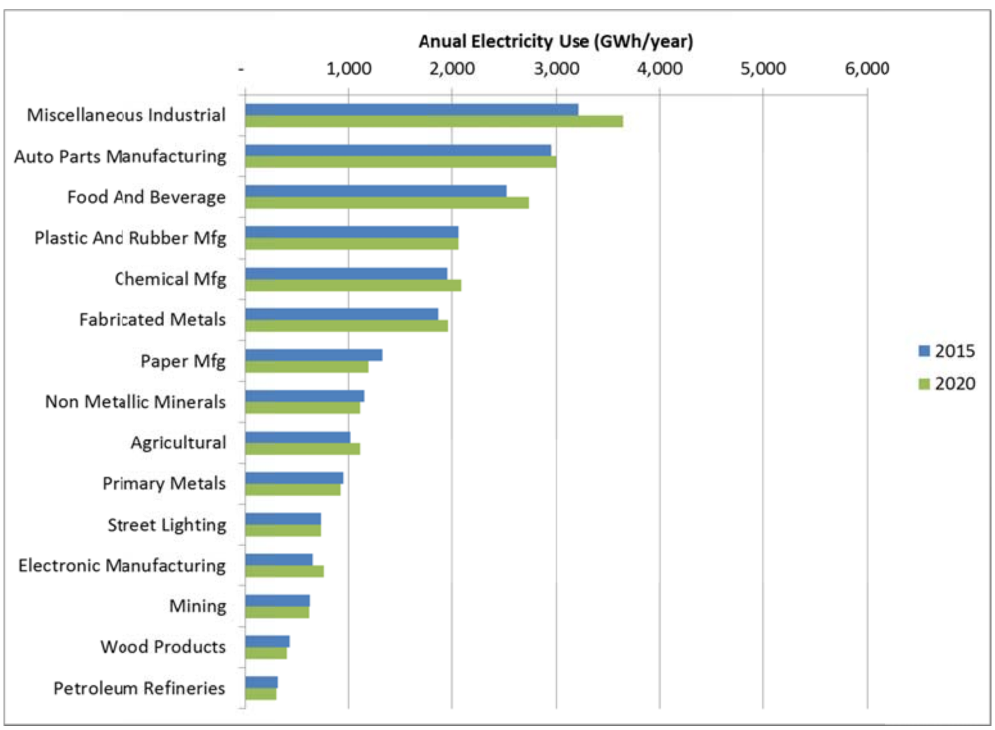
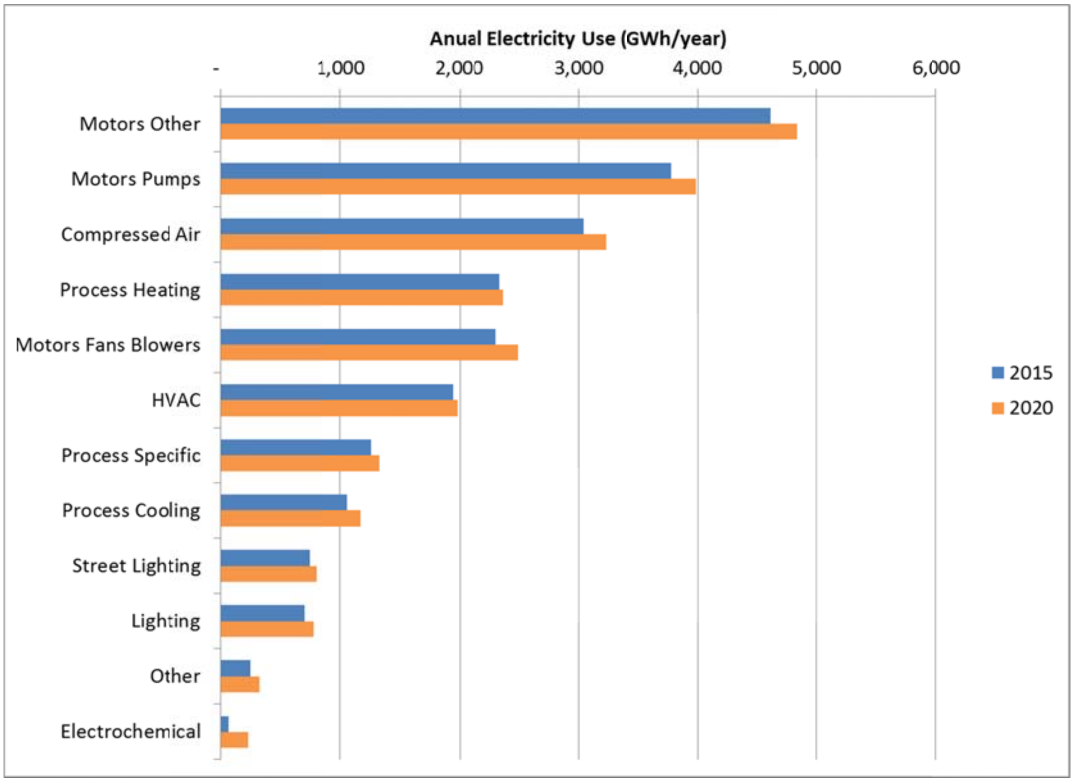


Figure 7-14: Industrial Sector Load Forecast (2015 to 2020) by End Use

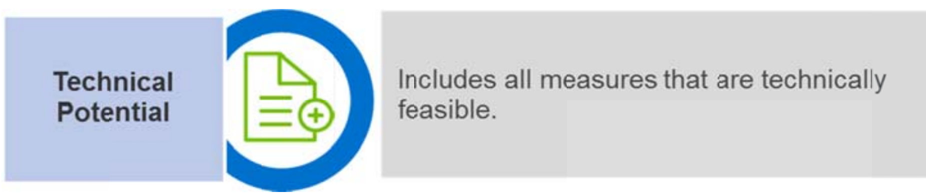


8 Technical Potential Scenarios

In the previous sections, energy efficiency measures were identified and characterized (Section 4), archetype programs were developed (Section 5), LDC Profiles were developed (Section 6), and the 2014 base year energy use and reference case forecast for 2015 to 2020 were developed (Section 7). The outputs from these tasks provided the input for estimating the technical potential scenario, which is discussed in this section.

The technical potential scenario estimates the savings potential when all technically feasible energy efficiency measures are implemented at their full market potential, while taking equipment turnover rates into account. This savings potential can be considered as a maximum potential.

The subsequent sections (Sections 9 and 10) will discuss the development of the economic and achievable potential scenarios.



8.1 Methodology

The main steps in estimating the technical savings potential included:

- Mapping energy efficiency measures to archetype programs.
- Running measures through Nexant Technical, Economic, and Achievable Potential (TEA-POT) model to assess energy efficiency potential for each measure.
- Aggregating measure savings potential to derive archetype program potential savings by LDC.
- Aggregating LDC potential savings to derive provincial potential savings.

These steps are described in more detail in the remainder of this section.

8.1.1 Mapping EE Measures to Archetype Programs

As described in Section 5, eight archetype programs were defined for the residential sector and four archetype programs were defined for the commercial and industrial sectors. All the technically feasible measures, as discussed in Section 4, were mapped to the archetype programs to ensure each measure is allocated to an archetype program. The measures are discussed in Section 4, the archetype programs are described in Section 5, and the mapping of measures to the archetype programs are provided in Appendix B.

8.1.2 Model Energy Efficiency Potential for Each Measure

Each technically feasible measure was run through Nexant's TEA-POT model to assess energy efficiency potential for each measure. This assessment was necessary to:

- Develop *measure interactions* and measure competition groups.
- Integrate *measure ranking logic*, which arranged and applied measures in order of cost-effectiveness.
- *Avoid double-counting potential savings* (repeat participation) by limiting the total adoption to 100% within each measure competition group by end use or archetype program.
- Iteratively *reduce the baseline forecast* after the application of each subsequent measure.

- The core equation used in the residential sector energy efficiency potential analysis is shown in Equation 1, while the core equation used in the non-residential sector potential analysis for each individual measure is shown in Equation 2.

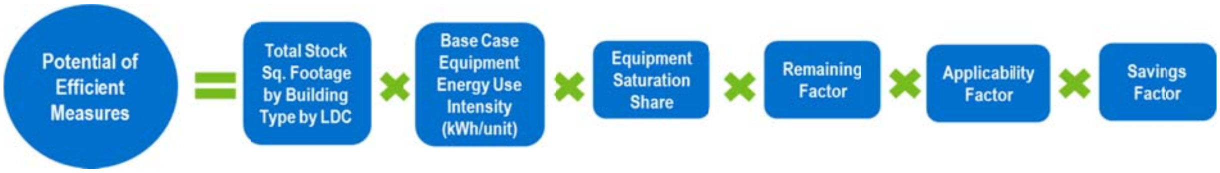
.

Equation 1: Core Equation for Residential Sector – Measure Savings Potential

$$\text{Potential of Efficient Measures} = \text{Total Number of Households} \times \text{Base Case Equipment Energy Use Intensity (kWh/unit)} \times \text{Saturation Share} \times \text{Remaining Factor} \times \text{Applicability Factor} \times \text{Savings Factor}$$

Parameter	Definition
Total number of households	Number of households eligible and adopting a given measure.
Base equipment energy use intensity	Amount of kWh consumed per year for baseline equipment.
Saturation/Fuel share	Percentage of households with the measure's electric end use present (e.g. share of homes with electric water heating).
Remaining Factor	Fraction of equipment that is not already energy efficient, which takes into account historical savings and persistence of the savings.
Applicability Factor	Fraction of applicable units that is technically feasible for conversion to efficient technology (e.g. it is not technically feasible to install heat pump water heaters in all homes). Care was taken so that the applicability factor does not overlap with the remaining factor.
Savings Factor	Percentage reduction in energy consumption with efficient equipment.

Equation 2: Core Equation for Non-residential Sector – Measure Savings Potential



Parameter	Definition
Total stock sq. footage by building type by LDC	The forecasted aggregated square footage for a given building type that adopts a given measure
Base equipment energy use intensity	The electricity used per square foot per year by each base-case equipment and/or end use in each subsector
Equipment saturation and fuel share	Percentage of square footage served by a given measure's electric end use (for example, percentage of floor space served by electric water heating)
Remaining factor	Fraction of equipment that is not already energy efficient, which takes into account historical savings and persistence of the savings
Applicability factor	Fraction of applicable units that are technically feasible for conversion to efficient technology
Savings factor	Percentage reduction in energy consumption with efficient equipment

Since the archetype programs will differ by climate region, they were developed at the climate-region level. However, the initial measure assessment was completed for each LDC and provided the input for the development of the archetype programs at the climate region level. Some of the input data used in the equations were from the development of the LDC profiles, which are described in Section 6.

8.1.3 Potential Savings by Archetype Programs

The output of the previous step was a detailed matrix table that showed each measure permutation (by sector, subsector, end use, vintage, and climate region) with the associated savings potential and costs. Using the mapping of measures to archetype programs and the savings per measure from the previous step, the measure savings were aggregated to produce the potential savings per archetype program per LDC.

8.1.4 Provincial Potential Savings

The resulting potential savings per LDC derived in the previous step was aggregated to produce a provincial estimate of technical potential savings at the archetype program level.

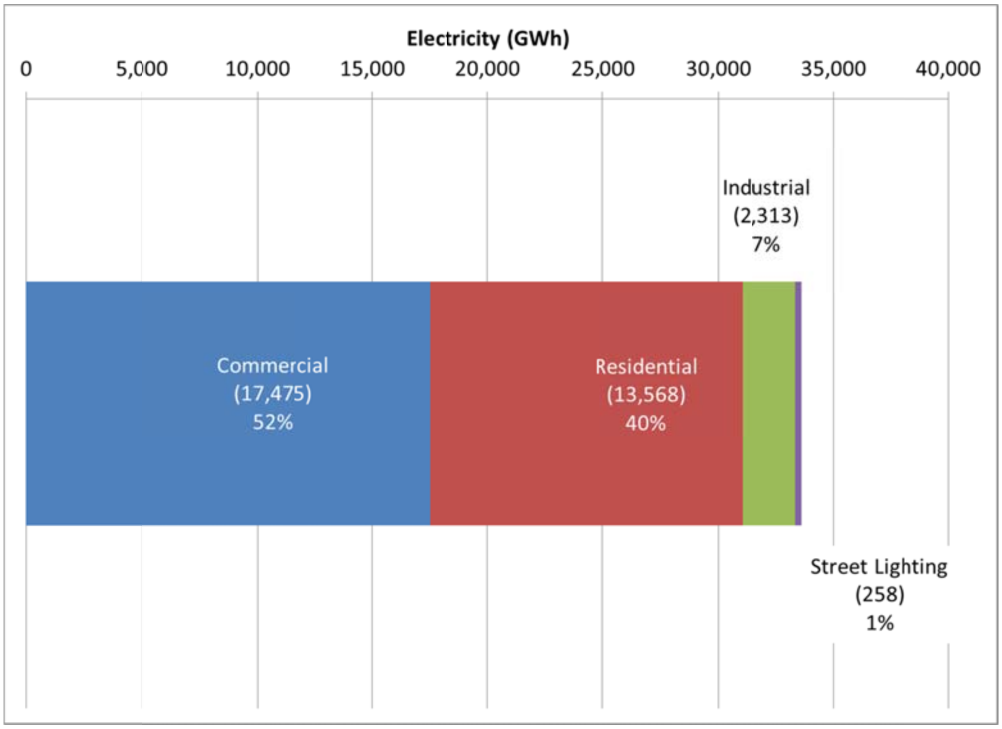
8.2 Results and Discussion

8.2.1 Portfolio

The technical potential in 2020 was estimated to be an annual savings of 33,614 GWh (or 28% of the total electricity use in 2020).The largest portion of the savings was from the commercial sector, which accounted for 52% of the savings, while the residential sector accounted for 40%

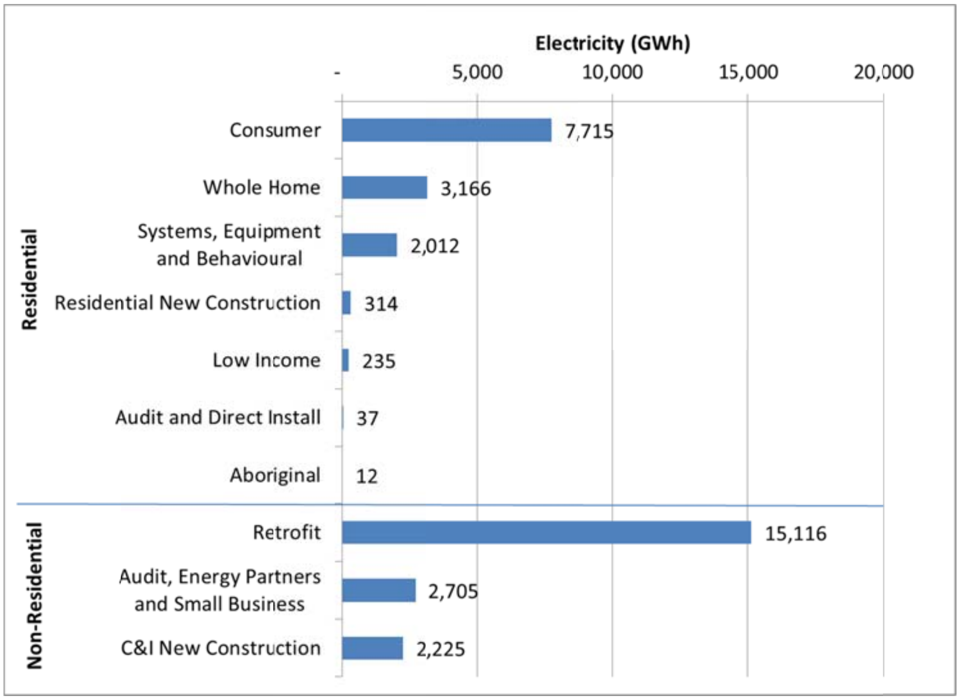
and the industrial sector (including street lighting) accounted for the remaining 8%, as illustrated in Figure 8-1.

Figure 8-1: Technical Potential Persistent Savings by Sector in 2020



The technical potential by archetype program is illustrated in Figure 8-2. The largest technical potential was estimated to be obtained from the Retrofit (77% of total persistent savings in 2020) and Consumer (39% of total persistent savings) archetype programs.

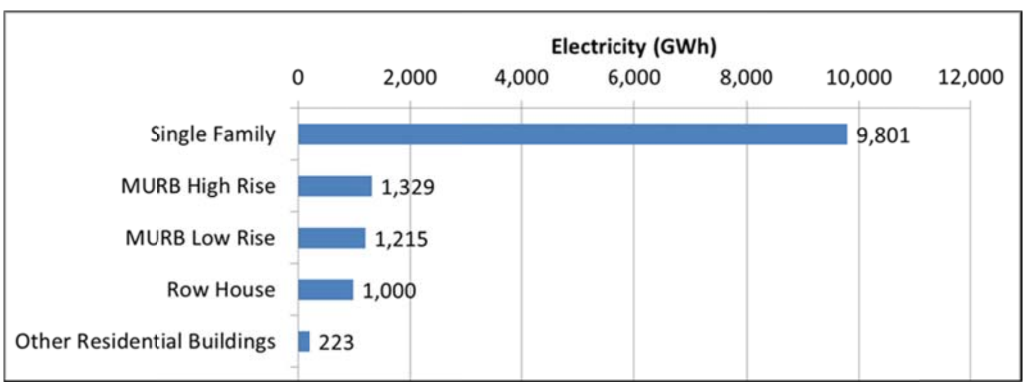
Figure 8-2: Technical Potential Persistent Savings by Archetype Program in 2020



8.2.2 Residential Sector

In the residential sector, the largest technical potential was estimated for the single family subsector, which accounted for 72% of the residential persistent savings in 2020 (Figure 8-3).

Figure 8-3: Technical Potential Persistent Savings by Residential Subsector in 2020

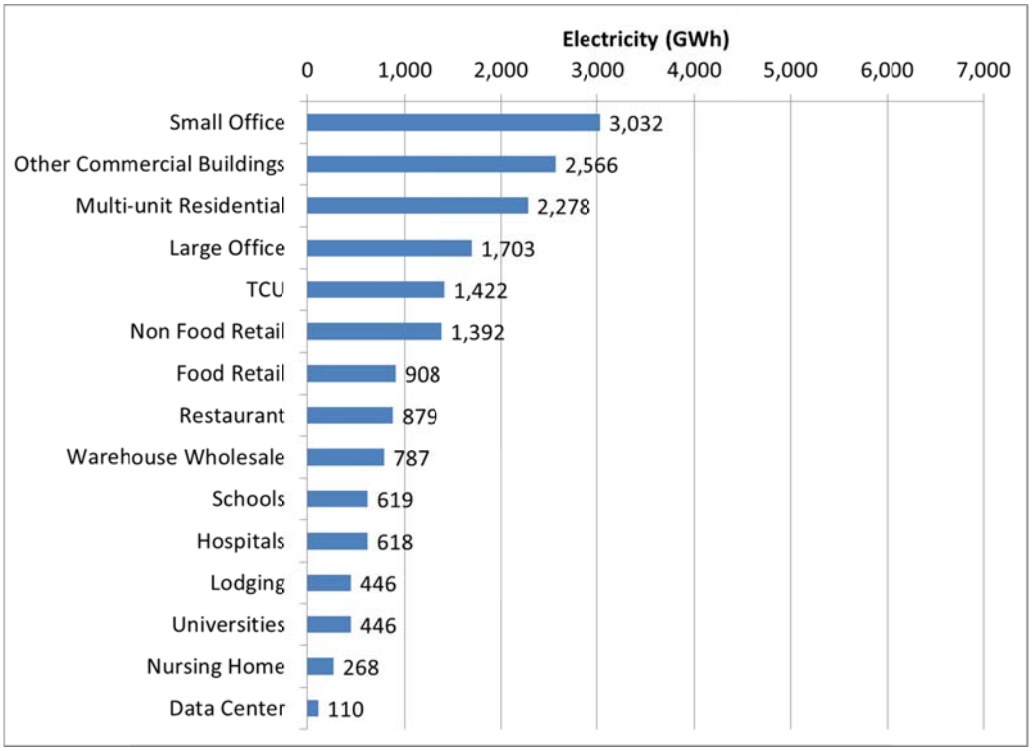


8.2.3 Commercial Sector

In the commercial sector, six subsectors accounted for slightly more than 70% of the persistent savings in 2020: small office (17% of total commercial savings), other commercial buildings

(15%), multi-unit residential common areas (13%), large office space (10%), TCU (8%), and non-food retail (9%) (Figure 8-4).

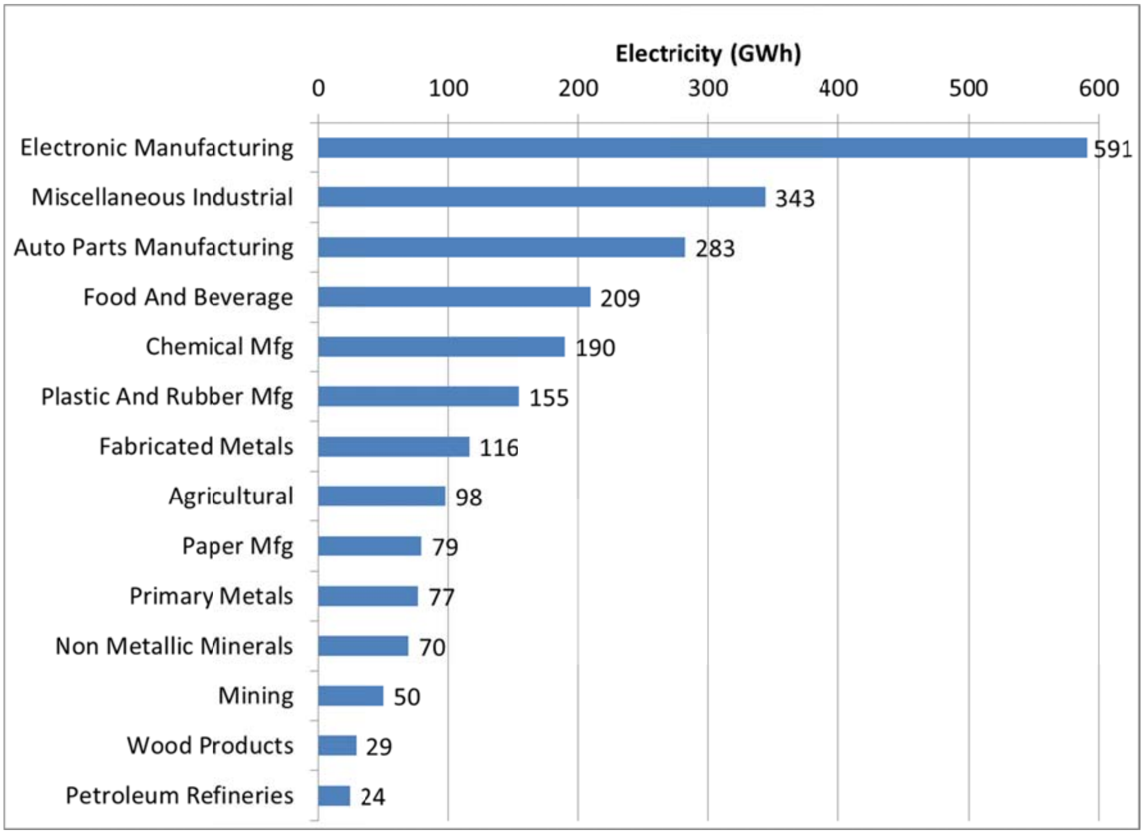
Figure 8-4: Technical Potential Persistent Savings by Commercial Subsector in 2020



8.2.4 Industrial Sector

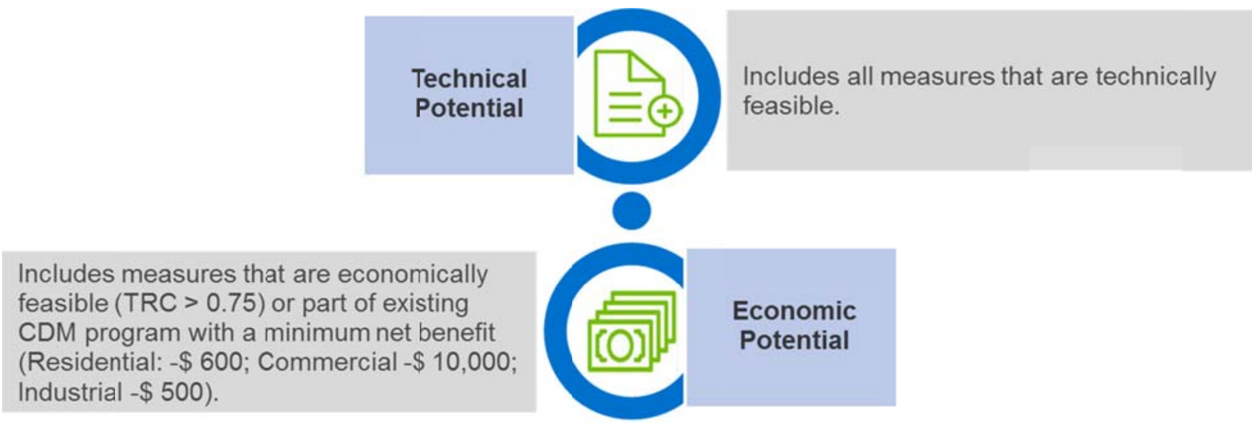
In the industrial sector, three subsectors each accounted for more than 10% of the persistent savings in 2020: electronic manufacturing (26% of total industrial savings), miscellaneous industrial (15%), and auto-parts manufacturing (12%) (Figure 8-5).

Figure 8-5: Technical Potential Persistent Savings by Industrial Subsector in 2020



9 Economic Potential Scenario

The previous sections described the process used for identifying and characterizing energy efficiency measures (Section 4), developing archetype programs (Section 5), developing LDC profiles (Section 6), and developing the 2014 base year use and reference case forecast for 2015 to 2020 (Section 7). Estimating the potential savings for the technical potential scenario, described in Section 8, was a key step towards estimating the potential savings for the economic potential scenario. Whereas the technical potential scenario provided a maximum potential if all *technically feasible* energy efficiency measures were implemented, the economic potential scenario estimated the maximum potential if all *economically feasible* EE measures were implemented.



The remainder of this section addresses the economic potential scenario, which provided a key step towards developing the achievable potential scenarios. The achievable potential scenarios are discussed in Section 10.

9.1 Methodology

Economic potential was estimated through the modelling of the available savings potential of individual measures, taking into account measure level interactive effects and competition, as well as measure level cost-effectiveness, which is described in the methodology for the technical potential scenario (see Section 8.1). Using the technical potential as the starting point to develop the economic potential, the cost-effectiveness of all the measures included in the technical potential scenario was screened. The following criteria were used to include measures that are considered cost-effective, or economically feasible:

- Measure vintage bundle had average TRC > 0.75.
- Measure was part of an existing CDM program with a minimum net benefit, while the archetype program had a TRC greater than 1.0. The minimum net benefit per sector is: -$ 600for residential, - $ 10,000 for commercial, and - $ 500 for industrial. The minimum

net benefits were determined through an iterative process to determine the minimum value that would result in the archetype programs having a TRC greater than 1.0.

The TRC of a measure may differ by climate region, but the TRC of a measure will be the same for all LDCs within the same climate region. The study uses three climate regions, as discussed in Section 6.

The savings potential of the EE measures were calculated for the technical potential scenario, as described in Section 8.1. The sum of the savings for the economically feasible EE measures within an archetype program provided the savings potential for each of the archetype programs in the economic potential scenario. The savings were modelled within each year of the study horizon for each LDC.

Savings were expressed as persistent savings over time, which took into consideration measure lifetime. This meant savings would persist only for the duration of the measure life. At the end of the measure life, the baseline technology that was applicable at the specific time was used as the presumed replacement of the measure.

9.2 Results and Discussion

9.2.1 Portfolio

The economic potential in 2020 was estimated to be an annual persistent savings of 23,381 GWh, or 19% of the total electricity use in 2020. The largest portion of the savings was from the commercial sector, which accounted for 58% of the savings, while the residential sector accounted for 34% and the industrial sector for the remaining 8% (including street lighting), as illustrated in Figure 9-1. Close to 22% of the 550 measures included in the technical potential scenario did not pass the cost-effectiveness screening and were not included in the economic potential scenario.

The economic potential by archetype program is illustrated in Figure 9-2. Similar to the technical potential, the largest economic potential was estimated to be obtained from the Retrofit (49% of total persistent economic potential savings in 2020) and Consumer (28% of savings) archetype programs.

Figure 9-1: Economic Potential Persistent Savings by Sector in 2020

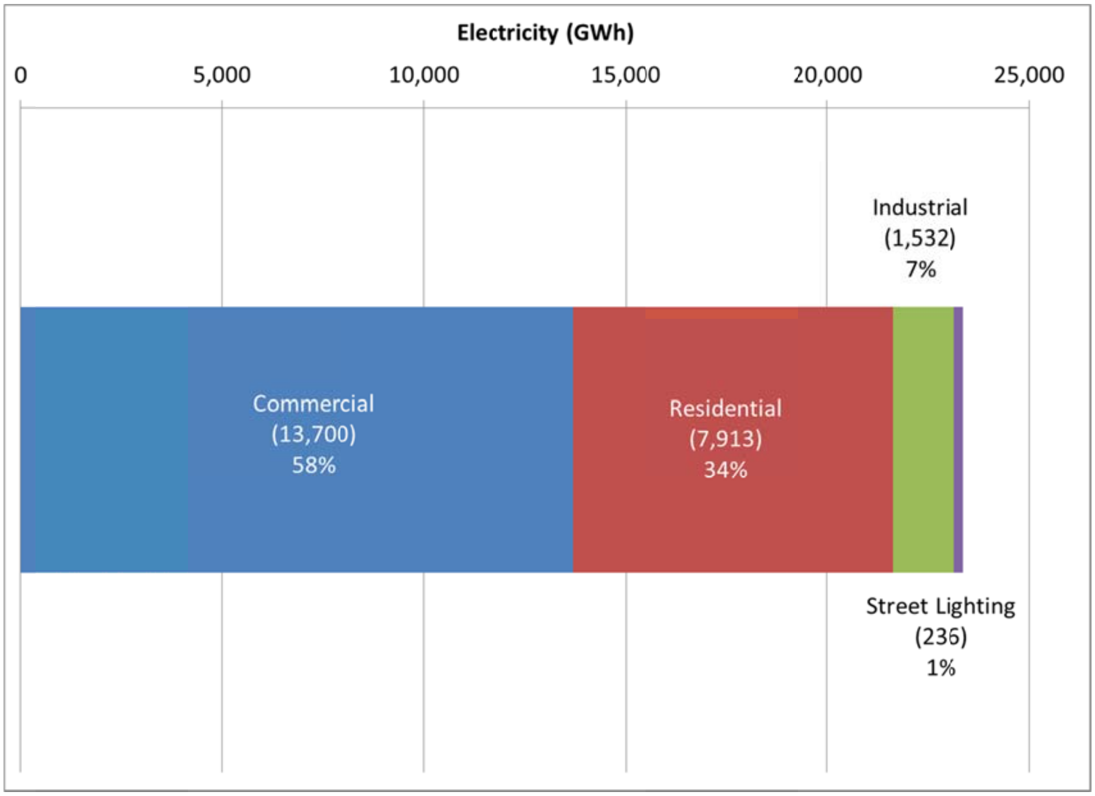
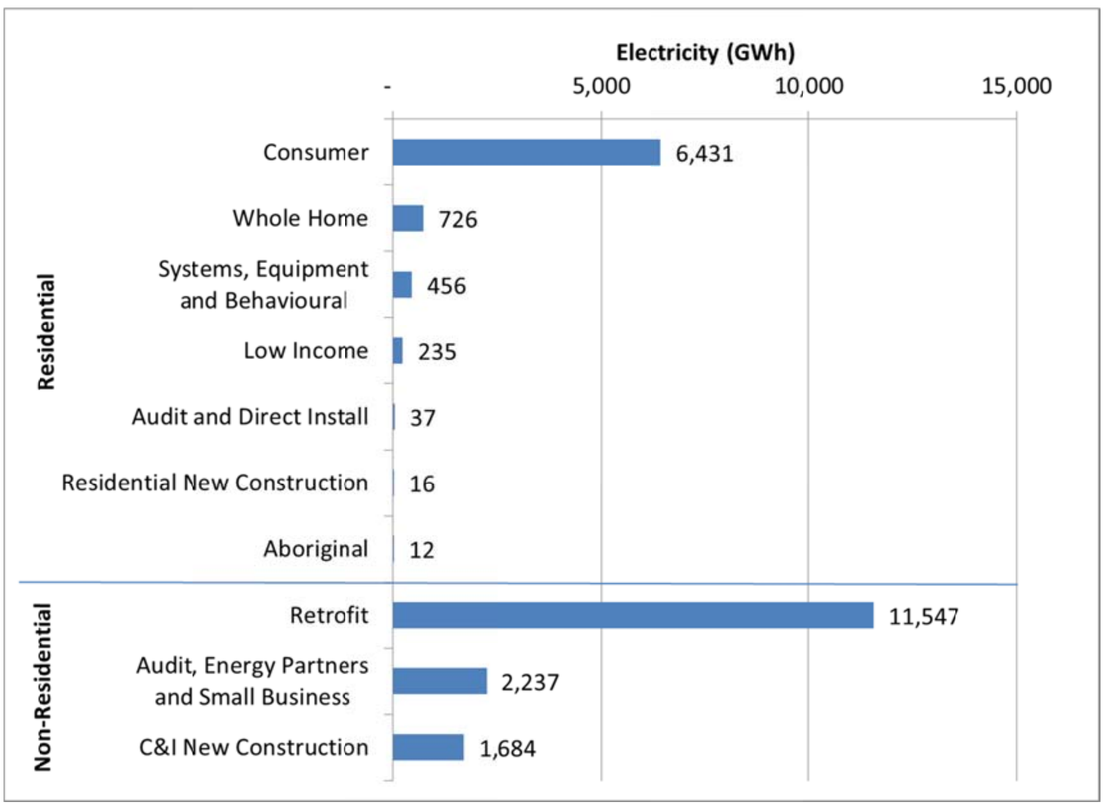


Figure 9-2: Economic Potential Persistent Savings by Archetype Program in 2020



9.2.2 Residential Sector

In the residential sector, the largest economic potential was estimated for the single family subsector, which accounts for 74% of the residential persistent savings in 2020 (Figure 9-3). The largest portion of estimated, persistent, economic potential savings in 2020 was from the lighting end use (43% of residential savings).

