Q. Further to the reply of CA-NP-183:

(a) Please provide any information that NP has with respect to (i) the energy efficiency of the new appliances typically installed in the new premises of newly attached customers as compared to the average efficiency of the stock of appliances used by existing customers; (ii) the impact of changes in building codes (e.g., insulation standards) that affect the envelope efficiency of new housing stock versus the existing housing stock; and (iii) the impact of differences in the average size (square feet) of new housing versus the existing housing stock in the NP service area.

(b) If NP does not have the information requested in part (a), please provide the directional impacts that NP expects to prevail and any generic information that NP has with respect to these trends in other jurisdictions.

A. (a) Attachment A provides a copy of the Conservation and Demand Management (CDM) Potential study for the residential sector in Newfoundland and Labrador. The report provides comprehensive information with respect to energy usage in the residential sector including the impact of energy efficiency and changes in housing stock on energy growth.

(b) Please refer to the response to part (a).

Conservation and Demand Management (CDM) Potential
Newfoundland and Labrador
Residential Sector

CONSERVATION AND DEMAND MANAGEMENT (CDM) POTENTIAL

NEWFOUNDLAND and LABRADOR

Residential Sector

–Final Report–

Prepared for:

Newfoundland & Labrador Hydro and
Newfoundland Power

Prepared by:

Marbek Resource Consultants Ltd.

In association with:

Sustainable Housing and Education Consultants
and
Applied Energy Group

January 18, 2008

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EXECUTIVE SUMMARY

❑ Background and Objectives

Newfoundland and Labrador Hydro and Newfoundland Power (collectively the Utilities) have partnered to produce this study, recognizing the role that each has in energy conservation and least cost electric utility planning within the province. Increasing electricity costs and the expectations of a growing number of their customers and stakeholders have contributed to the increased focus on conservation and demand management (CDM) and resulted in a number of recent initiatives and projects targeting energy savings in the province. This study is the next step in the Utilities efforts to develop a comprehensive plan for CDM in Newfoundland and Labrador. The Utilities envision electricity conservation and demand management (CDM) to be a valuable component in meeting the province's future electricity requirements.

This study will also be a significant component in the further implementation of the Province's recently released Energy Plan. The Energy Plan establishes a long-term vision for how the province's energy resources will be developed and utilized to benefit the people of the province today as well as for future generations. Electricity conservation and demand management (CDM) are an important component of the provincial Energy Plan as are the conservation and demand management components for the other energy resources of the province.

This report meets, in part, the requirements of the Public Utilities Board Order PU 8 2007 requiring NLH to file this study and a five-year plan for implementation of CDM programs in 2008.

The objective of this study is to identify the potential contribution of specific CDM technologies and measures in the Residential, Commercial and Industrial sectors and to assess their economic costs and benefits. The Newfoundland and Labrador economy is expected to grow over the next 20 years, with an associated increase in energy consumption. The benefits of increased penetration of energy efficiency technologies include reduced energy costs for individuals and businesses, as well as environmental benefits through reduced pollution and greenhouse gas emissions.

The outputs from this study will assist the Utilities CDM planners and others to develop specific CDM programs for implementation and to optimize the contribution of CDM technologies and measures to the province's overall energy future.

❑ Scope and Organization

This study covers a 20-year study period from 2006 to 2026 and addresses the Residential, Commercial and Industrial sectors as well as street lighting. The study addresses the customers from both utilities. Due to differences in cost and rate structures, the Utilities' customers are organized into two service regions, which in this report are referred to as the Island and Isolated, and the Labrador Interconnected. For the purposes of this study, the isolated diesel system customers have been combined with those in the Island service region due to their relatively small size and electricity usage.

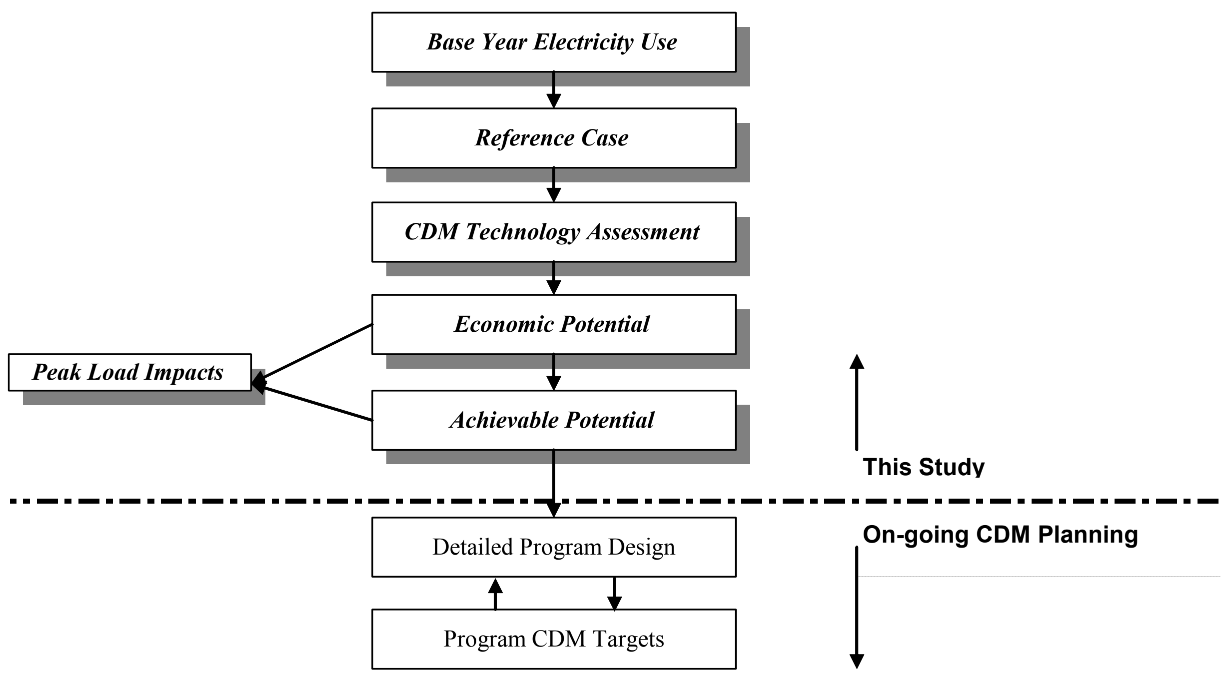
The study reviews all commercially viable electrical efficiency technologies or measures. In addition, the study also reviews selected peak load reduction and fuel switching measures.

❑ Approach

The detailed end-use analysis of electrical efficiency opportunities in the Residential sector employed two linked modelling platforms: **HOT2000,** a commercially supported residential building energy-use simulation software, and **RSEEM** (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

The major steps involved in the analysis are shown in Exhibit ES1 and are discussed in greater detail in Chapter 1. As illustrated in Exhibit ES1, the results of this study, and in particular the estimation of Achievable Potential,[1] support the on-going work of the Utilities; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific targets or with program design.

Exhibit ES1: Study Approach - Major Analytical Steps



❑ Overall Study Findings[2]

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the province's building stock and customer willingness to implement new CDM measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the Utilities and are based on

[1] The proportion of savings identified that could realistically be achieved within the study period without consideration for budgetary constraints.

[2] Consistent with the study scope, the results presented in this Executive Summary address the Island and Isolated service region. The main report provides a similar breakdown for the Labrador Interconnected service region.

best available information, which in many cases includes the professional judgement of the consultant team, Utilities' personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

The study findings confirm the existence of significant potential cost-effective opportunities for CDM in Newfoundland and Labrador's Residential sector. Electricity savings from efficiency improvements within the Island and Isolated service region would provide between 439 and 236 GWh/yr. of electricity savings by 2026 in, respectively, the Upper and Lower Achievable scenarios. The most significant Achievable Savings opportunities were in the actions that addressed lighting, space heating and household electronics (e.g., computers and peripherals, televisions and television peripherals).

The study also assessed the peak load reductions that would result from the electricity savings (noted above). Electricity savings would provide peak load reductions of approximately 103 to 55 MW during the Utilities' typical Winter Peak Day[3] by 2026 in, respectively, the Upper and Lower Achievable scenarios.

- **Summary of Electricity Savings**

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by the study is presented in Exhibits ES2 and ES3, by milestone year, and discussed briefly in the paragraphs below.

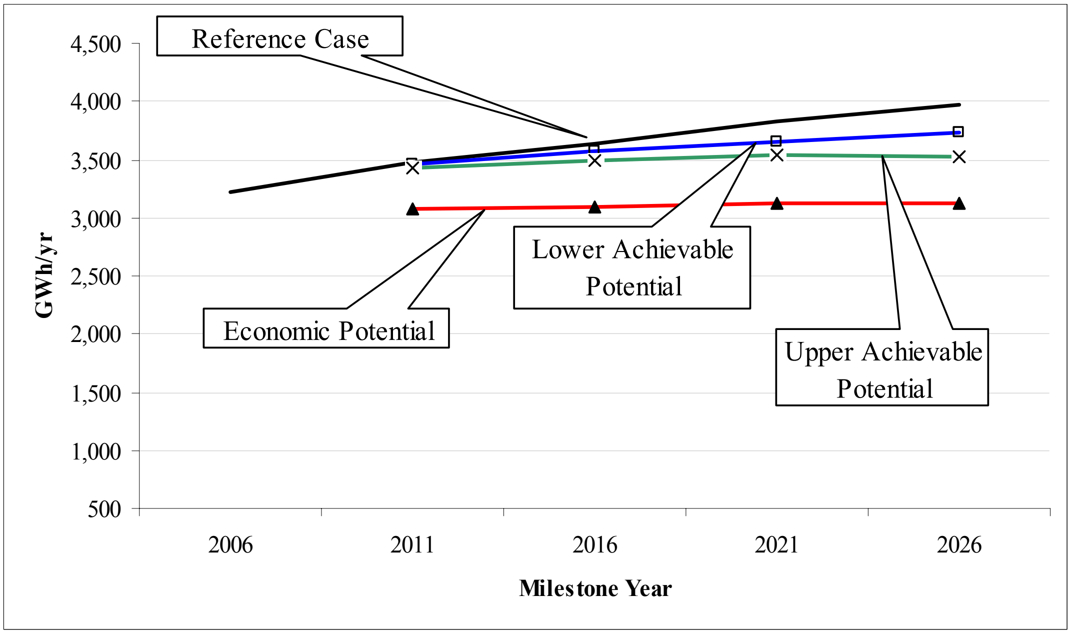
Exhibit ES2: Summary of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Residential Sector (GWh/yr.)

Annual Consumption (GWh/yr.) Residential Sector						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
2006	3,228	3,228						
2011		3,483	3,074	3,425	3,468	409	58	16
2016		3,637	3,092	3,486	3,568	545	151	69
2021		3,821	3,120	3,533	3,660	701	288	161
2026		3,968	3,122	3,529	3,732	846	439	236

*Results are measured at the customer's point-of-use and do not include line losses.

[3] Winter Peak Day is defined as the weekday hours from 7 am to noon and 4 pm to 8 pm on the four coldest days in the December to March period; totals 36 hours.

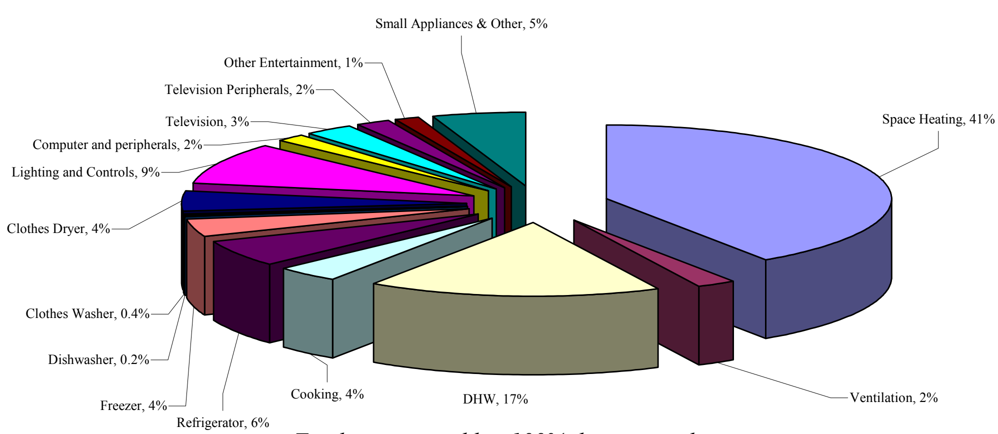
Exhibit ES3: Graphic of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Residential Sector (GWh/yr.)



Base Year Electricity Use

In the Base Year of 2006, the Residential sector in the Island and Isolated service region consumed about 3,228 GWh. Exhibit ES4 shows that space heating accounts for about 41% of total residential electricity use.[4] Domestic hot water (DHW) accounts for about 17% of the total electricity use, followed by kitchen appliances (14%) and lighting (9%). Household electronics (i.e., computers and peripherals, televisions and television peripherals) account for about 8% of electricity use.

Exhibit ES4: Base Year Electricity Use by End Use in the Island and Isolated Service Region, Residential Sector



Totals may not add to 100% due to rounding.

[4] Values are for all residential dwellings. Space heating share is much higher in electrically heated homes.

The overwhelming majority of residential electricity use in the Island and Isolated service region occurs in single detached dwellings (81%). The remaining electricity use is in attached dwellings (11%) followed by apartments (6%). Isolated and other residential buildings each account for about 1%.

Reference Case

In the absence of new utility CDM initiatives, the study estimates that electricity consumption in the Residential sector will grow from 3,228 GWh/yr. in 2006 to about 3,968 GWh/yr. by 2026 in the Island and Isolated service region. This represents an overall growth of about 23% in the period and compares very closely with NLH's load forecast, which also included consideration of the impacts of "natural conservation."

Economic Potential Forecast

Under the conditions of the Economic Potential Forecast,[5] the study estimated that electricity consumption in the Residential sector would decline to about 3,124 GWh/yr. by 2026 in the Island and Isolated service region. Annual savings relative to the Reference Case are 844 GWh/yr. or about 21%.

Achievable Potential

The Achievable Potential is the proportion of the economic electricity savings (as noted above) that could realistically be achieved within the study period. In the Residential sector within the Island and Isolated service region, the Achievable Potential for electricity savings was estimated to be 439 GWh/yr. and 236 GWh/yr. by 2026 in, respectively, the Upper and Lower scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed lighting and space heating, followed by water heating, household electronics (e.g., computers and peripherals, televisions and television peripherals) and large appliances.

❑ **Peak Load Savings**

The electricity savings noted above also result in a reduction in capacity requirements (MW), which can be of particular value to the Utilities during periods of high electricity demand. The study defined the Newfoundland Labrador system peak period as:

> *The morning period from 7 am to noon and the evening period from 4 to 8 pm on the four coldest days during the December to March period; this is a total of 36 hours per year.*

The resulting peak load reductions are presented in Exhibit ES5. As illustrated in Exhibit ES5, the Residential sector peak load savings was estimated to be 103 MW and 55 MW by 2026 in, respectively, the Upper and Lower scenarios. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

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[5] The level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against future avoided electricity costs.