Figure 9-3: Economic Potential Persistent Savings by Residential Subsector in 2020

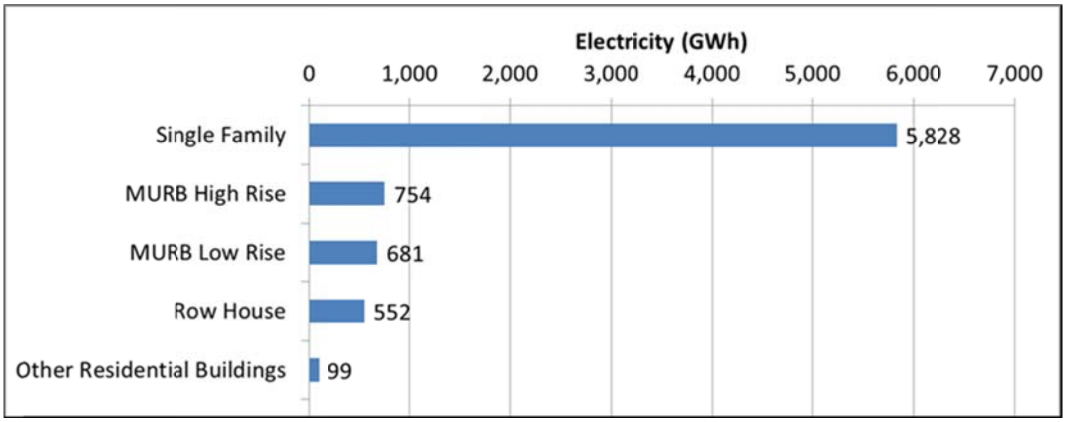
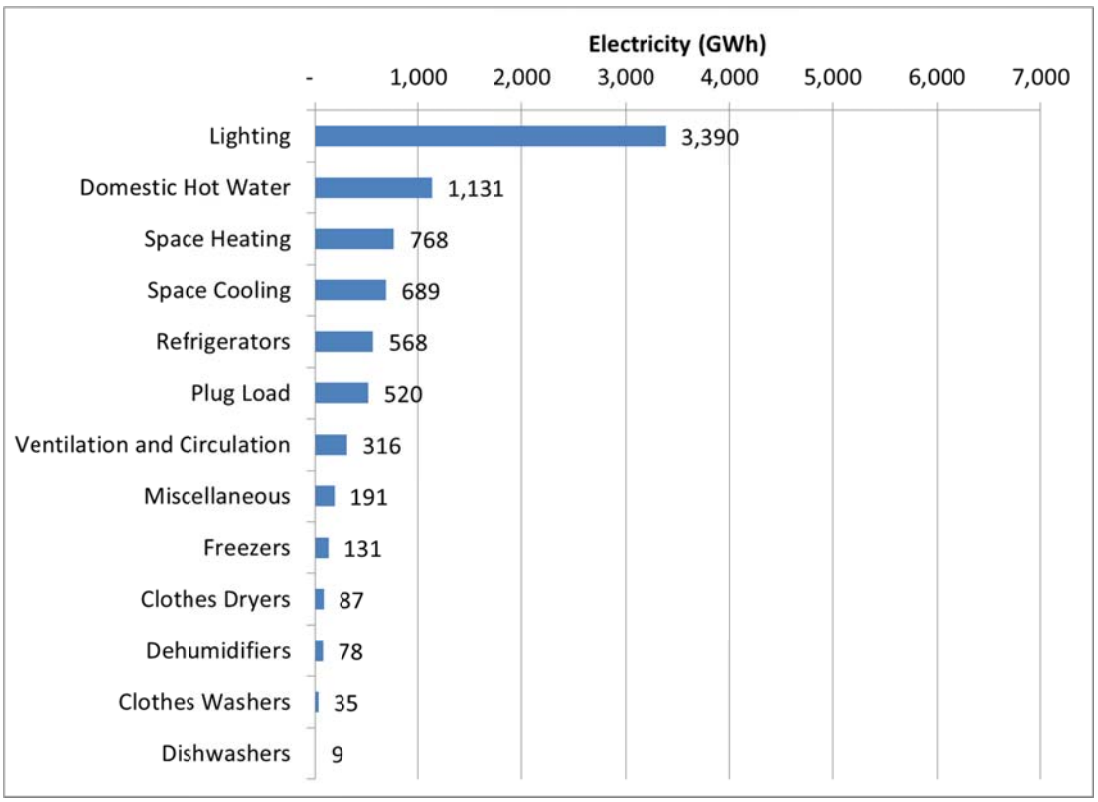


Figure 9-4: Economic Potential Persistent Savings by Residential End Use in 2020



9.2.3 Commercial Sector

The same six subsectors that contributed to the largest portion of the persistent savings in 2020 in the commercial sector's technical potential scenario, also contributed the largest portion of savings in the economic potential scenario: small office (17% of total commercial savings), other commercial buildings (16%), multi-unit residential common areas (13%), large office (10%), TCU (9%) and non-food retail (7%) (Figure 9-4). These percentages of savings by subsector were very similar to the technical potential scenario. The lighting interior general end use was estimated to account for 39% of the persistent savings in 2020. Other notable end use savings resulted from HVAC ventilation (11%) and cooling DX (10%) as illustrated in Figure 9-4.

Figure 9-5: Economic Potential Persistent Savings by Commercial Subsector in 2020

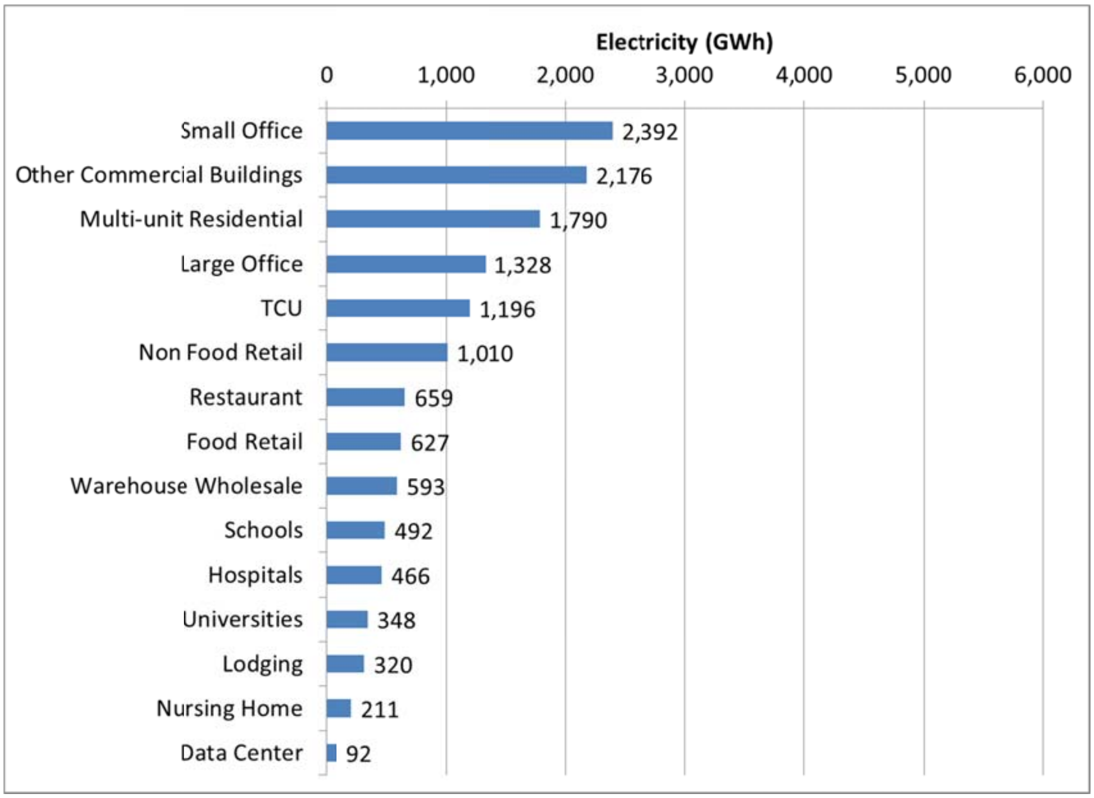
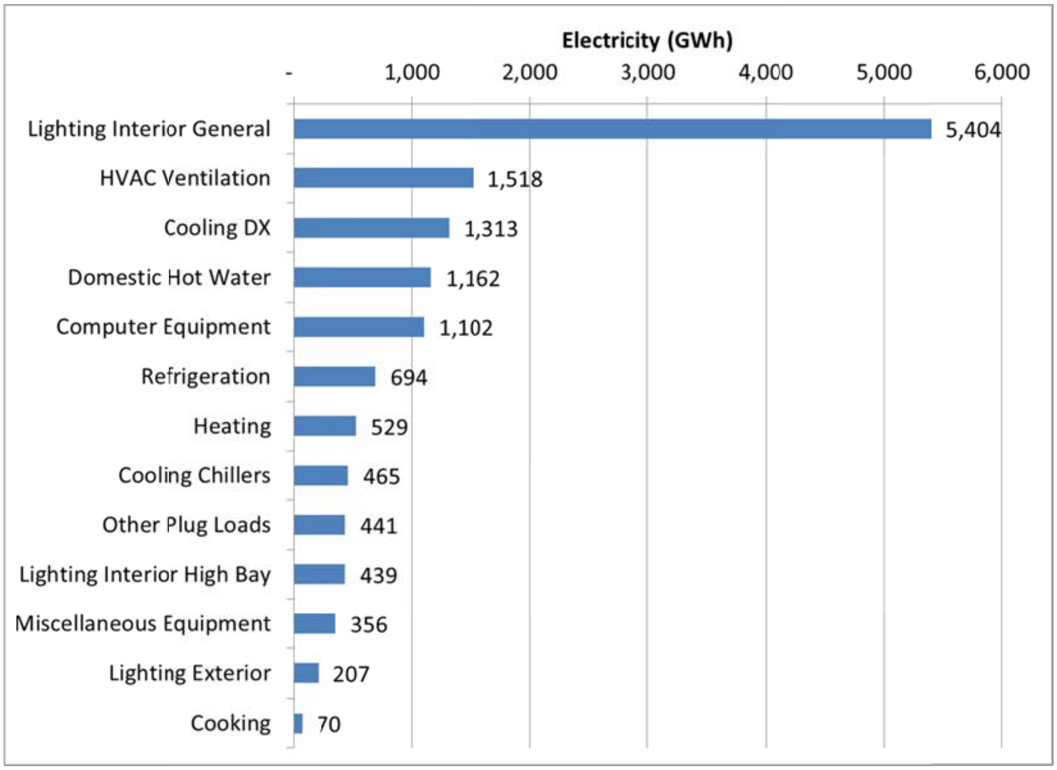


Figure 9-6: Economic Potential Persistent Savings by Commercial End Use in 2020



9.2.4 Industrial Sector

In the industrial sector, four subsectors each accounted for more than 10% of the persistent savings in 2020: miscellaneous industrial (19%), auto-parts manufacturing (15%), food and beverage manufacturing (11%), and chemical manufacturing (11%) (Figure 9-7). Five end uses were estimated to account for close to 87% of the persistent savings in 2020 in the industrial sector: HVAC (23%), compressed air (20%), lighting (16%), motor pumps (15%), and motors on fans and blowers (13%), as illustrated in Figure 9-8.

Figure 9-7: Economic Potential Persistent Savings by Industrial Subsector in 2020

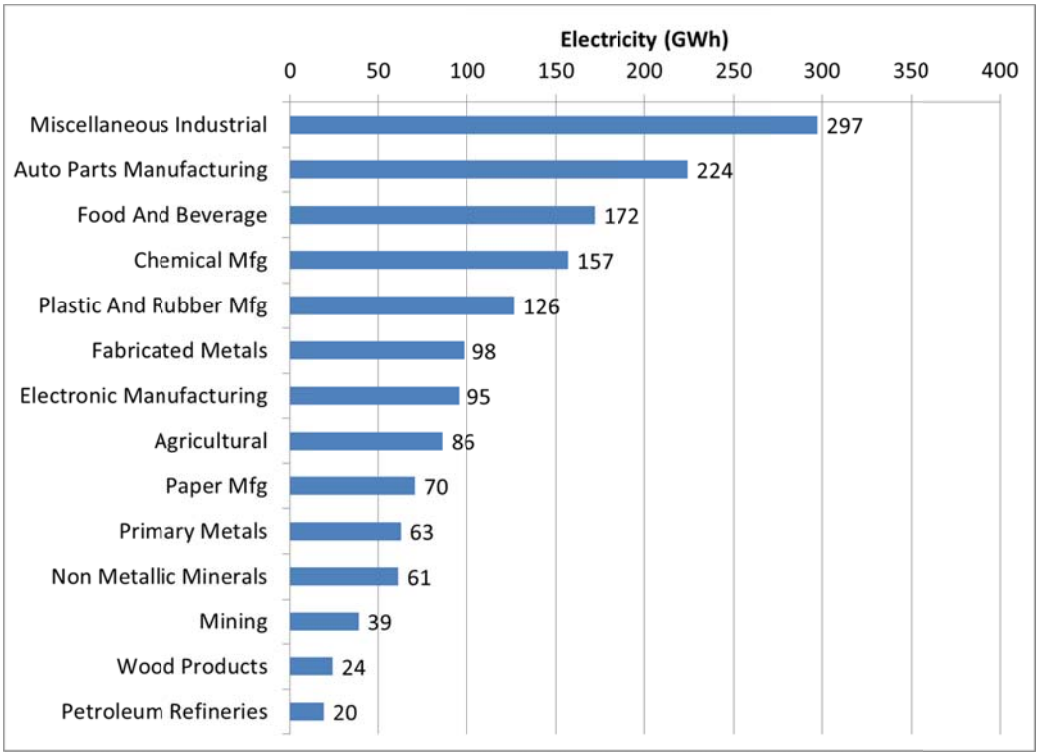
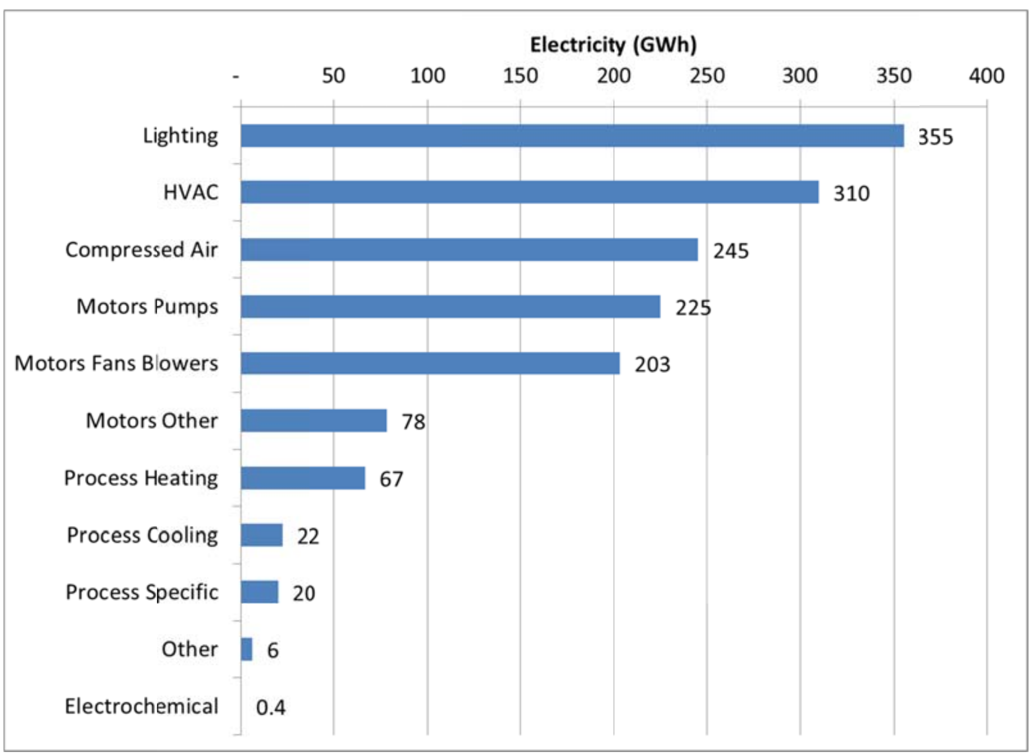
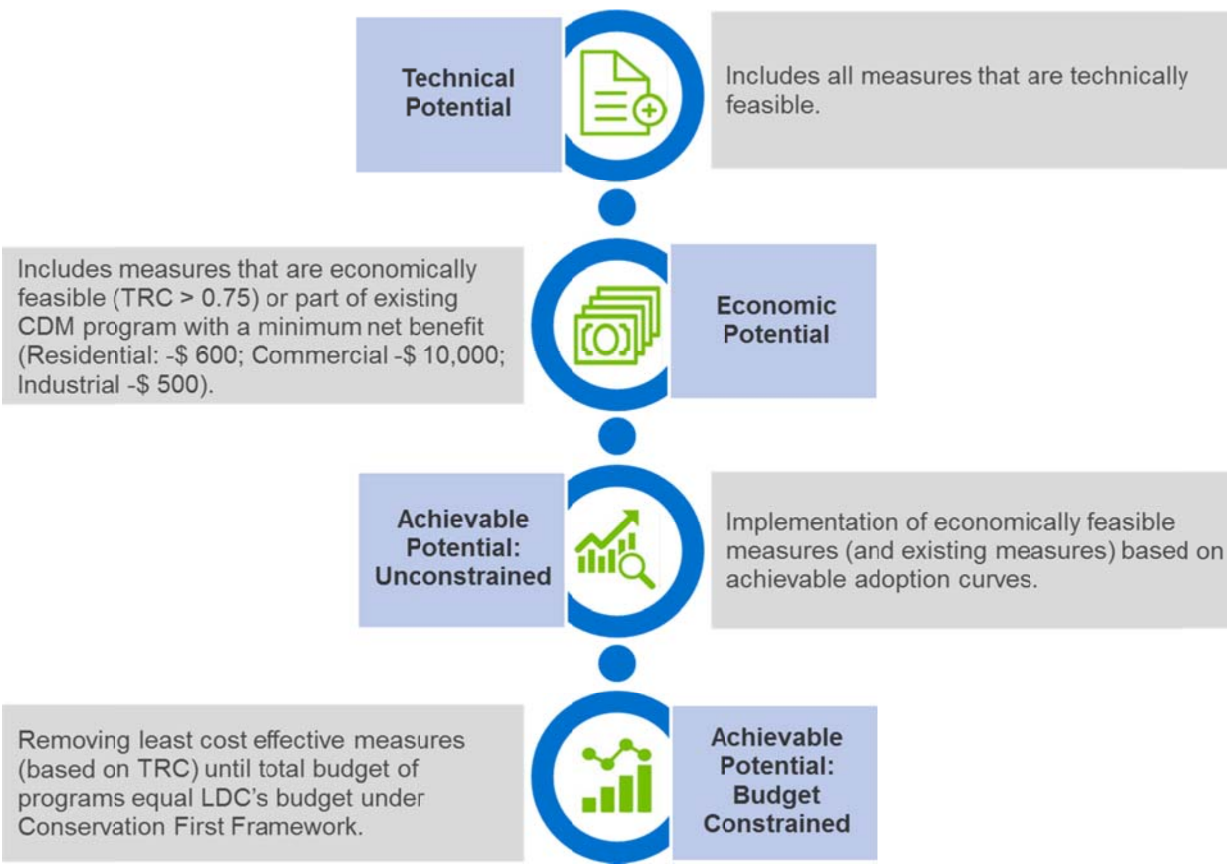


Figure 9-8: Economic Potential Persistent Savings by Industrial End Use in 2020



10 Achievable Potential Scenarios

In Section 8, the technical potential was described, which included all technically feasible energy efficiency measures. In Section 9, economic potential was discussed, which included only economically feasible measures and measures that are included in existing CDM programs. All the measures that were included in the economic potential scenario were included in the analysis of the achievable potential scenario. The achievable potential scenario addressed in this section took into consideration the adoption of the archetype program's economically feasible measures over time. Two achievable potential scenarios were assessed: a budget unconstrained scenario and a budget constrained scenario. Section 11 provides additional analyses, which includes a comparison of the potential savings with the baseline and reference case up to 2020, a sensitivity analysis, and a comparison with actual savings achieved in other North American jurisdictions.



10.1 Methodology

Assessing achievable energy efficiency potential required estimating the rate at which cost-effective archetype programs could be adopted over time. The following key items were considered and addressed in developing the methodology:

- Development and application of representative adoption curves.
- Mapping of measures to the adoption curves, and to the archetype programs.
- Historic performance of programs in each LDC's territory.
- Non-incentive program enhancements.
- Inclusion and exclusion of measures.
- Adding new measures to archetype programs.
- Budget unconstrained and constrained scenarios, where the budget constrained scenario represented the maximum potential that could be achieved with an LDC's budget, per the Conservation First Framework.

The development of the achievable potential scenario built on the economic potential scenario, by applying adoption curves to the measures that were included in the economic potential. Adoption curves estimated the achievable annual participation in archetype programs, or the annual take-up of measures due to archetype programs, from 2015 to 2020. In essence, adoption curves represented the percentage of participation by eligible customers in a program. Twenty-two adoption curves were developed for the residential sector and six adoption curves were developed for the non-residential sector (i.e. commercial and industrial sectors). All the measures included in the economic potential scenario were mapped to the appropriate adoption curve and archetype program. This mapping, together with a detailed discussion and example of the steps to calculate the savings, are included Appendix C. These steps included:

- Using the LDC specific load profiles (see Section 6) and LDC kWh load forecasts (see Section 7), a baseline forecast by sector, subsector, end use, equipment type, and vintage[1] was developed for each LDC.
- Using the Ontario market adoption equations with the LDC specific historic program participation to develop LDC specific adoption curves.
- Mapping of the measure vintage permutations and their parameters to subsector, end use and equipment type. Measure research defined the parameters, such as measure savings, cost, and life, and is discussed in Section 4. The mapping results in defining competition groups, which were the measures that were applicable to the same equipment type. For example, the "screw-in lamp" equipment type had a number of energy-efficient lamps that could be installed, which were defined as the competition group for the equipment type.
- Measures mapped to the adoption curves and archetype programs.

[1] The vintage indicates whether the stock fell into one of the following categories:

- *New:* Based on growth rates
- *Turnover:* Based on average measure life for equipment type
- *Early retirement:* Based on a factor of 0.5% of stock
- *Remaining:* Portion remaining after subtracting other vintages from total.

- Measure in each vintage competition group, ranked according to TRC.
- In each vintage group, calculated savings for first ranked TRC. Removed this savings from available load for next measure in TRC ranking, to calculate savings for the next measure.
- Calculated the measure savings, which were the product of the load share, incremental adoption rate, measure applicability, and savings of the measure. (See Appendix C for an example and Section 8.1 for equations).
- In the budget unconstrained achievable potential scenario, the savings of all the measures were added up to provide archetype program savings for each LDC. The savings of all of the LDCs were aggregated to determine the provincial savings potential.
- In the budget constrained achievable potential scenario, the following steps were followed:
  - Ranked measures (and their associated costs) for all sectors in order of cost-effectiveness (based on TRC).
  - Identified all measures, in order of TRC ranking, which could be adopted for less than LDC's CDM 2015–2020 budget. A TRC ranking approach was used to develop the budget constrained scenario in order to derive a relatively optimized achievable potential estimate.
  - Calculated the sum of savings of these cost-effective measures to derive budget constrained achievable potential for each archetype program per LDC.
  - The savings of all the LDCs were aggregated to determine the provincial savings potential.
- Nexant's model estimated potential at the gross savings level. Net-to-gross (NTG) values were applied to all measure savings values by program category to derive net savings. NTG values were derived from the most recent 2015 evaluation results.
- Acquisition cost was equal to the sum of the gross administrative costs and gross incentive costs, divided by the net energy savings. Average administrative and incentive costs were researched by program category and applied to each measure, then summed up for the portfolio. These costs were divided by the total net savings for the portfolio to estimate portfolio acquisition cost. Formulas, lookup tables, and assumptions for acquisition costs can be found in each LDC summary workbook.

10.2 Results and Discussion

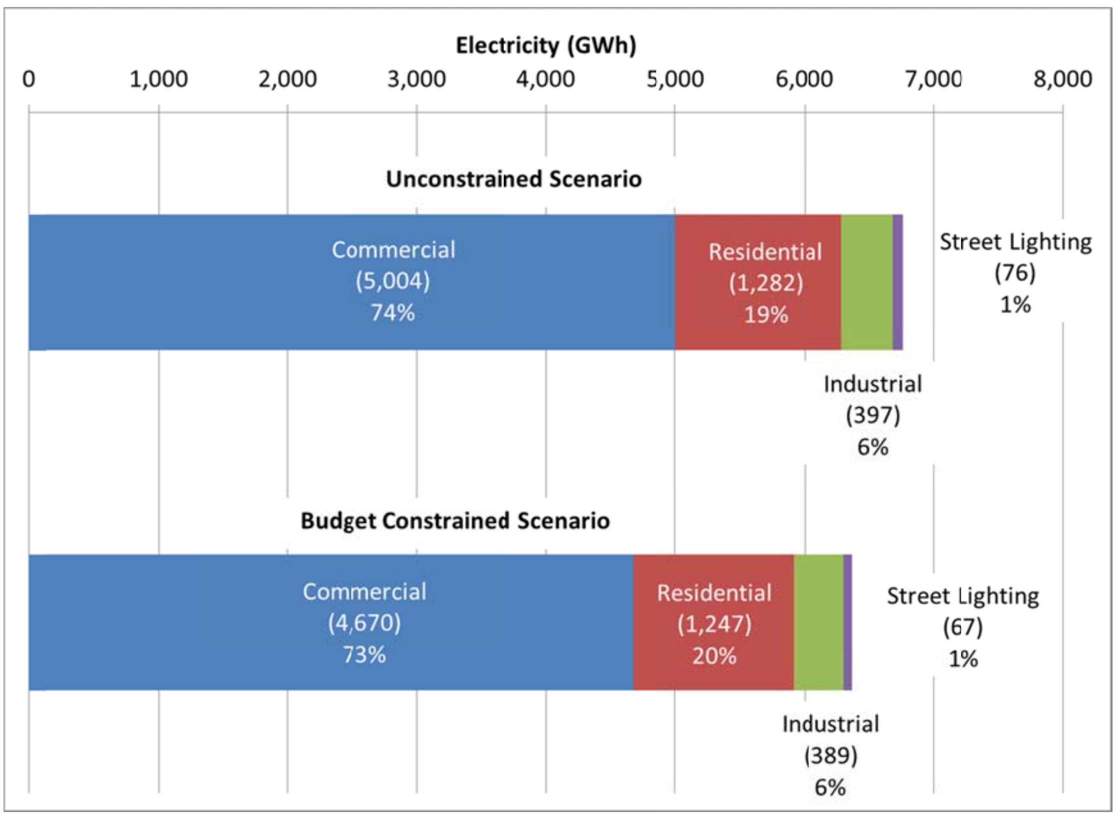
10.2.1 Portfolio

The achievable potential in 2020 was estimated to be an annual persistent savings of 6,760 GWh (or 5.6% of the total electricity use in 2020) for the unconstrained scenario, and 6,373 GWh for the budget constrained scenario (or 5.3% of the total electricity use in 2020). The largest portion of the savings was from the commercial sector, which accounted for 74% of the savings, while the residential sector accounted for 19% in the unconstrained scenario and 20% in the budget constrained scenario, as illustrated in Figure 10-1. Of all the measures included in the economic potential scenario, close to 11% were not included in the budget constrained achievable potential scenario.

The achievable potential by archetype program is illustrated in Figure 10-2 and Figure 10-3. Similar to the technical and economic potential scenarios, the largest achievable potential was estimated to be obtained from the Retrofit (close to 60% of total persistent achievable potential savings in 2020) and Consumer (close to 15%) archetype programs.

The cost-effectiveness in terms of TRC and PAC of the archetype programs is summarized in Table 10-1 and Table 10-2, while the acquisition cost analysis by archetype program is summarized in Table 10-3. The archetype programs with the highest TRC in the budget constrained achievable potential scenario were the Audit and Direct Install (TRC of 23.9) and Small Business (TRC of 3.5) archetype programs. Only the Low Income and Aboriginal archetype programs had a TRC of less than 1.0.

Figure 10-1: Achievable Potential Persistent Savings by Sector in 2020



Similarly, the highest PAC in the budget constrained achievable potential scenario was observed for the Audit and Direct Install (PAC of 22.3) archetype program, while the Retrofit (PAC of 5.5) archetype program had the second highest PAC. Except for the Low Income and Aboriginal archetype programs, all other archetype programs had a PAC greater than 1.0.

As summarized in Table 10-3, the portfolio acquisition cost was estimated to be $312 per MWh for the budget constrained scenario and $358 per MWh for the unconstrained scenario. In the budget constrained scenario, the highest acquisition costs were associated with the Aboriginal ($1,282 per MWh) and Whole Home ($1,241 per MWh) archetype programs, while the lowest acquisition costs were associated with the Audit and Energy Partners ($192 per MWh) and Retrofit ($253 per MWh) archetype programs. The total budget for the unconstrained achievable potential scenario was $2,440 million; it was $1,984 million for the budget constrained scenario.

Figure 10-2: Unconstrained Achievable Potential Persistent Savings by Archetype Program in 2020

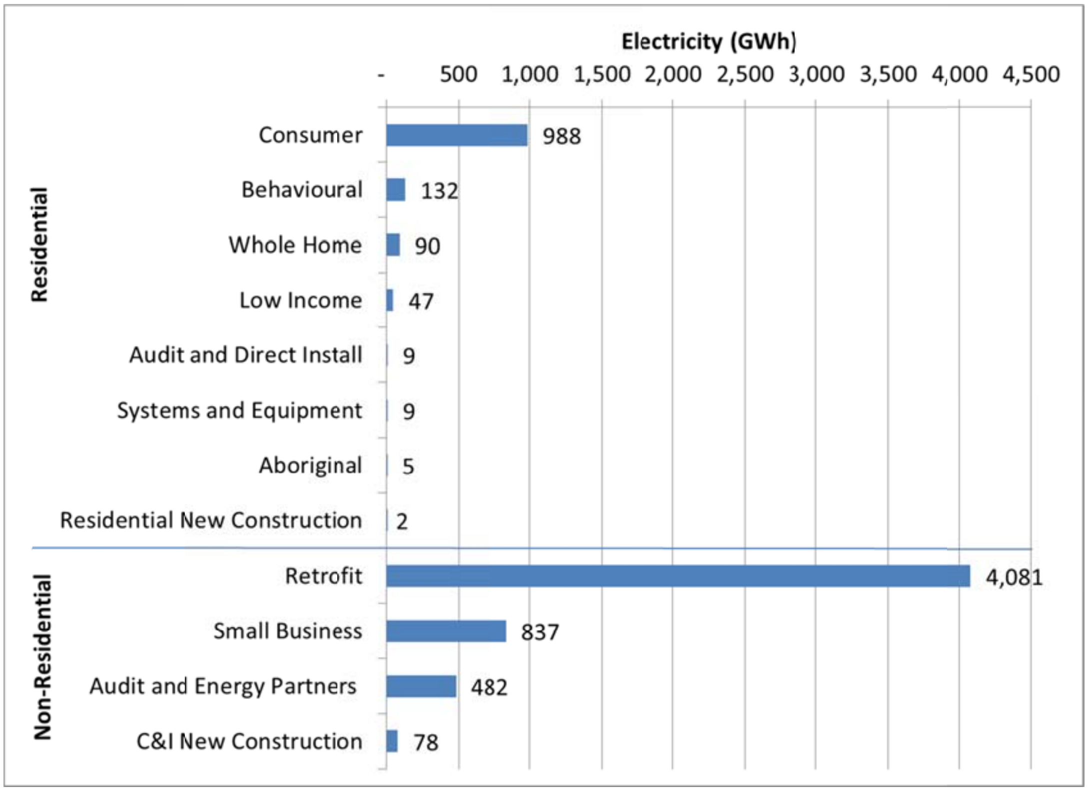


Figure 10-3: Budget Constrained Achievable Potential Persistent Savings by Archetype Program in 2020

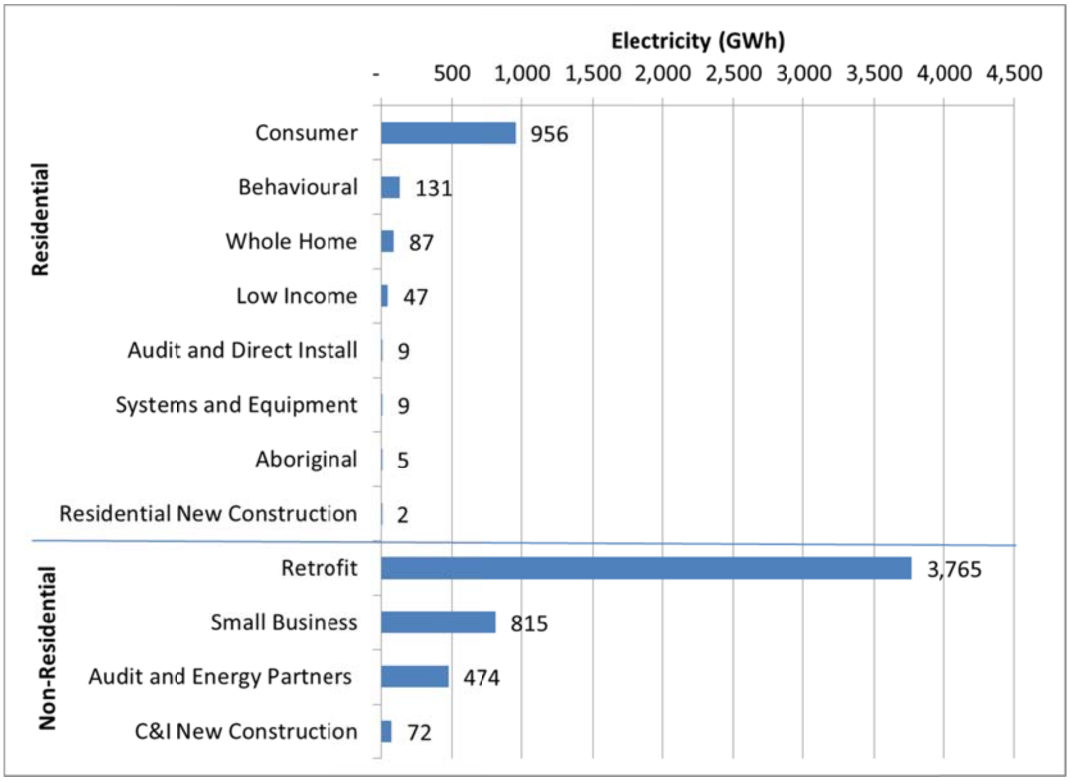


Table 10-1: Achievable Potential TRC Cost-Effectiveness by Archetype Program

	Unconstrained Achievable Scenario (2015–2020)				Budget Constrained Achievable Scenario (2015–2020)			
				Residential				
Audit and Direct Install	$0.05	$1.1	$1.1	23.9	$0.05	$1.1	$1.1	23.9
Consumer	$118.0	$142.4	$24.4	1.2	$107.6	$137.6	$30.0	1.3
Systems and Equipment	$2.7	$3.2	$0.5	1.2	$2.6	$3.2	$0.5	1.2
Behavioural	$28.3	$31.1	$2.8	1.1	$28.2	$31.0	$2.8	1.1
Whole Home	$30.9	$36.5	$5.6	1.2	$24.3	$36.2	$11.8	1.5
Residential New Construction	$0.2	$0.3	$0.1	1.5	$0.2	$0.3	$0.1	1.5
Low Income	$6.2	$4.1	-$2.1	0.7	$6.2	$4.1	-$1.9	0.7
Aboriginal	$0.8	$0.5	-$0.2	0.7	$0.7	$0.5	-$0.2	0.7
				Commercial and Industrial (C&I)				
Retrofit	$729.1	$933.3	$204.2	1.3	$451.0	$862.7	$411.7	1.9

Small Business	$40.8	$96.8	$55.9	2.4	$26.6	$92.6	$66.0	3.5
Audit and Energy Partners	$24.3	$40.4	$16.1	1.7	$23.6	$39.8	$16.2	1.7
C&I New Construction	$13.6	$17.0	$3.4	1.3	$7.9	$15.7	$7.8	2.0
Portfolio	***$995***	***$1,307***	***$312***	***1.3***	***$679***	***$1,225***	***$546***	***1.8***

[1] Net present value
[2] Benefit and cost

Table 10-2 Achievable Potential PAC Cost-Effectiveness by Archetype Program

	Unconstrained Achievable Scenario (2015–2020)				**Budget Constrained Achievable Scenario (2015–2020)**			
Residential								
Audit and Direct Install	$0.04	$1.0	$0.9	22.3	$0.04	$1.0	$0.9	22.3
Consumer	$83.0	$123.9	$40.9	1.5	$75.9	$119.7	$43.8	1.6
Systems and Equipment	$1.5	$2.8	$1.3	1.8	$1.5	$2.8	$1.3	1.8
Behavioural	$28.3	$27.1	-$1.2	1.0	$28.2	$27.0	-$1.2	1.0
Whole Home	$19.6	$31.7	$12.1	1.6	$15.5	$31.5	$16.0	2.0
Residential New Construction	$0.1	$0.3	$0.2	2.3	$0.1	$0.3	$0.2	2.3
Low Income	$6.2	$3.5	-$2.6	0.6	$6.2	$3.5	-$2.6	0.6
Aboriginal	$0.8	$0.5	-$0.3	0.6	$0.7	$0.4	-$0.3	0.6
Commercial and Industrial (C&I)								
Retrofit	$214.8	$827.5	$612.7	3.9	$138.5	$764.6	$626.0	5.5
Small Business	$28.0	$84.1	$56.1	3.0	$19.6	$80.6	$61.0	4.1
Audit and Energy Partners	$10.3	$35.2	$24.8	3.4	$10.0	$34.6	$24.6	3.4
C&I New Construction	$4.2	$14.8	$10.5	3.5	$2.6	$13.7	$11.1	5.3
Portfolio	***$397***	***$1,152***	***$755***	***2.9***	***$299***	***$1,080***	***$781***	***3.6***

Table 10-3: Achievable Potential Acquisition Cost by Archetype Program

Archetype Program	2015-2020 Program Costs ($ mil.)	2015-2020 Program Savings (MWh)	Acquisition Costs ($/MWh)	2015-2020 Program Costs ($ mil.)	2015-2020 Program Net Savings (MWh)	Acquisition Costs ($/MWh)
	Unconstrained Achievable Scenario (2015–2020)			Budget Constrained Achievable Scenario (2015–2020)		
Residential						
Audit and Direct Install	$2.7	9,459	$284	$2.7	9,459	$284
Consumer	$657.5	987,829	$666	$619.5	955,632	$647
Systems and Equipment	$9.4	9,167	$1,031	$9.4	9,113	$1,028
Behavioural	$102.0	131,633	$775	$101.8	131,457	$775
Whole Home	$136.2	90,140	$1,511	$108.4	87,378	$1,241
Residential New Construction	$1.0	1,986	$504	$1.0	1,986	$504
Low Income	$52.9	47,041	$1,125	$52.9	47,041	$1,113
Aboriginal	$6.4	5,004	$1,271	$6.4	4,982	$1,282
Commercial and Industrial (C&I)						
Retrofit	$1,057.3	4,080,566	$259	$718.6	3,764,778	$191
Small Business	$300.3	837,497	$359	$259.6	814,921	$319
Audit and Energy Partners	$92.6	482,159	$192	$90.7	474,563	$191
C&I New Construction	$22.0	77,285	$285	$15.1	71,568	$211
Portfolio	***$2,440***	***6,759,767***	***$361***	***$1,984.1***	***6,372,880***	***$311***

10.2.2 Residential Sector

Similar to the technical and economic potential scenarios, the largest achievable potential in the residential sector was estimated to be for the single family subsector, which accounted for 73% of the residential persistent savings in 2020 (as illustrated in Figure 10-4 and Figure 10-5). The largest portion of estimated, persistent, achievable potential savings in 2020 was from lighting end use (close to 60% of residential savings), which was a relatively larger portion compared to the economic potential scenario, in which lighting accounted for 43% of the residential savings.

Figure 10-4: Unconstrained Achievable Potential Persistent Savings by Residential Subsector in 2020

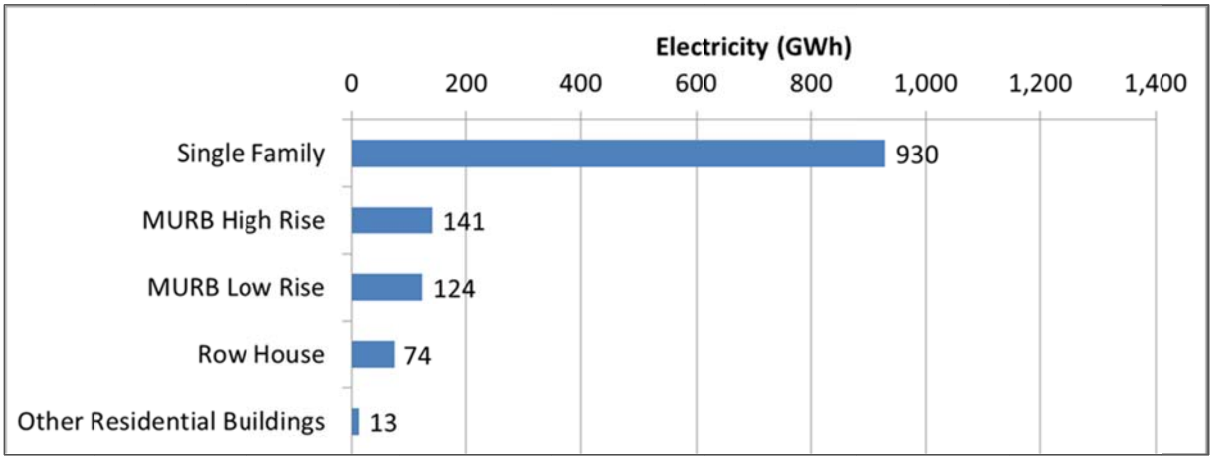


Figure 10-5: Budget Constrained Achievable Potential Persistent Savings by Residential Subsector in 2020

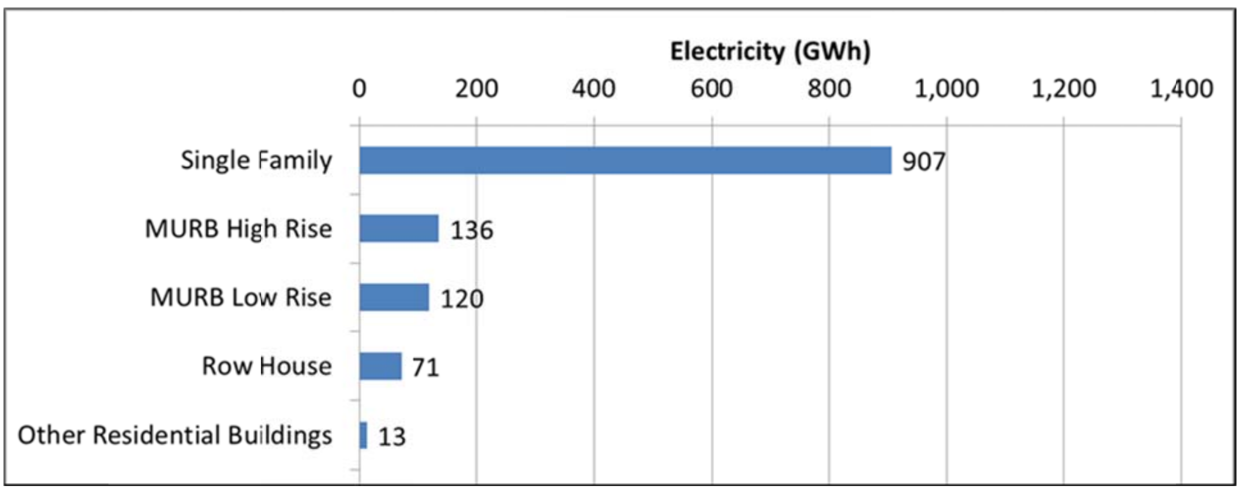


Figure 10-6: Unconstrained Achievable Potential Persistent Savings by Residential End Use in 2020

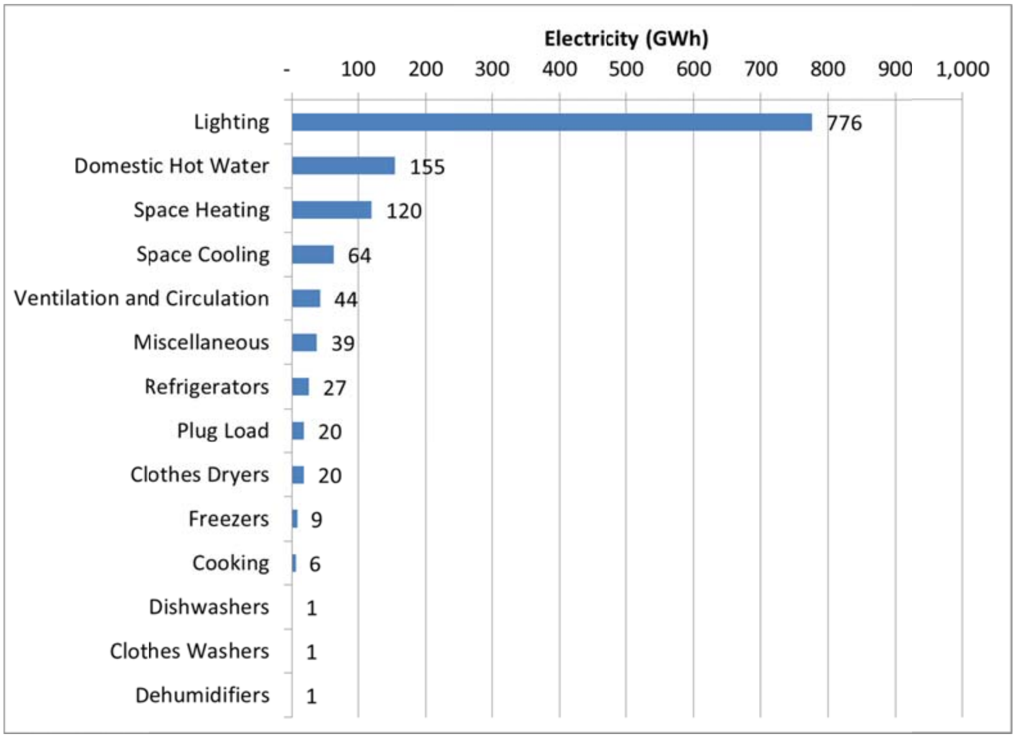
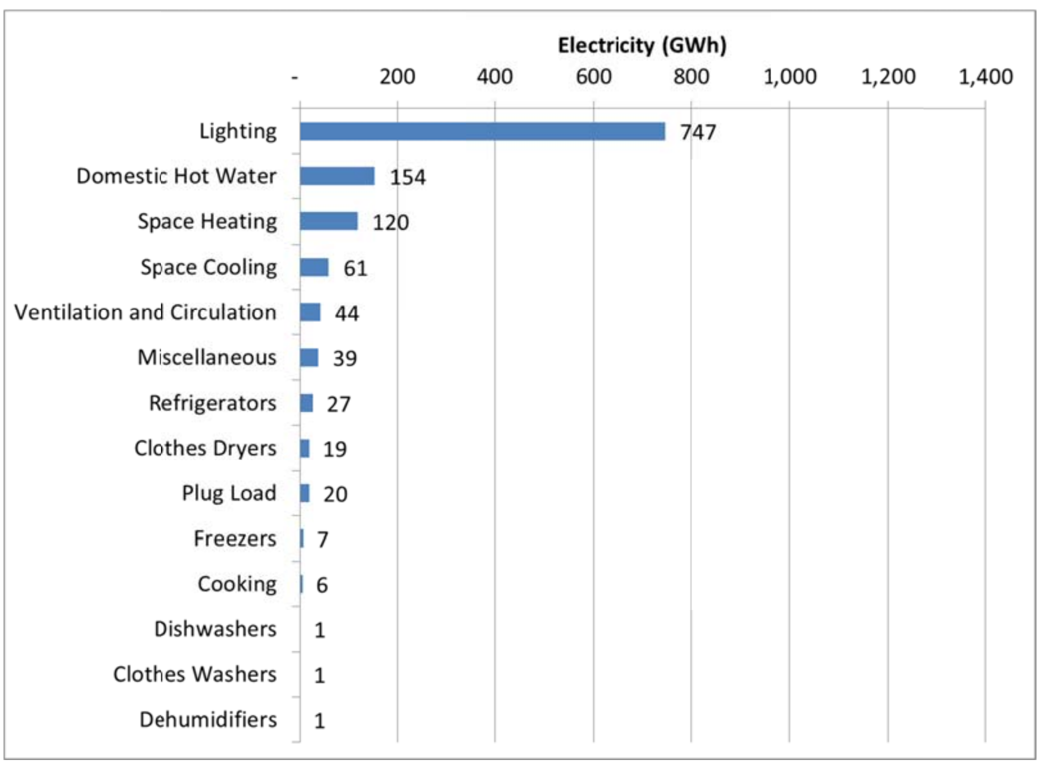


Figure 10-7: Budget Constrained Achievable Potential Persistent Savings by Residential End Use in 2020



10.2.3 Commercial Sector

The same six subsectors that contributed to the largest portion of the persistent savings in 2020 in the commercial sector's technical and economic potential scenarios also contributed the largest portion of savings in the achievable potential scenarios: small office (19% of total commercial savings), other commercial buildings (about 17%), multi-unit residential common areas (about 11%), TCU (9%) large office (about 9%), and non-food retail (7%) (Figure 10-8 and Figure 10-9).

These percentages of savings by subsector were very similar to the economic potential scenario. The lighting interior general end use was estimated to result in close to 53% of the persistent budget constrained achievable savings in 2020 in the commercial sector, compared to 39% in the economic potential scenario. In the achievable potential scenario, the portion of savings attributed to the lighting interior general end use increased significantly, while the portion of savings of HVAC ventilation and cooling DX decreased slightly, compared to the economic potential scenario (Figure 10-10 and Figure 10-11).

Figure 10-8: Unconstrained Achievable Potential Persistent Savings by Commercial Subsector in 2020

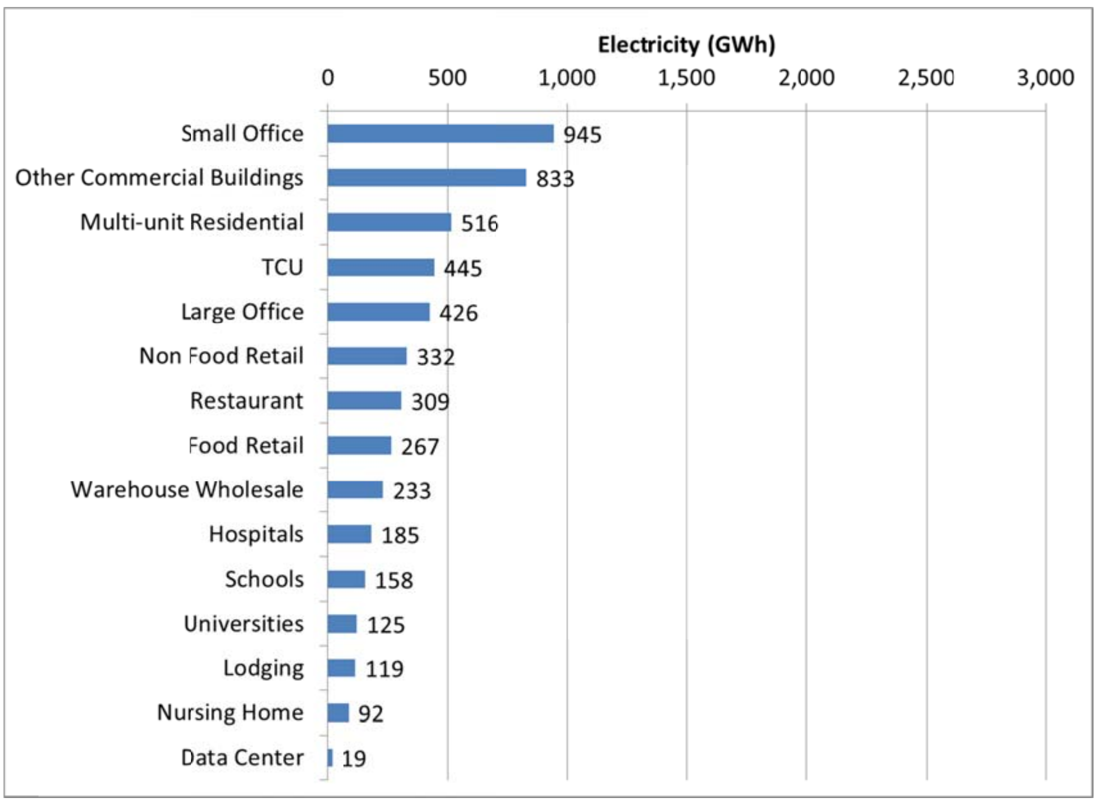


Figure 10-9: Budget Constrained Achievable Potential Persistent Savings by Commercial Subsector in 2020

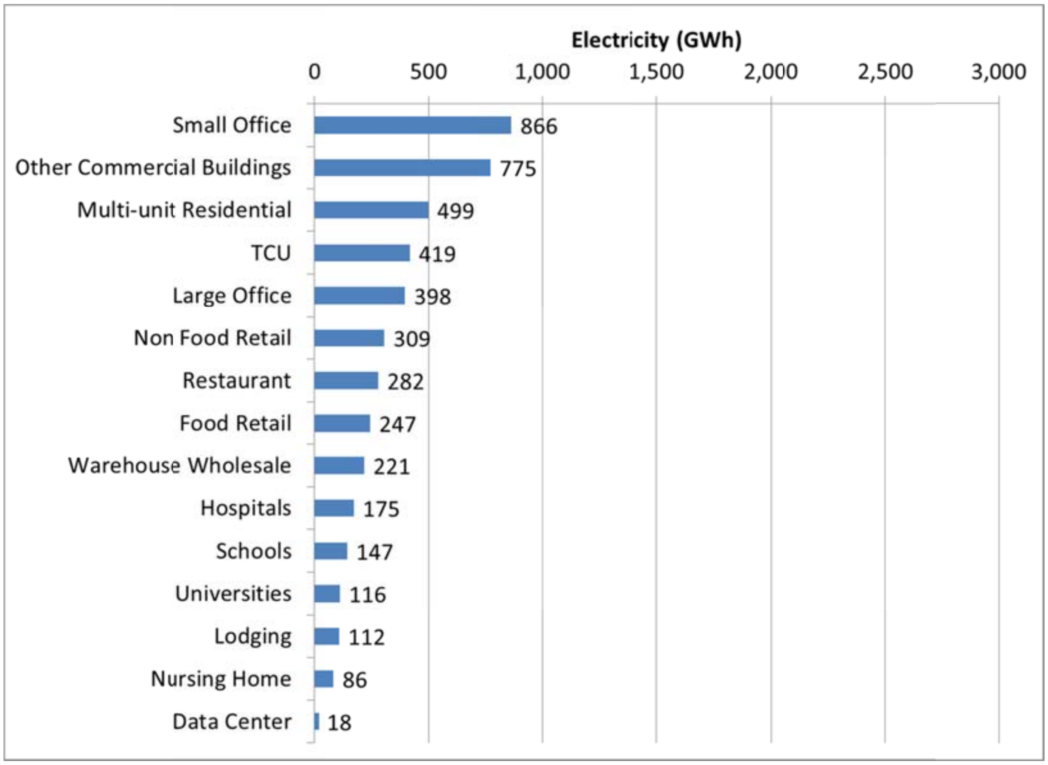


Figure 10-10: Unconstrained Achievable Potential Persistent Savings by Commercial End Use in 2020

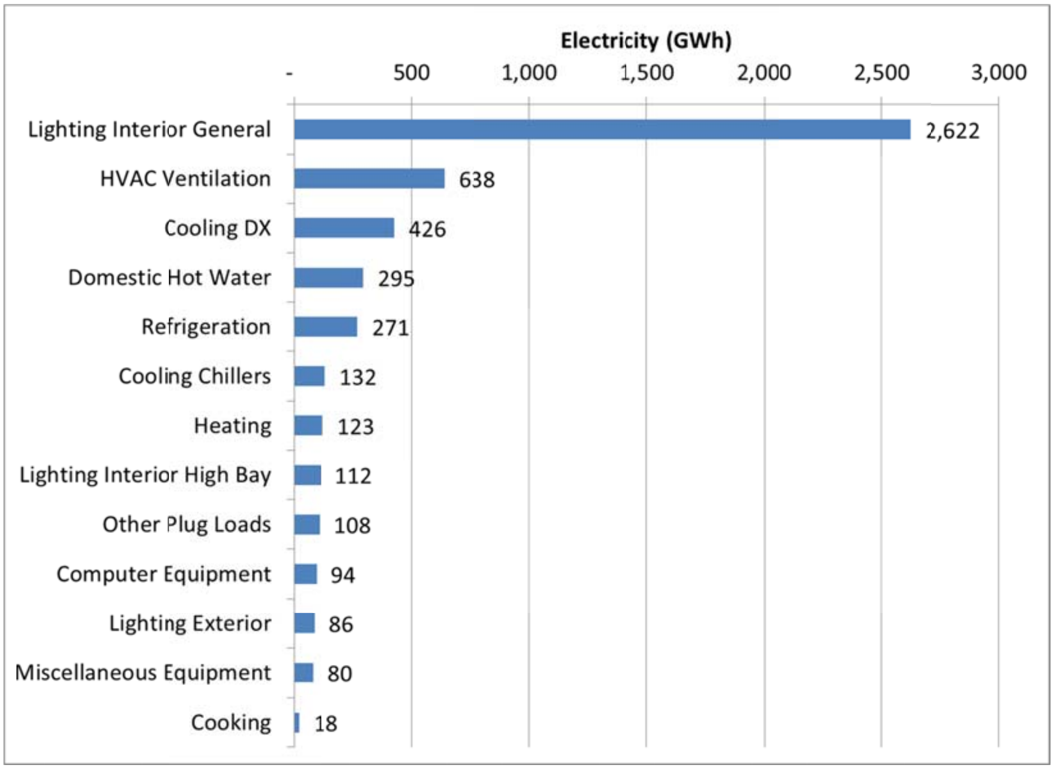
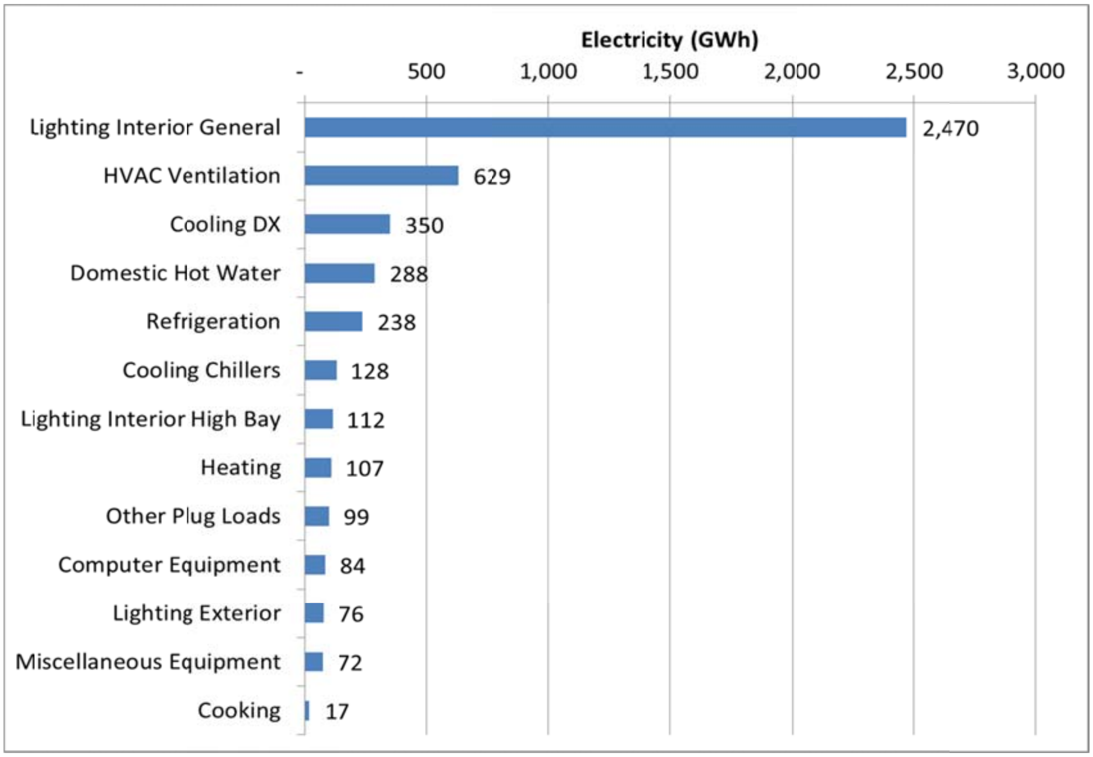


Figure 10-11: Budget Constrained Achievable Potential Persistent Savings by Commercial End Use in 2020



10.2.4 Industrial Sector

Similar to the findings in the technical and economic potential scenario, in the industrial sector, four subsectors each accounted for 10% or more of the persistent achievable potential savings in 2020: miscellaneous industrial (about 16% of total industrial savings), auto-parts manufacturing (15%), food and beverage manufacturing (12%), and chemical manufacturing (10%) (Figure 10-12 and Figure 10-13). Four end uses are estimated to account for close to 80% of the persistent savings in 2020 in the industrial sector: lighting (29%), HVAC (22%), compressed air (16%), and motor pumps (14%), as illustrated in Figure 10-14 and Figure 10-15. When comparing these end use percentage savings with the economic potential scenario, the lighting end use shows a slight increase in the industrial sector.