Exhibit ES5: Peak Load Savings from Electricity Savings in the Island and Isolated Service Region, Residential Sector

Milestone Year	Electricity Savings (GWh/yr.)		Peak Load Savings (MW)	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
2011	58	16	11	3
2016	151	69	29	13
2021	288	161	58	32
2026	439	236	91	49

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APPENDICES

List of Exhibits

1. INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

Newfoundland and Labrador Hydro and Newfoundland Power (collectively the Utilities) have partnered to produce this study, recognizing the role that each has in energy conservation and least cost electric utility planning within the province. Increasing electricity costs and the expectations of a growing number of their customers and stakeholders have contributed to the increased focus on conservation and demand management (CDM) and resulted in a number of recent initiatives and projects targeting energy savings in the province. This study is the next step in the Utilities efforts to develop a comprehensive plan for CDM in Newfoundland and Labrador. The Utilities envision electricity conservation and demand management (CDM) to be a valuable component in meeting the province's future electricity requirements.

This study will also be a significant component in the further implementation of the Province's recently released Energy Plan. The Energy Plan establishes a long-term vision for how the province's energy resources will be developed and utilized to benefit the people of the province today as well as for future generations. Electricity conservation and demand management (CDM) are an important component of the provincial Energy Plan as are the conservation and demand management components for the other energy resources of the province.

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The outputs from this study will assist the Utilities CDM planners and others to develop specific CDM programs for implementation and to optimize the contribution of CDM technologies and measures to the province's overall energy future.

1.2 STUDY SCOPE

The scope of this study is summarized below.

- **Sector Coverage:** This study addresses the Residential, Commercial and Industrial sectors as well as street lighting. It was agreed that the Industrial sector would be treated at a much higher level than the Residential and Commercial sectors.

- **Geographical Coverage**: The study addresses the customers from both utilities. Due to differences in cost and rate structures, the Utilities' customers are organized into two service regions, which in this report are referred to a: the Island and Isolated, and the Labrador Interconnected. For the purposes of this study, the isolated diesel system customers have been combined with those in the Island service region due to their relatively small size and electricity usage.

- **Study Period**: This study covers a 20-year period. The Base Year is the calendar year 2006, with milestone periods at five-year increments: 2011, 2016, 2021 and 2026. The Base Year of 2006 was selected as it was the most recent calendar period for which complete customer data were available.

- **Technologies:** The study addresses conservation and demand management (CDM) measures. CDM refers to a broad range of potential measures (see Section 1.3, Definitions); however, for the purposes of this study, it was agreed that the primary focus is on energy-efficiency measures. This includes measures that reduce electricity use as well as the associated capacity impact on a winter peak period. The study also provides a high-level treatment of selected demand management measures, such as direct control of space heating loads, etc.[6]

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the province's building stock and customer willingness to implement new CDM measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the Utilities and are based on best available information, which in many cases includes the professional judgement of the consultant team, Utilities' personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

1.3 DEFINITIONS

This study uses numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study.

Base Year Electricity Use The Base Year is the starting point for the analysis. It provides a detailed description of "where" and "how" electrical energy is currently used in the existing Residential sector building stock. Building electricity use simulations were undertaken for the major dwelling types and calibrated to actual utility customer billing data for the Base Year. As noted previously, the Base Year for this study is the calendar year 2006.

[6] The information provided is based on the detailed analysis that Marbek is currently undertaking in other jurisdictions.

Reference Case Electricity Use (includes Natural Conservation)

The Reference Case Electricity Use estimates the expected level of electrical energy consumption that would occur over the study period in the absence of new (post-F2006) utility-based CDM initiatives. It provides the point of comparison for the subsequent calculation of "economic" and "achievable" electrical energy potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the dwelling types, estimation of the expected growth in building stock and appliances and, finally, an estimation of "natural" changes affecting electricity consumption over the study period. The Reference Case aligns well with the NLH Long Term Planning (PLF) Review Forecast, Summer/Fall 2006.

Conservation and Demand Management (CDM) Measures

CDM refers to a broad range of potential measures that can include: energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and self-generation/co-generation (displace load off of grid).

As noted in Section 1.2, it was agreed that the primary focus is on energy-efficiency measures. This includes measures that reduce electricity use as well as the associated capacity impact on a winter peak period.

The Cost of Conserved Energy (CCE)

The CCE is calculated for each energy-efficiency measure and operating and maintenance (O&M) practice. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

Economic Potential Electricity Forecast

The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the future avoided cost of electricity in the Newfoundland and Labrador Hydro service area (for this study, the value was set at $0.0980/kWh for the Island and Isolated service region and $0.0432/kWh for the Labrador Interconnected service region).[7] All the energy-efficiency upgrades included in the technology assessment that had a CCE equal to, or less than, the preceding avoided costs of new electricity supply were incorporated into the Economic Potential Forecast.

[7] Sensitivity analysis was also conducted using avoided cost values expected to prevail if the Lower Churchill/DC Link project is completed.

Achievable Potential The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period. Achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as "upper" and "lower."

1.4 APPROACH

To meet the objectives outlined above, the study was conducted within an iterative process that involved a number of well-defined steps. At the completion of each step, the client reviewed the results and, as applicable, revisions were identified and incorporated into the interim results. The study then progressed to the next step. A summary of the steps is presented below.

Step 1: **Develop Base Year Electricity Calibration Using Actual Utility Billing Data**

- Compile and analyze available data on Newfoundland and Labrador's existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual utility billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.

Step 2: **Develop Reference Case Electricity Use**

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with NLH load forecast for the study period.

Step 3: **Identify and Assess Energy-efficiency Measures**

- Develop list of energy-efficiency upgrade measures.
- Compile detailed cost and performance data for each measure.
- Identify the baseline technologies employed in the Reference Case, develop energy-efficiency upgrade options and associated electricity savings for each option and determine the CCE for each upgrade option.

Step 4: **Estimate Economic Electricity Savings Potential**

- Compile utility economic data on the forecast cost of new electricity generation; costs of $0.0980/kWh and $0.0432/kWh were selected as the

economic screens for, respectively, the Island and Isolated and Labrador Interconnected service regions.
- Screen the identified energy-efficiency upgrade options from Step 3 against the utility economic data.
- Identify the combinations of energy-efficiency upgrade options and building types where the cost of saving one kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy use simulation model developed previously for the Reference Case.
- Determine annual electricity consumption in each building type and end use when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: **Estimate Achievable Potential Electricity Savings**
- "Bundle" the electricity and peak load reduction opportunities identified in the Economic Potential Forecasts into a set of opportunities.
- For each of the identified opportunities, create an Opportunity Profile that provides a high-level implementation framework, including measure description, cost and savings profile, target sub sectors, potential delivery allies, barriers and possible synergies.
- Review historical achievable program results and prepare preliminary Assessment Worksheets.
- Conduct a full day workshop involving the client, the consultant team and technical experts to reach general agreement on "upper" and "lower" range of achievable potential.

Step 6: **Estimate Peak Load Impacts of Electricity Savings**
- The electricity (electric energy) savings (GWh) calculated in the preceding steps were converted to peak load (electric demand) savings (MW).[8]
- The study defined the Newfoundland and Labrador system peak period as the morning period from 7 am to noon and the evening period from 4 to 8 pm on the four coldest days of the year during the December to March period; this is a total of 36 hours per year.
- The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end use electricity load shapes. Using the load shape data, the following steps were applied:
  - Annual electricity savings for each combination of sub sector and end use were disaggregated *by month*
  - Monthly electricity savings were then further disaggregated *by day type* (weekday, weekend day and peak day)
  - Finally, each day type was disaggregated *by hour*.

[8] Peak load savings were modeled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

1.5 ANALYTICAL MODELS

The analysis of the Residential sector employed two linked modelling platforms:

- HOT2000, a commercially supported, residential building energy-use simulation software
- RSEEM (Residential Sector Energy End-use Model), a Marbek in-house spreadsheet-based macro model.

HOT2000 was used to define household heating, cooling and domestic hot water (DHW) electricity use for each of the residential building archetypes. HOT2000 uses state-of-the-art heat loss/gain and system modelling algorithms to calculate household electricity use. It addresses:

- Electric, natural gas, oil, propane and wood space heating systems
- DHW systems from conventional to high-efficiency condensing systems
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

The outputs from HOT2000 provide the space heating/cooling energy-use intensity (EUI) inputs for the Thermal Archetype module of RSEEM.

RSEEM consists of three modules:

- A General Parameters module that contains general sector data (e.g., number of dwellings, growth rates, etc.)
- A Thermal Archetype module, as noted above, which contains data on the heating and cooling loads in each archetype
- An Appliance Module that contains data on appliance saturation levels, fuel shares, unit electricity use, etc.

RSEEM combines the data from each of the modules and provides total use of electricity by service region, dwelling type and end use. RSEEM also enables the analyst to estimate the impacts of the electrical efficiency measures on the Utilities' on-peak system demand.

1.6 STUDY ORGANIZATION AND REPORTS

The study was organized and conducted by sector using a common methodology, as outlined above. The results for each sector are presented in individual reports as well as in a summary report. They are entitled:

- *Conservation and Demand Management Potential (2006 to 2026), Newfoundland and Labrador, Residential Sector*

- *Conservation and Demand Management Potential (2006 to 2026), Newfoundland and Labrador, Commercial Sector*

- *Conservation and Demand Management Potential (2006 to 2026), Newfoundland and Labrador, Industrial Sector*

- *Conservation and Demand Management Potential (2006 to 2026), Newfoundland and Labrador, Residential, Commercial and Industrial Sectors, Summary Report*

The study also prepared a brief CDM program evaluation report, which is entitled:

- *Conservation and Demand Management Potential (2006 to 2026), Newfoundland and Labrador, Program Evaluation Guidelines*.

This report presents the Residential sector results; it is organized as follows:

- Section 2 presents a profile of Residential sector Base Year electricity use in Newfoundland and Labrador, including a discussion of the major steps involved and the data sources employed.

- Section 3 presents a profile of Residential sector Reference Case electricity use in Newfoundland and Labrador for the study period 2006 to 2026, including a discussion of the major steps involved.

- Section 4 identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Residential sector.

- Section 5 presents the Residential sector Economic Potential Electricity Forecast for the study period 2006 to 2026.

- Section 6 presents the estimated Upper and Lower Achievable Potential for electricity savings for the study period 2006 to 2026.

- Section 7 presents conclusions and next steps.

- Section 8 presents a listing of major references.

2. BASE YEAR (2006) ELECTRICITY USE

2.1 INTRODUCTION

This section provides a profile of Base Year (2006) electricity use in Newfoundland and Labrador's Residential sector. The discussion is organized into the following sub sections:

- Segmentation of Base Year Housing Stock
- Definition of End Uses
- Estimation of Net Space Heating Loads
- Development of Thermal Archetypes
- Annual Appliance Electricity Use
- Appliance Saturation
- Estimation of Fuel Share, by End Use
- Average Electricity Use Per Unit
- Summary of Model Results.

2.2 SEGMENTATION OF BASE YEAR HOUSING STOCK

The first major task in developing the Base Year electricity calibration involved the segmentation of the residential building stock on the basis of four factors:

- Dwelling type
- Service region
- Vintage
- Heating category (electrically heated versus non-electrically heated).

Based on discussions with the Utilities' personnel, it was agreed that Newfoundland and Labrador's existing residential stock would be segmented into the following dwelling types:

- Single-family detached, pre-2007 – electric space heat
- Single-family detached, pre-2007 – non-electric space heat
- Attached,[9] pre-2007 – electric space heat
- Attached, pre-2007 – non-electric space heat
- Apartment,[10] pre-2007 – electric space heat
- Apartment, pre-2007 – non-electric space heat
- Isolated (all residences in diesel communities)
- Other – includes very low use facilities and non-dwellings such as garages, sheds, wells, etc.
- Vacant and Partial – includes dwelling units that are either vacant all the time (such as homes owned by people who have moved away) or are used only seasonally (including cottages). The energy consumption of this residential stock is not reported in the remainder of this document.

[9] Includes the main dwellings above a basement apartment.
[10] Includes basement apartments, which make up about 50% of the units defined under this category.

Utility customer billing data was used to develop a breakdown of the Residential sector into the above dwelling types. The same customer data was also used to further divide the total population of each dwelling type by service region and primary heating type.

A summary is provided in Exhibit 2.1 and highlights are presented below:

- The Utilities currently service about 228,000 residential dwelling units between the two service regions; the Island and Isolated service region accounts for approximately 96.5% of the total residential customers served by the Utilities.
- 8% of residential dwellings are currently listed as vacant or partially occupied. This includes seasonal homes or cottages as well as vacant residences. These buildings have been separated out from the other dwelling types in the Base Year as their inclusion may result in an understating of the energy consumption.
- Of those residential units that are currently fully occupied, approximately 76% are single-family detached, followed by 11% attached units, 9% apartment units, and 2% other types of dwellings. The remaining 2% is made up of isolated dwellings.
- Electricity is the primary space heating fuel in approximately 55% of the provincial housing stock in the Island and Isolated service region and 92% of the provincial housing stock in the Labrador Interconnected service region.
- The inclusion of single-family dwellings with a basement apartment in the dwelling type "Attached," may result in energy consumption in this segment being slightly higher than is typical of other areas of Canada.

Exhibit 2.1: Existing Newfoundland and Labrador Residential Units by Dwelling Type, Service Region and Primary Heating Source

Dwelling Type	Units		
	Island and Isolated	Labrador Interconnected	Total
Single Family Detached, Electric Heat	80,300	5,031	**85,331**
Single Family Detached, Non-Electric Heat	74,231	103	**74,334**
Attached, Electric Heat	15,227	1,663	**16,890**
Attached, Non-Electric Heat	5,060	34	**5,094**
Apartment, Electric Heat	16,399	462	**16,861**
Apartment, Non-Electric Heat	2,728	9	**2,737**
Isolated	3,491	0	**3,491**
Other	3,512	606	**4,118**
Vacant and Partial	18,970	0	**18,970**
Subtotal	**219,918**	**7,908**	**227,826**

Source: NLH-NP customer billing data.

2.3 DEFINITION OF END USES

Electricity use within each of the dwelling types noted above is further defined on the basis of specific end uses. In this study, an end use is defined as, "the final application or final use to which energy is applied. End uses are the services of economic value to the users of energy."

A summary of the major Residential sector end uses used in this study is provided in Exhibit 2.2, together with a brief description of each.

Exhibit 2.2: Residential Electric End Uses

End Use	Description
Space heating	All space heating, including both central heating and supplementary heating
Space cooling	Saturation of space cooling is very low in Newfoundland and Labrador; the model includes any space cooling energy use under "Small Appliance & Other"
Ventilation	Primarily the furnace fan, but also includes the fan in heat recovery ventilators as well as kitchen and bathroom fans
Domestic Hot Water (DHW)	Heating of water for DHW use. Does not include hydronic space heating
Cooking	Includes ranges, separate ovens and cook tops and microwave ovens
Refrigerator	
Freezer	
Dishwasher	
Clothes washer	
Clothes dryer	
Lighting	Includes interior, exterior and holiday lighting
Computer and peripherals	Printers, scanners, modems, faxes, PDA and cell phone chargers
Television	
Television peripherals	Set top boxes, including digital cable converters and satellite converters
Other electronics	Stereos, DVD players, VCRs, boom boxes, radios, video gaming systems, security systems
Small Appliance & Other	There are hundreds of additional items within this category, each accounting for a fraction of a percent of household energy use, e.g., hair dryers, doorbells, garage door openers, block heaters, home medical equipment, electric lawnmowers

2.4 ESTIMATION OF NET SPACE HEATING LOADS

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains.

The net space heating loads for each combination of dwelling type and service region were developed based on the following combination of data sources:

- Marbek's database of residential energy consumption from other jurisdictions
- Current utility sales data combined with knowledge of the energy consumption and saturation of other end uses.

The net space heating load for each dwelling type is given by the following equation:

$$NetHL_1 = HL_1 + a_{i,1} * s_{i,1}$$

Where: $NetHL_1$ = Net heating load for dwelling type #1
HL_1 = Load on primary heating appliance for dwelling type #1
$a_{i,1}$ = Average consumption for supplementary heating in dwelling type #1
$s_{i,1}$ = Saturation of supplementary heating in dwelling type #1

HL_1 was estimated for each dwelling type and service region, based on the Utilities' customer sales data for electric and non-electrically heated dwellings combined with data on the electricity consumption of non-space heating end uses. The values for a_{i1} and s_{i1} were developed based on the estimated share of space heating that is provided by electricity (versus supplementary fuels), as taken from the Utilities' Residential End-use Surveys (REUS). The net space heating loads are presented in Exhibit 2.3 by dwelling type and service region.

It should be noted that the values shown in Exhibit 2.3 are not fuel specific; rather, they represent the total tertiary space heat load for each dwelling. The efficiency of the space heating appliances used to meet these loads are considered in subsequent stages of the analysis.

Exhibit 2.3: Existing Residential Units, 2006 (kWh/yr.) Net Space Heating Loads by Dwelling Type[11]

Dwelling Type	Island and Isolated	Labrador Interconnected
Single Family Detached, Electric Heat	12,554	29,379
Single Family Detached, Non-Electric Heat	16,700	39,081
Attached, Electric Heat	11,377	27,294
Attached, Non-Electric Heat	15,134	36,309
Apartment, Electric Heat	5,742	8,745
Apartment, Non-Electric Heat	5,742	8,745
Isolated	12,293	N/A
Other	10,036	5,411

[11] Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heated dwellings are shown in kilowatt hours for format consistency. Work in other jurisdictions has shown significantly higher space heating energy consumption in homes with oil and gas furnaces than in homes with electric heat, even after accounting for furnace efficiency. The reasons for this require more research, but may include factors such as greater air leakage where air intake is required for combustion or homeowners turning down individual electric baseboards in unoccupied rooms.

2.4.1 Development of Thermal Archetypes – Existing Stock

The next major step involved the development of a thermal archetype for each of the major dwelling types noted in Exhibit 2.3 using HOT2000.

Each HOT2000 file contains a comprehensive physical description of the size, layout and thermal characteristics of each dwelling type. HOT2000 then uses these inputs to create a full computer model of the residence, calculating loads, interactive effects and energy consumption. In each case, the net heating and cooling loads simulated by HOT2000 were calibrated to the values shown in Exhibit 2.3, which had been established on the basis of the sources described above. The process of calibrating simulation models to the loads estimated from available data served to further confirm the estimated loads. Adjustments were made to the estimates as required.

The physical and operating characteristics of each residential thermal archetype were researched using a number of sources, including:

- Database of EnerGuide for Houses (EGH) evaluations in Newfoundland and Labrador
- Natural Resources Canada (NRCan) and Statistics Canada housing data
- Consultations with energy auditors and residential housing experts located in Newfoundland and Labrador.

For the existing housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

❑ **Single-family Dwellings**

For the Island and Isolated service region, a "typical" existing, single-detached dwelling can be defined as a single-story bungalow of approximately 93.5m^2 (1000 ft^2), with a finished basement. This home has 7.7 m^2 (83 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.4 (R-13.5) insulation values, ceilings RSI-4.5 (R-25.5) and the basement is insulated to a value of RSI-0.6 (R-3.5). The houses are typically not very airtight with about five air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

For the Labrador Interconnected service region, a "typical" existing, single-detached dwelling can be defined as a single-story bungalow of approximately 85 m^2 (915 ft^2), with a heated basement. This home has 6.1 m^2 (66 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.1 (R-12) insulation values, ceilings RSI-4 (R-23) and there is no insulation in the basement. The houses are typically not very airtight with about seven air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

- **Attached Dwellings**

For the Island and Isolated service region, a "typical" existing, attached dwelling can be defined as a two-story middle-unit of approximately 104 m^2 (1120 ft^2), with a finished basement. This home has 7.2 m^2 (77 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.4 (R-13.5) insulation values, ceilings RSI-4.5 (R-25.5) and the basement is insulated to a value of RSI-0.6 (R-3.5). The houses are typically not very airtight with about five air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

For the Labrador Interconnected service region, a "typical" existing, attached dwelling can be defined as a two-story middle-unit of approximately 104 m^2 (1120 ft^2) with a heated basement. This home has 7.2 m^2 (77 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.1 (R-12) insulation values, ceilings RSI-4 (R-23) and there is no insulation in the basement. The houses are typically not very airtight with about seven air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

2.5 ANNUAL APPLIANCE ELECTRICITY USE

The next major task involved the development of estimated average annual unit electricity consumption (UEC) values for each of the major residential appliances.

While most appliances have increased in efficiency over time, there is no evident correlation or available data that links the age of the dwelling and the age of the appliances in it. Older homes likely have had major appliances replaced several times and newer homes can have old appliances transferred from previous residences. Lacking any definite relation between the age of the home and the age of an appliance, an average value for all in-place appliances was used for all existing vintages. This was based on an appliance stock model that takes into account the expected useful life of each type of appliance, the rate of purchase and retirement of appliances, the average annual consumption of newly purchased appliances in a given year and the average annual consumption of appliances being retired in a given year. The stock average consumption thus evolves with time. In any specific year, the average age of appliances in place is assumed to be half of the expected useful life of the appliance and the stock average is built up of all the appliances purchased and installed up to that point.

Exhibits 2.4 and 2.5 summarize the estimated average annual UEC for major end-use appliances in, respectively, the Island and Isolated and Labrador Interconnected service regions.

The values shown in Exhibits 2.4 and 2.5 apply to the current stock mix. Further discussion is provided below.

Exhibit 2.4: Annual Appliance Electricity Use (UEC) for the Island and Isolated Service Region, (kWh/yr.)

Dwelling Type	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	121	3,301	633	830	650	75	64	820	1,515	394	178	226	159	902
Single Family Detached, Non-Electric Heat	800	3,301	633	830	650	75	64	820	1,515	394	178	226	159	902
Attached, Electric Heat	110	2,991	488	830	650	58	48	615	1,373	394	178	226	159	428
Attached, Non-Electric Heat	725	2,991	488	830	650	58	48	615	1,373	394	178	226	159	428
Apartment, Electric Heat	55	2,239	378	560	370	49	41	490	693	394	178	226	159	135
Apartment, Non-Electric Heat	275	2,239	378	560	370	49	41	490	693	394	178	226	159	135
Isolated	118	3,301	806	813	827	73	63	803	1,483	385	174	221	156	883
Other	97	2,639	506	664	520	60	51	656	1,211	315	142	180	127	721

Exhibit 2.5: Annual Appliance Electricity Use (UEC) for the Labrador Interconnected Service Region, (kWh/yr.)

Dwelling Type	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	121	3,961	633	830	650	75	64	820	1,818	394	178	226	159	902
Single Family Detached, Non-Electric Heat	800	3,961	633	830	650	75	64	820	1,818	394	178	226	159	902
Attached, Electric Heat	112	3,680	488	830	650	58	48	615	1,689	394	178	226	159	428
Attached, Non-Electric Heat	743	3,680	488	830	650	58	48	615	1,689	394	178	226	159	428
Apartment, Electric Heat	36	2,687	378	560	370	49	41	490	832	394	178	226	159	135
Apartment, Non-Electric Heat	179	2,687	378	560	370	49	41	490	832	394	178	226	159	135
Other	22	730	117	153	120	14	12	151	335	72	33	42	29	166

❑ Occupancy

Occupancy rates[12] for each dwelling type were based on residential utility data from other jurisdictions. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as DHW, laundry and lighting. Exhibit 2.6 summarizes the occupancy rates, by dwelling type. The table indicates, for example, that 12% of single-family dwellings are occupied by only one person, 42% by two persons and 46% by three or more persons.

Exhibit 2.6: Occupancy Rates by Dwelling Type

Occupants	SFD	Attached	Apt
1	12%	27%	54%
2	42%	40%	35%
3+	46%	33%	12%

❑ Ventilation

Ventilation electricity is associated with fan/blower electricity in heating systems, kitchen fans, bathroom fans and heat recovery ventilators.

A furnace fan UEC of 700 kWh (heat mode only) is assumed for single-family dwellings having central forced air heating systems. This value is towards the upper range of Canadian end-use metered data, as reported in a study conducted for Natural Resources Canada, and is consistent with the relatively longer heating season experienced in Newfoundland and Labrador.[13]

For the purpose of estimating kitchen and bathroom fan electricity, it was assumed that a typical exhaust fan is rated at 75 Watts and operates, on average, for two hours per day. In homes with heat supplied by baseboard electric or by hydronic systems, these exhaust fans are the predominant ventilation load. With two such fans in a typical house, consumption would be approximately 100-110 kWh/yr.

The UEC for a forced air system includes the energy from both the furnace fan and the exhaust fans. The UEC for a baseboard electric system includes only the energy from the latter. The ventilation UEC values shown in Exhibits 2.4 and 2.5 for electrically heated dwellings in Newfoundland and Labrador reflect the mix between forced air systems (under 2% of electrically heated homes) and baseboard systems.

❑ Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day and a temperature rise of 45°C. Exhibit 2.7 shows the distribution of DHW load by major end use.

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[12] Electricity use related to personal consumption increases with number of occupants in dwelling.

[13] This area is the focus of extensive research efforts. *See*: Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.

Exhibit 2.7: Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

End Use	Sample Electricity Use Single Family Detached (kWh/yr.)	%
Personal Use	1,155	35
Dishwashing	759	23
Clothes Washing	891	27
Standby Losses	495	15
Total	3,301	100

Note: Any differences in totals are due to rounding.

The DHW values shown in Exhibit 2.7 are based on a combination of sources including available data from other jurisdictions, NRCan studies (NRCan, 2005) and the results of conditional demand analysis and customer survey work done by both NP and NLH in the 1990s.[14]

- **Cooking Appliances, Refrigerator, Freezer and Dishwasher**

UEC estimates for the existing stock of this group of food preparation and storage appliances were obtained from *The End Use Energy Data Handbook* (NRCan, 2005). The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC.

- **Clothes Washer and Dryer**

Appliance UEC data was obtained from *The End Use Energy Data Handbook* (NRCan, 2005) and adjusted by region and dwelling type based on previous data. The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC.

- **Computers**

UEC data for computers is based on Marbek's current work for BC Hydro.[15] UEC varies with occupancy rate by region and dwelling type.

- **Lighting**

The lighting loads shown in Exhibits 2.4 and 2.5 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- *The End Use Energy Data Handbook* (NRCan, 2005).

Exhibit 2.8 shows the derivation of lighting UECs.

[14] The values shown in Exhibit 2.7 do not include combustion efficiency; therefore, if the water is heated using oil or propane, the on-site energy consumption would be higher than shown in Exhibit 2.7.
[15] Marbek Resource Consultants, *Conservation Potential Review – 2007*. Prepared for BC Hydro. 2007.

Exhibit 2.8: Derivation of Lighting UECs

Incandescent		
Number of regularly used bulbs		
SFD/Duplex	16	
Row	15	
Apt	8	
Mobile/Other	8	
Average wattage	60	
Average Hours/year	1,200	
Fluorescent		
(includes linear tubes and CFLs)		
Number of regularly used linear lamps/CFLs	*Linear*	*CFL*
SFD/Duplex	2	2
Row	2	3
Apt	1	3
Mobile/Other	1	2
Average wattage (including ballast)	48	15
Average Hours/year	1,200	1,200
Holiday/Other Lighting		
(includes garden and other outdoor lighting)		
Average wattage		
SFD/Duplex	350	
Row	250	
Apt	0	
Mobile/Other	225	
Average Hours/year	300	
Total Base Year Energy Use		
SFD/Duplex	1,388	
Row	1,373	
Apt	693	

❑ Television

UEC data for televisions was obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006). Saturation of televisions (number of sets per household) is adjusted by dwelling type based on data from the "Frequency Per Dwelling Type 2005" Survey (see Section 2.6) but consumption per television is not varied by dwelling type in this study.

❑ Television Peripherals

UECs, saturations and numbers per household for television peripherals were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006) and other published data. A weighted UEC for the end use as a whole was generated from these numbers as shown in Exhibit 2.9. UEC varies with occupancy rate by dwelling type and region.

Exhibit 2.9: Derivation of UEC for Television Peripherals

	% of TV households	UEC kWh/yr
Digital Cable Service	17%	
Digital Adaptor	17%	82
Standard Digital STB	14%	194
Advanced Digital STB	3%	325
	Average UEC	299
Satellite Service	21%	
Standard Satellite STB	17%	141
Advanced Satellite STB	4%	273
	Average UEC	166
	Total Weighted UEC	**226**

❑ Other Electronics

Due to the large presence of electronic entertainment devices in many residential dwellings, this end use was separated from the general "Other" category. UECs were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006), *Residential Miscellaneous Electricity Use* (LBL) and other published data. A weighted UEC for the end use as a whole was then generated from these numbers as shown in Exhibit 2.10.

Exhibit 2.10: Derivation of UECs for Other Electronics

	Penetration	Number Per Household	UEC (kWh/yr)	Weighted UEC (kWh/yr)
DVD	72%	1.2	35	30
VCR	69%	1.3	55	49
Audio System	29%	1.3	55	21
Surround Sound	25%	1	50	13
Compact Audio	79%	1.5	25	30
Game Console	25%	1.3	55	18
			Total Weighted UEC	**160**

❑ Small Appliances and Other

"Other" end uses include a wide range of appliances and equipment found in most homes. Reliable data on the actual annual electricity use of this collection of appliances and equipment within Newfoundland and Labrador is not available.

Exhibit 2.11 illustrates the major items included in this end use and presents sample UEC data estimated in earlier studies undertaken in other jurisdictions.[16] It should be noted that actual UECs for individual appliances will vary from those shown in Exhibit 2.11 and are affected by factors such as saturations by dwelling type, occupancy rates and service region. Saturation

[16] Lawrence Berkeley National Laboratory (LBL), *Residential Miscellaneous Electricity Use,* 1997.

information from LBL was not applied for this study because reliable information for Newfoundland and Labrador was not available. The "Other" category is not built up based on detailed analysis, but is an approximation only. The LBL data provided should be treated as being illustrative of the types of energy-using items in the category and how much electricity they typically use.

Exhibit 2.11: Typical UECs for Selected "Other" Appliances

Appliance	UEC (kWh/yr)	Appliance	UEC (kWh/yr)
Home radio, small/clock	18	Timer	18
Battery Charger	21	Hot Plate	30
Clock	18	Stand Mixers	1
Power Strip	3	Hand-Held Rechargeable	16
Vacuum	31	Hand-Held Electric Vacuum	4
Hand Mixers	2	Air Corn Popper	6
Iron	53	Security System	195
Hair Dryer	36	Perc Coffee	65
Toaster	39	Deep Fryer	20
Auto Coffee Maker	116	Waterbed Heaters	900
Blender	7	Humidifier	100
Heating Pads	3	Electric Toothbrush	20
Doorbell	18	Hot Oil Corn Popper	2
Answering Machine	29	Women's Shaver	12
Can Opener	3	Aquariums	548
Slow Cooker	16	Espresso Maker	19
Curling Iron	1	Electric Lawn Mower	100
Food Slicer	1	Mounted Air Cleaner	500
Garbage Disposer	10	Multi-fcn Device	41
Electric Knife	1	Heat Tape	100
Portable Fans	8	Auto Engine Heaters	250
Men's Shaver	13	Electric Kettle	75
Waffle Iron/Sandwich Grill	25	Bottled Water Dispenser	300
Electric Blankets	120	Central Vacuum	24
Garage Door Opener	30	Grow Lights	800
Hair Setter	10	Home Medical Equipment	400

2.6 APPLIANCE SATURATION

Exhibits 2.12 and 2.13 summarize the saturation levels that are used in the present analysis for, respectively, the Island and Isolated and Labrador Interconnected service regions. In each case, the assumed saturation levels are developed from the most recent utility REUS. Saturations were obtained through querying the database, by end use and dwelling type; minor refinements were made in selected cases to assist in calibration.