Figure 10-12: Unconstrained Achievable Potential Persistent Savings by Industrial Subsector in 2020

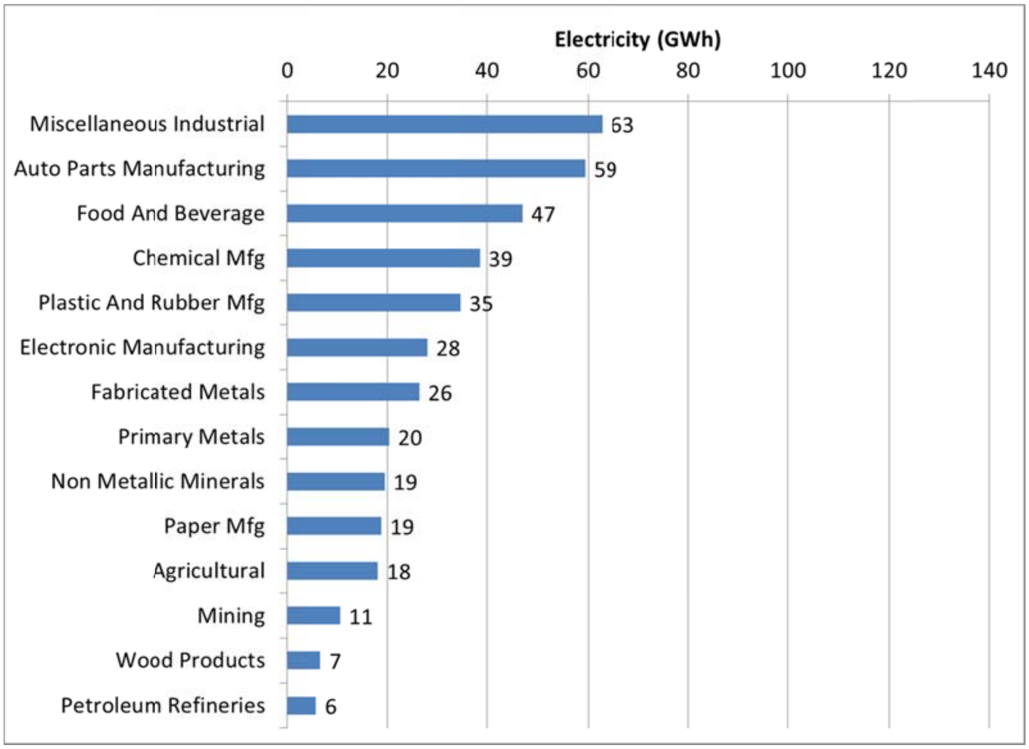


Figure 10-13: Budget Constrained Achievable Potential Persistent Savings by Industrial Subsector in 2020

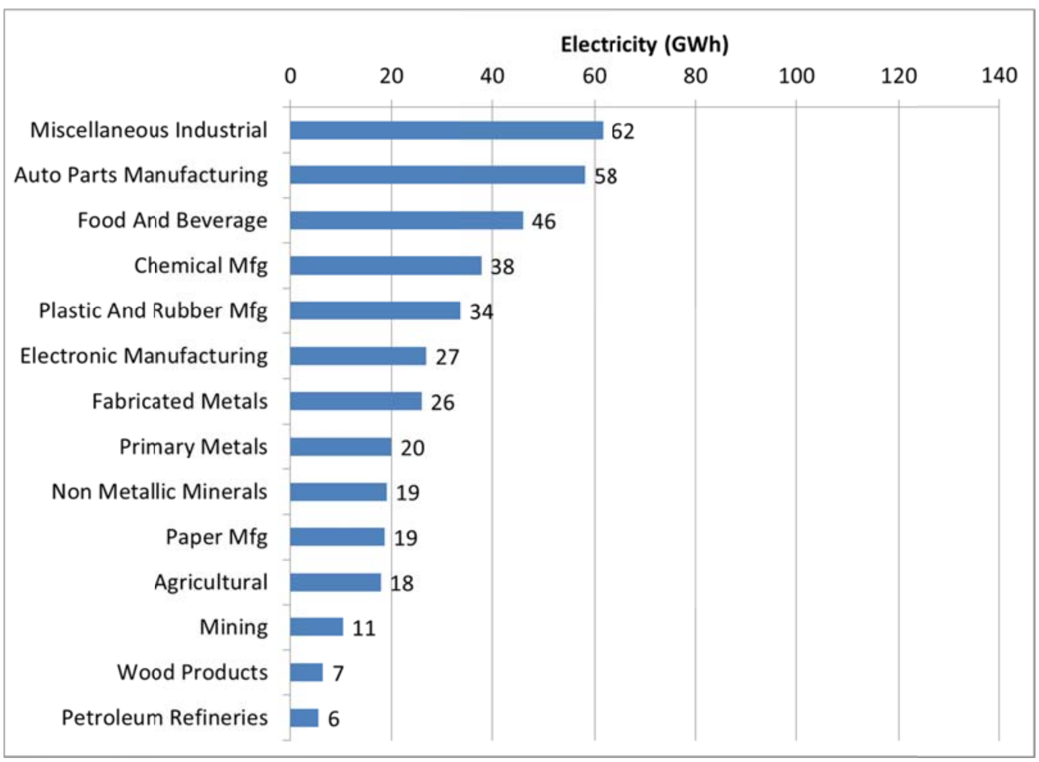


Figure 10-14: Unconstrained Achievable Potential Persistent Savings by Industrial End Use in 2020

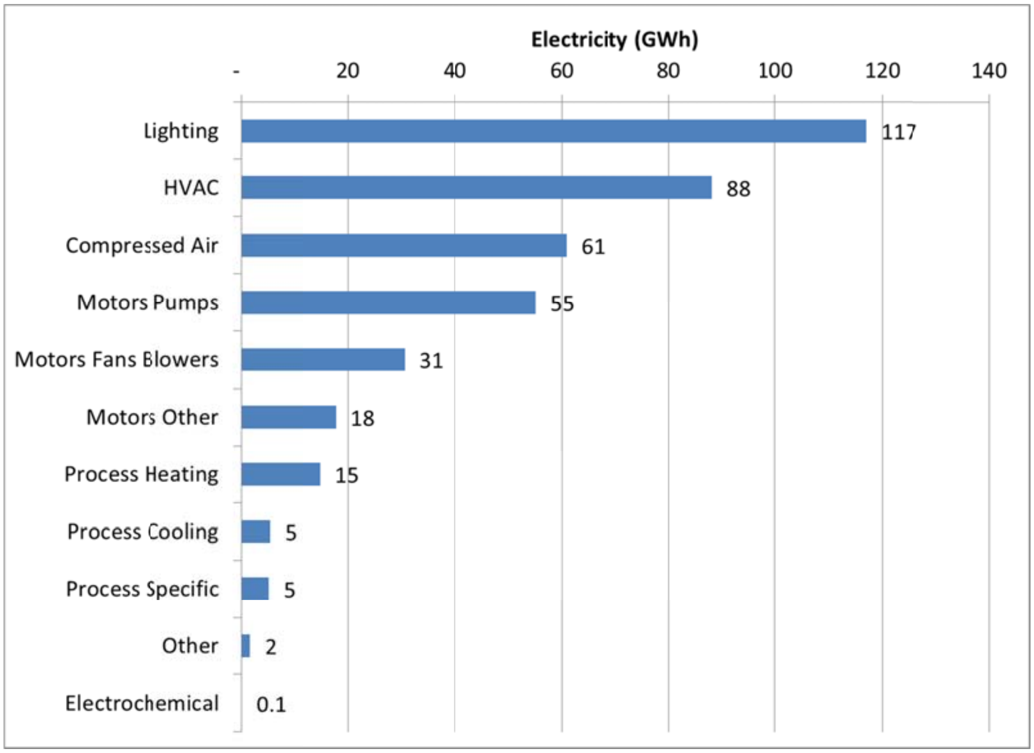
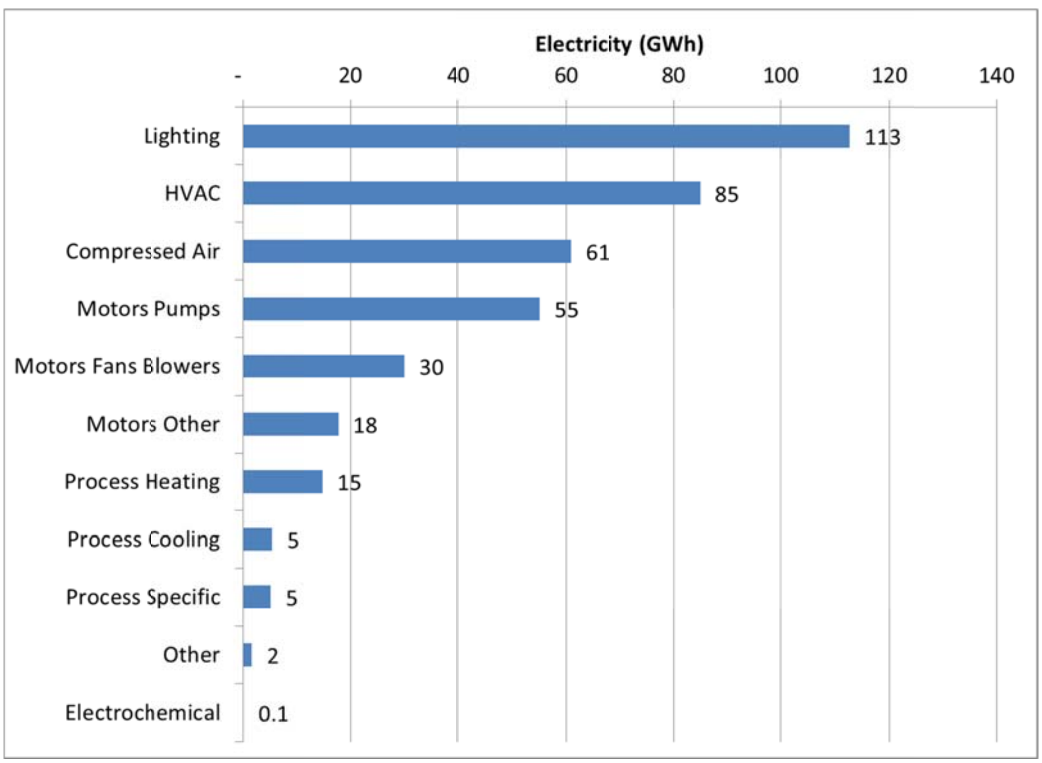


Figure 10-15: Budget Constrained Achievable Potential Persistent Savings by Industrial End Use in 2020



11 Additional Analyses

The previous sections describe that the potential savings were estimated for four scenarios: technical, economic, unconstrained achievable and budget constrained achievable potential scenarios. This section includes additional analyses discussing how the potential savings were:

- Compared to the baseline use case and reference case forecast.
- Assessed to determine the sensitivity of the savings to changes in various input parameters.
- Assessed against actual savings from states in the northeastern United States to determine how realistic and feasible the savings estimates were.

In Section 12, recommendations are provided for future studies.

11.1 Potential Compared with Baseline and Reference Case Forecast

The comparison of the technical, economic and achievable potential scenarios with the baseline and the reference case forecast is illustrated in Figure 11-1, and the electricity load values are summarized Table 11-1. The persistent savings in 2020 ranged from 28% for the technical potential scenario to 5% for the budget constrained achievable potential scenario when compared to the reference case forecast. The budget constrained achievable potential was 6,373 GWh in 2020, as summarized in Table 11-2.

Figure 11-1: Potential Scenarios Compared with Baseline and Reference Case

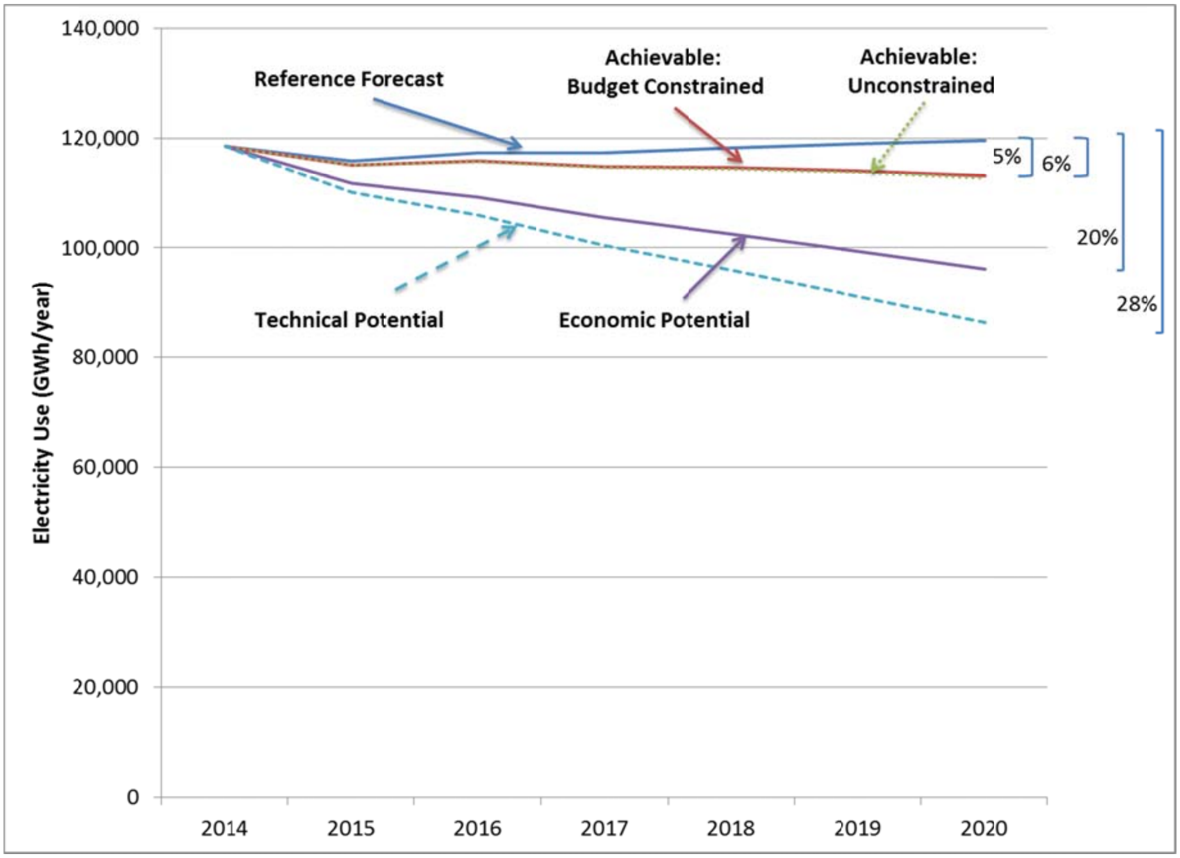


Table 11-1: Annual Electricity Use by Scenario for 2014 to 2020 (GWh/year)

Scenario	2014	2015	2016	2017	2018	2019	2020
Base year and reference case	118,443	115,877	117,331	117,331	118,237	118,907	119,515
Achievable potential: budget constrained	118,443	115,120	115,801	114,772	114,572	113,963	113,142
Achievable potential: unconstrained	118,443	115,078	115,712	114,623	114,357	113,666	112,756
Economic potential	118,443	111,798	109,311	105,450	102,514	99,345	96,108
Technical potential	118,443	110,067	105,744	100,216	95,588	90,762	85,902

Table 11-2: Persistent Savings by Scenario in 2020 (GWh/year)

Scenario	2020
Technical potential	33,613
Economic potential	23,381
Achievable potential: unconstrained	6,760
Achievable potential: budget constrained	6,373

11.2 Comparison with Other Jurisdictions

The main objective of the comparison of the Ontario achievable potential scenario savings with comparable states in the United States was to assess how realistic and feasible the potential savings estimates were. The following items and data were considered in the comparative methodology:

- Compared Ontario achievable potential results with nine northeastern American states: New York, Massachusetts, Maryland, Connecticut, New Hampshire, the District of Columbia, Rhode Island, Vermont, and Maine.
- The specific states were selected because:
  - The climate is similar to two of the climate regions in Ontario (in which almost 92% of Ontario's electricity load is located).
  - The states provide a range of average annual electricity sales that are less, similar, and more compared to Ontario's. The sales comparison is provided in Figure 11-2.
- Ontario's data was based on the annual average potential savings estimated for six years from 2015 to 2020.
- The American. states' data is based on actual average annual savings and costs for a four-year period from 2011 to 2014.
- Data for American states were obtained from the Northeast Energy Efficiency Partnerships Regional Energy Efficiency Database (https://reed.neep.org/Focus.aspx). Detailed information about the degree of program evaluation of project M&V were not available.

As illustrated in Figure 11-2, Ontario's annual average sales from 2011 to 2014 were comparable to Connecticut and relatively close to the average of the nine northeastern American states. When this study's estimate of achievable potential for all sectors was compared to the actual savings of the nine states (see Figure 11-3), the following was observed:

- Ontario's unconstrained and budget constrained achievable potential (respectively 0.94% and 0.88% of total sales) is slightly less than the average savings achieved by the American states (1.08% of total sales).

- Massachusetts and Vermont achieved more than double the percentage of savings (2.08% and 1.85%, respectively, of total sales) when compared to Ontario's 0.88% budget constrained achievable.
- Connecticut achieved 0.89% savings of total sales, which is almost the same as Ontario's 0.88% budget constrained achievable potential.

When the residential and non-residential savings were considered, as a percentage of total provincial or state sales (as illustrated in Figure 11-4 and Figure 11-5), then the comparison indicated:

- A large portion of achievable potential was achieved in the residential sector versus the non-residential sector for American states when compared with Ontario. Ontario's non-residential savings percentage (0.70%) of the total sales was relatively close to the average of the nine states (0.68%), while the Ontario residential savings percentage (0.17%) was almost half that of the American states (0.40%)
- Massachusetts and Vermont achieved significantly larger savings in both residential and non-residential sectors when compared to Ontario's budget constrained achievable potential.

The most likely reason for the larger residential portion of savings in the American states was due to the proportion of residential versus non-residential sales in these states, compared to Ontario. Data was not available to separate out the residential versus non-residential sales for the selected American states.

Based on the comparative analysis, Ontario's achievable potential savings estimate appeared to be within the feasible range of actual savings achieved by the American states, and some states achieved a significantly higher percentage savings of sales than was estimated for Ontario.

The acquisition costs to achieve the savings in Ontario and the nine American states are compared in Figure 11-6 and Figure 11-7. Comparing the estimated Ontario acquisition costs for the achievable potential scenarios with the actual acquisition costs in the American states led to the following observations:

- The average acquisition costs of the nine American states were between the estimated acquisition cost for Ontario's unconstrained and budget constrained scenarios.
- Ontario's estimated acquisition cost to achieve the total savings under the budget constrained scenario:
    - Was comparable to New York, which has the second lowest acquisition costs of the nine American states.
    - Was significantly less when compared to Massachusetts, Connecticut, and Vermont.

Since the budget constrained scenario was based on an optimized TRC ranking approach, one would expect the acquisition cost to be somewhat optimized. Having the Ontario estimated acquisition cost for the unconstrained and budget constrained scenarios respectively higher and lower than the average acquisition cost of the American states, indicated that the Ontario estimate was in the range of what would be practically achievable.

Figure 11-2: Average Annual Sales of Ontario and American States (Total for Residential, Commercial, and Industrial Sectors)

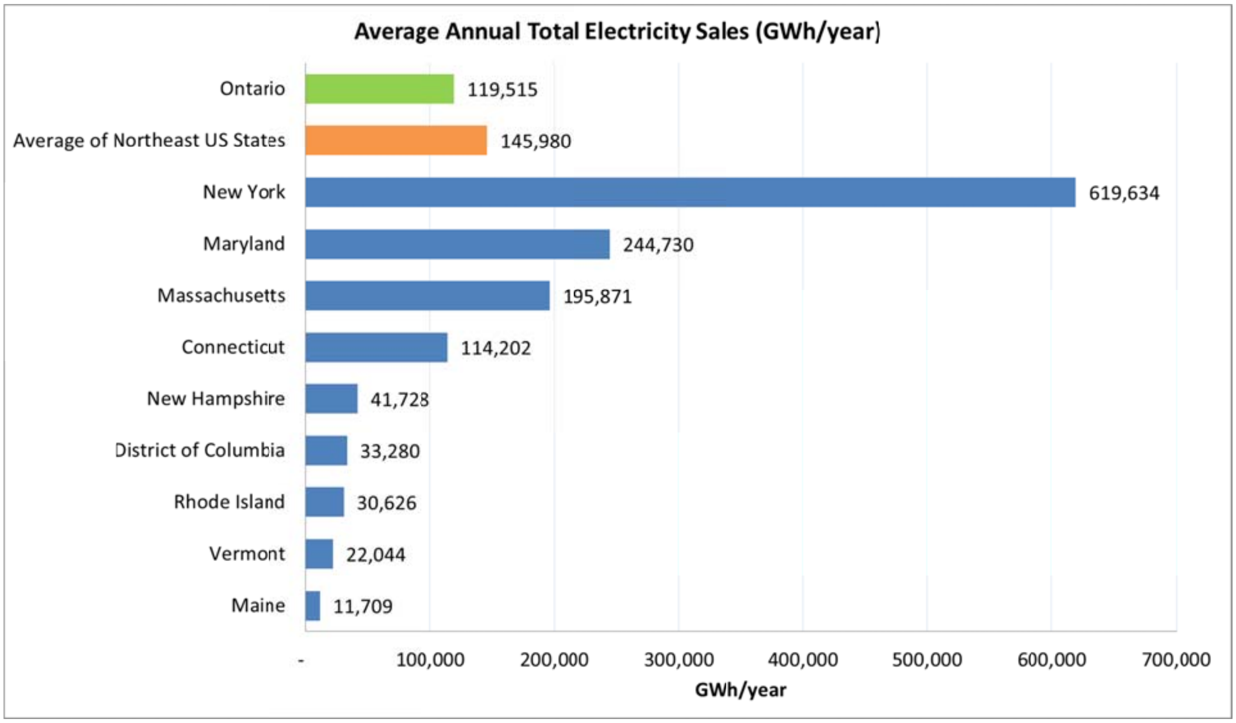


Figure 11-3: Comparison of Savings as Percentage of Total Sales

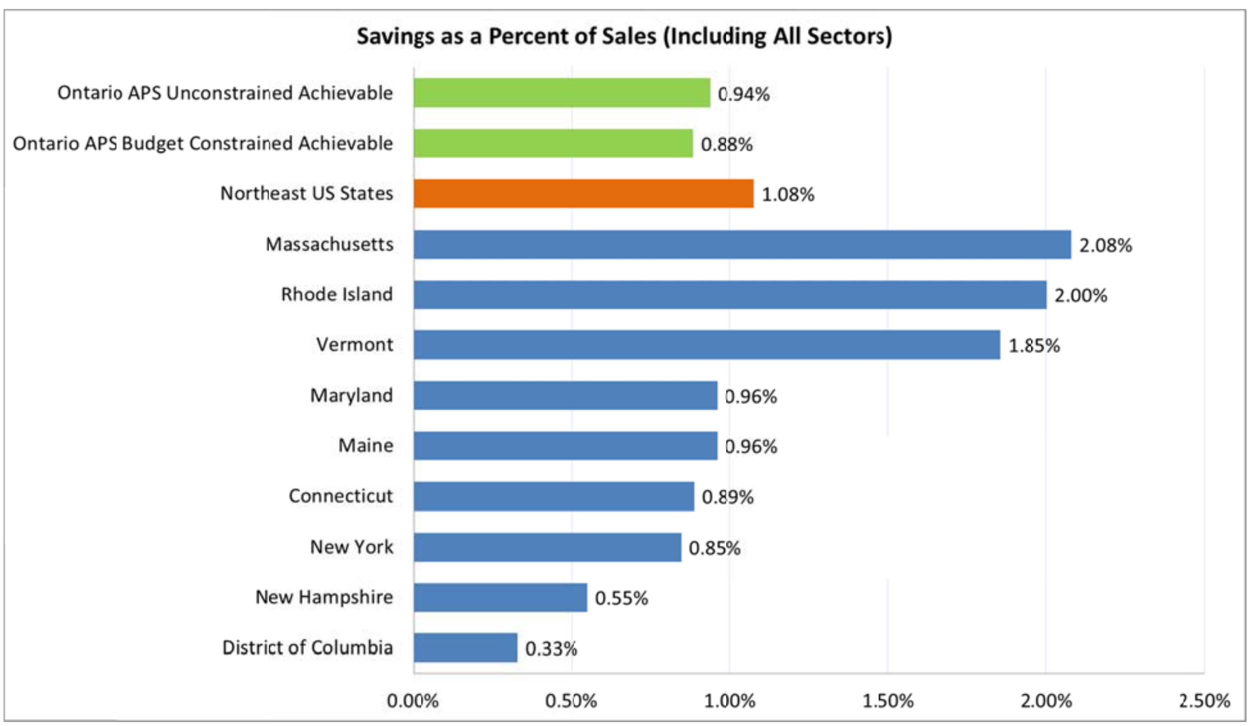


Figure 11-4: Comparison of Residential Savings as Percentage of Total Sales

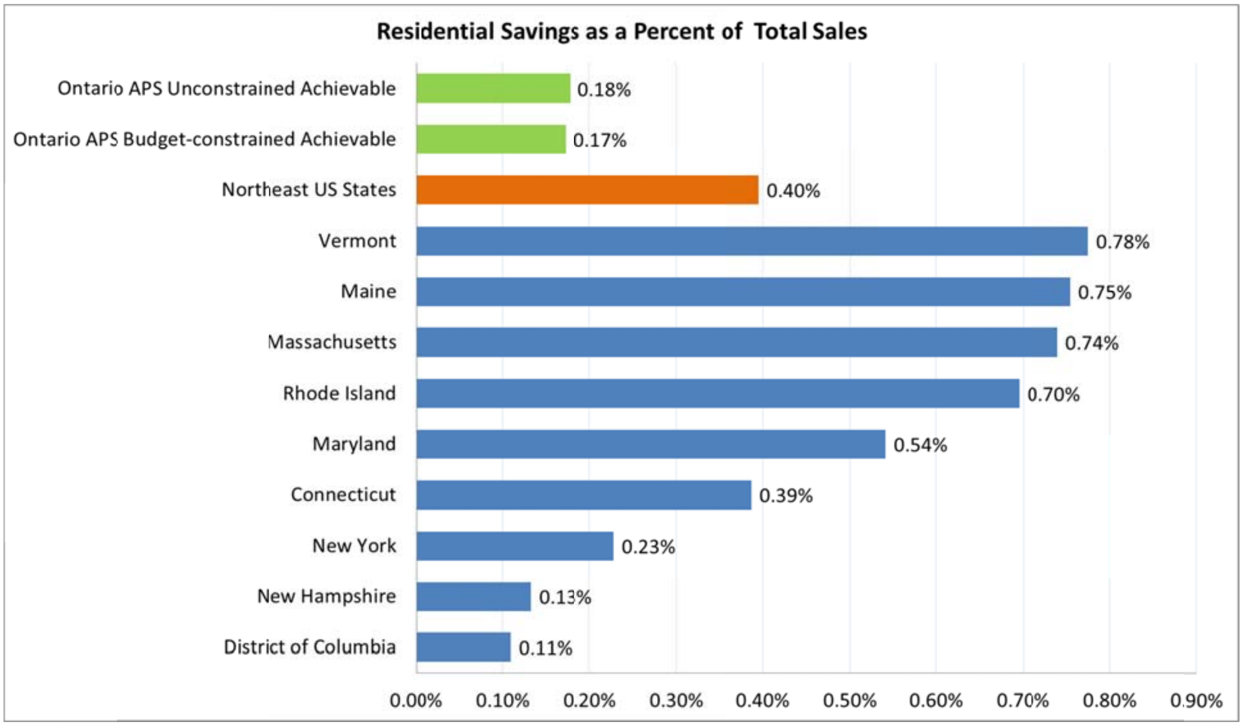


Figure 11-5: Comparison of Non-Residential Savings as Percentage of Total Sales

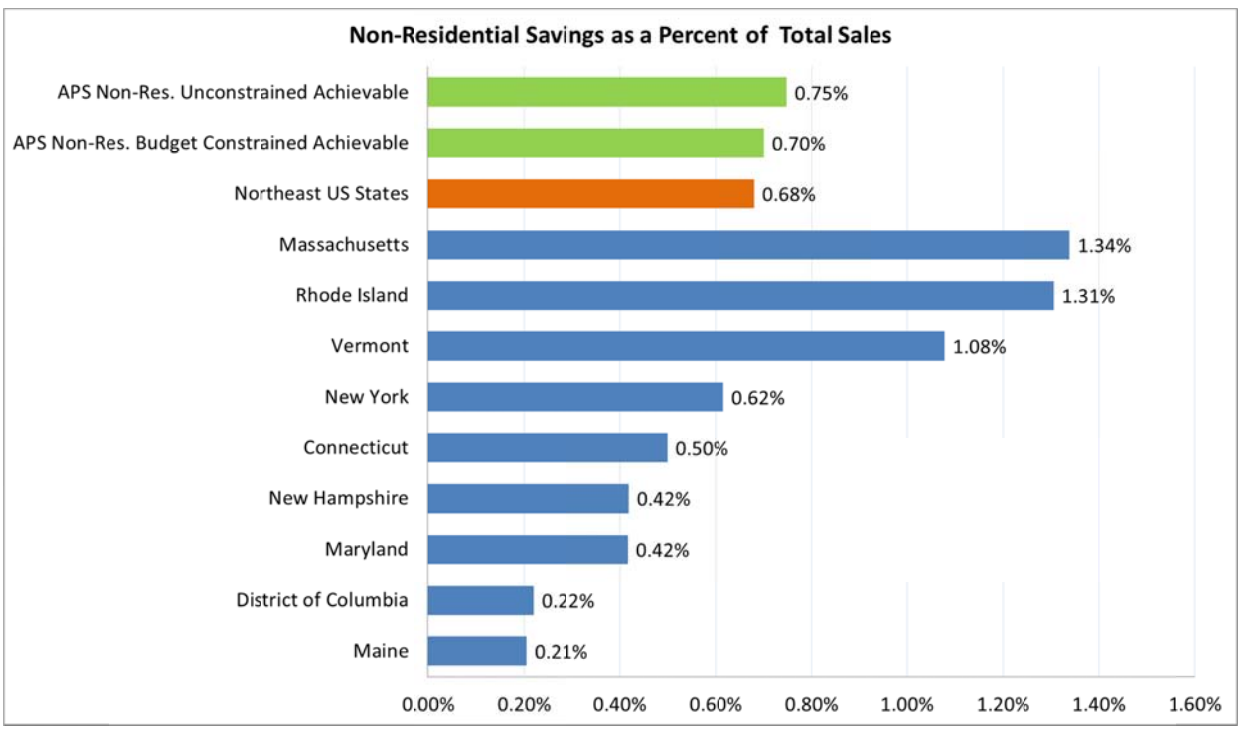


Figure 11-6: Comparison of Acquisition Costs

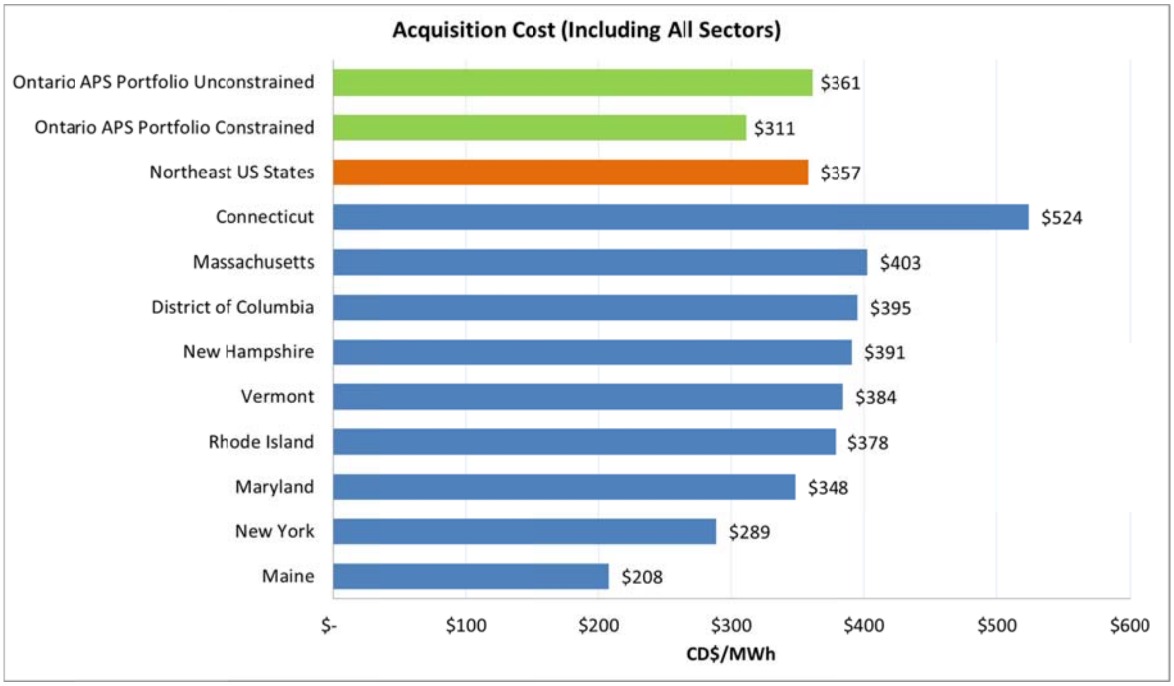
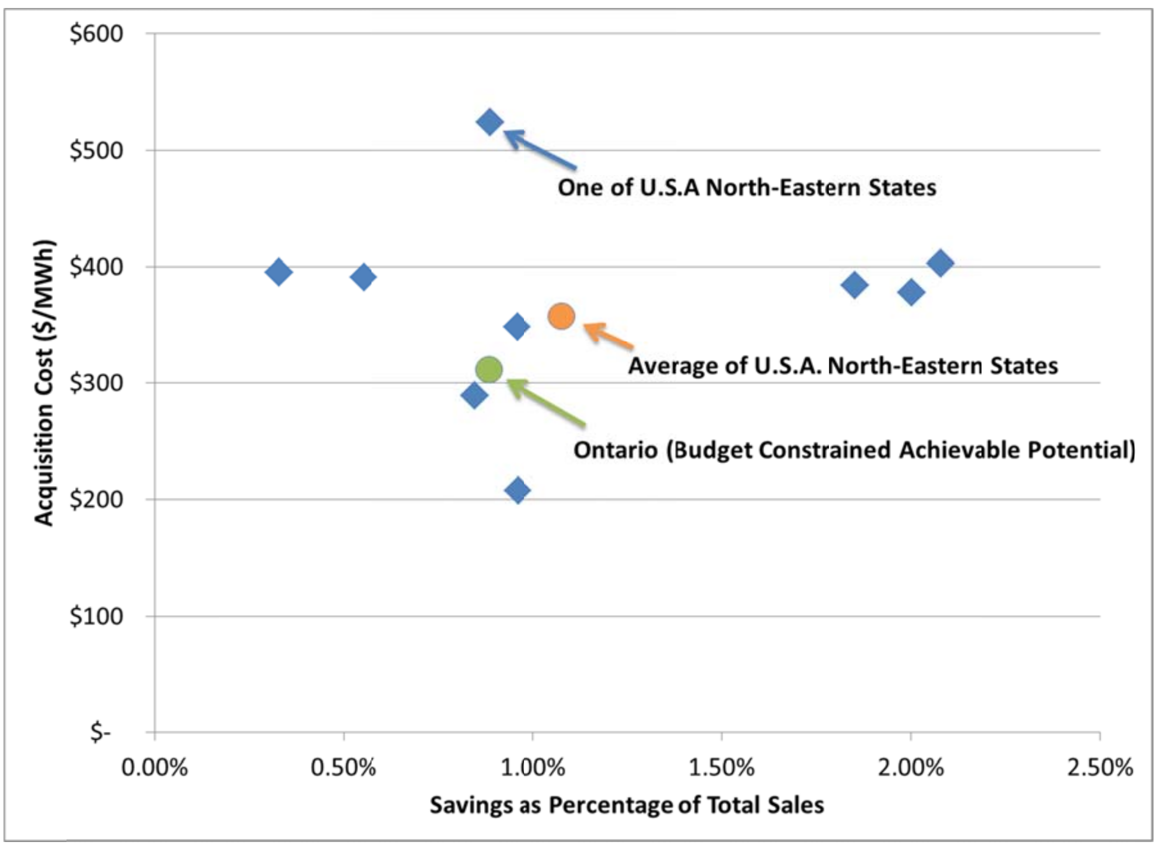


Figure 11-7: Comparison of Acquisition Costs and Savings



11.3 Sensitivity Analysis

The objective of this task was to assess the impact on the achievable potential savings if key input parameters were changed. This provided an indication of how sensitive the results were to changes in input parameters. Results from two LDCs were used in the sensitivity analyses:

- LDC 1: medium to large sized LDC with a relatively smaller portion of residential load.
- LDC 2: medium to large sized LDC with relatively larger portion of residential load.