Exhibit 2.12: Appliance Saturation Levels for Island and Isolated in 2006, (%)

Dwelling Type	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	100%	100%	100%	119%	108%	48%	99%	96%	100%	77%	242%	158%	147%	100%
Single Family Detached, Non-Electric Heat	100%	100%	100%	119%	108%	48%	99%	96%	100%	77%	242%	158%	147%	100%
Attached, Electric Heat	100%	100%	110%	121%	74%	40%	96%	92%	100%	83%	234%	153%	143%	100%
Attached, Non-Electric Heat	100%	100%	110%	121%	74%	40%	96%	92%	100%	83%	234%	153%	143%	100%
Apartment, Electric Heat	100%	100%	100%	101%	50%	15%	55%	54%	100%	58%	166%	109%	101%	100%
Apartment, Non-Electric Heat	100%	100%	100%	101%	50%	15%	55%	54%	100%	58%	166%	109%	101%	100%
Isolated	100%	100%	99%	67%	116%	23%	86%	87%	100%	34%	157%	103%	96%	100%
Other	50%	20%	0%	5%	5%	0%	5%	5%	100%	0%	5%	3%	3%	100%

Exhibit 2.13: Appliance Saturation Levels for Labrador Interconnected in 2006, (%)

Dwelling Type	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	100%	100%	100%	99%	105%	62%	93%	94%	100%	60%	177%	116%	108%	100%
Single Family Detached, Non-Electric Heat	100%	100%	100%	99%	105%	62%	93%	94%	100%	60%	177%	116%	108%	100%
Attached, Electric Heat	100%	100%	100%	89%	98%	66%	98%	98%	100%	64%	170%	112%	104%	100%
Attached, Non-Electric Heat	100%	100%	100%	89%	98%	66%	98%	98%	100%	64%	170%	112%	104%	100%
Apartment, Electric Heat	100%	100%	100%	75%	58%	17%	58%	58%	100%	17%	142%	93%	86%	100%
Apartment, Non-Electric Heat	100%	100%	100%	75%	58%	17%	58%	58%	100%	17%	142%	93%	86%	100%
Other	50%	20%	0%	5%	5%	0%	5%	5%	100%	0%	5%	3%	3%	100%

2.7 ESTIMATION OF FUEL SHARE, BY END USE

Data on fuel shares, for all end uses except space heating, is taken from the most recent utility REUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as reported in the REUS and in the EnerGuide for Houses database:

- Electricity in non-electrically heated dwellings, and
- Non-electric sources in electrically heated dwellings.

Exhibits 2.14 and 2.15 summarize the electricity fuel shares assumed for each of the end uses included in the present analysis for, respectively, the Island and Isolated and Labrador Interconnected service regions. The space heating fuel shares presented in these exhibits[17] have been selected on the basis that they provide a reasonable fit with:

- General market description (i.e., known distribution of heating appliances by fuel)
- Electricity sales to different categories of homes.

The market share of electricity for space heating is a combination of the fuel shares shown in the exhibits below and the relative numbers of dwellings in the electric category and the non-electric category. For example, Exhibit 2.15 shows 94% of the space heating energy in electrically-heated homes is supplied by electricity (the rest is assumed to be provided by auxiliary heating sources such as wood stoves. As shown earlier in Exhibit 2.1, 98% of single-family dwellings in the Labrador Interconnected service region are in the electrically heated category. Therefore, the assumption used for market share of electric heat in single-family dwellings in the Labrador Interconnected service region is 98% x 94% = 92%. The market share of electricity for both space heating and water heating is very high in the Labrador Interconnected service region, largely due to the very low retail price of electricity.

[17] Adjustment of fuel shares for space heating was done in tandem with the adjustment of space heating loads described in Section 2.4 above.

Exhibit 2.14: Electricity Fuel Shares for the Island and Isolated in 2006, (%)

Dwelling Type	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Single Family Detached, Non-Electric Heat	4%	100%	63%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Attached, Electric Heat	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Attached, Non-Electric Heat	4%	100%	25%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Apartment, Electric Heat	95%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Apartment, Non-Electric Heat	4%	100%	56%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Isolated	5%	100%	83%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Other	52%	100%	50%	98%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Exhibit 2.15: Electricity Fuel Shares for Labrador Interconnected in 2006, (%)

Dwelling Type	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other
Single Family Detached, Electric Heat	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Single Family Detached, Non-Electric Heat	0%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Attached, Electric Heat	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Attached, Non-Electric Heat	0%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Apartment, Electric Heat	94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Apartment, Non-Electric Heat	0%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Other	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

2.8 AVERAGE ELECTRICITY USE PER UNIT

Exhibits 2.16 and 2.17 combine the building stock, efficiency, saturation and fuel share data presented in the preceding exhibits and show the resulting electricity use, by end use, for each dwelling type in, respectively, the Island and Isolated and Labrador Interconnected service regions.

Exhibit 2.16: Average Electricity Use per Dwelling Unit for the Island and Isolated Service Region in 2006, (kWh/yr.)

Dwelling Type	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other	Total
Single Family Detached, Electric Heat	11,956	121	3,301	634	985	703	36	64	787	1,515	305	430	358	235	902	**22,330**
Single Family Detached, Non-Electric Heat	621	800	2,085	622	985	703	36	64	787	1,515	305	430	358	235	902	**10,446**
Attached, Electric Heat	10,835	110	2,991	539	1,006	482	23	46	564	1,373	328	417	346	227	428	**19,716**
Attached, Non-Electric Heat	563	725	743	529	1,006	482	23	46	564	1,373	328	417	346	227	428	**7,800**
Apartment, Electric Heat	5,469	55	2,239	378	567	185	7	23	263	693	226	296	246	161	135	**10,944**
Apartment, Non-Electric Heat	214	275	1,258	370	567	185	7	23	263	693	226	296	246	161	135	**4,920**
Isolated	615	118	2,740	778	541	958	17	54	697	1,483	132	274	227	149	883	**9,666**
Other	4,215	48	264	0	33	26	0	3	33	1,211	0	7	6	4	2,884	**8,734**

Exhibit 2.17: Average Electricity Use per Dwelling Unit for Labrador Interconnected Service Region in 2006, (kWh/yr.)

Dwelling Type	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer	Lighting	Computer etc.	Television	TV peripherals	Other electronics	Small apps & Other	Total
Single Family Detached, Electric Heat	27,616	121	3,961	633	824	680	46	60	770	1,818	236	314	261	171	902	**38,412**
Single Family Detached, Non-Electric Heat	1,954	800	3,921	633	824	680	46	60	770	1,818	236	314	261	171	902	**13,389**
Attached, Electric Heat	25,656	112	3,680	488	736	635	38	47	601	1,689	250	303	252	165	428	**35,082**
Attached, Non-Electric Heat	1,815	743	3,643	488	736	635	38	47	601	1,689	250	303	252	165	428	**11,835**
Apartment, Electric Heat	8,220	36	2,687	378	420	216	8	24	286	832	66	252	209	137	135	**13,907**
Apartment, Non-Electric Heat	437	179	2,660	378	420	216	8	24	286	832	66	252	209	137	135	**6,240**
Other	5,411	11	144	0	8	6	0	1	8	335	0	2	1	1	747	**6,675**

2.9 SUMMARY OF MODEL RESULTS

This section presents the results of the model runs for the Base Year 2006. The results are measured at the customer's point-of-use and do not include line losses; they are presented in four separate exhibits:

- Exhibits 2.18 and 2.19 present the model results for the Island and Isolated service region. The results are broken out by dwelling type and end use.
- Exhibits 2.20 and 2.21 present the model results for the Labrador Interconnected service region. The results are broken out by dwelling type and end use.

❑ By Dwelling Type

Single detached dwellings account for the overwhelming majority of residential electricity use in both service regions: approximately 81% of residential electricity consumed in the Island and Isolated service region and 73% in the Labrador Interconnected service region.

In the Island and Isolated service region, the remaining electricity use is in attached dwellings (11%) followed by apartments (6%). Isolated and other residential buildings each account for about 1%.

In the Labrador Interconnected service region, the remaining electricity use is in attached dwellings (22%) followed by apartments (2%). Other residential buildings account for the remaining electricity use (2%).

❑ By End Use

Space heating accounts for the largest share of residential electricity use in both service regions: approximately 41% of residential electricity consumed in the Island and Isolated service region and 71% in the Labrador Interconnected service region. The larger space heating share in the Labrador Interconnected service region is due to the colder climate and the very high share of heating load met by electricity. The large electric space heating share reflects the low electricity prices in that region.

DHW is the second largest electricity end use in both service regions: approximately 17% of residential electricity consumed in the Island and Isolated service region and 11% in the Labrador Interconnected service region.

In the Island and Isolated service region, other significant end uses include lighting (9%) and refrigerators (6%). The electronic end uses (computers, televisions and peripherals, other electronics) combined account for approximately 8% of residential electricity use.

In the Labrador Interconnected service region, other significant end uses include lighting (5%), refrigerators (2%), freezers (2%) and cooking (2%). The electronic end uses (computers, televisions and peripherals, other electronics) combined account for approximately 3% of residential electricity use.

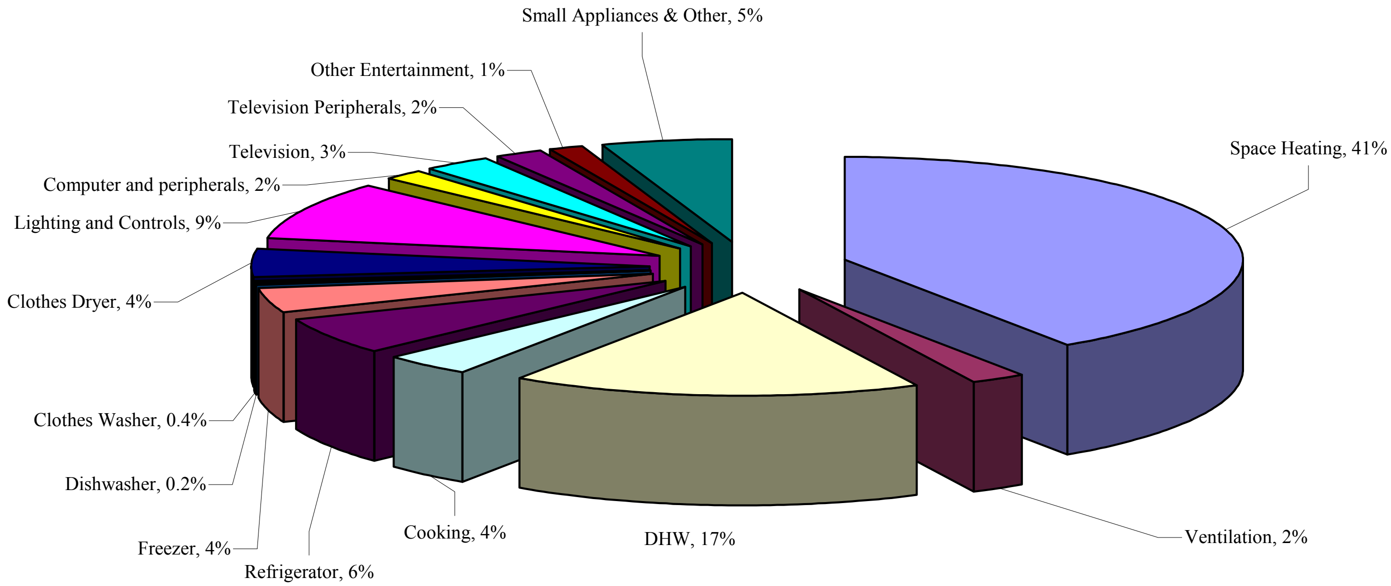
Exhibit 2.18: Electricity Consumption for the Island and Isolated Service Region, Modelled by End Use and Segment in the Base Year (2006), (GWh/yr.)[18]

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting and Controls	Computer and peripherals	Television	Television Peripherals	Other Entertainment	Small Appliances & Other
Single-Family	2006	2,569	1,006	69	420	97	152	109	6	10	122	234	47	67	55	36	139
Attached	2006	340	168	5	49	11	20	10	0.5	1	11	28	7	8	7	5	9
Apartment	2006	193	90	2	40	7	11	4	0.1	0	5	13	4	6	5	3	3
Isolated	2006	34	2	0.4	10	3	2	3	0.1	0	2	5	0.5	1	1	1	3
Other	2006	31	15	0.2	1	0.0	0.1	0.1	0.00	0.01	0.1	4	0	0.02	0.02	0.01	10
TOTAL	2006	3,166	1,281	77	520	118	186	125	6	11	141	285	59	82	68	44	164

Note: Any differences in totals are due to rounding.

[18] Electricity consumption in this exhibit does not include the "vacant and partially occupied" category of dwellings. Consumption data for the vacant and partial group must be added to these figures to obtain a total that matches the Utilities' forecast data.

Exhibit 2.19: Distribution of Electricity Consumption, by End Use in the Base Year (2006) for the Island and Isolated Service Region



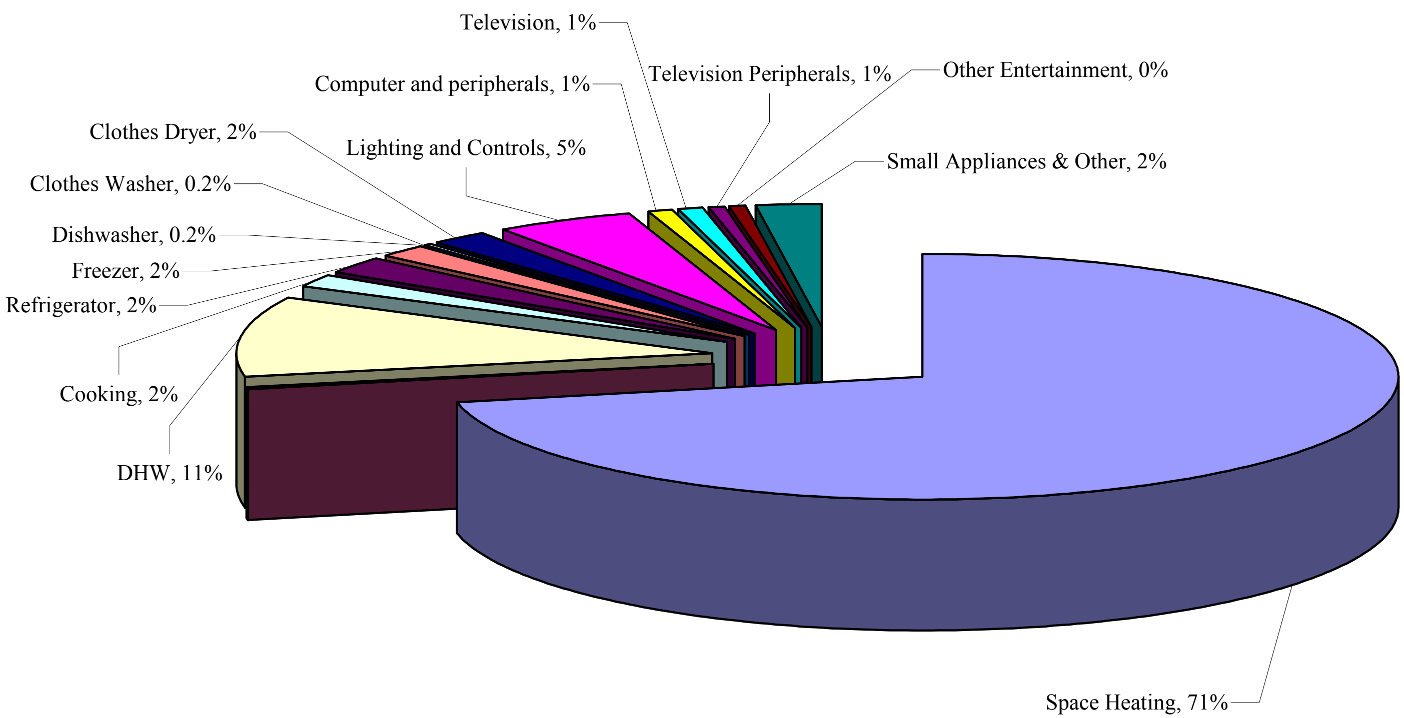
Totals may not add to 100% due to rounding.

Exhibit 2.20: Electricity Consumption for the Labrador Interconnected Service Region, Modelled by End Use and Segment in the Base Year (2006), (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting and Controls	Computer and peripherals	Television	Television Peripherals	Other Entertainment	Small Appliances & Other
Single-Family	2006	195	139	1	20	3	4	3	0.2	0.3	4	9	1	2	1	1	5
Attached	2006	59	43	0.2	6	1	1	1	0.1	0.1	1	3	0.4	1	0.4	0.3	1
Apartment	2006	6	4	0.02	1	0.2	0.2	0.1	0.004	0.01	0.1	0.4	0.03	0.1	0.1	0.1	0.1
Other	2006	4.0	3.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.5
TOTAL	2006	264	189	1	28	4	6	5	0.3	0.4	5	13	2	2	2	1	6

Note: Any differences in totals are due to rounding.

Exhibit 2.21: Distribution of Electricity Consumption, by End Use in the Base Year (2006) for the Labrador Interconnected Service Region



Totals may not add to 100% due to rounding.

3. REFERENCE CASE ELECTRICITY USE

3.1 INTRODUCTION

This section presents the Residential sector Reference Case for the study period (2006 to 2026). The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new utility-based CDM initiatives. The forecast data provided were based on a set of assumptions that include future rate changes. The Reference Case includes the same assumption and it becomes part of the environment in which conservation potential will be evaluated. The Reference Case, therefore, provides the point of comparison for the calculation of electricity-savings opportunities associated with each of the scenarios that are assessed within this study.

The Reference Case discussion is presented within the following sub sections:

- Estimation of Net Space Heating Loads—New Dwellings
- "Natural" Changes to Space Heating Loads—Existing Dwellings
- "Natural" Changes to Electric Appliance UECs
- Appliance Saturation Trends
- Stock Growth
- Fuel Shares
- Summary of Model Results.

3.2 ESTIMATION OF NET SPACE HEATING LOADS—NEW DWELLINGS

The first task in building the Reference Case involved the development of estimates of the net space heating loads for new dwellings to be built over the study period. As was the case with the existing building stock, the study relied on several sources to prepare these estimates, including:

- Estimated household electricity consumption levels contained in the NLH Long Term Planning Review Forecast, Summer/Fall 2006
- Consultation with housing experts in Newfoundland and Labrador
- Review of experience in other jurisdictions.

Based on consideration of the best available data from the above sources, this study assumes that the net space heating loads in new dwellings remain the same as for the existing dwellings. This conclusion recognizes that while thermal efficiencies are improving in new dwellings, they are being partially, or wholly, offset by changing construction practices.

Examples of these off-setting trends include:

- Overall, window, wall and roofing thermal efficiency levels have increased in new residential buildings and air leakage rates have been reduced by more than 40% compared to typical existing dwellings.

- The amount of window area in new houses has increased by up to 20% compared to typical existing homes.

- The new stock tends to have floor areas that are 15%-20% larger, on average.
- Buildings also feature an increase in exterior wall surface area of between 5%-20%. This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

Exhibit 3.1 summarizes the resulting new net space heating loads.

Exhibit 3.1: New Residential Units—Net Space Heating Loads[19] by Dwelling Type and Service Region, (kWh/yr.)[20]

Dwelling Type	Island and Isolated	Labrador Interconnected
Single Family Detached, Electric Heat	12,554	29,966
Single Family Detached, Non-Electric Heat	16,700	39,863
Attached, Electric Heat	11,377	27,840
Attached, Non-Electric Heat	15,134	37,035
Apartment, Electric Heat	5,742	8,920
Apartment, Non-Electric Heat	5,742	8,920
Isolated	12,293	N/A
Other	10,036	5,630

3.2.1 Development of Thermal Archetypes – New Stock

Although the study assumes that the net space heating loads remain approximately the same for both new and existing dwellings, the physical and thermal specifications of the new dwellings differ from the existing dwellings. Thus, as in the Base Year discussion, a thermal archetype for each of the major new dwelling types was developed using HOT2000.

For the new housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

❑ **Single-family Dwellings**

For the Island and Isolated service region, a "typical" existing, single-detached dwelling can be defined as a single-story bungalow of approximately 110 m^2 (1184 ft^2) with an unheated basement. This home has 9.6 m^2 (103 ft2) of windows, defined as double-glazed, mostly with vinyl frames. Walls are represented by RSI-3.0 (R-17) insulation values, ceilings RSI-5.5 (R-31) and no basement insulation. The houses are reasonably

[19] Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heated dwellings are shown in kilowatt hours for format consistency.
[20] Vacant and partially-occupied dwelling units are not shown in this exhibit.

airtight with about 2.87 air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

For the Labrador Interconnected service region, a "typical" existing, single-detached dwelling can be defined as a single-story bungalow of approximately 110 m^2 (1184 ft^2) with a heated basement. This home has 9.6 m^2 (103 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-3.0 (R-17) insulation values, ceilings RSI-5.5 (R-31) and there is no insulation in the basement. The houses are typically not very airtight with about 4.55 air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

- **Attached Dwellings**

For the Island and Isolated service region, a "typical" existing attached dwelling can be defined as a two-story home of approximately 130 m^2 (1400 ft^2) with an unheated basement. This home has 9.6 m^2 (103 ft^2) of windows, defined as double-glazed, mostly with vinyl frames. Walls are represented by RSI-3.0 (R-17) insulation values, ceilings RSI-5.5 (R-31) and there is no basement insulation. The houses are average in terms of air tightness with about 3.57 air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

For the Labrador Interconnected service region, a "typical" existing single-detached dwelling can be defined as a single-story bungalow of approximately 130 m^2 (1400 ft^2) with a heated basement. This home has 9.6 m^2 (103 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.5 (R-14) insulation values, ceilings RSI-5.0 (R-28) and there is no insulation in the basement. The houses are typically not very airtight with about 4.55 air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Typically, there is no central ventilation system.

3.3 "NATURAL" CHANGES TO SPACE HEATING LOADS – EXISTING DWELLINGS

In addition to new dwellings, space heating loads in existing dwellings are also expected to change over the study period. However, no specific data are available and, as outlined in the preceding discussion of new dwellings, contrary trends[21] are occurring. Consequently, this analysis assumes that net space heating loads in existing buildings remain unchanged in the reference case.

Examples of trends that tend to decrease the net space heating loads include:

- Insulation and other improvements that occur when renovation projects are undertaken
- Replacement of old windows with new models that provide comfort and aesthetic benefits as well as improved energy efficiency
- Installation of more efficient thermostatic controls.

[21] Replacement of the heating equipment itself is not one of these factors, first, because it does not actually change the net heating load and second, because electric space heating in Newfoundland and Labrador is mainly done with baseboard strip, already at 100% efficiency.

Examples of trends that tend to increase net space heating loads include:

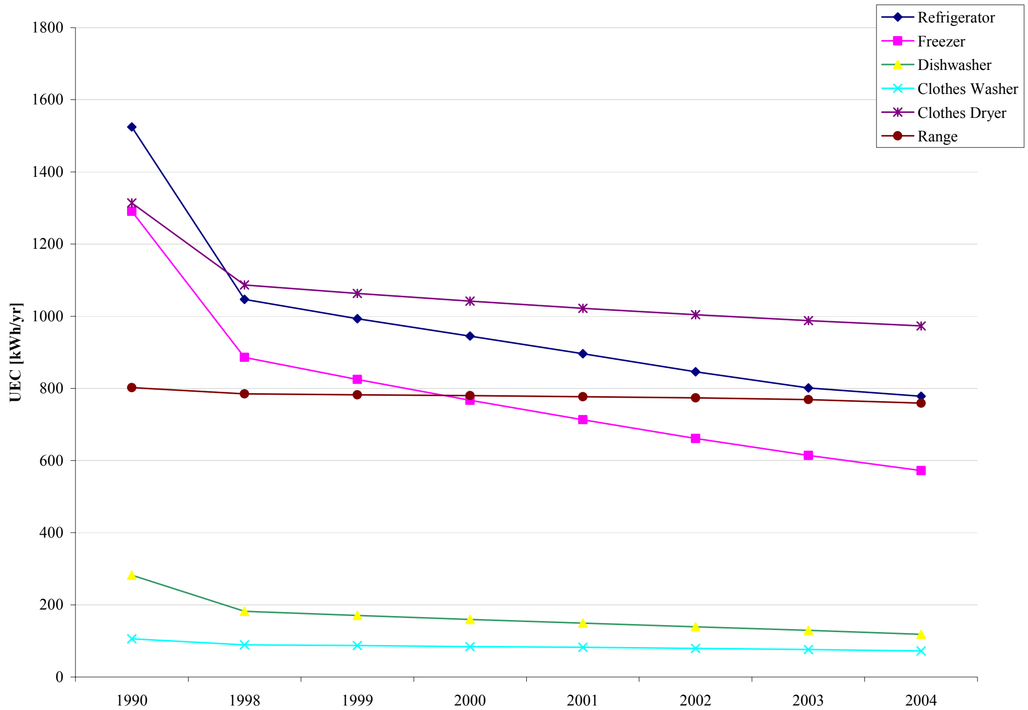
- Enlargement of houses with additions
- Reductions in internal gains due to more efficient appliances and lights.

3.4 "NATURAL" CHANGES TO ELECTRIC APPLIANCE UECS

This section identifies the annual unit electricity consumption (UEC) for the major household appliances and equipment for both "stock in place" and new sales for the period 2006 to 2026.

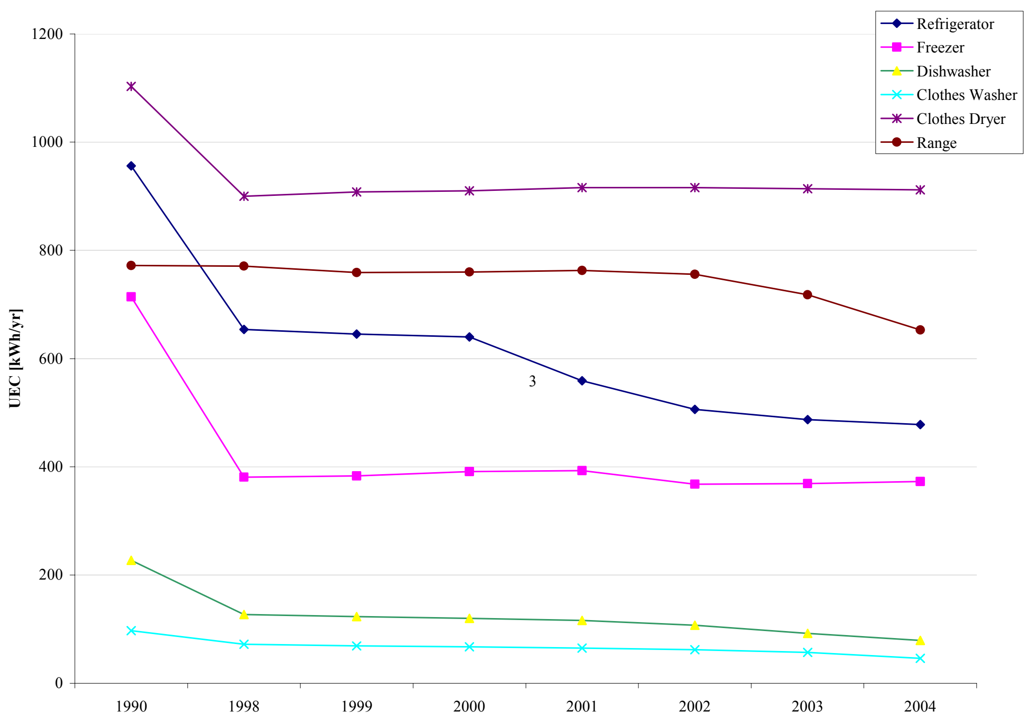
Exhibits 3.2 and 3.3 show Canadian trend information for both the existing stock and new sales of white goods for the period 1990 to 2004.

Exhibit 3.2: Canadian White Goods UECs for Existing Stock



Source: NRCan, Energy Efficiency Trends in Canada 1990 and 1998–2004, August 2006.

Exhibit 3.3: Canadian White Goods UECs for New Sales



Source: NRCan, Energy Efficiency Trends in Canada 1990 and 1998–2004, August 2006.

As shown in Exhibit 3.2, the annual UEC for major household white good type appliances in existing stock declined steadily between 1990 and 2000, due to stock turnover and to continuing improvements in new stock. However, as shown in Exhibit 3.3, the majority of efficiency improvements to large electrical appliances took place in the early to mid 1990s with the trend line levelling off after that for most appliances (except refrigerators and ranges, which show further improvement post 2000). In the future, federal energy-efficiency regulations will continue to regulate additional appliances and to revise existing regulations, suggesting that additional minor improvements in the UECs for new white goods will take place.

Further discussion of the modelled assumptions applied to each of the major appliances follows.

Note: Assumptions for cooking appliances, refrigerators, freezers, dishwashers, clothes washers and clothes dryers are based on appliance energy use trend data compiled by Natural Resources Canada and reported in Energy Efficiency Trends in Canada 1990 and 1998–2004 (NRCan, August 2006) and Marbek's Appliance Replacement Model.

- **Cooking**

A UEC, which includes both ranges and microwave ovens, of 770 kWh/yr. is assumed in the Base Year, adjusted for occupancy and region declining to 730 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 750 kWh/yr. to 700 kWh/yr.

- **Refrigerator**

A UEC of 830 kWh/yr. is assumed in the Base Year, adjusted for occupancy and service region declining to 510 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 680 kWh/yr. to 450 kWh/yr.

- **Freezer**

A UEC of 650 kWh/yr. is assumed in the Base Year, adjusted for occupancy and service region declining to 480 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 560 kWh/yr. to 420 kWh/yr.