The key input parameters that were assessed in the sensitivity analysis were:

- Incentive rates
- Adoption curves
- Avoided cost.

The sensitivity analysis is discussed in the remainder of this section.

11.3.1 Incentive Rates

The following methodology was used to assess the impact on the achievable potential when incentive rates were changed:

- Incentive rates were changed +/- 25% for all archetype programs. The 25% incentive increase was not applied to archetype programs, such as Low Income, since its incentive rate was already 100%.
- The price elasticity research conducted for this study was referenced. For the commercial and industrial sectors, the price elasticity value was found to be 0.46; the residential sector price elasticity value was estimated at 0.25.[1]
- The price elasticity values were used to establish the adjustment factor to be applied to the base case modelled savings estimates using the formula: *Savings Factor Adjustment = 1+ (Price Elasticity Value x Incentive Change %)*.
  - For commercial and industrial sectors, the savings adjustment factor was estimated at 1.115 for +25% incentive adjustment and 0.885 for -25% incentive adjustment.
  - For the residential sectors, the savings adjustment factor was estimated at 1.0625 for +25% incentive adjustment and 0.9375 for -25% incentive adjustment.

[1] Price elasticity is a basic measure of demand or supply sensitivity to changes in price. An elasticity value of 1.0 would indicate a product that is perfectly elastic: any change in price would result in drastic changes to supply and demand (in this case, supply and demand would drop to 0). An elasticity value of 0 indicates that changes to price have no effect on supply and demand. These extreme cases are theoretical, or at least rare. More commonly, elasticity values fall within the range of 0 to 1 and indicate a percentage change in quantity supplied or demanded for a given percentage change in price. Price is not the only factor that affects demand or supply. For example, in this study, the elasticity for incentives is lower in the commercial sector than in the residential sector. Commercial customers are less sensitive to changes in incentives mainly due to the following reasons: time spent to evaluate energy efficiency product may represent time taken away from other, more valuable business activities. In short, other aspects of running the business may be more important than evaluating and identifying cost-effective energy savings measures. Residential customers, on the other hand, are likely to be more sensitive to price because there are more product options in the residential market, and price is a more important consideration for those with limited household budgets.

- The combination of the incentive rate adjustment and modeled savings adjustment was used to estimate a revised 2020 portfolio savings estimate. This result was compared against both the unconstrained, achievable base case savings and the budget constrained base case savings.

The results from the analysis are illustrated in Figure 11-8 and Figure 11-9. The unconstrained scenario indicated that increasing or decreasing the incentive rates would lead to proportional increases and decreases in savings.

The budget constrained scenario indicated that the portion of residential load affects the impact of increasing or decreasing the incentive rates because of the lower price elasticity for the residential sector. For an LDC with a relatively larger portion of residential load, more money allocated to incentives would not translate into incrementally more savings.

Figure 11-8: Sensitivity to Changes in Incentive Rates – Unconstrained Achievable

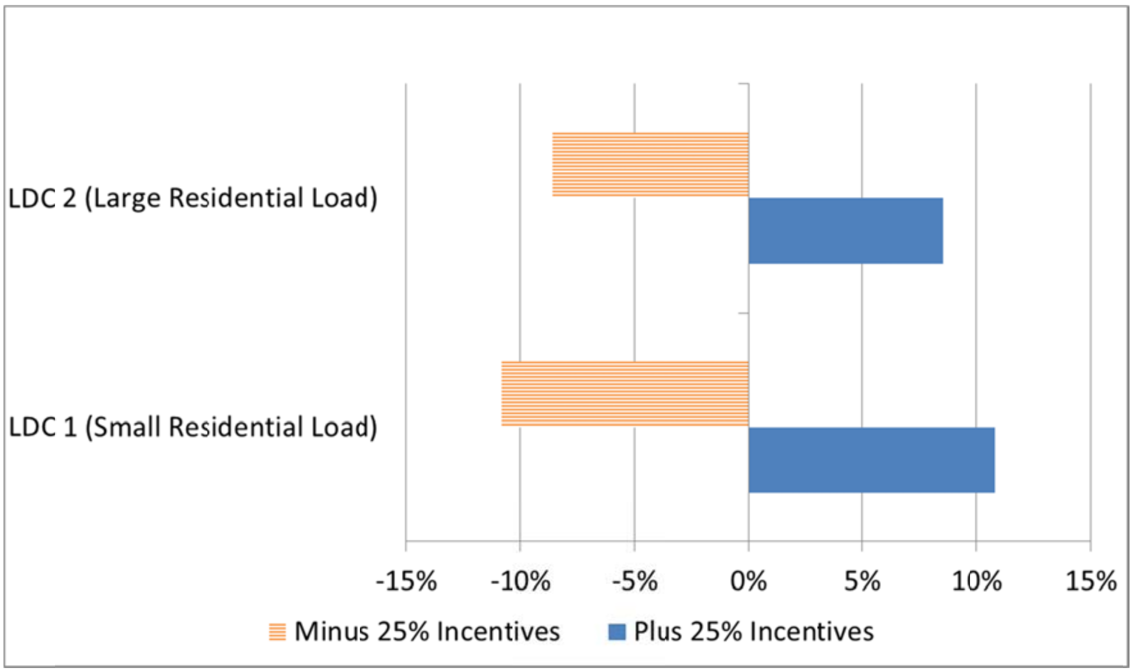
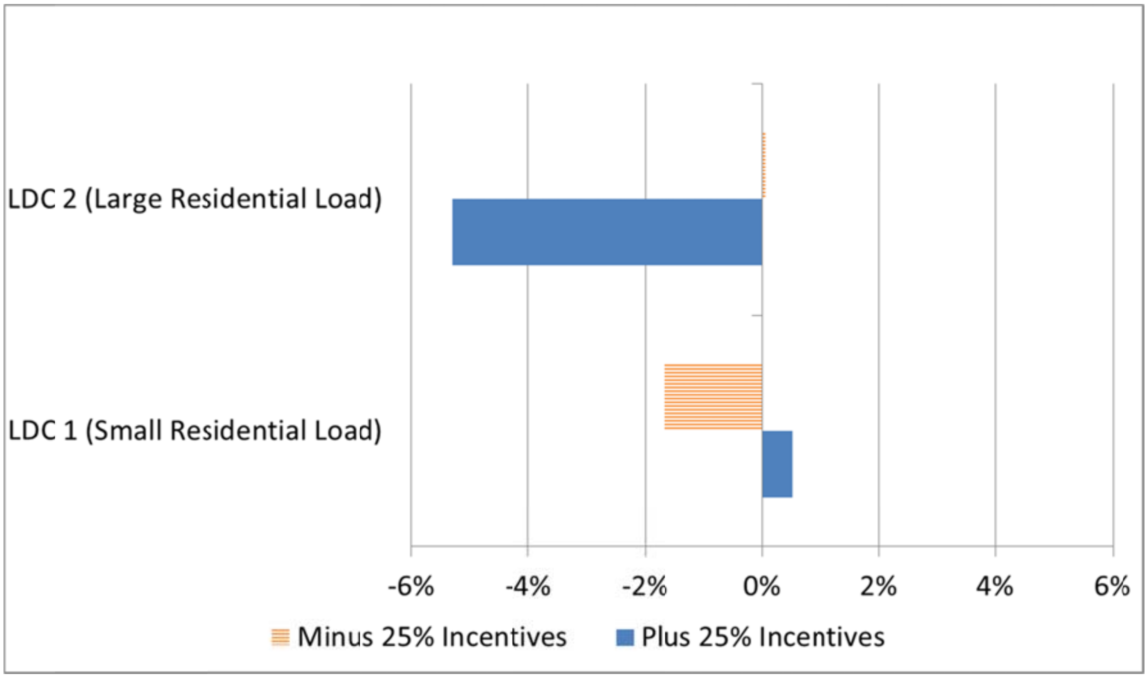


Figure 11-9: Sensitivity to Changes in Incentive Rates – Budget Constrained Achievable



11.3.2 Adoption Curves

A faster or slower participation rate in programs compared to the estimated adoption in this study would result in a change in the adoption curves. The sensitivity of the estimated achievable potential to changes in the adoption curves was assessed. The following methodology was used to assess the impact on the achievable potential when adoption curves were changed:

- Adoption rates were revised by +/-25% across all measures for each year of the short term horizon
- Incentive and program administrative costs were also revised, in line with the calculated savings increase/decrease
- The impact on the 2020 portfolio energy savings was calculated and was compared with both unconstrained and budget constrained achievable potential base case scenarios.

Figure 11-10 and Figure 11-11 provide the results of the sensitivity analysis; for both the unconstrained and the budget constrained scenarios, the increase or decrease in savings were relatively proportional to the changes in adoption rates. Increased adoption rates in the budget constrained scenario did have a significant lower impact on increased savings, compared to the unconstrained scenario. A 25% increase in adoption rates resulted in a savings increase of between 6% and 8% in the budget constrained achievable potential scenario, compared to 23% to 24% for the unconstrained achievable potential scenario.

Figure 11-10: Sensitivity to Changes in Adoption Curves – Unconstrained Achievable

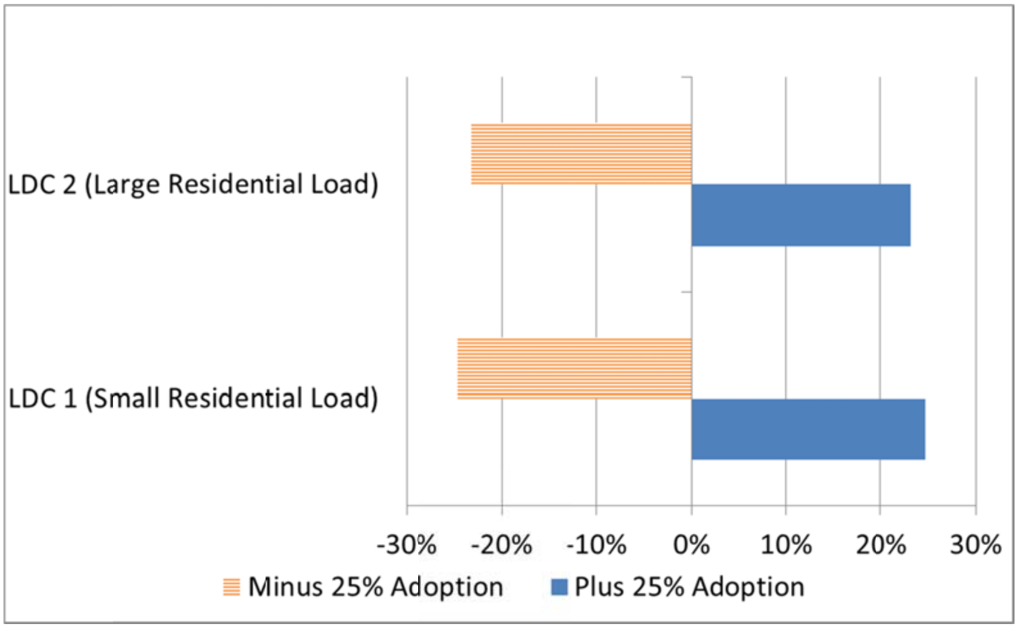
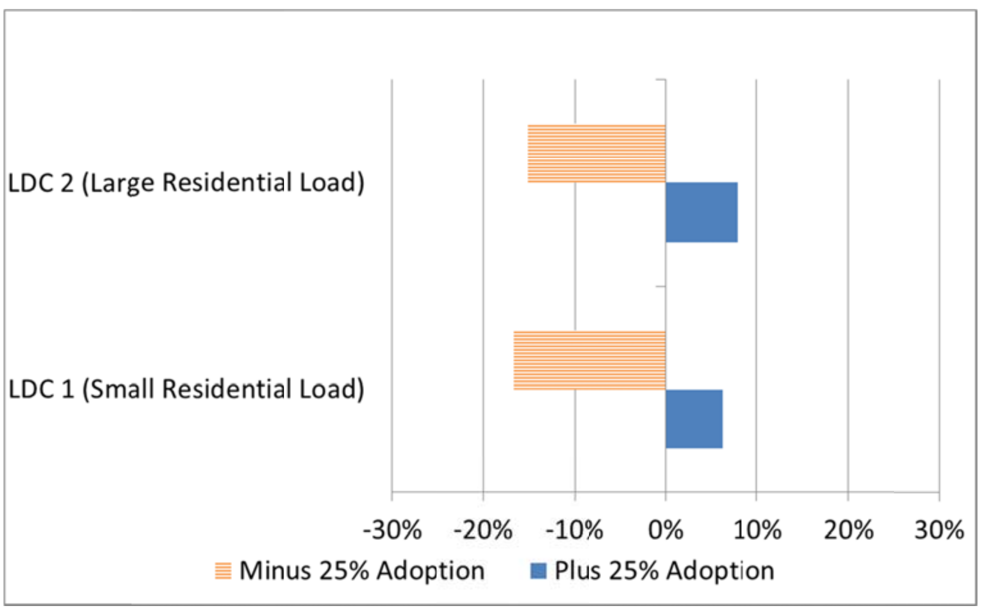


Figure 11-11: Sensitivity to Changes in Adoption Curves – Budget Constrained Achievable



11.3.3 Avoided Cost

The following methodology was used to assess the impact on the achievable potential when avoided costs were changed:

- Avoided costs were revised by +/-25% for the short term horizon

- The impact on the 2020 portfolio energy savings were calculated and were compared with both the unconstrained and the budget constrained achievable potential base case scenarios.

Figure 11-12 and Figure 11-13 provide the results of the sensitivity analysis for both the unconstrained and the budget constrained scenarios. A small correlated impact was observed for the unconstrained potential: a 25% increase in avoided costs led to 3% additional potential. There are only a few measures that moved over the cost-effectiveness threshold with a 25% increase in avoided cost; for a 25% decrease in avoided costs, the potential was slightly reduced. The sensitivity analysis indicated that the residential sector was more sensitive to changes in avoided costs; LDC 2 was more sensitive to changing the avoided costs compared to LDC 1.

For the budget constrained achievable potential scenario, there was no direct correlation with an increase or decrease of avoided cost. A potential reason for this result was that the change in measures (as measures got added or removed from the program) and the cost to deliver the measures that actually got adopted in each scenario (+/-25%) was not correlated with the avoided costs. Even though avoided costs increased by 25% and a few more measures were included in the portfolio, the cost to deliver those added measures (based on acquisition cost) was on average greater, and therefore the budget-cap was reached sooner.

Figure 11-12: Sensitivity to Changes in Avoided Costs – Unconstrained Achievable

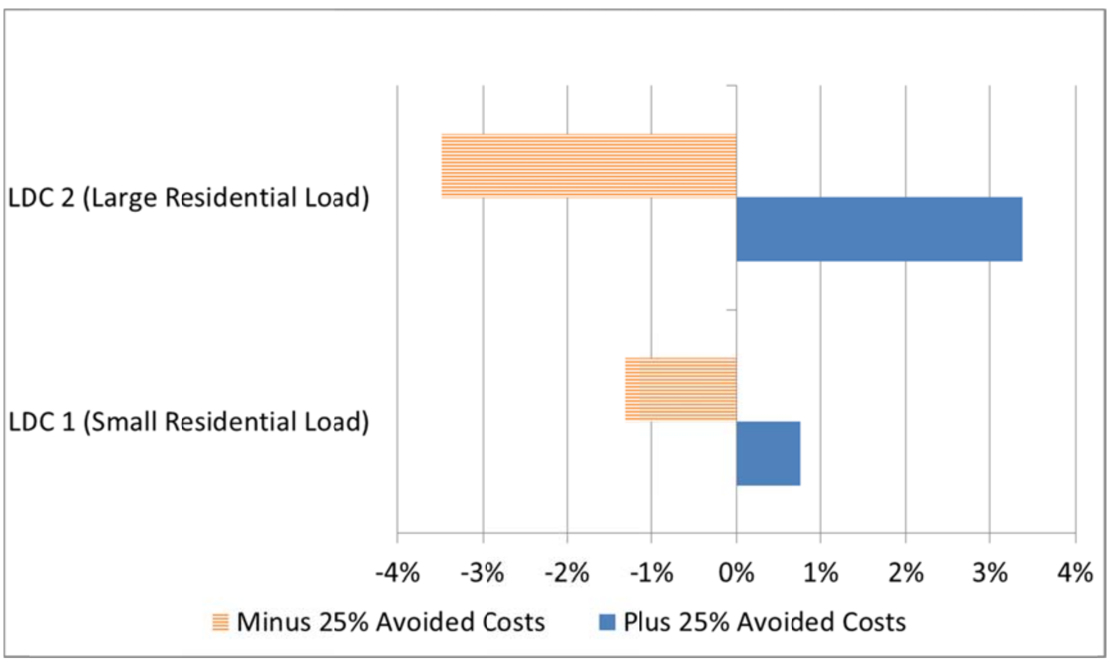
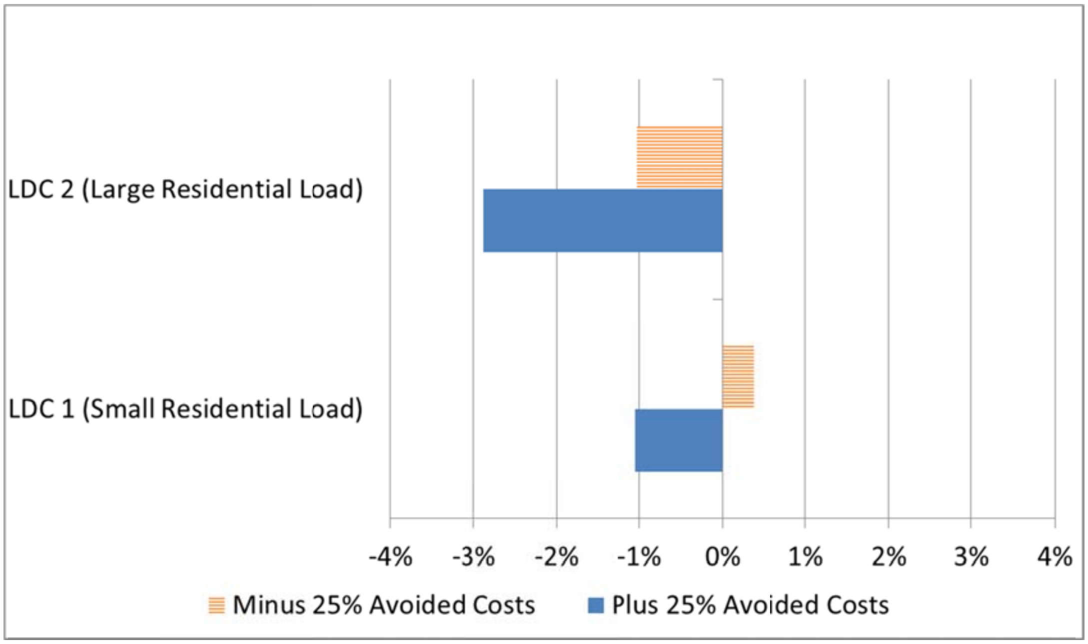


Figure 11-13: Sensitivity to Changes in Avoided Costs – Budget Constrained Achievable



11.4 Conservation First Framework and Behind-the-Meter Generation

The potential for electricity reduction resulting from BMG was assessed in a separate study and the methodology and results were presented in a separate report published by IESO. The results from the BMG study were used to determine the total achievable potential for electricity reduction. To ensure that no double counting of electricity reduction occurred, the EE potential was modelled using a reference case forecast that was reduced by the value of the BMG potential. The total budget constrained EE potential is 6,373 GWh in 2020, as discussed in Section 10.2. The total budget was derived from summing the CFF budget and the carry over budget (or legacy budget) from the previous framework that was spent in 2015, and subtracting the budget associated with the BMG potential. The total constrained budget for EE was $2,035 million and is summarized in Table 11-3.

The total budget constrained achievable potential for EE and BMG is 7,351 GWh in 2020, 5% more than the 7,000 GWh provincial target set by the CFF for 2020. The total achievable potential in 2020 is summarized in Table 11-4; the budget associated with the achievable potential was $ 2,213 million.

Table 11-3 Provinvial Budget 2015 to 2020 (Millions of Dollars)

1,836	377	178	**2,035**

Table 11-4: Provincial Budget Constrained Achievable Potential: Budget and Savings

Option	Spending ($ million)	Savings (GWh)
EE	2,035	6,373
BMG	178	978
Total APS	**2,213**	**7,351**
CFF Target		7,000

12 Conclusions and Recommendations

This section provides a summary of the conclusions from the potential analysis and recommendations on how future achievable potential studies could be improved, both through study processes and through additional data collection.

12.1 Summary Conclusions from Potential Analysis

In the 2014 base year, the largest portion of electricity was consumed by the commercial sector (57,031 GWh per year or 48% of the total electricity use), followed by the residential sector (39,461 GWh per year or 33%); the industrial sector used the smallest portion of electricity (21,951 GWh per year or 19%). The residential single family subsector accounted for the largest electricity use by subsector, with 29,974 GWh per year. The end use with the largest electricity use was general interior lighting in the commercial sector, with 17,882 GWh per year consumed.

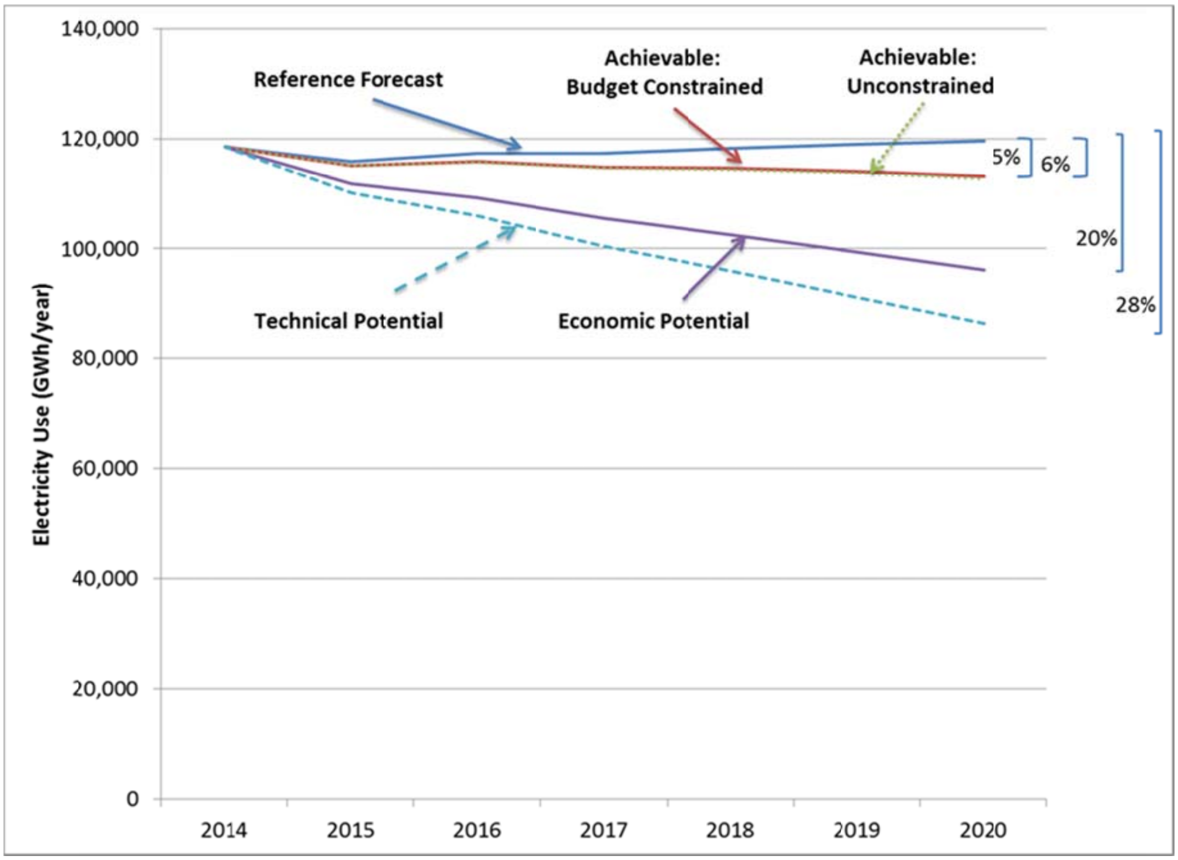
The load forecast for 2015 to 2020 estimated a total increase in electricity use of 0.9% from 118,443 GWh in 2014 to 119,515 GWh in 2020. The commercial sector is expected to provide the largest increase in electricity use of 2,451 GWh from 2014 to 2020, a 4.3% increase. The growth in electricity use was mainly due to the expected increase in commercial floor space. The residential sector electricity use is expected to decrease by 5.5%, mainly due to the continued conversion of space heating and water heating fuel share, the rising share of multi-residential dwellings, and more efficient appliances. The industrial sector is undergoing significant economic restructuring and electricity use is expected to increase marginally by 3.6%. In absolute terms, the largest decrease in electricity consumption by subsector is expected to occur in the residential single family and industrial paper and non-metallic mineral manufacturing subsectors. The largest increases in electricity by subsector are expected to occur in most of the commercial subsectors.

The persistent savings in 2020 ranged from 28% for the technical potential to 5% for the budget constrained achievable potential when compared to the reference case forecast, as illustrated in Figure 12-1. The budget constrained achievable potential in 2020 was estimated to be an annual persistent saving of 6,373 GWh, as summarized in Table 12-1. The largest portion of the savings was from the commercial sector, which accounted for 73% of the budget constrained achievable potential savings. Since the commercial sector accounted for the largest portion of electricity use, it was expected to also account for the largest savings potential. For the commercial sector, close to 75% of the technically feasible measures made it into the achievable budget constrained scenario, while close to 60% of the technically feasible measures made it into the residential sector's budget constrained achievable potential scenario. The measures that were included differed by LDC and were included in the results workbooks that were provided to each LDC.

Table 12-1: Persistent Savings by Scenario in 2020 (GWh/year)

Scenario	2020
Technical potential	33,613
Economic potential	23,381
Achievable potential: unconstrained	6,760
Achievable potential: budget constrained	6,373

Figure 12-1: Potential Scenarios Compared with Baseline and Reference Case



To achieve the potential savings, the following archetype programs were identified to address gaps and recommendations from the evaluations of existing programs, and to guide LDCs in developing and enhancing programs:

- Residential Sector:
  - Consumer
  - System and Equipment
  - Audit and Direct Install

- Whole Home
- Behavioural
- Low Income
- Aboriginal
- New Construction

- Commercial and Industrial Sectors:
  - Audit and Energy Partners
  - Retrofit
  - Small Business
  - New Construction

These archetype programs are described in detail in Section 5. The potential savings from the archetype programs indicated that the largest budget constrained achievable potential could be obtained from the Retrofit (close to 60% of total persistent, achievable potential savings in 2020) and Consumer (close to 15% of savings) archetype programs.

Figure 12-2: Achievable Potential Persistent Savings by Sector in 2020

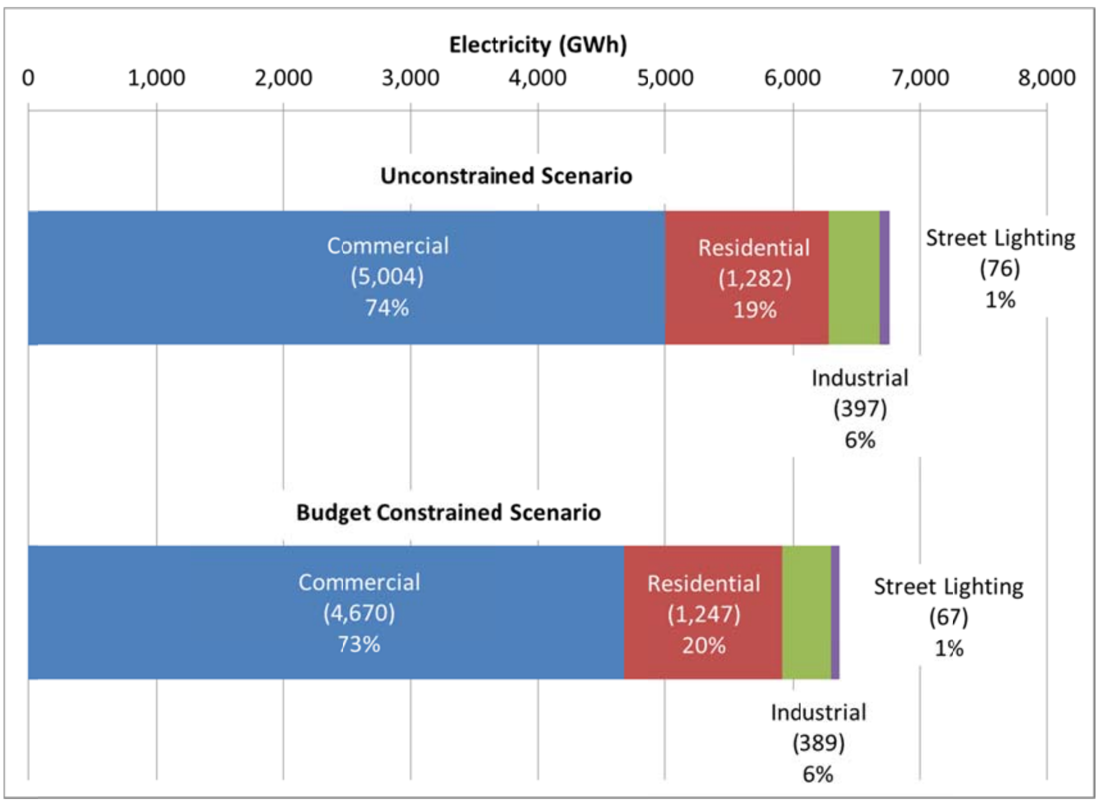
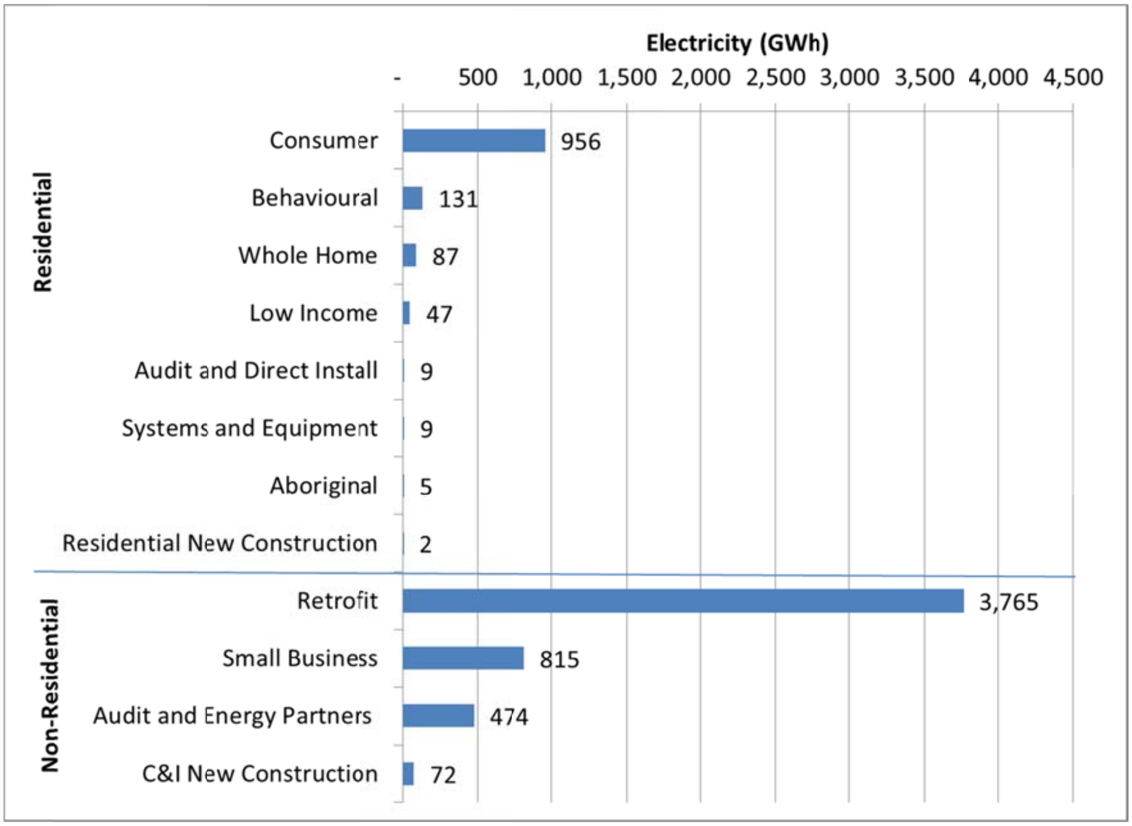


Figure 12-3: Budget Constrained Achievable Potential Persistent Savings by Archetype Program in 2020



The archetype programs with the highest TRC in the budget constrained achievable potential scenario are the Audit and Direct Install (TRC of 23.9) and Small Business (TRC of 3.5) archetype programs. Similarly, the highest PAC in the budget constrained achievable potential scenario was observed for the Audit and Direct Install (PAC of 22.3) programs, while the Retrofit (PAC of 5.5) archetype program had the second highest PAC.