- **Dishwasher**

A UEC of 92 kWh/yr. is assumed in the Base Year, adjusted for occupancy and region declining to 83 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 88 kWh/yr. to 81 kWh/yr.

The values shown are for mechanical energy only; hot water use is included with the DHW UEC.

❑ Clothes Washer

A UEC of 78 kWh/yr. is assumed in the Base Year, adjusted for occupancy and region declining to 71 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 75 kWh/yr. to 68kWh/yr.

The values shown are for mechanical energy only; hot water use is included with the DHW UEC.

❑ Clothes Dryer

A UEC of 1,000 kWh/yr. is assumed in the Base Year, adjusted for occupancy and region declining to 850 kWh/yr. in the final milestone year. In new stock, the UEC was assumed to decrease from 940 kWh/yr. to 800 kWh/yr.

❑ Ventilation

Ventilation energy in existing stock is assumed to remain constant. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, there is a trend towards manufacturers' use of larger fan motors (1/2-HP versus 1/3-HP) in new oil and propane furnaces. This means that furnaces replaced in the study period may have a larger furnace fan motor. However, the trend towards larger fan motors is at least partially offset by efficiency improvements. For example, an earlier study for the Canadian Electricity Association (CEA) noted that improved fan design, combined with the use of permanent split capacitor fan motors, had improved furnace fan efficiency by between 13% and 19%.[22]

In new stock, average ventilation energy was assumed to increase to around 450 kWh/yr. from the current average of approximately 340 kWh/yr. This value was based on the HOT2000 modelled results and assumes compliance with municipal building codes. Building codes in Newfoundland and Labrador are based on the National Building Code (for example, the St. John's building bylaw references the 2005 edition of the National Building Code).

❑ Domestic Hot Water

Exhibit 3.4 summarizes DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Section 2) shows significant reductions for hot water use in dishwashing and clothes washing; however, slightly more modest changes have been assumed for personal consumption.

DHW electricity for new and existing appliances is obtained from NRCan (NRCan, 2005), augmented by results from conditional demand analysis and customer survey work done by both NP and NLH in the 1990s. For existing and retrofitted buildings, the DHW UEC is assumed to

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[22] Phillips, B. Blower. *Efficiency in Domestic Heating Systems*, CEA Report No. 9202-U-921, 1995 and *Optimizing Heat and Air Distribution Systems when Retrofitting Houses with Energy Efficient Equipment*, Canada Mortgage and Housing Corporation, 2002. Ventilation UECs will be higher in dwellings that have air conditioning and/or continuous ventilation.

decrease by 0.2% per year based on data from NRCan.[23] The UEC for DHW in new buildings is assumed to be constant.

Exhibit 3.4: Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

End Use	Sample Electricity Use Single Family Detached (kWh/yr.)	%
Personal Use	1,075	38
Dishwashing	600	21
Clothes Washing	750	26
Standby Losses	425	15
Total	2,850	100

❑ Lighting

The lighting UEC was assumed to decrease at a rate of 0.2% per year. This value is based on the results of analysis undertaken by Natural Resources Canada and reported in their *Energy End Use Data Handbook* (NRCan, June 2005).

❑ Televisions

The North American television industry has announced its commitment to convert all analog television to digital broadcasting within the next five years. These broadcast changes are occurring at a time when television technology and programming options are also rapidly changing. Some television technology changes, such as the introduction of liquid crystal display (LCD) and plasma models, may also have significant impacts on household electricity consumption. It is also possible that these changes will result in an increased rate of turnover in the current stock of televisions to models that are better able to take advantage of the high definition (HD) digital signal.

LCD is expected to become the dominant television technology by 2010, capturing approximately 57% of sales in that year. Although LCD screens typically use less electricity on a per inch basis, consumers typically choose screens that are larger when purchasing an LCD screen compared to cathode ray tube screens (CRTs). The most popular television on the market today is the 27” CRT but this is expected to shift within the next five years to the 32” LCD television. This trend has the effect of reducing the electricity advantage that would be gained from a direct switch to the new LCD technology.

In addition to the increase in screen size, HD television models typically consume more power than equivalent standard definition televisions for all technology types. Since the trend with televisions is towards HD sets with greater resolution, television unit electricity use is expected to increase in the future.

[23] Natural Resources Canada. *Energy Efficiency Trends in Canada*, 1990–2000, June 2002.

The growing popularity of larger and higher resolution screens means that, by 2010, national television electricity consumption is expected to grow by 40% to 45%.

In light of these changes, UECs for televisions are assumed to increase from 178 kWh/yr. to 250 kWh/yr. over the study period. These assumptions are based on market and energy use data collected as part of a 2006 study *Technology and Market Profile: Consumer Electronics.*[24]

- **Television Peripherals**

One implication of the pending changes towards digital television broadcasting is that new signal adaptors, commonly referred to as set-top boxes (STBs), will need to be added to nearly two-thirds of Canadian households to receive a television signal.

Industry representatives estimate that each Canadian subscriber household has, on average, 1.5 set-top boxes.[25] They also note that the trend is towards a greater number of STBs per household and, by 2010, the industry estimates that the average will have increased to approximately two STBs per subscriber household.

When complete, the switch to digital broadcasting is expected to increase national STB electricity consumption by up to four times its current level due to the added requirement for STBs among those televisions currently operating on analog cable or over-the-air broadcast signals. Moreover, within these STBs, the most significant trend is towards greater functionality, which is directly associated with further increases in unit electricity consumption.

In light of these changes, UECs for television peripherals are assumed to increase from 220 kWh/yr. to 310 kWh/yr. over the study period.[26]

- **Computers and Peripherals**

Electricity consumption for personal computers is expected to increase despite the move to more energy-efficient flat screen technology. This is due in part to the growing preference for larger screens but mainly due to a trend towards longer operating hours both in full operating mode and in idle mode. There is also a move towards increasing numbers and functionality of computer peripherals, further increasing consumption.

UECs for personal computers and their peripherals are assumed to increase from 390 kWh/yr. to 560 kWh/yr. over the study period.

- **Other Electronics**

As functionality increases, other entertainment devices, such as computer games and music systems are becoming more powerful. For example, the new PlayStation 3 games console uses 360 Watts compared to its predecessor, which uses only 45 Watts. One of the selling features of

[24] Marbek Resource Consultants. *Technology and Market Profile: Consumer Electronics*, September 2006.
[25] Ibid.
[26] Ibid.

the Nintendo Wii and other next generation products is that they can be left on-line for 24 hours a day.

UECs for other electronics are assumed to increase from 160 kWh/yr. to 190 kWh/yr. over the study period.

- **Small Appliances and Other**

The UECs for the small appliances and other categories increase over the study period in anticipation of new end uses, but there is considerable uncertainty in the amount of this increase.

Based on the changes observed in previous studies, new end uses are constantly emerging, some of which are substantial consumers of electricity. One example is electric vehicle charging. Electric cars and plug-in hybrids could achieve substantial penetration by the end of the study period; charging of a typical electric vehicle would require approximately 7,000 kWh/yr.[27]

3.5 APPLIANCE SATURATION TRENDS

To develop estimates of the future saturation of residential equipment, references from NLH were reviewed along with data on trends in the increasing use of entertainment-based electronics.

The saturation of most end-use appliances has remained relatively constant in recent years, suggesting that further changes to saturations are unlikely within the study period. There are two main exceptions:[28] computers and television peripherals. Based on current trends and industry data,[29] the following assumptions have been incorporated into the Reference Case.

- Computer saturation levels increase by approximately 60% over the study period
- Television peripherals saturation levels increase by more than 100%.

3.6 STOCK GROWTH

The next step in developing the Reference Case involved the development and application of estimated levels of growth in each dwelling type and service region over the study period. The number of dwelling units, by type and service region were provided by NLH and match exactly those contained in NLH Long Term Planning (PLF) Review Forecast, Summer/Fall 2006.

Exhibit 3.5 presents a summary of the resulting percentage stock growth, by year and dwelling type in each service region.

[27] California EPA, Air Resources Board. *Fact Sheet: Battery Electric Vehicles*, Sacramento, CA, 2003, http://www.arb.ca.gov/msprog/zevprog/factsheets/evinformation.pdf.
[28] Some increase in space cooling saturation levels may also occur over the 20-year period and it may become material by the end of the period; however, based on client discussions it was agreed that residential space cooling consumption would experience minimal predicted growth with considerable uncertainty in that growth, and therefore it has not been addressed separately.
[29] Op. cit. *Technology and Market Profile: Consumer Electronics.*

Exhibit 3.5: Residential Stock Growth Rates by Service Region, 2011 to 2026,

Region and Period	Electric Accounts					Non-Electric Accounts				
	Single Family	Attached	Apart ment	Isolated	Other	Single Family	Attached	Apart ment	Isolated	Other
Island and Isolated										
2006-2011	1.5%	1.5%	1.5%	0.6%	0.4%	0.1%	0.1%	0.1%	0.6%	0.4%
2011-2016	1.2%	1.2%	1.2%	0.5%	0.3%	0.1%	0.1%	0.1%	0.5%	0.3%
2016-2021	1.1%	1.1%	1.1%	0.5%	0.2%	-0.1%	-0.1%	-0.1%	0.5%	0.2%
2021-2026	1.1%	1.1%	1.1%	0.5%	0.1%	-0.2%	-0.2%	-0.2%	0.5%	0.1%
Labrador Interconnected										
2006-2011	0.7%	0.7%	0.7%	N/A	0.7%	0.0%	0.0%	0.0%	N/A	0.0%
2011-2016	0.5%	0.5%	0.5%	N/A	0.5%	0.0%	0.0%	0.0%	N/A	0.0%
2016-2021	0.5%	0.5%	0.5%	N/A	0.5%	0.6%	0.6%	0.0%	N/A	0.0%
2021-2026	0.5%	0.5%	0.5%	N/A	0.5%	0.6%	0.6%	0.0%	N/A	0.0%

3.7 FUEL SHARES

The only change in fuel shares assumed in the study period is the relative growth in electrically heated versus non-electrically heated dwellings. No changes are assumed in the fuel shares for any of the other end uses.

3.8 SUMMARY OF MODEL RESULTS

This section presents the results of the model runs for the entire study period. The results are measured at the customer's point-of-use and do not include line losses. They are presented in two exhibits:

- Exhibits 3.6 and 3.7 present the model results for the Island and Isolated service region. The results are broken out by dwelling type, end use and milestone year.
- Exhibits 3.8 and 3.9 present the model results for the Labrador Interconnected service region. The results are broken out by dwelling type, end use and milestone year.

Selected highlights of electricity use in 2026 are provided below.

❑ **By Dwelling Type**

Single-family detached dwellings continue to account for the overwhelming majority of total residential electricity consumption in both the Island and Isolated (79%) and the Labrador Interconnected (74%) service regions.

❑ **By End Use**

Space heating continues to account for the largest share of residential electricity use in both service regions (41% in Island and Isolated and 71% in Labrador Interconnected), followed by DHW (15% in Island and Isolated and 9% in Labrador Interconnected).

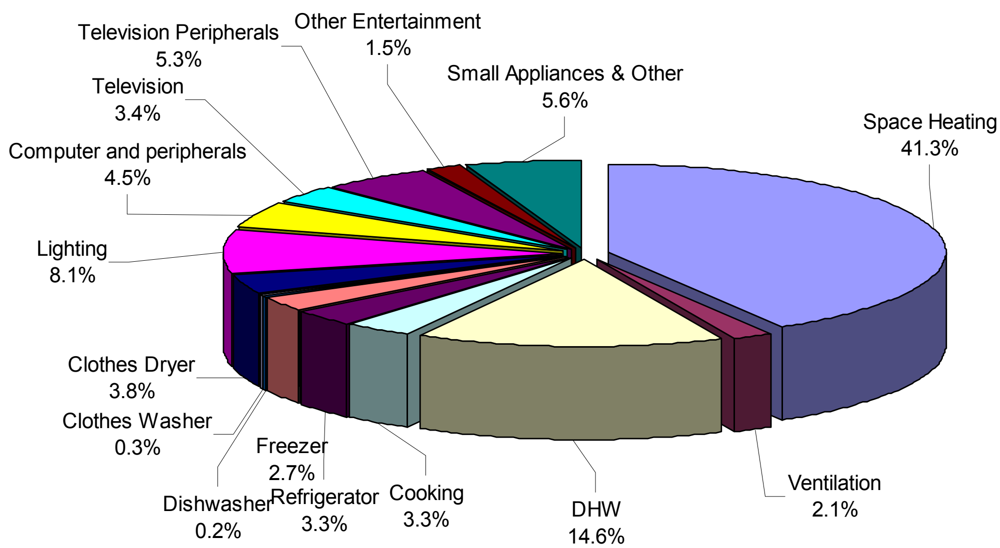
The most notable increase in electricity consumption occurs in the group of electronic end uses represented by televisions, television peripherals, computers and other entertainment. By 2026, these combined end uses are expected to account for approximately 15% of residential electricity use in the Island and Isolated service region and 6% in the Labrador Interconnected service region.

Exhibit 3.6: Reference Case Electricity Consumption for the Island and Isolated Service Region, Modelled by End Use, Dwelling Type and Milestone Year (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Entertainment	Small Appliances & Other
Single Family	2006	2,569	1,006	69	420	97	152	109	6	10	122	234	47	67	55	36	139
	2011	2,757	1,076	70	431	99	136	104	6	10	123	241	69	87	112	39	152
	2016	2,873	1,139	72	439	101	125	100	6	10	125	247	91	94	119	42	166
	2021	3,016	1,211	72	446	103	114	95	6	10	125	252	114	100	144	45	179
	2026	3,125	1,264	73	452	104	103	90	6	10	126	256	141	108	152	48	193
Attached	2006	340	168	5	49	11	20	10	0	1	11	28	7	8	7	5	9
	2011	377	180	6	52	11	18	10	0	1	12	29	10	11	23	5	10
	2016	398	191	6	53	12	17	9	0	1	12	30	13	12	25	6	11
	2021	420	201	6	55	12	16	9	1	1	12	31	17	13	28	6	12
	2026	441	212	6	57	12	15	9	1	1	12	32	21	15	30	7	13
Apartment	2006	193	90	2	40	7	11	4	0	0	5	13	4	6	5	3	3
	2011	218	97	2	42	8	11	4	0	0	5	14	6	8	15	3	3
	2016	233	103	2	43	8	11	4	0	0	5	15	9	8	18	4	3
	2021	250	109	2	45	8	11	4	0	0	6	15	11	9	22	4	4
	2026	264	115	2	46	8	11	3	0	0	6	16	14	10	24	4	4
Isolated	2006	34	2	0	10	3	2	3	0	0	2	5	0	1	1	1	3
	2011	35	2	0	10	3	2	3	0	0	2	5	1	1	2	1	3
	2016	36	2	0	10	3	2	3	0	0	2	5	1	1	2	1	4
	2021	37	2	0	10	3	1	3	0	0	2	5	1	1	2	1	4
	2026	38	2	0	10	3	1	3	0	0	2	6	1	2	2	1	4
Other	2006	31	15	0	1	0	0	0	0	0	0	4	0	0	0	0	10
	2011	32	15	0	1	0	0	0	0	0	0	4	0	0	0	0	11
	2016	33	15	0	1	0	0	0	0	0	0	4	0	0	0	0	12
	2021	34	15	0	1	0	0	0	0	0	0	4	0	0	0	0	12
	2026	34	16	0	1	0	0	0	0	0	0	4	0	0	0	0	13
TOTAL	2006	3,228	1,298	77	530	120	189	128	6	12	144	291	60	83	69	45	175
	2011	3,483	1,388	79	545	124	170	123	6	12	146	300	87	109	154	49	191
	2016	3,637	1,467	80	556	126	157	118	7	12	147	307	115	118	167	53	207
	2021	3,821	1,557	81	566	128	144	112	7	12	149	314	146	126	200	57	224
	2026	3,968	1,626	82	575	130	132	107	7	12	149	320	180	136	211	61	241

Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) Rounding reduces many non-zero values in this table to apparent zeroes.

Exhibit 3.7: Distribution of Electricity Consumption, by End Use in 2026 for the Island and Isolated Service Region



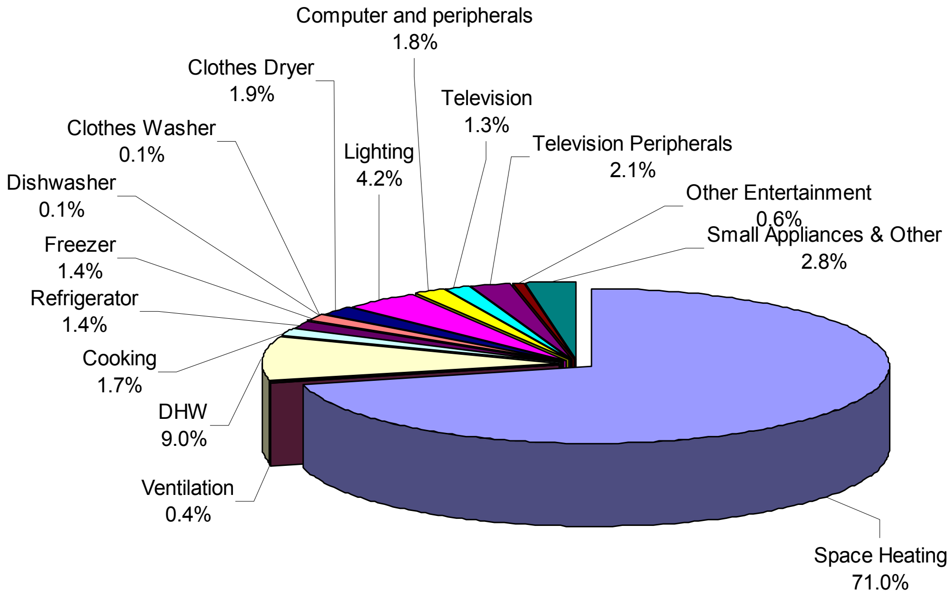
Totals may not add to 100% due to rounding.

Exhibit 3.8: Reference Case Electricity Consumption for the Labrador Interconnected Service Region, Modelled by End Use, Dwelling Type and Milestone Year (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Entertainment	Small Appliances & Other
Single Family	2006	195	139	1	20	3	4	3	0	0	4	9	1	2	1	1	5
	2011	205	147	1	21	3	4	3	0	0	4	10	2	2	3	1	5
	2016	210	150	1	21	3	3	3	0	0	4	10	2	2	3	1	5
	2021	215	154	1	21	3	3	3	0	0	4	10	3	2	3	1	6
	2026	220	158	1	21	3	3	3	0	0	4	10	4	3	4	1	6
Attached	2006	59	43	0	6	1	1	1	0	0	1	3	0	1	0	0	1
	2011	62	45	0	6	1	1	1	0	0	1	3	1	1	1	0	1
	2016	64	46	0	6	1	1	1	0	0	1	3	1	1	1	0	1
	2021	65	47	0	6	1	1	1	0	0	1	3	1	1	2	0	1
	2026	67	49	0	6	1	1	1	0	0	1	3	1	1	2	0	1
Apartment	2006	6	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2011	7	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2016	7	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2021	7	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	2026	8	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Other	2006	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2011	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2016	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2021	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	2026	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1
TOTAL	2006	264	189	1	28	4	6	5	0	0	5	13	2	2	2	1	6
	2011	279	199	1	28	4	5	4	0	0	5	13	2	3	4	1	6
	2016	285	204	1	28	4	5	4	0	0	5	13	3	3	5	1	7
	2021	292	209	1	28	4	4	4	0	0	5	13	4	3	5	1	7
	2026	300	215	1	29	4	4	4	0	0	5	14	5	4	6	2	8

Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) Rounding reduces many non-zero values in this table to apparent zeroes.

Exhibit 3.9: Distribution of Electricity Consumption, by End Use in 2026 for the Labrador Interconnected Service Region



Totals may not add to 100% due to rounding.

4. CONSERVATION & DEMAND MANAGEMENT (CDM) MEASURES

4.1 INTRODUCTION

This section identifies and assesses selected energy-efficiency, fuel switching and peak load reduction measures for the Residential sector. The discussion is organized and presented as follows:

- Methodology for Assessment of Energy-efficiency Measures
- Description of Energy-efficiency Technologies
- Summary of Energy-efficiency Results
- Peak Load Reduction Measures.

4.2 METHODOLOGY FOR ASSESSMENT OF ENERGY-EFFICIENCY MEASURES

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each option within a range of applicable load sizes and/or service region conditions (e.g., degree days)
- Establish the capital, installation and operating costs for each option
- Calculate the cost of conserved energy (CCE) for each technology and O&M measure.

Step 1 Select Candidate Measures

The candidate measures were selected in collaboration with the Utilities and from a literature review and previous study team experience. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including the experience and on-going research work of study team members.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members.

The incremental cost is applicable when a measure is installed in a new facility, or at the end of its useful life in an existing facility; in this case, incremental cost is defined as the cost difference for the energy-efficiency measure relative to the “baseline” technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.

In both cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate, and the costs incorporate applicable changes in annual O&M costs. All costs are expressed in constant (2007) dollars.

Step 4 Calculate CCE for Each Measure

One of the important sets of information provided in this section is the CCE associated with each energy-efficiency measure. The CCE for an energy-efficient measure is defined as the annualized incremental cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying tables (see Appendix A) are expressed in constant (2007) dollars.

The CCE provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast. The CCE is calculated according to the following formula:

$$\frac{C_A + M}{S}$$

Where:

C_A is the annualized installed cost
M is the incremental annual cost of O&M
S is the annual kWh energy savings.

And A is the annualization factor.

Where: $$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

i is the discount rate
n is the life of the measure.

The detailed CCE tables (see Appendix A) show both "incremental" and "full" installed costs for the energy-efficiency measures, as applicable. If the measure or technology is installed in a new facility or at the point of natural replacement in an existing facility, then the "incremental" cost of the measure versus the cost of the baseline technology is used. If, prior to the end of its life, an operating piece of equipment is replaced with a more efficient model, then the "full" cost of the efficient measure is used.

The annual saving associated with the efficiency measure is the difference in annual electricity consumption with and without the measure.

The CCE calculation is sensitive to the chosen discount rate. In the CCE calculations that accompany this document, three discount rates are shown: 4%, 6% and 8%. The 6% real discount rate was used for the primary CCE calculation. The CCE was also calculated using the 4% and 8% real discount rates to provide sensitivity analysis.

Selection of the appropriate discount rate to be used in this analysis was guided by the intended use of the study results. This study seeks to identify the economic potential for DSM in Newfoundland and Labrador from a provincial perspective. Therefore, the appropriate discount rate is the social opportunity cost of capital, which is the estimated average pre-tax rate of return on public and private investments in the provincial economy.[30]

4.3 DESCRIPTION OF ENERGY-EFFICIENCY TECHNOLOGIES

This subsection provides a brief description of each of the energy-efficiency technologies and measures that are included in this study, as listed in Exhibit 4.1.

Exhibit 4.1: Energy-efficiency Technologies and Measures - Residential Sector

Existing Building Envelope
- High- & super high-performance windows
- Air leakage Sealing
- Attic insulation
- Wall insulation
- Foundation insulation
- Crawl space insulation

New Building Design
- R-2000 Home
- EnerGuide for Housing 80
- Energy-efficient new apartment building construction

Space Heating and Ventilation Equipment
- Programmable thermostat
- Electronic and high-efficiency thermostats
- Air source heat pump for homes
- Ground source heat pump for homes
- Low-temperature heat pump for apartments
- Ground source heat pump for apartments
- Integrated heating and DHW heat pumps
- High-efficiency heat recovery ventilator
- Electronically commutated permanent magnet (ECPM) motors for furnace fans
- Premium motors for apartment building ventilation systems
- Building recommissioning – apartment buildings
- Oil-fired central forced air heating system

Domestic Hot Water
- Low-flow shower heads and faucets
- Water tank insulation
- Pipe insulation

Major Appliances
- Microwave/convection oven
- ENERGY STAR refrigerator
- ENERGY STAR freezer
- ENERGY STAR dishwasher
- ENERGY STAR front loading clothes washer
- ENERGY STAR top loading clothes washer

Household Electronics
- Reduction in standby losses
- ENERGY STAR compliant computer
- ENERGY STAR television
- LCD television

Lighting
- CFLs
- Replacement of T12s with T8s
- LED holiday Lighting
- Lighting timers
- Motion sensors

[30] This discount rate allows for analytic consistency with the earlier NERA Marginal Cost Study, which used a nominal discount rate of 8.4% (approximately 6% real, i.e. net of inflation). NLH lowered its nominal discount rate in the summer of 2007 to 7.75%; however, this change has no material impact on the results of this study.

The discussion is organized by major end use and is presented in the following subsections:

- Existing building envelope
- New building design
- Space heating and ventilation equipment
- Domestic hot water
- Major appliances
- Household electronics
- Lighting.

Each energy-efficiency improvement opportunity is discussed below, with a brief description of the technology, savings relative to the baseline with respect to detached homes in the Island and Isolated service region (with savings ranges provided for other dwelling types and climate regions), typical installed costs, applicability and co-benefits.[31]

4.3.1 Existing Building Envelope

Building envelope measures improve the thermal performance of the building's walls, roof and/or windows. These measures also provide significant co-benefits, such as increased occupant comfort, improved resale value, etc. Ten energy-efficiency upgrade options were identified and assessed for this end use. They are:

- High-performance (ENERGY STAR) windows
- Super high-performance windows
- Air leakage sealing
- Attic insulation
- Wall insulation
- Foundation insulation
- Crawl space insulation
- High-performance glazing systems for apartment buildings
- Upgrade wall insulation for apartment buildings
- Upgrade roof insulation for apartment buildings.

❑ **High-Performance (ENERGY STAR) Windows**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$4 per square foot incremental cost in existing $2 per square foot incremental cost in new
Savings	3%-7% HVAC energy, depending on dwelling type, vintage, and region
Useful Life	25 years

[31] Measure inputs not otherwise sourced are based on the consultants' recent work with BC Hydro and other utility clients.

High-performance windows are double glazed with a ½-inch air space; they incorporate a number of additional energy-saving features including low-e (soft coating), insulating spacers, argon fill and low conductivity frames (a mix of sliders, hinged and picture). The more efficient windows reduce heat loss through the window by 20% or more, compared to the average low- or mid-efficiency replacement window depending on dwelling type and region. High-performance windows have an RSI value of 0.5 (R-2.8) or higher, compared to standard double glazed windows, which are clear with no gas filling and typically have an RSI value of 0.34 (R-1.9) or less. High-performance windows also provide occupant co-benefits, such as reduced interior noise, reduced air leakage, greater thermal comfort and fewer condensation problems.

This analysis employs an incremental cost of $4 per square foot[32] to renovate an attached or detached dwelling to high-performance windows as opposed to standard windows; the corresponding savings are approximately 3%-7% of space heating, depending on housing type and climate.

If the upgrade is chosen as part of a new construction, the incremental cost is $2 per square foot[33] and the potential savings are higher because new homes tend to have more and larger windows. They are also a larger proportion of the heating energy consumption; because the other building shell components are better in a new home, windows account for a larger fraction of the heat loss than they do in an older home. The product lifetime for windows is approximately 25 years.[34]

- **Super High-Performance Windows**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$8 per square foot
Savings	5%-11% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

Super high-performance windows incorporate additional features such as triple glazing, transparent insulating films or fibreglass frames as well as the low-e coating, argon fill and insulating spacers, giving them an equivalent R-value of up to R-11. These windows are approximately twice the cost of the high-performance windows; incremental costs would be approximately $8 per square foot and the corresponding savings are approximately 5%-11% of space heating, depending on housing type and climate. Triple glazed units are considerably heavier and present fastening issues for existing vinyl window frame extrusions.

[32] Cost data from product review undertaken for Terasen Gas, 2006.
[33] Incremental costs are generally lower for windows installed in new homes, because tract builders are able to purchase windows in the wholesale market where the incremental cost of efficient windows is usually smaller than it is in the retail marketplace.
[34] BC Hydro Power Smart. *QA STANDARD Technology: Effective Measure Life*. September 11, 2006.

❑ Air Leakage Sealing

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$900 incremental cost in existing $600 incremental cost in new
Savings	8%-26% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

Air sealing of building envelopes includes completion of a blower door test to quantify leakage levels and to identify the location of air leaks. Generally, major leakage occurs at window-to-wall interfaces, around doors, through electrical and plumbing penetrations, at the top of foundation walls and around chimneys and fireplaces.[35] Installation of sealant and gaskets are generally accepted methods for reducing air leakage in buildings.

Air sealing also provides important co-benefits, including reduced drafts, increased occupant comfort and greater control over ventilation capability. In addition, reduced air leakage around windows and attic penetrations eliminates one of the key contributors to water ingress into exterior envelope assemblies.

HOT2000 simulations for Newfoundland showed significant HVAC savings in the range of 8% to 26% due to air leakage sealing, depending on housing type and climate. Electricity savings from ventilation fans, if applicable, would be approximately the same percentage. The cost of leakage control is approximately $900 per existing single-family dwelling if undertaken by an air sealing contractor who can perform an air test as part of the work. If homeowners undertake the air sealing work, significant cost savings can be achieved, but the resulting energy savings would be substantially reduced as well.

The incremental cost of improved air sealing in a new construction project used in this analysis is $600. The life of this measure is approximately 25 years; however, some elements of air leakage sealing, such as weather stripping, will require more frequent replacement and an annual O&M cost of $50 has been added in to account for this.[36]

[35] Fireplaces are particularly challenging to seal around, because of the difficulty of obtaining high-temperature sealants. Selection of fireplaces and woodstoves with outside air intake and proper air sealing built into them avoids this problem.

[36] Energy impacts are from HOT2000 simulations; cost data are based on discussions with installation contractors.

❑ Attic Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$600 incremental cost
Savings	2%-6% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

Insulation levels can be increased in attics by blowing insulation into the attic spaces to fill and cover the space within the roof frame. One technique is to make sure loose-fill or batt insulation fills the attic floor joists fully, then add an additional layer of unfaced fibreglass batt insulation across the joists. This analysis assumed attic insulation is improved to RSI-7.0.

This analysis estimates the incremental cost of this measure to be about $600, with a resulting savings of approximately 2%-6% of the space heating costs depending on housing type and climate. Electricity savings from ventilation fans, if applicable, would be approximately the same percentage. The life of this measure is estimated at 25 years.[37]

❑ Wall Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$750-$2,400
Savings	3%-11% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

Wall insulation is usually challenging to retrofit in an existing house because the inside surfaces of the exterior walls are already finished and in place. Adding insulation is only possible by blowing insulating materials into the wall cavity, if sufficient space exists, or by adding insulation to the exterior of the building under the siding. Insulation levels are assumed to increase to RSI-3.5.