The portfolio acquisition cost was estimated to be $311 per MWh for the budget constrained scenario. In the budget constrained scenario the highest acquisition costs were associated with the Aboriginal ($1,282 per MWh) and Whole Home ($1,241 per MWh) archetype programs, while the lowest acquisition costs were associated with the Audit and Energy Partners ($191 per MWh) and Retrofit ($191 per MWh) archetype programs.

Based on the comparative analysis, Ontario's achievable potential savings estimate for the study timeframe was within the feasible range of actual savings achieved by the American states, and some states achieved significantly higher percent savings of sales than estimated for Ontario. Since the budget constrained scenario is based on an optimized TRC ranking approach, one would expect the acquisition cost to be somewhat optimized. Having Ontario's estimated acquisition cost for the unconstrained and budget constrained scenarios respectively higher and lower than the average acquisition cost of the American states indicated that the Ontario estimate was in the range of what could be practically achievable.

The budget constrained scenario indicated that the portion of residential load affected the impact of increasing or decreasing the incentive rates because of the lower price elasticity for the residential sector. For an LDC with a relatively larger portion of residential load, allocating more money to incentives did not result in incrementally more savings.

For both the unconstrained and budget constrained scenarios, the increase or decrease in savings were relatively proportional to the changes in adoption rates. Increased adoption rates in the budget constrained scenario did have a significantly lower impact on increased savings compared to the unconstrained scenario. A 25% increase in adoption rates resulted in a savings increase of between 6% and 8% in the budget constrained achievable potential scenario, compared to 23% to 24% for the unconstrained achievable potential scenario.

A small correlated impact was observed for the unconstrained potential: a 25% increase in avoided costs led to 3% additional potential. The sensitivity analysis indicated that the residential sector was more sensitive to changes in avoided costs. For the budget constrained achievable potential scenario, there was no apparent, direct correlation with an increase or decrease in avoided cost. A potential reason for this result was that the change in measures (measures getting added or removed from the program) and the cost to deliver the measures that actually got adopted in each scenario (+/-25%) was not correlated with the avoided costs.

The total budget constrained achievable potential savings for EE and BMG was 7,351 GWh in 2020, 5% more than the 7,000 GWh provincial target, set by the CFF for 2020. The budget associated with the achievable potential was $ 2,213 million.

12.2 Recommendations for Future Studies

A number of observations and recommendations were identified that would improve data, ensure accuracy, address gaps, and enhance the process for future potential analyses.

Overall Process, Methodology, and Schedule

- Since this was the first time LDC profiles were developed as part of the achievable potential study, the development and review of the profiles took more time than originally planned. This resulted in reducing the time available for subsequent tasks. It is anticipated that the updating of the LDC profiles will require less time in the next study, but sufficient time needs to be allocated to this step.
- Sufficient time needs to be allocated to generate and review draft results. It is recommended that conducting test model runs to review draft results take place before undertaking a full model run. A full model run requires significantly more time and effort compared to a test model run.

- Methodologies and approaches were reviewed and adjusted as needed throughout the study. In some cases, extra time would have provided even more opportunity to refine the methodologies. In future studies, it may be beneficial to identify key methodologies and plan extra time to review these methodologies and their implications.
- The study used an optimized TRC ranking approach to estimate the budget constrained achievable potential. Depending on the objectives of future potential studies, it may be beneficial to review additional approaches to developing budget constrained achievable potential.
- This was the first time that both EE and BMG potential was assessed and integrated to derive the potential savings. Combining the two studies into one study would assist in a more effective alignment of the methodologies and the schedule of the integration.
- The study was completed in mid-2016 and used 2014 as the base year, but close to the completion of the project, program evaluation data became available for 2015. It is recommended that IESO consider the timing of the program evaluation results when scheduling the achievable potential study and when selecting the base year.

Data Collection:

- Since the study followed a bottom-up approach that was LDC and program focused, it was important to obtain as much LDC and program primary data as possible; this will also be the case in future studies.
- Obtaining LDC data prior to the formal kick-off of the study assisted in optimizing the time required to conduct the study; IESO should follow a similar approach in the future.
- Program performance data would provide important input for the study, especially in terms of understanding participation rates and measure adoption. Accurately tracking this information and being able to access the information for the study, helps increase the accuracy of future studies. This is especially applicable to the commercial programs and measures, since the largest potential was identified in this sector, but the tracking of measure adoption and of participation in programs occurred at a very aggregated level. It is recommended that IESO identify internal program data at the measure level that can be leveraged for future potential studies.

LDC Profiles:

- The LDC profiles provided a significant benefit to the study by defining the segmentation and load share for each LDC. The data provided by LDCs to develop the profiles covered more than 80% of the electric load and significantly increased the confidence in accuracy of the base year profile. The LDC profiles were one of the key inputs in the model. Updating the profiles will be a critical component to include in future studies.
- The larger LDCs were able to provide data to develop the LDC profiles, while many of the smaller LDCs had difficulty submitting the data. Most often, the smaller LDCs did not have the necessary resources or did not track and collect the data in a way that was easy to compile in the format requested for the study. It is recommended that IESO take

the lead in collecting data from the smaller LDCs, providing assistance to the smaller LDCs in the data collection step.

- Mapping the billing data to the NAICS is very beneficial to segmenting the LDC data and developing more accurate LDC profiles. It is recommended that IESO promote the mapping of billing data to NAICS when it can be done cost-effectively, and when it also provides additional benefits to the LDC. This is especially relevant to the commercial sector, which in this study accounted for the largest electricity use and the largest achievable potential, but had very diverse subsectors. Developing a more accurate segmentation of the commercial sector load would assist in developing a more accurate estimate of the achievable potential.
- The accuracy of the achievable potential analysis would be improved by having studies of primary data and information to inform, for example, energy intensity values according to building type and end use saturation. However, these studies can be relatively expensive and IESO would need to compare the cost versus the benefit of the studies. The benefit of the studies can be increased if they serve a purpose beyond the achievable potential analysis; for example, the information may also benefit the gas utilities. It is recommended that IESO identify two to three critical subsectors and evaluate the cost-benefit of the studies to determine if these studies should be commissioned. Collaborating with the gas utilities on the initiative could potentially result in cost sharing and could also optimize efficiency in reaching out to customers to participate in the study.

Measures:

- The incentive rate was a significant driver in the acquisition costs, typically representing the majority of the program delivery costs. The incentive rates were provided to Nexant by IESO based on 2014 evaluation findings. While fairly good records were kept on the incentive costs, information on the average measure incremental costs was not as well organized. A provincial-wide database that tracks measure incremental costs would be useful for the accurate estimation of incentive rates.
- The IESO’s M&A list and measure database were important information sources for the achievable potential studies. It is recommended that IESO expand the measure database to include:
  - Baseline information about residential and commercial average equipment efficiencies (e.g. average central AC SEER value) and building characteristics (e.g. average residential ceiling R-value) throughout the province.
  - Province-wide measure incremental cost data.
  - The “8760” avoided energy costs (currently the avoided energy costs are seasonal).
  - Assign climate zone specific deemed savings and costs for key parameters, such as: lighting hours of use (HOU) and HVAC equivalent full load hours (EFLH).

Working Group:

- The working group functioned very well throughout the study and was a critical element in the success of the study. It is recommended that IESO continue with the inclusion of a working group and sub-working groups in future studies, to assist with guidance, input, review of draft and final project material, and communication with the LDCs.
- Due to the size and complexity of the study, providing both underlying (i.e. assumptions) data and results data to working group members in an expedited manner and in an understandable format proved challenging. For future studies, it is recommended that IESO build this into the process early on to provide information to LDCs in a meaningful and digestible format with more comfortable lead-time.
- To manage the project and ensure effective communication and interaction with the working group, IESO should have adequate staff dedicated to the project. Having a full-time IESO project manager on the project was a very important element of success.

Coordination with Natural Gas DSM Programs

- A few measures are applicable to both CDM and DSM programs. It is recommended that IESO share data relevant to the adoption of these measures to inform future potential studies.
- The shared data can also assist in program design and program delivery to minimize the duplication of efforts between LDCs and the gas utilities.

13 Acronyms

AC: Air conditioning

ACP: Aboriginal Conservation Program

AEP: American Electric Power

APS: Achievable potential study

BC: Benefit and cost

BMG: Behind-the-meter generation

C&I: Commercial and industrial

CAC: Central air conditioning

CDM: Conservation and demand management

CDM: Conservation and demand management

CEE: Consortium for Energy Efficiency

CFF: Conservation First Framework

CFL: Compact fluorescent lightbulb

DES: Detailed Engineering Study

DX: Direct expansion

EBCII: Existing Building Commissioning Incentive Initiative

ECA: Energy conservation agreement

ECM: Electronically commutated motor

EE: Energy efficiency

EFLH: Equivalent full load hours

EUF: End use forecasting

GWh: Gigawatt-hours

HOU: Hours of use

HPNC: High-performance new construction

HVAC: Heating, ventilation, and air conditioning

HVLS: High-volume, low-speed

IESO: Independent Electricity System Operator

kWh: Kilowatt-hours

LDC: Local distribution company

LED: Light-emitting diode

M&A: Measures and assumptions

MURB: Multi-unit residential building

MWh: Megawatt-hours

NAICS: North American Industry Classification System

NPV: Net present value

NYSERDA: New York State Energy Research and Development Authority

OEB: Ontario Energy Board

PAC: Program administrative cost

PES: Preliminary Engineering Study

PSUI: Process and System Upgrade Initiative

SBL: Small Business Lighting

SDG&E: San Diego Gas & Electric

SEER: Seasonal energy-efficiency ratio

TCU: Transportation, communication, and utilities facilities

TCU: Transportation, communication, and utilities

TRC: Total resource cost

TRC: Total resource cost

TRM: Technical reference manual

TWh: Terawatt-hours

VSD: Variable speed drive

Appendix A: Subsector Definitions

Table A-1 provides descriptions for each of the subsectors used in the study.

Table A-1: Subsector descriptions

Sector	Subsector	Description
Residential	Single family	Single family, detached households
	Row house	Single family, attached households (for example, townhomes)
	Multi-residential low rise	Individually or suite-metered units in multi-unit residential buildings (MURBs) of fewer than five stories
	Multi-residential high rise	Individually or suite-metered units in MURBs of five stories or more.
	Other residential	Miscellaneous residential households not included in single family, row-house, or multi-residential sectors (for example, mobile homes)
Commercial	Large office	Office buildings greater than 20,000 square feet, including government offices
	Small office	Office buildings less than or equal to 20,000 square feet including government offices
	Non-food retail	All retail buildings in which the primary business operations do not include the sale of food (for example, department stores, car dealerships, hardware stores, etc.)
	Food retail	Retail buildings in which the primary business operations includes the sale of food (for example, supermarkets, beverage stores, convenience stores, etc.)
	Restaurant	Full-service restaurants, caterers, cafeterias, and pubs
	Lodging	Hotel and motel overnight accommodation buildings
	Hospital	Inpatient and outpatient health facilities, as well as buildings in which the primary business operations include healthcare-related services (for example, laboratories and dialysis centers)
	Nursing home	Home healthcare facilities and homes for the elderly
	School	Elementary and secondary education, apprenticeship, training, and daycare facilities; includes both publically funded and private schools
	University	Post-secondary education facilities, including community colleges
	Warehouse (wholesale)	Warehouse and wholesale distribution facilities
	Data center	Buildings that primarily house computer servers
	Transportation, communication, and utilities	Transportation, communication and utilities facilities
	Multi-unit residential	MURBs that are bulk metered, including common-area energy load from both individually and bulk-metered MURBs
	Other commercial buildings	All commercial building types not specified above (for example, theaters, sports arenas, libraries, bowling alleys, auto repair, amusement parks, etc.)
Industrial	Primary metals	Facilities, mills, and foundries that manufacture products from primary metals (for example, iron and steel mills, aluminum manufacturers, iron foundries, etc.)

Sector	Subsector	Description
	Non-metallic minerals	Manufacturing of non-metallic minerals, including brick, clay, ceramics, glass, and concrete products
	Chemical manufacturing	Manufacturing of chemicals from petroleum and coal products
	Petroleum refineries	Facilities primarily dedicated to the refining of petroleum products
	Plastic and rubber manufacturing	Facilities involved in the manufacture of plastic, resin, synthetic rubber, and rubber products
	Paper manufacturing	Paper, pulp, and paper-product mills and associated manufacturing
	Food and beverage manufacturing	Facilities involved in manufacturing food and beverage products (for example, mills, cheese manufacturing, breweries, distilleries, commercial bakeries, etc.)
	Auto-parts manufacturing	Automotive and automotive-parts manufacturing, as well as other transportation-equipment manufacturing (for example, aircraft engines)
	Fabricated metals	Fabricated metal product manufacturing (for example, sheet metal, iron and steel forging, metal stamping, etc.)
	Electronic manufacturing	Computer and electronic device and parts manufacturing
	Wood-products manufacturing	Sawmills, veneer, and plywood manufacturing and other wood-product manufacturing facilities
	Mining	Mining facilities and associated load (for example, oil and gas extraction, ore mining, quarries, etc.)
	Agricultural	Agricultural facilities and operations for farming, vineyards, greenhouses, etc.
	Miscellaneous industrial	All industrial facilities not specified above (for example, construction, textile manufacturing, apparel, machinery, furniture, toy manufacturing, printing, etc.)

Appendix B: Mapping of EE Measures to Archetype Programs

Tables B-1, B-2, and B-3 provide the mapping of measures to archetype programs and adoption curves for the residential, commercial, and industrial sectors.

Table B-1: Residential Sector

Measure	Program	Adoption Curve
ENERGY STAR® Dryers	Consumer Program	AchNew_Misc appliance
Clothes Washers CEE Tier 1/ ENERGY STAR®	Consumer Program	AchNew_Misc appliance
Clothes Washers CEE Tier 2	Consumer Program	AchNew_Misc appliance
Clothes Washers CEE Tier 3	Consumer Program	AchNew_Misc appliance
ENERGY STAR® DEHUMIDIFIER	Consumer Program	AchExisting_dehumidifier
ENERGY STAR® Dishwashers (Electric Water Heating)	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Dishwashers (Gas Heating)	Consumer Program	AchNew_Misc appliance
Heat Pump Water Heaters 50 gallon	Systems and Equipment Program	AchNew_Misc all
Solar Water Heaters	Systems and Equipment Program	AchNew_Misc all
Heat Pump Water Heaters 80 gallon	Systems and Equipment Program	AchNew_Misc all
Instantaneous Water Heater	Systems and Equipment Program	AchNew_Misc appliance
ENERGY STAR® Freezer	Consumer Program	AchExisting_freezer
CEE Tier 2 Freezer	Consumer Program	AchExisting_freezer
CEE Tier 3 Freezer	Consumer Program	AchExisting_freezer
Freezer Recycling with Replacement	Consumer Program	AchExisting_freezer
Freezer Recycling without Replacement	Consumer Program	AchExisting_freezer
ENERGY STAR® QUALIFIED LED BULBS - Specialty LEDs (Flood/Reflector)	Consumer Program	AchExisting_led
ENERGY STAR® QUALIFIED LED BULBS - Specialty LEDs (Globe)	Consumer Program	AchExisting_led
ENERGY STAR® QUALIFIED LED BULBS - Specialty LEDs (Candle)	Consumer Program	AchExisting_led
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - 19W Dimmable CFL	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - Chandelier CFLs	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED COMPACT FLUORESCENT LAMPS (CFLS)-COVERED CFL	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED SPECIALTY COMPACT	Consumer Program	AchExisting_cfl

Measure	Program	Adoption Curve
FLUORESCENT LAMPS (CFLS) - Globe CFLs		
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - 26W, Indoor	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - 26W, Outdoor	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - High Wattage 3-Way CFL	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED SPECIALTY COMPACT FLUORESCENT LAMPS (CFLS) - Low Wattage 3-Way CFL	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED COMPACT FLUORESCENT LAMPS (CFLS) TRI-LIGHT	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED COMPACT FLUORESCENT LAMPS (CFLS) TWISTER - 13 W CFL Twister	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED LIGHT FIXTURE - 1 OR 2 SOCKETS (CFL)	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED LIGHT FIXTURE - 3 OR MORE SOCKETS (CFL)	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED RECESSED LIGHTING-LED	Consumer Program	AchExisting_led
ENERGY STAR® QUALIFIED RECESSED LIGHTING-CFL	Consumer Program	AchExisting_cfl
ENERGY STAR® QUALIFIED UNDER THE COUNTER LIGHTING - LED	Consumer Program	AchExisting_led
LED Nightlight	Consumer Program	AchExisting_led
Electroluminescent Nightlight	Consumer Program	AchExisting_led
ENERGY STAR® Torchiere	Consumer Program	AchExisting_led
Holiday Lights	Consumer Program	AchExisting_led
ENERGY STAR® LED 5W	Consumer Program	AchExisting_led
ENERGY STAR® LED 7W	Consumer Program	AchExisting_led
ENERGY STAR® LEDL 12W	Consumer Program	AchExisting_led
ENERGY STAR® LED 18W	Consumer Program	AchExisting_led
ENERGY STAR® LED 25W	Consumer Program	AchExisting_led
ENERGY STAR® CFL 10W	Consumer Program	AchExisting_cfl
ENERGY STAR® CFL 15W	Consumer Program	AchExisting_cfl
ENERGY STAR® CFL 25W	Consumer Program	AchExisting_cfl
ENERGY STAR® CFL 40W	Consumer Program	AchExisting_cfl
ENERGY STAR® CFL 20W	Consumer Program	AchExisting_cfl
High Efficiency Bathroom Exhaust Fan	Consumer Program	AchNew_fans
Variable Speed Pool Pump Motors	Consumer Program	AchNew_timer
Dual Speed Pool Pump Motors	Consumer Program	AchNew_timer

Measure	Program	Adoption Curve
ENERGY STAR® Printer	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Water Coolers	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Air Purifier/Cleaner	Consumer Program	AchNew_Misc appliance
ENERGY STAR® TV	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Audio/Video Equipment - Audio Amplifiers	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Audio/Video Equipment - Optical Disc Player	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Computers - Desktop	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Computers- Notebook	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Displayes (Monitors)	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Game Consoles	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Qualified Set Top Box	Consumer Program	AchNew_Misc appliance
ENERGY STAR® Refrigerator	Consumer Program	AchExisting_refrigerator
CEE Tier 2 Refrigerator	Consumer Program	AchExisting_refrigerator
CEE Tier 3 Refrigerator	Consumer Program	AchExisting_refrigerator
Refrigerator Recycling with Replacement	Consumer Program	AchExisting_refrigerator
Refrigerator Recycling without Replacement	Consumer Program	AchExisting_refrigerator
ENERGY STAR® Ceiling Fans	Consumer Program	AchExisting_fans
ENERGY STAR® Room Air Conditioner	Consumer Program	AchExisting_air conditioner
ENERGY STAR® Central Air Conditioner 14.5 SEER	Systems and Equipment Program	AchExisting_CACI
ENERGY STAR® Central Air Conditioner 16 SEER	Systems and Equipment Program	AchExisting_CACII
ENERGY STAR® Central Air Conditioner 15 SEER	Systems and Equipment Program	AchExisting_CACI
ENERGY STAR® Central Air Conditioner 18 SEER	Systems and Equipment Program	AchExisting_CACII
ENERGY STAR® Central Air Conditioner 20 SEER	Systems and Equipment Program	AchExisting_CACII
ENERGY STAR® Room Air Conditioner (8000-9999 Btuh)	Consumer Program	AchExisting_air conditioner
Residential Whole House Fan	Systems and Equipment Program	AchExisting_fans
Ductless Mini Split Air Conditioner 16 SEER	Systems and Equipment Program	AchExisting_air conditioner
Installing ECM on an Electric Furnace (Non-continuous Usage)	Systems and Equipment Program	AchExisting_ECM
Installing ECM on an Gas Furnace (Non-continuous Usage)	Systems and Equipment Program	AchExisting_ECM
Ductless Mini Split Heat Pump 16 SEER	Systems and Equipment Program	AchExisting_refrigerator
Air Source Heat Pump 15 SEER 8.5 HSPF	Systems and Equipment Program	AchNew_ECMII

Measure	Program	Adoption Curve
Air Source Heat Pump 16 SEER 9 HSPF	Systems and Equipment Program	AchNew_ECMII
Ground Source Heat Pump 17 EER 3.6 COP	Systems and Equipment Program	AchNew_ECMII
Ground Source Heat Pump 17 SEER 3.6 COP	Systems and Equipment Program	AchNew_ECMII
Ground Source Heat Pump 17 EER / 3.6 COP - with desuperheater	Systems and Equipment Program	AchNew_ECMII
Residential New Construction Tier 1 (10% more efficient)	Systems and Equipment Program	AchExisting_Misc all
Residential New Construction Tier 2 (20% more efficient)	Systems and Equipment Program	AchExisting_Misc all
Residential New Construction Tier 3 (30% more efficient)	Systems and Equipment Program	AchExisting_Misc all
Home Energy Reports	Behavioural	Ach_HER
Clotheslines	Consumer Program	AchExisting_air dry
Water-heater blanket	Consumer Program	AchExisting_dhw blanket
Efficient aerators: kitchen; flow rate < 5.7 L/min	Consumer Program	AchExisting_pipes
Efficient aerators: bathroom; flow rate < 3.8 L/min	Consumer Program	AchExisting_pipes
Efficient showerhead (handheld) 2.8 L/min	Consumer Program	AchExisting_pipes
Efficient showerhead (handheld) 3.8 L/min	Consumer Program	AchExisting_pipes
Efficient showerhead (standard) 3.8 L/min	Consumer Program	AchExisting_pipes
Efficient showerhead (standard) 2.8 L/min	Consumer Program	AchExisting_pipes
Hot water pipe wrap: per 3' Pipe Wrap (3/4" Pipe)	Audit and Direct Install	AchExisting_pipes
Water-heater temperature setback	Audit and Direct Install	AchExisting_pipes
Thermostatic Shower Restriction Valve	Systems and Equipment Program	AchNew_Misc all
Drain Water Heat Recovery Device	Systems and Equipment Program	AchNew_Misc all
Furnace Whistle	Audit and Direct Install	AchExisting_pipes
LIGHTING TIMERS (HARD-WIRED, INDOOR)	Consumer Program	AchExisting_timer
Motion Sensors (Hard-wired, Indoor)	Consumer Program	AchExisting_light control
Dimmer Switch (Hard-wired)	Consumer Program	AchExisting_light control
Outdoor Lighting Timer	Consumer Program	AchExisting_timer
Outdoor Motion Sensor	Consumer Program	AchExisting_light control
Heavy Duty Plug-in Timers, Spa Pump Timer	Consumer Program	AchExisting_timer
Heavy Duty Plug-in Timers, Pool Pump Timer	Consumer Program	AchExisting_timer
Heavy Duty Plug-in Timers, Car Block Timer	Consumer Program	AchExisting_timer
Smart Strip Plug Outlets, Home Office connected to Television	Consumer Program	AchExisting_powerbar
Smart Strip Plug Outlets, Home Office	Consumer Program	AchExisting_powerbar
Smart Strip Plug Outlets, Entertainment Center	Consumer Program	AchExisting_powerbar

Measure	Program	Adoption Curve
Central AC Maintenance/Tune Up	Whole Home Program	AchExisting_Misc all
Programmable Thermostat, Baseboard Heating	Consumer Program	AchExisting_thermo
Programmable Thermostat, Electric Forced Air Heating	Consumer Program	AchExisting_thermo
Smart Thermostat	Consumer Program	AchExisting_thermo
Heat Pump Maintenance/Tune Up	Whole Home Program	AchNew_Misc all
Ceiling Insulation going from R-20 to R-60	Whole Home Program	AchExisting_shell
Ceiling Insulation going from R-5 to R-60	Whole Home Program	AchExisting_shell
Ceiling Insulation going from R-5 to R-49	Whole Home Program	AchExisting_shell
Ceiling Insulation going from R-30 to R-49	Whole Home Program	AchExisting_shell
Ceiling Insulation going from R-20 to R-49	Whole Home Program	AchExisting_shell
Ceiling Insulation going from R-30 to R-60	Whole Home Program	AchExisting_shell
Wall Insulation going from R-4 to R-23	Whole Home Program	AchExisting_shell
Wall Insulation going from R-4 to R-29	Whole Home Program	AchExisting_shell
Wall Insulation from R-4 to R-13	Whole Home Program	AchExisting_shell
Wall Insulation from R-4 to R-19	Whole Home Program	AchExisting_shell
Floor Insulation from R5 to R 30	Whole Home Program	AchExisting_shell
Floor Insulation going from R-5 to R 38	Whole Home Program	AchExisting_shell
Basement Wall Insulation going from R-3 to R-15	Whole Home Program	AchExisting_shell
Basement Wall Insulation going from R-3 to R-10	Whole Home Program	AchExisting_shell
Air Sealing 13 to 9 ACH50	Whole Home Program	AchExisting_shell
Air Sealing 9 to 7 ACH50	Whole Home Program	AchExisting_shell
Duct Sealing from 38.5% to 25%	Whole Home Program	AchNew_shell
Duct Sealing from 25% to 16.25%	Whole Home Program	AchNew_shell
Duct Insulation from R-0 to R-8	Whole Home Program	AchNew_shell
Window Film (U=0.51, SHGC=0.24)	Whole Home Program	AchNew_shell
ENERGY STAR® Windows (U=0.25, SHGC=0.40)	Whole Home Program	AchNew_shell
ENERGY STAR® Windows (U=0.30, SHGC=0.40)	Whole Home Program	AchNew_shell
ENERGY STAR® Windows (U=0.35, SHGC=0.40)	Whole Home Program	AchNew_shell
Radiant Barrier	Whole Home Program	AchNew_shell
Drain Water Heat Recovery	Systems and Equipment Program	AchNew_Misc all
Low Income Program	Low Income Program	AchExisting_Misc all
Aboriginal Program	Aboriginal Program	AchExisting_Misc all
Residential New Construction Program	Residential New Construction Program	AchExisting_Misc all

Table B-2: Commercial Sector

Measure	Program	Adoption Curve
ENERGY STAR® Scanner	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Copiers	Retrofit Program	Prescriptive_Existing
ENERGY STAR® desktop	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Fax	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Monitors	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Printers	Retrofit Program	Prescriptive_Existing
Smart Strip Plug Outlets	Small Business Program	Engineered_Existing
Electrically Commutated Plug fans in data centers	Retrofit Program	Custom_Existing
High Efficiency Hot Food Holding Cabinet	Retrofit Program	Custom_Existing
Efficient Steamer (ENERGY STAR®)	Retrofit Program	Custom_Existing
ENERGY STAR® Combination Oven	Retrofit Program	Custom_Existing
ENERGY STAR® Convection Oven	Retrofit Program	Custom_Existing
High Efficiency Fryer (ENERGY STAR®)	Retrofit Program	Custom_Existing
High Efficiency Griddle (ENERGY STAR®)	Retrofit Program	Custom_Existing
High Efficiency Induction Cooking	Retrofit Program	Custom_Existing
High Efficiency Air Cooled Chiller, 100 Tons	Retrofit Program	Engineered_Existing
High Efficiency Air Cooled Chiller, 150 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 175 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 300 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 500 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 600 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 175 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 300 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 50 Tons	Retrofit Program	Engineered_Existing
VFD on Cooling Tower Fan	Retrofit Program	Custom_Existing
UNITARY AIR-CONDITIONING UNIT - Split system < 5.4 tons, Electric Resistance, 12.5 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system < 5.4 tons, All Other, 12.5 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Single package, ≥ 5.4 to ≤ 7.5 tons, Electric Resistance, 12.2 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Single package, ≥ 7.5 to ≤ 20 tons, Electric Resistance, 11 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Single package < 5.4 tons, All Other, 12.0 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system/Single package ≥ 20 to < 63 tons, Electric Resistance, 10.8 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system/Single package ≥ 20 to < 63 tons, All Other, 10.6 EER (per ton)	Retrofit Program	Engineered_Existing

Measure	Program	Adoption Curve
UNITARY AIR-CONDITIONING UNIT WITH ECONOMIZER - Single package, ≥ 5.4 to ≤ 7.5 tons, Electric Resistance, 12.2 EER (per ton)	Retrofit Program	Engineered_Existing
ECM Motors for split systems	Retrofit Program	Engineered_Existing
PTAC (12 EER/10,000 BTU)	Retrofit Program	Engineered_Existing
Room AC (w/ louvered sides) 13 SEER from 12 SEER code	Retrofit Program	Prescriptive_Existing
Room AC (w/ louvered sides) 12.5 SEER from 12 SEER code	Retrofit Program	Prescriptive_Existing
Room AC (w/ louvered sides) 14 SEER from 12 SEER code	Retrofit Program	Prescriptive_Existing
Outdoor Air Economizer	Retrofit Program	Engineered_Existing
Ductless Heat Pump	Retrofit Program	Engineered_Existing
Ground Source Heat Pump (Closed Loop)	Retrofit Program	Engineered_Existing
Ground Source Heat Pump (Open Loop)	Retrofit Program	Engineered_Existing
High Efficiency Air Source Heat Pump (12 EER, 3.6 COP)	Retrofit Program	Engineered_Existing
High Efficiency Air Source Heat Pump (12 EER, 2.6 COP)	Retrofit Program	Engineered_Existing
Variable Refrigerant Flow Heat Pump	Retrofit Program	Engineered_Existing
Water Source Heat Pump (4 ton)	Retrofit Program	Engineered_Existing
Heat Pump Water Heater (50 Gallon)	Retrofit Program	Engineered_Existing
High Efficiency Electric Water Heater (50 Gallon)	Retrofit Program	Engineered_Existing
High Efficiency Small Instantaneous Water Heater (30% above the minimum)	Retrofit Program	Custom_Existing
Solar Electric Water Heater (50 Gallon)	Retrofit Program	Custom_Existing
VFD on Hot Water Pump	Retrofit Program	Engineered_Existing
Ozone Generator on Laundry Systems	Retrofit Program	Custom_Existing
Efficient Unit Heating System	Retrofit Program	Custom_Existing
ECM MOTORS FOR HVAC APPLICATION (FAN POWERED VAV BOX)	Retrofit Program	Engineered_Existing
ECM MOTORS FOR HVAC APPLICATION (FAN MOTOR REPLACEMENT	Retrofit Program	Engineered_Existing
Demand Controlled Ventilation	Retrofit Program	Custom_Existing
Variable Speed Drive on Kitchen Exhaust Fan	Retrofit Program	Custom_Existing
VFD on Chilled Water Pump	Retrofit Program	Engineered_Existing
VFD on Condenser Water Pump	Retrofit Program	Engineered_Existing
VFD on HVAC Fan	Retrofit Program	Engineered_Existing
LED EXTERIROR AREA LIGHTS- LED FIXTURE (200W)	Retrofit Program	Prescriptive_Existing
Incandescent to HID (Outdoor)	Retrofit Program	Prescriptive_Existing
Refrigerated Display Case LED Strip Light	Retrofit Program	Engineered_Existing
T8 Lamps & Electronic Ballast	Small Business Program	SBL LED_Existing
Energy Star LED lamps- Omnidirectional A shape or Wet Location Rates Par 10W	Small Business Program	SBL LED_Existing
LED Recessed Downlights	Small Business Program	Engineered_Existing

Measure	Program	Adoption Curve
LED light Bulb- LED MR16 lamp	Small Business Program	Engineered_Existing
Reduced Wattage T8 fixtures - Three-lamped reduced wattage T-8 fixtures	Retrofit Program	Engineered_Existing
T5 Fixtures	Retrofit Program	Engineered_Existing
Reduced Wattage T-8 re-lamping (28W T8) replacing 3 32W T-8	Small Business Program	Engineered_Existing
Integral LED Troffers- 2'X 4' LED Troffer	Retrofit Program	Engineered_Existing
T8/T5 Replacement - 4 - 4' 54 W T5 High Output Fixture	Retrofit Program	Engineered_Existing
T8/T5 Replacement - 4 - 4' 32W HBF	Retrofit Program	Engineered_Existing
ENERGY STAR® LED Par 16-20-38- Lamps E26 Base	Small Business Program	Engineered_Existing
ENERGY STAR® LED Lamps PAR16 MR16 GU10 base	Small Business Program	Engineered_Existing
ENERGY STAR® LED Lamps MR16 Gu 5.3 base	Small Business Program	Engineered_Existing
9 W Exit Sign Retrofit: CFL replacing Incandescent	Small Business Program	SBL Other_Existing
Cold Cathode Screw-In Bulb	Retrofit Program	Custom_Existing
LED Exit sign single sided (5W)	Small Business Program	SBL Other_Existing
Photoluminescent Exit Sign	Retrofit Program	Prescriptive_Existing
Self Ballasted Ceramic Metal Halide Lamp	Retrofit Program	Engineered_Existing
Lower Wattage HID lamps- 320 W Pulse Start Metal Halide	Retrofit Program	Engineered_Existing
Lower Wattage HID lamps- 400 W Pulse Start Metal Halide	Retrofit Program	Engineered_Existing
High Performance Medium Bay T8 fixture	Retrofit Program	Engineered_Existing
High Performance Medium Bay LED fixture	Retrofit Program	Engineered_Existing
T5 Medium and High Bay Fixtures 8 lamp HO T5 fixture	Retrofit Program	Engineered_Existing
Metal Halide Direct Lamp Replacement 360W Metal Halide	Retrofit Program	Engineered_Existing
Induction High Bay Lighting	Retrofit Program	Custom_Existing
15 HP ODP-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
75 HP ODP-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
150 HP ODP-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
15 HP TEFC-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
75 HP TEFC-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
150 HP TEFC-High efficiency Motor (4 pole, 1800 rpm)	Retrofit Program	Engineered_Existing
Synchronous Belt: Motor Size: 5 HP, 73.5% Load Factor	Retrofit Program	Engineered_Existing
Synchronous Belt: Motor Size: 15 HP, 73.5% Load Factor	Retrofit Program	Engineered_Existing
Synchronous Belt: Motor Size: 75 HP, 73.5% Load Factor	Retrofit Program	Engineered_Existing
Variable Speed Drive Control, 5HP	Retrofit Program	Engineered_Existing
Variable Speed Drive Control, 20 HP	Retrofit Program	Engineered_Existing
Variable Speed Drive Control, 50 HP	Retrofit Program	Engineered_Existing
ENERGY STAR® Clothes Washer	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Dishwasher	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Ice Machines-Ice Making Head	Retrofit Program	Custom_Existing

Measure	Program	Adoption Curve
ENERGY STAR® Ice Machines-Remote Condensing Unit (w.o Remote Compressor)	Retrofit Program	Custom_Existing
ENERGY STAR® Ice Machines-Remote Condensing Unit (w. Remote Compressor)	Retrofit Program	Custom_Existing
ENERGY STAR® Ice Machines-Self Contained Unit	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Televisions	Retrofit Program	Prescriptive_Existing
ENERGY STAR® Water Coolers	Retrofit Program	Custom_Existing
ENERGY STAR® Battery Charger	Retrofit Program	Custom_Existing
ENERGY STAR® External Power Adapter	Retrofit Program	Custom_Existing
ENERGY STAR® Freezer-Glass Door	Retrofit Program	Custom_Existing
ENERGY STAR® Freezer-Solid Door	Retrofit Program	Custom_Existing
ENERGY STAR® Refrigerator-Glass Door	Retrofit Program	Custom_Existing
ENERGY STAR® Refrigerator-Solid Door	Retrofit Program	Custom_Existing
Walk-in Shaded Pole to ECM Evaporator Fan Motor	Retrofit Program	Engineered_Existing
Walk-in PSC to ECM Evaporator Fan Motor	Retrofit Program	Engineered_Existing
High Efficiency Refrigeration Compressors-Discus	Retrofit Program	Custom_Existing
High Efficiency Refrigeration Compressors-Scroll	Retrofit Program	Custom_Existing
Efficient compressor motor	Retrofit Program	Engineered_Existing
ENERGY STAR® Refrigerated Beverage Vending Machine (Class-A)	Retrofit Program	Custom_Existing
ENERGY STAR® Refrigerated Beverage Vending Machine (Class-B)	Retrofit Program	Custom_Existing
Reach-in PSC to ECM Evaporator Fan Motor	Retrofit Program	Engineered_Existing
Reach-in Shaded Pole to ECM Evaporator Fan Motor	Retrofit Program	Engineered_Existing
Reach-in Shaded Pole to PSC Evaporator Fan Motor	Retrofit Program	Engineered_Existing
VSD Controlled Compressor	Retrofit Program	Engineered_Existing
VSD Air Compressor	Retrofit Program	Engineered_Existing
Facility Commissioning	Audit and Energy Partners Program	Custom_Existing
Re-Commissioning (Existing Construction)	Audit and Energy Partners Program	Custom_Existing
Data Center-Server/Storage Consolidation	Retrofit Program	Custom_Existing
Data Center-Server/Storage Virtualization	Retrofit Program	Custom_Existing
Solid-state temperature controls	Retrofit Program	Custom_Existing
Chiller Tune-up/Diagnostics	Retrofit Program	Custom_Existing
Cooling Tower Optimization	Audit and Energy Partners Program	Custom_New
Active Chilled Beam Cooling	Retrofit Program	Custom_Existing
Chilled Water Reset, Optimizer System for Chiller(s)	Audit and Energy Partners Program	Custom_New
Hi Eff HVAC Design	Audit and Energy Partners Program	Custom_New

Measure	Program	Adoption Curve
DX Coil Clean	Retrofit Program	Custom_Existing
HVAC Diagnostic/Air Conditioner Tune Up	Retrofit Program	Custom_Existing
Adding reflective (White) roof treatment	Retrofit Program	Custom_Existing
Adding window shade film	Retrofit Program	Custom_Existing
Adding window shade screen	Retrofit Program	Custom_Existing
Automated control system	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R30)	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R35)	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R40)	Retrofit Program	Custom_Existing
Energy Recovery Ventilation Systems	Retrofit Program	Engineered_Existing
Duct Insulation R-8	Retrofit Program	Custom_Existing
Green (living) Roof (New construction or roof replacement)	Retrofit Program	Custom_Existing
Programmable Thermostat (7 Day, 2 Stage Setback)	Small Business Program	Prescriptive_Existing
Wall Insulations (R23 to R30)	Retrofit Program	Custom_Existing
Wall Insulations (R23 to R38)	Retrofit Program	Custom_Existing
Wall Insulations (R10 to R30)	Retrofit Program	Custom_Existing
HVAC Diagnostic Tune Up	Retrofit Program	Custom_Existing
Notched V Belts for HVAC Systems	Retrofit Program	Custom_Existing
Demand controlled Circulating Systems	Retrofit Program	Custom_Existing
Drainwater Heat Recovery Water Heater	Retrofit Program	Engineered_Existing
Faucet Aerators	Small Business Program	Prescriptive_Existing
Heat Recovery Unit	Retrofit Program	Engineered_Existing
Heat Trap	Retrofit Program	Engineered_Existing
Hot Water (DHW) Pipe Insulation	Small Business Program	Engineered_Existing
Hot Water Circulation Pump Time Clock	Retrofit Program	Custom_Existing
Insulating Tank Wrap on Water Heater (R-11)	Small Business Program	Prescriptive_Existing
Low Flow Pre-Rinse Sprayers	Retrofit Program	Prescriptive_Existing
Low-Flow Showerhead	Retrofit Program	Prescriptive_Existing
Ultrasonic Faucet Control	Retrofit Program	Custom_Existing
Water Heater Thermostat Setback	Small Business Program	Custom_Existing
Humidification w/ High pressure, Ultrasonic devices	Retrofit Program	Custom_Existing
Energy Efficient Laboratory Fume Hood	Retrofit Program	Custom_Existing
CO sensors for parking garage exhaust fans	Retrofit Program	Custom_Existing
Photocell Dimming Control (Outdoors)	Retrofit Program	Prescriptive_Existing
Occupancy Sensor	Retrofit Program	Engineered_Existing
Indoor Daylight Sensors	Retrofit Program	Engineered_Existing
Photocell Dimming Control (Interior)	Retrofit Program	Engineered_Existing
Auto Off Time Switch	Retrofit Program	Engineered_Existing

Measure	Program	Adoption Curve
Central Lighting Control System	Retrofit Program	Custom_Existing
Time Clock Control	Retrofit Program	Engineered_Existing
Downsizing motor during retrofit	Audit and Energy Partners Program	Custom_New
Escalator Motor Controller	Retrofit Program	Custom_Existing
Fan Motor - correct sizing	Audit and Energy Partners Program	Custom_New
Beverage Machine Control	Retrofit Program	Custom_Existing
Air curtain technology	Retrofit Program	Engineered_Existing
Anti-Sweat Heat Controls-Cooler	Retrofit Program	Engineered_Existing
Anti-Sweat Heat Controls-Freezer	Retrofit Program	Engineered_Existing
Auto Closer on Refrigerator Door	Retrofit Program	Custom_Existing
Demand Hot Gas Defrost	Retrofit Program	Custom_Existing
Door Gasket- Freezer	Retrofit Program	Custom_Existing
Door Gasket- Refrigerator	Retrofit Program	Custom_Existing
Economizer on Walk-In Cooler	Retrofit Program	Custom_Existing
eCube	Retrofit Program	Custom_Existing
Evaporator Coil Defrost Control (Cooler)	Retrofit Program	Engineered_Existing
Floating head pressure controller	Retrofit Program	Engineered_Existing
High R-Value Glass Doors	Retrofit Program	Custom_Existing
No-heat glass doors	Retrofit Program	Custom_Existing
Quick acting freezer doors	Retrofit Program	Custom_Existing
Refrigeration Commissioning	Audit and Energy Partners Program	Custom_New
Strip Curtains - Freezer	Retrofit Program	Prescriptive_Existing
Strip Curtains - Refrigerator	Retrofit Program	Prescriptive_Existing
Suction Pipe Insulation - Refrigerator	Retrofit Program	Custom_Existing
Vertical Night Covers for Display Cases	Retrofit Program	Engineered_Existing
Vendor Miser	Retrofit Program	Custom_Existing
Door Heater Controls for Coolers	Retrofit Program	Engineered_Existing
Door Heater Controls for Freezers	Retrofit Program	Engineered_Existing
Evaporator Fan Controls on Cooler	Retrofit Program	Engineered_Existing
Refrigeration Optimization	Audit and Energy Partners Program	Custom_New
Chilled Water Plant Optimization	Audit and Energy Partners Program	Custom_New
Business Energy Manager/Facility Audit	Audit and Energy Partners Program	Custom_Existing
High Efficiency Transformer	Retrofit Program	Custom_Existing

Table B-3: Industrial Sector

Measure	Program	Adoption Curve
VFD Controlled Compressor	Retrofit Program	Engineered_Existing
HE Compressor motors	Retrofit Program	Custom_Existing
Variable Displacement Air Compressor	Retrofit Program	Custom_Existing
Efficient Compressed Air Nozzles	Retrofit Program	Custom_Existing
Dual Exhaust Ventilation System	Retrofit Program	Custom_Existing
UNITARY AIR-CONDITIONING UNIT - Split system < 5.4 tons, Electric Resistance, 12.5 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system < 5.4 tons, All Other, 12.5 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Single package < 5.4 tons, All Other, 12.0 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system/Single package ≥ 20 to < 63 tons, Electric Resistance, 10.8 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT - Split system/Single package ≥ 20 to < 63 tons, All Other, 10.6 EER (per ton)	Retrofit Program	Engineered_Existing
UNITARY AIR-CONDITIONING UNIT WITH ECONOMIZER - Single package, ≥ 5.4 to ≤ 7.5 tons, Electric Resistance, 12.2 EER (per ton)	Retrofit Program	Engineered_Existing
ECM MOTORS FOR HVAC APPLICATION (FAN-POWERED VAV BOX) - VAV Units	Retrofit Program	Engineered_Existing
ECM MOTORS FOR HVAC APPLICATION (FAN MOTOR REPLACEMENT	Retrofit Program	Engineered_Existing
ECM MOTORS FOR HVAC APPLICATION (FAN MOTOR REPLACEMENT - Motor ≥ 1 hp	Retrofit Program	Engineered_Existing
Ductless Heat Pump	Retrofit Program	Engineered_Existing
Ground Source Heat Pump (Closed Loop)	Retrofit Program	Engineered_Existing
Ground Source Heat Pump (Open Loop)	Retrofit Program	Engineered_Existing
High Efficiency Air Cooled Chiller, 100 Tons	Retrofit Program	Engineered_Existing
High Efficiency Air Cooled Chiller, 130 Tons	Retrofit Program	Engineered_Existing
High Efficiency Air Source Heat Pump (12 EER, 3.6 COP)	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 175 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 300 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 500 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Centrifugal Chiller, 600 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 100 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 175 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 300 Tons	Retrofit Program	Engineered_Existing
High Efficiency Water Cooled Reciprocating Chiller, 50 Tons	Retrofit Program	Engineered_Existing
Variable Refrigerant Flow Heat Pump	Retrofit Program	Engineered_Existing
VFD on Cooling Tower Fan	Retrofit Program	Custom_Existing
Water Source Heat Pump (4 ton)	Retrofit Program	Engineered_Existing
Outside Air Economizer	Retrofit Program	Prescriptive_Existing

Measure	Program	Adoption Curve
T8 Lamps & Electronic Ballast	Small Business Program	SBL LED_Existing
ENERGY STAR® LED lamps- Omnidirectional A shape or Wet Location Rates Par 10W	Small Business Program	SBL LED_Existing
LED EXTERIROR AREA LIGHTS- LED FIXTURE (200W)	Retrofit Program	Prescriptive_Existing
LED Recessed Downlights	Retrofit Program	Engineered_Existing
LED light Bulb- LED MR16 lamp	Small Business Program	Engineered_Existing
LED LIGHT BULB - LED PAR lamp - 16W	Small Business Program	Prescriptive_Existing
REDUCED WATTAGE T8 FIXTURES - Three-lamp Reduced Watt. T-8 fixtures (25W)	Small Business Program	Prescriptive_Existing
HIGH PERFORMANCE MEDIUM BAY T8 FIXTURES - Four-lamp High Performance T-8 fixtures (32W)	Retrofit Program	Prescriptive_Existing
T5 FIXTURES	Retrofit Program	Prescriptive_Existing
T5 MEDIUM AND HIGH BAY FIXTURES - 8-lamp HO T-5 fixtures (54W)	Retrofit Program	Prescriptive_Existing
REDUCED WATTAGE T8 RE-LAMPING (28W T8) - Three 28W Lamps for Three Lamp Fixture	Small Business Program	Prescriptive_Existing
INTEGRAL LED TROFFERS - 2' x 4' LED troffer	Retrofit Program	Prescriptive_Existing
METAL HALIDE DIRECT LAMP REPLACEMENT - 1 – 360W Metal Halide Direct Lamp Replacement	Retrofit Program	Prescriptive_Existing
T8 / T5 REPLACEMENT - 4 – 4' 54W T5 High Output Fixture	Retrofit Program	Prescriptive_Existing
T8 / T5 REPLACEMENT – VAPOUR/DUST PROOF FIXTURE - 4 – 4' 32W HBF Vapour / Dust Proof Fixture (Minimum of 3,100 Lumens Per Lamp)	Retrofit Program	Prescriptive_Existing
ENERGY STAR® LED PAR16/20/30/38 LAMPS E26 BASE: 16 W	Small Business Program	Prescriptive_Existing
ENERGY STAR® LED LAMPS - PAR16 OR MR16 GU10 BASE: 7W	Small Business Program	Prescriptive_Existing
ENERGY STAR® LED LAMPS - MR16 GU5.3 BASE: 7W	Small Business Program	Prescriptive_Existing
Induction High Bay Lighting	Retrofit Program	Prescriptive_Existing
TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS - TEFC 1800 RPM, <11 HP, 90%Eff	Retrofit Program	Prescriptive_Existing
TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS - TEFC 1800 RPM, 11 - 100 HP, 94%Eff	Retrofit Program	Prescriptive_Existing
TOTALLY ENCLOSED FAN-COOLED (TEFC) MOTORS - TEFC 1800 RPM, >100 HP, 95.8%Eff	Retrofit Program	Prescriptive_Existing
High Efficiency Ventilation Exhaust Fans	Retrofit Program	Prescriptive_Existing
High Volume Low Speed Fan	Retrofit Program	Prescriptive_Existing
Circulating Fans	Retrofit Program	Custom_Existing
Properly Sized Fans	Audit and Energy Partners	Custom_Existing
Efficient Centrifugal Fan	Retrofit Program	Custom_Existing
OPEN DRIP-PROOF (ODP) MOTORS - ODP 1800 RPM, < 26 HP	Retrofit Program	Prescriptive_Existing

Measure	Program	Adoption Curve
90%Eff		
OPEN DRIP-PROOF (ODP) MOTORS - ODP 1800 RPM, 40 - 124 HP, 95%Eff	Retrofit Program	Prescriptive_Existing
OPEN DRIP-PROOF (ODP) MOTORS - ODP 1800 RPM, > 125 HP, 96%Eff	Retrofit Program	Prescriptive_Existing
SYNCHRONOUS BELT - Motor Size: <10 HP, 73.5% Load Factor	Retrofit Program	Prescriptive_Existing
SYNCHRONOUS BELT - Motor Size: 10 - 50 HP, 73.5% Load Factor	Retrofit Program	Prescriptive_Existing
SYNCHRONOUS BELT - Motor Size: >50 HP, 73.5% Load Factor	Retrofit Program	Prescriptive_Existing
VARIABLE FREQUENCY DRIVE (VFD) - Motor Size: <10 HP, 66% Load Factor	Retrofit Program	Prescriptive_Existing
VARIABLE FREQUENCY DRIVE (VFD) - Motor Size: 10-50 HP, 66% Load Factor	Retrofit Program	Prescriptive_Existing
VARIABLE FREQUENCY DRIVE (VFD) - Motor Size: >50 HP, 66% Load Factor	Retrofit Program	Prescriptive_Existing
Standard to Cogged Belt on Motors 1-25 HP	Retrofit Program	Custom_Existing
Standard to Cogged Belt on Motors 30-500 HP	Retrofit Program	Custom_Existing
Pneumatic Motors Replacement with Electric Motors	Retrofit Program	Custom_Existing
Motors Improvements	Retrofit Program	Custom_Existing
Material Handling Improvements	Retrofit Program	Custom_Existing
Material Handling VFD	Retrofit Program	Custom_Existing
Switch from Belt drive to Direct Drive	Retrofit Program	Custom_Existing
Low Energy Livestock Waterer	Retrofit Program	Custom_Existing
Automatic Milker Takeoff	Retrofit Program	Custom_Existing
High Efficiency Medium Voltage Dry-type, Single-Phase Transformers	Retrofit Program	Custom_Existing
High Efficiency Liquid Immersed, Single-Phase Transformers	Retrofit Program	Custom_Existing
3- Phase High Frequency Battery Charger	Retrofit Program	Custom_Existing
3- Phase High Frequency Battery Charger - 2 shift	Retrofit Program	Custom_Existing
3- Phase High Frequency Battery Charger - 3 shifts	Retrofit Program	Custom_Existing
Elec Chip Fab - Solidstate Chiller	Retrofit Program	Custom_Existing
Milk Precooler - Dairy Plate Cooler	Retrofit Program	Custom_Existing
Adjustable speed drive on compressors	Retrofit Program	Prescriptive_Existing
Efficient Refrigeration Condenser	Retrofit Program	Custom_Existing
Scroll Compressor > 10.5 EER with heat exchanger for dairy refrigeration	Retrofit Program	Custom_Existing
Scroll Compressor > 10.5 EER without heat exchanger for dairy refrigeration	Retrofit Program	Custom_Existing
Single Creep Pad	Retrofit Program	Custom_Existing
Double Creep Pad	Retrofit Program	Custom_Existing
Heat of Compression Air Dryer	Retrofit Program	Custom_Existing
Metal - New Arc Furnace	Retrofit Program	Custom_Existing

Measure	Program	Adoption Curve
Heat Lamps	Retrofit Program	Custom_Existing
Dual Exhaust Ventilation System Dairy	Retrofit Program	Custom_Existing
HE Stock Tank	Retrofit Program	Custom_Existing
High Efficiency Grain Dryers	Retrofit Program	Custom_Existing
Kraft - Efficient Agitator	Retrofit Program	Custom_Existing
Kraft - Effluent Treatment System	Retrofit Program	Custom_Existing
Mech pulp refiner replacement	Retrofit Program	Custom_Existing
Paper - Efficient Pulp Screen	Retrofit Program	Custom_Existing
Heated Desiccant Air Dryer on VSD Compressor	Retrofit Program	Custom_Existing
Heat Exchanger upgrades for product cooling	Retrofit Program	Custom_Existing
Free Cooling and New A/C Units	Retrofit Program	Custom_Existing
Variable Air Volume Conversion Project	Retrofit Program	Custom_Existing
Energy Efficient Refrigeration Unit	Retrofit Program	Custom_Existing
Heated Desiccant Air Dryer on VD Compressor	Retrofit Program	Custom_Existing
Heated Desiccant Air Dryer on LNL Compressor	Retrofit Program	Custom_Existing
Blower Purge Desiccant Air Dryer on VSD Compressor	Retrofit Program	Custom_Existing
Blower Purge Desiccant Air Dryer on VD Compressor	Retrofit Program	Custom_Existing
Blower Purge Desiccant Air Dryer on LNL Compressor	Retrofit Program	Custom_Existing
Ventilation System Optimization	Audit and Energy Partners	Custom_Existing
Induction Street Lighting	Retrofit Program	Engineered_Existing
Green LED Traffic Light	Retrofit Program	Engineered_Existing
Red LED Traffic Light	Retrofit Program	Engineered_Existing
Yellow LED Traffic Light	Retrofit Program	Engineered_Existing
Green Arrow LED Traffic Light	Retrofit Program	Engineered_Existing
Red Arrow LED Traffic Light	Retrofit Program	Engineered_Existing
Yellow Arrow LED Traffic Light	Retrofit Program	Engineered_Existing
LED Parking Lot Fixture	Retrofit Program	Engineered_Existing
LED Street Light Fixture	Retrofit Program	Engineered_Existing
Recommissioning / Facility Energy Management	Audit and Energy Partners	Custom_Existing
Integrated Plant Energy Management	Audit and Energy Partners	Custom_Existing
Zero Loss Condensate Drain	Retrofit Program	Custom_Existing
Air Compressor Demand Reduction	Retrofit Program	Custom_Existing
Improved Controls - Air Compressor	Retrofit Program	Custom_Existing
Air Leak Survey and Repair	Retrofit Program	Custom_Existing
Low Pressure-drop Filters	Retrofit Program	Custom_Existing
Outside Air Intake	Retrofit Program	Custom_Existing

Measure	Program	Adoption Curve
Receiver Capacity Addition	Retrofit Program	Custom_Existing
Air Compressor Optimization	Audit and Energy Partners	Custom_Existing
Head Pressure Control	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R30)	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R35)	Retrofit Program	Custom_Existing
Ceiling Insulations (R25 Code to R40)	Retrofit Program	Custom_Existing
Chiller Tuneup/Diagnostics	Retrofit Program	Custom_Existing
Cooling Tower Optimization	Audit and Energy Partners	Custom_Existing
Duct Insulation, Add R8	Retrofit Program	Custom_Existing
DX Coil Cleaning	Retrofit Program	Custom_Existing
HVAC Diagnostic/Air Conditioner Tune Up	Retrofit Program	Custom_Existing
Improved Controls - HVAC	Retrofit Program	Custom_Existing
Wall Insulations (Going from R23 to R30)	Retrofit Program	Custom_Existing
Wall Insulations (Going from R23 to R38)	Retrofit Program	Custom_Existing
Wall Insulations (Going from R10 to R30)	Retrofit Program	Custom_Existing
Heat Reclaimer	Retrofit Program	Custom_Existing
Heat Recovery Ventilators	Retrofit Program	Custom_Existing
Programmable Ventilation Controller	Retrofit Program	Custom_Existing
Building Shell Improvements	Retrofit Program	Custom_Existing
Automatic High Speed Doors - Exterior	Retrofit Program	Custom_Existing
Occupancy Sensor	Retrofit Program	Custom_Existing
OCCUPANCY SENSORS - Ceiling mounted	Retrofit Program	Custom_Existing
PHOTOCELL AND TIMER FOR LIGHTING CONTROL	Retrofit Program	Custom_Existing
Central Lighting Control System	Retrofit Program	Custom_Existing
Indoor Daylight Sensors	Retrofit Program	Custom_Existing
Lighting System Design Optimization	Audit and Energy Partners	Custom_Existing
Improved Controls - Fans	Retrofit Program	Custom_Existing
Improved Controls - Motors	Retrofit Program	Custom_Existing
Motor Management Plan	Audit and Energy Partners	Custom_Existing
Pump Equipment Upgrade	Retrofit Program	Custom_Existing
Pump System Optimization	Audit and Energy Partners	Custom_Existing
Greenhouse Heat Curtain	Retrofit Program	Custom_Existing
High Efficiency Welders	Retrofit Program	Custom_Existing
Clean Room - Change Filter Strategy	Retrofit Program	Custom_Existing
Clean Room - Chiller Optimize	Audit and Energy Partners	Custom_Existing

Measure	Program	Adoption Curve
Clean Room - Clean Room HVAC	Retrofit Program	Custom_Existing
Improved Controls - Process Cooling	Retrofit Program	Custom_Existing
Cold Storage Retrofit	Retrofit Program	Custom_Existing
Cold Storage Tune-up	Retrofit Program	Custom_Existing
Pellet Dryer Tanks and Ducts 3 dia	Retrofit Program	Custom_Existing
Refrigerated Cycling Dryers	Retrofit Program	Custom_Existing
Dew Point Sensor Control for Desiccant CA Dryer	Retrofit Program	Custom_Existing
Process Cooling Ventilation Reduction- fan hp	Retrofit Program	Custom_Existing
Automatic High Speed Doors- freezer	Retrofit Program	Custom_Existing
Automatic High Speed Doors- Cooler	Retrofit Program	Custom_Existing
Automatic High Speed Doors- Between cooler and dock	Retrofit Program	Custom_Existing
Dairy Refrigeration Tune-up	Retrofit Program	Custom_Existing
High Temperature Cutout Thermostat	Retrofit Program	Custom_Existing
Creep Heat Controller	Retrofit Program	Custom_Existing
Block Heater Timer	Retrofit Program	Custom_Existing
Improved Controls - Process Heating	Retrofit Program	Custom_Existing
Process Heat O&M	Retrofit Program	Custom_Existing
Heat Lamp Setback (Microzone)	Retrofit Program	Custom_Existing
Heat Lamp - Heating Pad Controller	Retrofit Program	Custom_Existing
Grain bin aeration control systems	Retrofit Program	Custom_Existing
Elec Chip Fab - Eliminate Exhaust	Retrofit Program	Custom_Existing
Elec Chip Fab: Exhaust Injector	Retrofit Program	Custom_Existing
Elec Chip Fab - Reduce Gas Pressure	Retrofit Program	Custom_Existing
Mech Pulp - Premium Process	Retrofit Program	Custom_Existing
Mech Pulp - Refiner Plate Improvement	Retrofit Program	Custom_Existing
Barrel Insulation - Plastic Injection Molding and Extrusion Machine Barrels	Retrofit Program	Custom_Existing
Chiller Optimization	Audit and Energy Partners	Custom_Existing
Process Optimization	Audit and Energy Partners	Custom_Existing
LEED New Construction Whole Building Design	C&I New Construction	Engineered_Existing
Infrared Film for Greenhouses	Retrofit Program	Custom_Existing
Fan Thermostat Controller	Retrofit Program	Custom_Existing
Drip Irrigation Nozzles	Retrofit Program	Custom_Existing
Scientific Irrigation System (SIS)	Retrofit Program	Custom_Existing

Appendix C: Methodology to Calculate Achievable Potential

This appendix provides a description of the methodology that was used to develop the adoption curves, and the calculation that was used to derive achievable potential savings.

Development of Adoption Curves

Adoption curves were developed to estimate the achievable annual participation in each archetype program from 2015 to 2020. The estimated participation was used in the model to derive the estimated achievable potential savings for each archetype program. Key items that were taken into consideration in developing and applying the adoption curves included:

- Historic program participation
- Transition from previous framework to CFF
- Design and launch period for new and enhanced programs
- Non-incentive influences.

An adoption curve represents the percentage of the participation of eligible customers in a program. As illustrated in Figure C-1, adoption curves typically included:

- A program launch period
- An acceleration of participation until a peak participation rate was reached
- A slow-down in participation, followed by a plateau as the maximum participation was approached.

Programs that were launched and delivered in Ontario during the previous framework will have moved past the launch period and will be on a slope of increased participation. As illustrated in Figure C-2, the analysis for this study began in 2015. New programs to be launched during the CFF will start at the beginning of the launch period. Program enhancements can be implemented to accelerate the rate of participation, as illustrated in Figure C-3.

The adoption curves were developed using the equation derived by the Bass diffusion equation and the historic program participation, as illustrated in Figure C-4.

Figure C-1: Adoption Curve Concepts

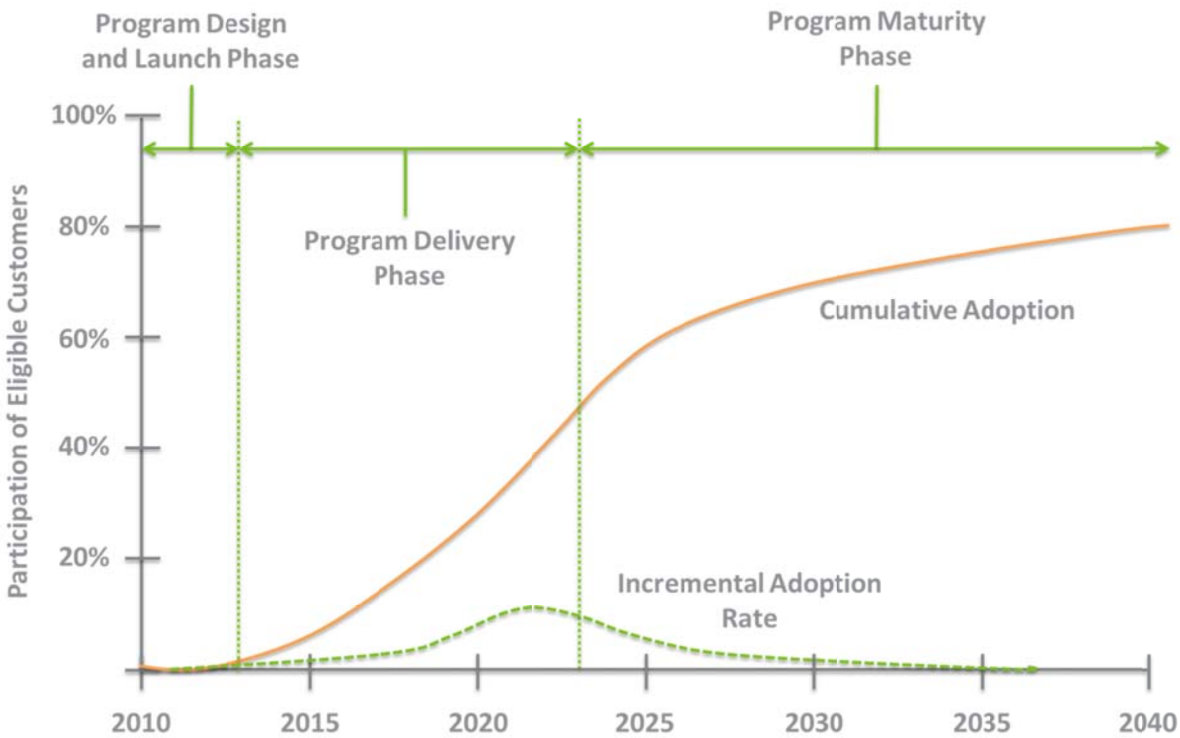


Figure C-2: 2015 as First Year of Potential Savings

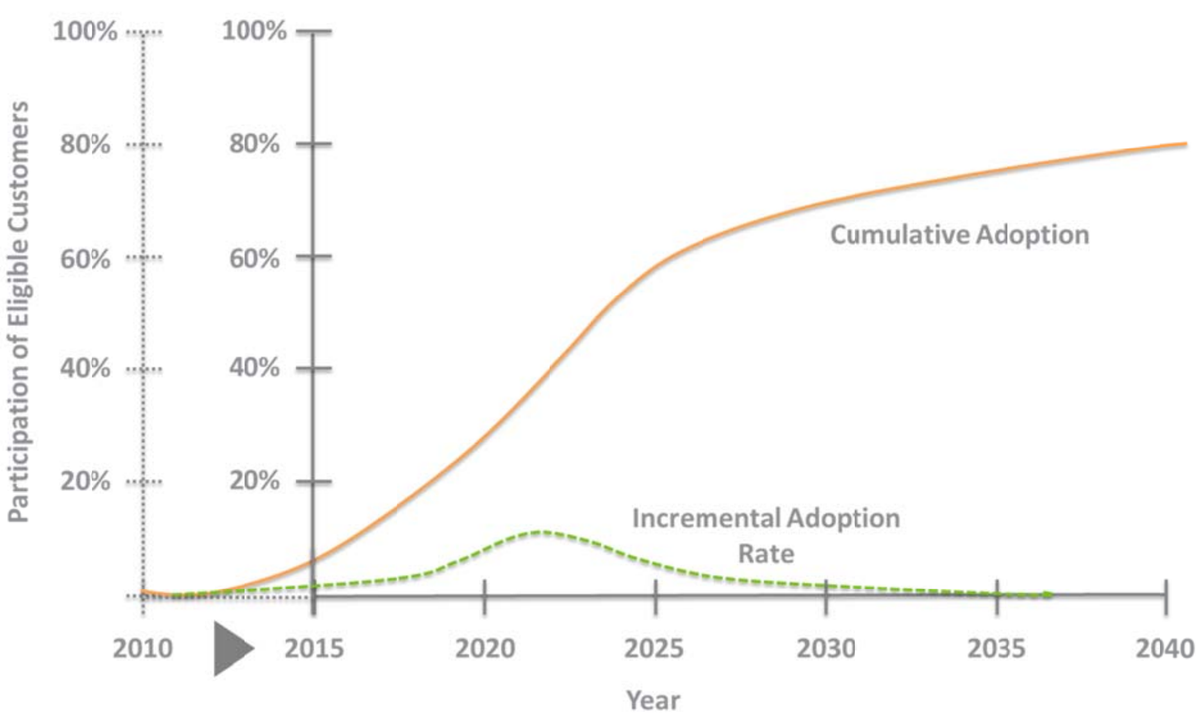


Figure C-3: Accelerated Adoption Due to Program Enhancements

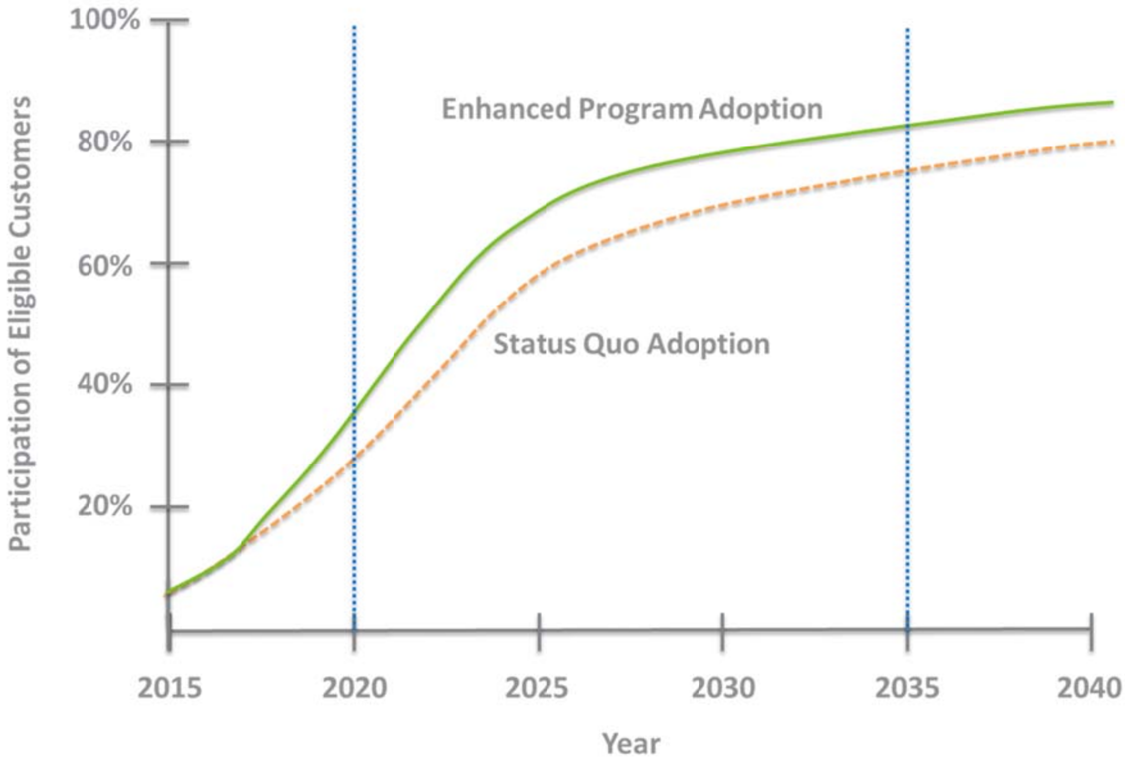
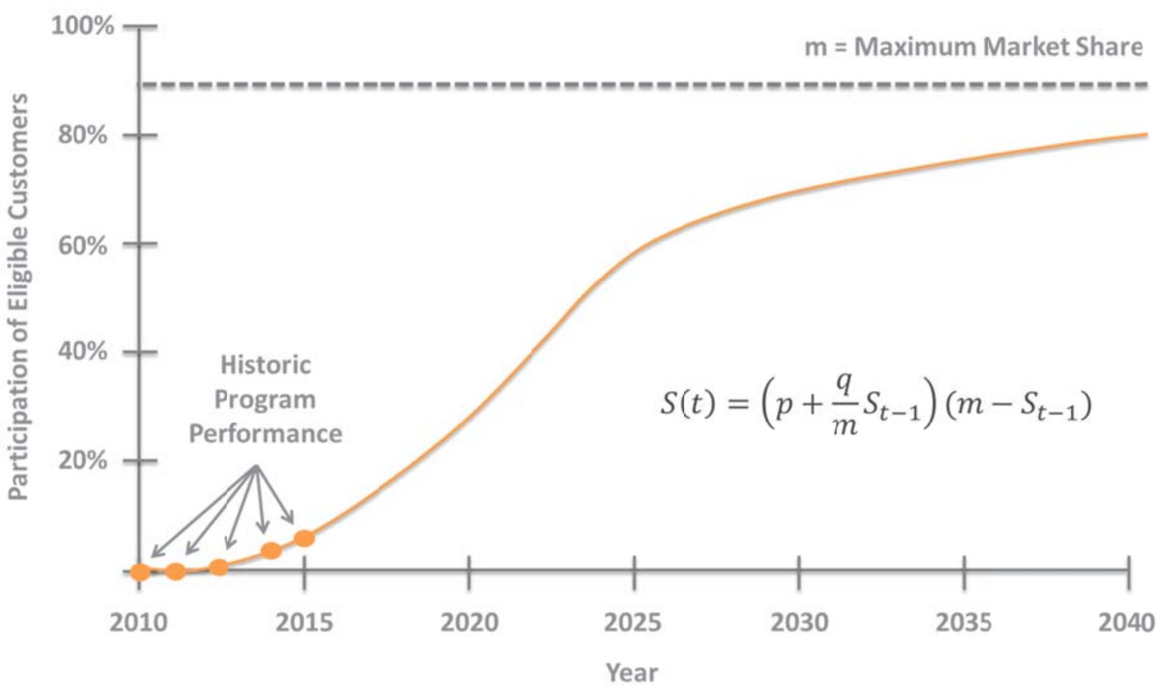


Figure C-4: Adoption Curved Based on Bass Diffusion Model and Historic Program Participation



In the Bass diffusion equation, S(t) is the market share (or participation) in the current year, while S_{t-1} is the market share (or participation) up to the previous year.

The following parameters are used in the Bass discussion equation:

- p = coefficient of innovation
  - Accounts for external effects
  - An external effect where program archetypes can influence adoption
- q = coefficient of imitation
  - Accounts for internal effects
  - Considered as an inherent property of the market and technology
- m = maximum market share of eligible population

Eligible population was determined as part of developing each LDC's energy use profile, based on:

- Total population
- End use saturation
- End use fuel share
- Equipment measure life.

The following equation is used to derive the eligible population:

$$\text{Eligible Population} = \frac{1}{\text{Equipment Type Average Measure Life}} \times (\text{Total Population})$$

Eligible population was the fraction of the total population based on average measure life by equipment type. Equipment type average measure life was the average measure life of all measures associated with an equipment type. For example, the commercial interior lighting equipment type included various kinds of lighting measures; the average life of these measures defines the equipment type average measure life.

Total population was the product of premise counts, end use saturation and end use fuel share, as shown in the following equation.

Total Population = (Premise Count) x (End use Saturation) x (End use Fuel Share)

End use saturation was the percentage of households with the end use present, and end use fuel share was the percentage of households with the end use present that were electric-fueled.

Historic Ontario program participation data for 2011 to 2015 was used to derive the Ontario market adoption curves. A sample of the data set is provided in Table C-1. Market adoption curves were aligned with availability of historic program participation data as summarized in Table C-2.

Table C-1 Sample Data Set of Historic Program Participation

LDC	Year	Measure	Units	Eligible Population
LDC 1	2011	ECM	26	6,953
LDC 1	2012	ECM	19	6,953
LDC 1	2013	ECM	83	6,953
LDC 1	2014	ECM	84	6,953
LDC 1	2011	Tier 1 CAC	0	302
LDC 1	2013	Tier 1 CAC	1	302
LDC 1	2014	Tier 1 CAC	1	302
LDC 1	2011	Tier 2 CAC	1	302
LDC 1	2014	Tier 2 CAC	6	302
LDC 2	2011	ECM	1	1,477
LDC 2	2013	ECM	2	1,477
LDC 2	2014	ECM	3	1,477
LDC 2	2011	Tier 1 CAC	0	295
LDC 2	2011	Tier 2 CAC	0	295
LDC 2	2013	Tier 2 CAC	1	295
LDC 3	2011	ECM	900	35,419
LDC 3	2012	ECM	554	35,419
LDC 3	2013	ECM	487	35,419
LDC 3	2014	ECM	587	35,419
LDC 3	2011	Tier 1 CAC	134	20,381
LDC 3	2012	Tier 1 CAC	55	20,381
LDC 3	2013	Tier 1 CAC	57	20,381
LDC 3	2014	Tier 1 CAC	46	20,381
LDC 3	2011	Tier 2 CAC	384	20,381
LDC 3	2013	Tier 2 CAC	343	20,381
LDC 3	2014	Tier 2 CAC	428	20,381
LDC 4	2011	ECM	178	7,868
LDC 4	2012	ECM	147	7,868
LDC 4	2013	ECM	126	7,868
LDC 4	2014	ECM	145	7,868
LDC 4	2011	Tier 1 CAC	47	5,849
LDC 4	2012	Tier 1 CAC	17	5,849
LDC 4	2013	Tier 1 CAC	16	5,849
LDC 4	2014	Tier 1 CAC	15	5,849
LDC 4	2011	Tier 2 CAC	66	5,849
LDC 4	2013	Tier 2 CAC	59	5,849
LDC 4	2014	Tier 2 CAC	78	5,849

Table C-2 Alignment of Adoption Curves with Available Historic Program Participation

Available Historic Participation Data by Measure and Program	Adoption Curve
Residential sector	
Furnace with ECM	ECM
Tier 1 CAC	CACI
Tier 2 CAC	CACII
Outdoor clothesline umbrella stand or clothesline kits	Air dry
ENERGY STAR® specialty and standard spiral CFL	CFL
Electric water heater blankets	DHW blanket
ENERGY STAR® qualified ceiling fans	Fans
ENERGY STAR® qualified fixtures	Fixture
ENERGY STAR® general purpose and specialty LEDs	LED
Lighting control products	Light control
Hot water pipe wraps	Pipes
Advanced power bars	Powerbar
Weather stripping (foam or V-strip packages; door frame kits)	Shell
Electric baseboard programmable thermostats	Thermo
Heavy-duty outdoor timers	Timer
Window air conditioner pick-up (home/retailer)	Air conditioner
Dehumidifier pick-up (home/retailer)	Dehumidifier
Freezer pick-up (home/retailer)	Freezer
Fridge pick-up (home/retailer)	Refrigerator
Average adoption rate: AC, dehumidifier, freezer and refrigerator measures	Miscellaneous appliances
Average adoption rate: all other measures' adoption curves	Miscellaneous all
75% adoption rate (adjusted to achieve full savings in second year)	Home energy report (HER)
C&I Sectors	
LED (SBL Program)	Small business: CFL
CFL (SBL Program)	Small business: LED
Other lighting measures (SBL Program)	Small business: Other
Custom track measures (Retrofit Program)	Retrofit custom
Engineered track measures (Retrofit Program)	Retrofit engineered
Prescriptive track measures (Retrofit Program)	Retrofit prescriptive

Twenty-two adoption curves were developed for the residential sector and six adoption curves were developed apiece for the commercial and industrial sectors. All the measures were mapped to the adoption curves and the archetype programs as illustrated in Figure C-5. The full list of mapping is provided in Appendix B.

Figure C-5: Mapping of Measures to Adoption Curves and Archetype Programs

Sector	Measures	Adoption Curves	Archetype Programs
Residential	146	22	8
Commercial	207	6	4
Industrial	196	6	4

Using statistical analysis of the Ontario historic program participation data, the p, q, and m parameters were derived for each of the adoption curves, as summarized in Table C-3. The "new p" value is a revised p-value due to program enhancements; the new value was developed through a choice model survey with input from LDCs, IESO, expert panel members, and Nexant experts.

Table C-3: Market Adoption Curve Parameters from Historic Program Participation

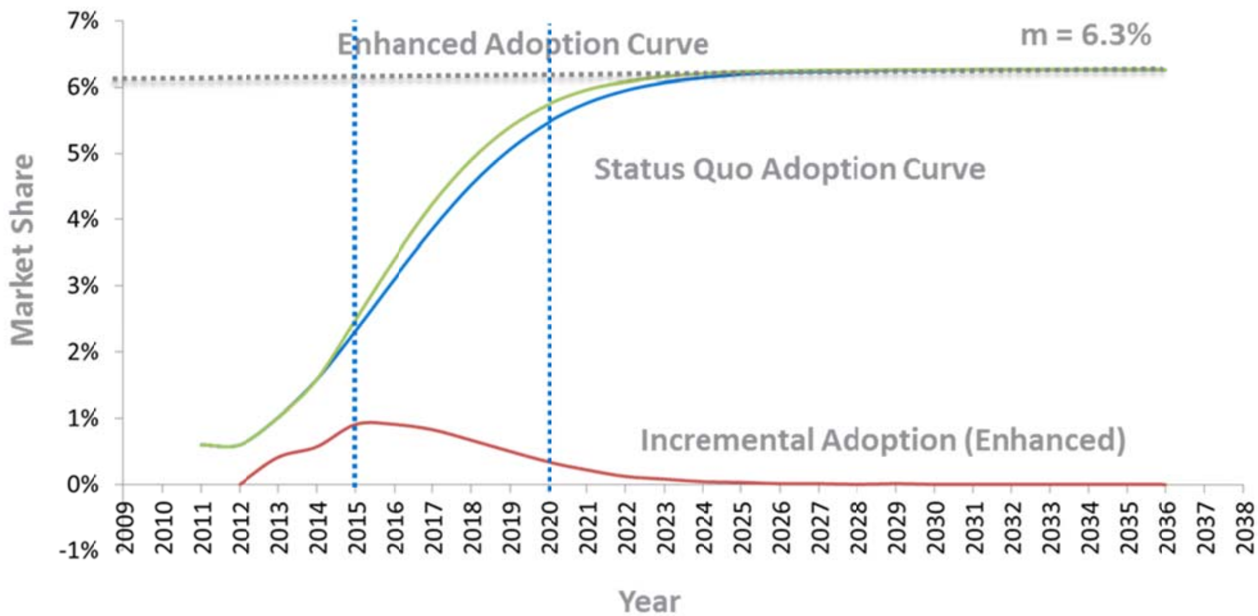
Adoption Curve	P	New p*	q	m
ECM	0.0348	0.0515	0.4081	14%
CACI	0.0334	0.0495	0.1048	8%
CACII	0.0327	0.0484	0.5688	9%
Air dry	0.0062	0.0065	0.3768	3%
CFL	0.0092	0.0098	0.2325	32%
DHW blanket	0.0050	0.0053	0.3489	1%
Fans	0.0087	0.0104	0.3065	1%
Fixture	0.0087	0.0104	0.3958	1%
LED	0.0092	0.0111	0.2325	32%
Light control	0.0122	0.0146	0.2730	12%
Pipes	0.0069	0.0073	0.2656	4%
Powerbar	0.0208	0.0220	0.2303	3%
Shell	0.0112	0.0214	0.2874	26%
Thermo	0.0070	0.0135	0.3444	4%
Timer	0.0103	0.0197	0.2509	6%
Air conditioner	0.0025	0.0030	0.2948	11%
Dehumidifier	0.0036	0.0043	0.1889	23%
Freezer	0.0026	0.0031	0.1043	47%
Refrigerator	0.0023	0.0028	0.0974	70%

Using the p, q, and m parameters derived from the Ontario market analysis, the historic participation data for LDCs was used in the Bass diffusion equation to derive the incremental adoption rates. An example of the incremental adoption rates for Tier 2 CAC for an LDC is provided in Table C-4 and the resulting adoption curves are illustrated in Figure C-6. The incremental adoption rates were used in the model.

Table C-4: Example of Incremental Adoption Rates

Year	Status Quo Adoption Curve		Enhanced Adoption Curve	
	Market Share	Incremental Adoption	Enhanced Market Share	Incremental Adoption
2011	0.60%	0.60%	0.60%	0.60%
2012	0.60%	0.00%	0.60%	0.00%
2013	1.01%	0.41%	1.01%	0.41%
2014	1.58%	0.57%	1.58%	0.57%
2015	2.32%	0.74%	2.49%	0.91%
2016	3.10%	0.78%	3.40%	0.91%
2017	3.85%	0.75%	4.23%	0.83%
2018	4.52%	0.67%	4.90%	0.67%
2019	5.06%	0.54%	5.40%	0.50%
2020	5.47%	0.41%	5.74%	0.34%
2021	5.76%	0.29%	5.96%	0.22%
2022	5.95%	0.19%	6.08%	0.12%
2023	6.07%	0.12%	6.16%	0.08%
2024	6.14%	0.07%	6.20%	0.04%
2025	6.19%	0.05%	6.23%	0.03%
2026	6.22%	0.03%	6.24%	0.01%
2027	6.23%	0.01%	6.25%	0.01%
2028	6.24%	0.01%	6.25%	0.00%
2029	6.25%	0.01%	6.26%	0.01%
2030	6.25%	0.00%	6.26%	0.00%
2031	6.26%	0.01%	6.26%	0.00%
2032	6.26%	0.00%	6.26%	0.00%
2033	6.26%	0.00%	6.26%	0.00%
2034	6.26%	0.00%	6.26%	0.00%
2035	6.26%	0.00%	6.26%	0.00%
2036	6.26%	0.00%	6.26%	0.00%

Figure C-6: Example Adoption Curve for Tier 2 CAC for an LDC



When new measures are applied to existing programs, they do not encounter the delays to market uptake associated with the design and launch phase of a new program. As such, it is assumed that Years 1 and 2 of the adoption curves were not applicable to these measures. The provincial market adoption curve was applied to the new measure, starting in Year 3, as demonstrated in Table C-5.

Table C-5: Example of Adding a New Measure to an Existing Program

Provincial Adoption Curve: Fans		Measure: High-Efficiency Bathroom Exhaust Fan	
Year	Incremental Adoption Rate	Year	Incremental Adoption Rate
Year 1	0.002%		N/A
Year 2	0.004%		N/A
Year 3	0.023%	2015	0.023%
Year 4	0.032%	2016	0.032%
Year 5	0.053%	2017	0.053%
Year 6	0.074%	2018	0.074%
Year 7	0.095%	2019	0.095%
Year 8	0.106%	2020	0.106%

Example Calculation of Achievable Potential

Below is an example that illustrates t steps in calculating achievable potential savings.

Step 1: LDC Specific Electricity Use Profile

LDC load profiles were developed with input from LDCs, and draft versions were reviewed with LDCs to develop final versions. The LDC specific profile provided the disaggregated load by sector, subsector, end use, and equipment type specific to each LDC.

An example of an LDC residential subsector profile:

Start Year Sales Distribution by Segment	
Segment	% of Start Yr Sales
Single Family	94%
Row House	3%
MURB Low Rise	2%
MURB High Rise	0%
Other Residential Buildings	2%
Total	100.00%

An example of LDC residential end use profile:

Start Year Sales Distribution by End Use																
	Space Heating	Space Cooling	Domestic Hot Water	Ventilation and Circulation	Lighting	Cooking	Refrigerators	Freezers	Clothes Washers	Clothes Dryers	Dishwashers	Plug Load	Dehumidifiers	Miscellaneous		Total
Single Family	21.2%	1.7%	14.8%	6.8%	9.5%	4.1%	6.7%	4.3%	0.6%	5.1%	0.8%	12.5%	1.1%	10.7%		100.0%
Row House	45.9%	1.2%	14.3%	3.3%	5.7%	2.9%	4.8%	2.6%	0.5%	3.0%	0.5%	9.5%	0.9%	5.1%		100.0%
MURB Low Rise	30.3%	1.5%	18.0%	5.2%	19.0%	3.7%	5.5%	2.5%	0.3%	1.2%	0.5%	9.9%	0.5%	2.0%		100.0%
MURB High Rise	25.0%	0.8%	18.2%	4.9%	22.9%	3.8%	5.5%	2.5%	0.3%	1.3%	0.5%	10.1%	0.5%	3.7%		100.0%
Other Residential Buildings	44.9%	1.4%	14.0%	2.6%	4.6%	3.3%	5.1%	3.3%	0.5%	3.6%	0.6%	10.4%		5.7%		100.0%
Must sum to 100% for each segment (column AD).																

An example of LDC profile by equipment type, showing the profiles for the first three subsectors in the model: single family, row house, and MURB low rise:

TYPE
tility
ipment Type Saturation
ent type saturation for all equipment types in all segments.

Lighting		Cooking		Refrigerators		Freezers	
Screw-in Lamps	100.0%	Oven	17.2%	Refrigerators	151.0%	Freezers	
Lighting Common Areas (MR)	5.0%	Range	94.3%				
Lighting Exterior	100.0%	Cooking Other	93.2%				
Lighting Other	100.0%						
Total Lighting	**305%**	**Total Cooking**	**205%**	**Total Refrigerators**	**151%**	**Total Freezers**	

Lighting		Cooking		Refrigerators		Freezers	
Screw-in Lamps	100.0%	Oven	17.2%	Refrigerators	115.0%	Freezers	
Lighting Common Areas (MR)	5.0%	Range	94.3%				
Lighting Exterior	100.0%	Cooking Other	93.2%				
Lighting Other	100.0%						
Total Lighting	**305%**	**Total Cooking**	**205%**	**Total Refrigerators**	**115%**	**Total Freezers**	

Lighting		Cooking		Refrigerators		Freezers	
Screw-in Lamps	100.0%	Oven	17.2%	Refrigerators	104.0%	Freezers	
Lighting Common Areas (MR)	100.0%	Range	94.3%				
Lighting Exterior	100.0%	Cooking Other	93.2%				
Lighting Other	100.0%						
Total Lighting	**400%**	**Total Cooking**	**205%**	**Total Refrigerators**	**104%**	**Total Freezers**	

Step 2: LDC Baseline Forecast and Load Share

Using load profiles and LDC kWh load forecasts, baseline forecasts were developed by sector, subsector, end use, equipment type, and vintage. This was used to define what share of the load the measure savings were applied to.

Example of LDC load forecast for screw-in-lamps, lighting end use, and single family subsector:

Scenario:	Segment:	End Use:	Equipment Type:	Measures ranked by:
AchBase	1 Single Family	5 Lighting	1 Screw-in Lamps	Total Resource Cost (TRC)

Screw-in Lamps					
Baseline Energy Sales Forecast					
	New	Turnover	Early Retirement	Remaining	Total
2015	32,639	414,786	20,739	4,127,124	**4,595,289**
2016	32,839	328,292	16,579	3,960,190	**4,337,899**
2017	29,086	299,777	15,134	3,928,886	**4,272,883**
2018	25,884	273,076	13,783	3,888,640	**4,201,382**
2019	20,905	250,693	12,639	3,875,628	**4,159,865**
2020	16,547	229,613	11,563	3,853,759	**4,111,482**
2021	14,344	209,758	10,560	3,824,670	**4,059,331**
2022	11,903	192,156	9,667	3,805,469	**4,019,195**
2023	10,657	176,499	8,878	3,798,120	**3,994,154**
2024	9,327	162,049	8,149	3,788,726	**3,968,251**
2025	8,088	149,280	7,504	3,791,819	**3,956,691**
2026	6,252	137,418	6,902	3,790,350	**3,940,922**
2027	5,113	126,742	6,363	3,797,399	**3,935,617**
2028	4,075	116,801	5,860	3,801,270	**3,928,005**
2029	3,282	107,837	5,408	3,812,482	**3,929,009**
2030	2,461	99,567	4,991	3,823,520	**3,930,539**
2031	1,440	91,844	4,599	3,829,785	**3,927,668**
2032	635	84,648	4,236	3,833,094	**3,922,613**
2033	69	78,056	3,903	3,838,933	**3,920,961**
2034	(523)	72,034	3,599	3,847,245	**3,922,355**
2035	(779)	66,297	3,311	3,846,470	**3,915,299**

Step 3: Adoption Curves

Using the Ontario market adoption equation with the LDC specific historic program participation, the LDC specific adoption curves were developed. The annual incremental adoption rates were used in the model.

An example LDC incremental adoption rates:

Utility **Adoption Curves**

	6	7	8	9	10	11	12	13	14	15
	AchExisting_ECM	AchExisting_CACI	AchExisting_CACI	AchExisting_ECMI	AchExisting_air dr	AchExisting_cfl	AchExisting_dhw	AchExisting_fans	AchExisting_fix	AchExisting_led
2015	1.18%	0.21%	0.77%	0.53%	0.18%	2.67%	0.05%	0.11%	0.33%	0.62%
2016	1.21%	0.21%	0.76%	0.73%	0.16%	2.97%	0.04%	0.10%	0.39%	0.77%
2017	1.17%	0.20%	0.72%	1.36%	0.11%	3.33%	0.03%	0.07%	0.53%	0.93%
2018	0.90%	0.17%	0.55%	1.61%	0.06%	3.48%	0.02%	0.04%	0.59%	1.10%
2019	0.61%	0.13%	0.38%	1.75%	0.03%	3.51%	0.01%	0.02%	0.65%	1.29%
2020	0.38%	0.09%	0.24%	1.69%	0.01%	3.41%	0.00%	0.01%	0.68%	1.46%

Step 4: Measure Mapping Parameters

Measure research defined the parameters (savings, cost, and measure life). Measure permutations were mapped to subsector, end use, and equipment type. This resulted in the development of competition groups. Measures were also mapped to adoption curves and archetype programs.

Example of LDC measure mapping parameters:

E	G	I	J	K	L	M	S	V	W	X	Y
Name	Baseline Description	Vintage	Segment	Climat	End Use	Equip Type/Competition Grou	Adoption Curve AchBase	Baseline kWh	Measure kWh	Savings kWh	Energy Savings
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Single Family	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Row House	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	MURB Low Rise	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	MURB High Rise	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Other Residential Builc	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Single Family	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Row House	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	MURB Low Rise	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	MURB High Rise	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	55	9	46	83.7%
ENERGY STAR LED 7W	EISA Compliant 43W Halogen Bulb	Turnover	Other Residential Builc	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	55	9	46	83.7%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Single Family	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Row House	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	MURB Low Rise	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	MURB High Rise	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Other Residential Builc	Zone 7	Lighting	Screw-in Lamps	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Single Family	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Row House	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	MURB Low Rise	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	MURB High Rise	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	68	15	52	77.4%
ENERGY STAR LEDL 12W	EISA Compliant 53W Halogen Bulb	Turnover	Other Residential Builc	Zone 7	Lighting	Lighting Common Areas (MR)	AchExisting_led	68	15	52	77.4%

Step 5: Ranking of Measures by TRC

Measures in each vintage competition group were ranked according to TRC.

Example of LDC ranking of measures:

Turnover											
Measure Number	Measure Code	Name	Measure Type	Equip Type/Competition Group	B/C Ratio	Applicability	Energy Savings % Lookup	Equip Rank	Nonequip Rank	Overall Rank	Equip Measure Count
1	ET917	ENERGY STAR LED 25W	Equip	Screw-in Lamps	5.77	5.9%	75.0%	1		1	27
2	ET767	Energy Star Torchiere	Equip	Screw-in Lamps	5.41	8.8%	68.1%	2		2	
3	ET887	ENERGY STAR LED 18W	Equip	Screw-in Lamps	4.77	5.9%	75.0%	3		3	
4	ET1067	ENERGY STAR CFL 20W	Equip	Screw-in Lamps	4.22	5.9%	62.3%	4		4	
5	ET857	ENERGY STAR LEDL 12W	Equip	Screw-in Lamps	4.16	5.9%	77.4%	5		5	
6	ET827	ENERGY STAR LED 7W	Equip	Screw-in Lamps	3.80	5.9%	83.7%	6		6	
7	ET977	ENERGY STAR CFL 15W	Equip	Screw-in Lamps	3.59	5.9%	65.1%	7		7	
8	ET662	ENERGY STAR QUALIFIED RECESSED LIGHTING	Equip	Screw-in Lamps	3.51	29.5%	82.1%	8		8	
9	ET1037	ENERGY STAR CFL 40W	Equip	Screw-in Lamps	3.46	5.9%	60.0%	9		9	
10	ET437	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	3.25	23.6%	71.1%	10		10	
11	ET482	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	3.21	58.9%	78.0%	11		11	
12	ET947	ENERGY STAR CFL 10W	Equip	Screw-in Lamps	3.19	5.9%	65.5%	12		12	
13	ET512	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	3.13	58.9%	74.7%	13		13	
14	ET1007	ENERGY STAR CFL 25W	Equip	Screw-in Lamps	2.87	5.9%	65.3%	14		14	
15	ET797	ENERGY STAR LED 5W	Equip	Screw-in Lamps	2.81	5.9%	82.8%	15		15	
16	ET332	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	2.74	23.6%	55.8%	16		16	
17	ET572	ENERGY STAR® QUALIFIED COMPACT FLUORE	Equip	Screw-in Lamps	2.29	5.9%	69.8%	17		17	
18	ET692	ENERGY STAR QUALIFIED RECESSED LIGHTING	Equip	Screw-in Lamps	2.06	29.5%	56.6%	18		18	
19	ET392	ENERGY STAR® QUALIFIED COMPACT FLUORE	Equip	Screw-in Lamps	1.80	29.5%	75.9%	19		19	
20	ET242	ENERGY STAR® QUALIFIED LED BULBS - Specia	Equip	Screw-in Lamps	1.71	29.5%	86.7%	20		20	
21	ET542	ENERGY STAR® QUALIFIED COMPACT FLUORE	Equip	Screw-in Lamps	1.55	58.9%	59.5%	21		21	
22	ET422	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	1.53	29.5%	75.0%	22		22	
23	ET632	ENERGY STAR QUALIFIED LIGHT FIXTURE - 3 C	Equip	Screw-in Lamps	1.47	30.4%	64.3%	23		23	
24	ET602	ENERGY STAR QUALIFIED LIGHT FIXTURE - 1 C	Equip	Screw-in Lamps	1.46	30.4%	64.0%	24		24	
25	ET362	ENERGY STAR® QUALIFIED SPECIALTY COMPA	Equip	Screw-in Lamps	1.12	58.9%	80.0%	25		25	
26	ET302	ENERGY STAR® QUALIFIED LED BULBS - Specia	Equip	Screw-in Lamps	1.09	23.6%	80.8%	26		26	
27	ET272	ENERGY STAR® QUALIFIED LED BULBS - Specia	Equip	Screw-in Lamps	1.00	29.5%	82.5%	27		27	
28											
29											
30											

Step 6: Calculate Savings

In each vintage group, the model calculated savings for the first ranked TRC. The savings was then removed from the available load for next measure in the TRC ranking to calculate savings for the next measure.

The following equation was used to calculate the savings:

Annual Savings per Measure (kWh/year) =

= (kWh Load share) x (% Incremental adoption rate) x (% Measure applicability) x (% Savings of measure)

Using the values as indicated in this example, the achievable potential savings for the LED measures was calculated:

= (414,786 kWh) x (0.62%) x (5.9%) x (75.0%) = 114 kWh/year

Example of LDC measure savings calculation in model:

1	Measure Code	Description	Type	Measure Life
(Overall rank)	ET917	ENERGY STAR LED 25W	Equip	20
Competition Group	Applicability	Adoption Curve	Energy Savings %	Demand-to-Energy Ratio
Screw-in Lamps	5.9%	AchExisting_led	75.0%	0.0%
These tables apply measure-level savings for each measure in the table above.				

	Annual Energy Savings	Cumulative Energy Saving
2015	114	114
2016	112	226
2017	123	349
2018	133	482
2019	143	625
2020	148	773

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