The incremental cost of adding the exterior insulation (as not all walls have sufficient space for blown-in insulation) used in this analysis is $750-$2,400 depending on dwelling vintage.[38] Savings are estimated to be 3%-11% of space heating costs depending on housing type and climate. Electricity savings from ventilation fans, if applicable, would

[37] Energy impacts are from HOT2000 simulations; cost data are based on discussions with retailers and installation contractors.
[38] Cost does not include siding. If insulation cannot be blown in, the rigid foam is assumed to be added in conjunction with an already-planned project to replace the siding. The insulation cost is incremental to the siding job.

be approximately the same percentage. The life of this measure is approximately 25 years.[39]

❑ Foundation Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	$40 per square meter
Savings	18%-43% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

In older homes the basement is often under insulated or even left uninsulated. Increasing the insulation level in basements can be achieved in a number of ways including: constructing a new insulated frame wall or moving the existing frame wall to increase the insulation level, adding extra insulation to the existing frame wall, adding rigid board insulation to the exterior of the foundation or using a combination of interior and exterior rigid board insulation. For the purposes of this report, increased basement insulation was assumed to be either moving an existing frame wall or constructing a new frame wall with an upgrade to RSI-4 insulation. The cost of adding insulation to the foundation, including labour and finishing, is approximately $40 per square meter ($3.70 per square foot) of basement wall area.[40]

HOT2000 simulations for Newfoundland showed significant HVAC savings in the range of 18% to 43% depending on housing type and climate. Electricity savings from ventilation fans, if applicable, would be approximately the same percentage. This measure has a life of approximately 25 years.[41]

❑ Crawl Space Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$1,000 incremental cost in existing
Savings	10%-25% HVAC energy, depending on dwelling type, vintage and region
Useful Life	25 years

Insulation levels may be inadequate in some homes that include a crawl space as part of the basement design. Co-benefits of improved crawl space insulation include improved thermal comfort, fewer drafts and less condensation.

[39] Op. cit., footnote 36.
[40] Cost does not include adding or rebuilding the basement interior walls. The insulation is assumed to be added in conjunction with an already planned basement renovation. The insulation cost is incremental to the renovation cost.
[41] Op. cit., footnote 36.

The addition of crawl space insulation in existing houses to bring the thermal resistance values up to existing code levels of RSI-2.1 provides annual energy savings of approximately 10%-25% of HVAC energy use. Electricity savings from furnace fans, if applicable, would be approximately the same percentage. This measure has a life of approximately 25 years.[42] Typical installed costs are approximately $1,000.

❑ High-performance Glazing Systems for Apartment Buildings

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$2.00/ft^2 (floor area) incremental cost
Savings	28% to 34% of heating and cooling energy
Useful Life	20 years

High-performance glazing systems consist of low-e coated films suspended inside an insulating glass unit. These units can be incorporated into both window and curtain wall systems. In addition to superior insulating performance and lower energy costs, the co-benefits include enhanced comfort, noise reduction, the elimination of perimeter heating and reduced HVAC equipment costs.

Visionwall window and curtain wall systems manufactured by Visionwall Corporation[43] have thermal resistance R-values ranging from 3 to 7 hr.ft^2.^{o}F/Btu, low shading coefficients and high visible light transmission. The highest performing product on the market is Superglass Quad (R-value 12.5 hr.ft^2.^{o}F/Btu) manufactured by Southwall Technologies.[44] It features two films suspended inside an insulating glass unit creating three krypton-filled air spaces. A tape system is used for gas retention and a thermally broken insolating spacer stops the conduction through the edge of the glass.

This upgrade is a high-performance glazing system with an overall U-value of 0.25 Btu/hr.ft^2.^{o}F (R-4). It is applicable to both existing buildings (at end of window life cycle) and new construction. The baseline is an electrically heated commercial building with standard double-glazed windows with an overall U-value of 0.45 Btu/hr.ft^2.^{o}F (R-2.2). The incremental cost is $2.00 per square foot of floor area, the savings range from 28% to 34% of the heating and cooling energy and the service life is 20 years.

❑ Upgrade Wall Insulation for Apartment Buildings

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1.38/ft^2 (floor area) incremental cost
Savings	18% of heating energy
Useful Life	25 years

[42] Op. cit., footnote 36.
[43] http://www.visionwall.com.
[44] http://www.southwall.com.

Various insulating materials and methods can be used to upgrade wall insulation including applying rigid polystyrene board to the exterior of a building or installing fibreglass batts between interior wall studs.

This measure involves upgrading wall insulation to R-24. It is applicable to both existing buildings (at time of recladding) and new construction. The baseline is an electrically heated commercial building with R-12 wall insulation. The incremental cost is $1.38 per square foot of floor area, the savings are 18% of heating energy and the service life is 25 years.

❑ **Upgrade Roof Insulation for Apartment Buildings**

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	$1.00/ft^2 (floor area) incremental cost
Savings	13% of heating energy
Useful Life	25 years

Upgrading insulation on a built-up roofing system typically involves adding additional layers of rigid insulation at the time of re-roofing.

This measure involves upgrading roof insulation to R-30. It is applicable to both existing buildings (at time of re-roofing) and new construction. The baseline is an electrically heated commercial building with R-20 roof insulation. The incremental cost is $1.00 per square foot of floor area, the savings are 13% of heating energy and the service life is 25 years.

4.3.2 New Building Design

New building design integrates advances in both building envelope and space/water conditioning technologies. Three energy-efficiency upgrades were addressed:

- R-2000 Home
- Construction of new homes to achieve an EnerGuide rating of 80 (EG80)
- Energy-efficient new apartment construction.

❑ **R-2000 Home**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$7,500 incremental cost for bungalow $9,000 incremental cost for 2-story
Savings	30% to 50% of HVAC
Useful Life	30 years

R-2000 homes are required to achieve a stringent energy budget that is determined by a combination of factors related to heating fuel, house size and climatic data. In addition, R-2000 homes are required to achieve an air tightness level of 1.5 ac/h at 50 Pa. A number of co-benefits are associated with R-2000 construction, such as improved occupant comfort, improved air quality due to the mandatory use of heat recovery ventilators, higher resale value and reduced environmental impact.

This analysis estimates that annual space heating savings are 30%[45] relative to standard, electrically heated new houses. Actual performance verification performed by an R-2000 builder in Newfoundland showed energy savings of between 30% and 50%[46] relative to standard practice. Fuel savings for non-electrically heated homes would be approximately the same percentage. Typical incremental construction costs for an R-2000 home are assumed to be $7,500 to $9,000.[47]

❑ **EnerGuide 80 Home**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$7,500 incremental cost for bungalow $9,000 incremental cost for 2-story
Savings	30% to 50% of space heating energy
Useful Life	30 years

An EnerGuide for Houses rating is a standard measure of a home's energy performance, calculated by a professional EnerGuide for Houses advisor. The rating is based on information on the construction of the home and the results of a blower door test performed once the house has been built. A blower door test measures air leakage when the air pressure within the house is lowered a specified amount below the air pressure outside. EnerGuide ratings for new houses fall within the following ranges:

- Typical new houses: 72 to 74
- Energy-efficient new houses: 77 to 82
- R-2000 houses: 80 minimum
- Highly energy-efficient new houses: 80 to 90
- Advanced houses using little or no purchased energy: 91 to 100.

The key difference between the R-2000 standard and the more flexible requirement to meet the EG80 rating is that builders do not need to install a heat recovery ventilator to achieve a rating of EG80, nor meet other environmental requirements of the R-2000 program. This substantially reduces the cost of the measure. However, in St. John's where electric heating is in the majority of homes, heat recovery ventilation is standard

[45] Energy impacts are from HOT2000 simulations; cost data are based on information from a paper by Anil Parekh of NRCan, *Cost Impact of the New R-2000 Technical Standard – Summary Report*, March 2000. Supplemented by discussions with installation contractors.
[46] Discussion with Greg Hussey of Karwood Contracting, an R-2000 builder in Newfoundland, August, 2007.
[47] Ibid.

practice,[48] meaning there will be no cost difference between a home achieving EG80 and an R-2000 home.

This analysis estimates that annual space heating savings are 30% to 50% relative to standard electrically heated new houses. Fuel savings in non-electrically heated homes would be approximately the same percentage. Typical incremental construction costs for an EG80 home are assumed to be $7,500 to $9,000.[49]

❑ **Energy-efficient New Apartment Construction**

New construction refers to new high-efficiency buildings designed using the integrated design process that achieve substantial improvements over conventional new buildings through the application and integration of energy-efficiency technologies and design approaches.

Baseline new construction is assumed to follow the MNECB and ASHRAE 90.1 - 1999 standards.

Two energy-efficiency upgrade options were evaluated for new construction:

- New apartment building - 25% more efficient than current standards
- New apartment building - 40% more efficient than current standards.

❑ **New Apartment Building - 25% More Efficient Than Current Standards**

Measure Profile	
Applicable Dwelling Type(s)	Apartment buildings
Vintage	New
Costs	$1.00/ft^2 incremental cost
Savings	25%
Useful Life	30 years

The integrated design approach (IDA) to new building design is predicated on a systematic application of energy measures to all end uses at the design stage. This includes targeting the building envelope, lighting, HVAC equipment (fans and pumps) and, finally, the heating and cooling plants. Savings of 25% are achievable at an average incremental cost of $1/ft^2. The 25% measure is a subset of the 40% measure and is, therefore, not considered separately in cases where the 40% measure passes the CCE test. If the 40% measure fails the CCE test for a particular region or dwelling type, the analysis falls back to the 25% improvement. If the latter passes the CCE test, it would be included in the potential.

[48] Ibid.
[49] Cost is based on R-2000 incremental cost, less the cost of installing an HRV.

❑ New Apartment Building - 40% More Efficient Than Current Standards

Measure Profile	
Applicable Dwelling Type(s)	Apartment buildings
Vintage	New
Costs	$4.50/ft^2$ incremental cost
Savings	40%
Useful Life	30 years

A new apartment building that is 40% more efficient than current design practice will require a very high-performance design, equivalent to C-2000 levels. This requires a full IDA that takes advantage of costs trade-offs from equipment downsizing. The design will require the most energy-efficient technologies, extremely efficient lighting designs and heating/cooling plants with very high part-load efficiencies. Savings of 40% are achievable at an average incremental cost of $4.50/ft^2.

4.3.3 Space Heating and Ventilation Equipment

Space heating and ventilation equipment refers to the equipment and controls used to heat and ventilate residential dwellings. The following energy-efficiency upgrade options were identified and assessed for this end use.[50]

- Programmable thermostat
- High-efficiency thermostat
- Low-temperature air source heat pumps for new homes
- Ground source heat pump for new homes
- Low-temperature heat pumps for apartments
- Ground source heat pump for apartments
- Integrated heating and DHW heat pumps
- High-efficiency heat recovery ventilator
- Electronically commutated permanent magnet (ECPM) motors for furnace fans
- Oil-fired central forced air heating system.
- Premium motors for apartment building ventilation systems
- Building recommissioning—apartment buildings.

[50] Duct sealing is not included due to the negligible number of homes with ducted electric heating systems in Newfoundland and Labrador. It should be noted that 27% of the electrically heated homes in the Labrador Interconnected service region do have ducts. Including both detached and attached dwellings, this would total approximately 1,800 dwellings. In a dwelling where the ducts run within the conditioned space (as is typical of Canadian homes), duct sealing saves approximately 5%. It costs approximately $1,000 per home, mostly in labour, and would not pass the CCE test in Labrador.

❑ Programmable Thermostat

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New and existing
Costs	$70 incremental cost
Savings	6% of HVAC energy
Useful Life	18 years

Digital programmable thermostats provide improved temperature setting accuracy and are capable of multiple time settings. When combined with an assumed 4ºC temperature setback during night and unoccupied periods, typical space heat savings are in the range of 10% to 15%[51] relative to the baseline, depending on the dwelling's vintage and type of dwelling. Other utility studies[52] have indicated that a lower savings percentage should be used, to reflect the fact that the thermostat's setback capabilities do not completely reflect how they are used, e.g., some home occupants reliably set back manual thermostats, and some home occupants do not use the setback features on their electronic thermostats. Accordingly a value of 6% savings has been used in this study.

These thermostats can be installed in both new and existing dwellings. The typical incremental installed cost for a programmable versus non-programmable thermostat is about $70[53] per thermostat and the units have an expected life of 15-20[54] years.

❑ High-efficiency Thermostat

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New and existing
Costs	$30 incremental cost
Savings	3% of HVAC energy
Useful Life	18 years

Digital programmable thermostats are, in general known for their increased accuracy and energy savings potential due to setback features. Recently, less expensive thermostats with the same accuracy, but without the programming functions, have become available. These improved electronic thermostats help reduce temperature fluctuations to less than 0.5-1^{o}C, whereas fluctuations usually range on an average from 1.5-2^{o}C. This increased sensitivity helps to ensure that electric furnaces or baseboard heaters start up as close as possible to the desired temperature set point. One model used with baseboard electric heaters will switch the heater on and off to maintain an ambient temperature within +/-

[51] Canadian ENERGY STAR Calculator.
[52] Enbridge Gas Distribution, Inc., consumer awareness campaign literature, supported by unpublished internal studies.
[53] From retail outlets e.g., Home Hardware and Canadian Tire.
[54] Canadian ENERGY STAR Calculator.

0.5°C of the set point. It could save around 3%[55] of energy use while improving comfort considerably. This model, however, is not recommended for fuel fired furnaces or wherever short cycling is not desirable.

It should be noted that increased temperature sensing precision may not have any significant impact on energy savings since the temperature setting in a home is generally linked to homeowner comfort and preference, not to the number displayed on the thermostat. The assumption would also need to be made that the less precise thermostat allows homes to overheat by 1 degree, not be under heated by 1 degree. Based on the NRCan 3% savings information, the assumption used in the analysis will be that this type of thermostat saves 3% compared to a regular thermostat. It is assumed to cost approximately $30.

- ❑ **Low-temperature Air Source Heat Pumps for New Homes**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$8,000 incremental cost
Savings	50% of space heating energy in Island houses 43% of space heating energy in Labrador houses
Useful Life	20 years

When outdoor air temperatures drop below freezing, standard air source heat pump (ASHPs) systems switch to auxiliary electric resistance heaters to meet the space heating requirements. This limitation has served to minimize the penetration of ASHPs in cold climates. However, a low-temperature air source heat pump (LTHP) developed by Hallowell International[56] is capable of operating at 0°F with a coefficient of performance (COP) of greater than two. At this temperature, standard ASHPs operate less efficiently, produce less than half their rated capacity, and rely primarily on backup electric resistance heaters to maintain comfort.

The LTHP features a two-speed, two-cylinder compressor for efficient operation, a back-up booster compressor that allows the system to operate efficiently down to 15ºF and a plate heat exchanger called an "economizer" that further extends the performance of the heat pump to well below 0ºF.

LTHPs were considered as an alternative for new dwellings only.[57] In new dwellings, LTHPs can provide increased efficiency compared to the more common electric baseboard heaters.[58] Energy savings in the Island and Isolated service region were

[55] NRCan Office of Energy Efficiency, *Heating with Electricity*, March 2003, http://oee.nrcan.gc.ca/publications/infosource/pub/home/Heating_With_Electricity_Chapter2.cfm?attr=4.

[56] www.gotohallowell.com

[57] In existing homes, it would be practical to install an ASHP only in electrically heated homes that already have ducts. The number of such homes in Newfoundland and Labrador is so small that the potential from this measure in existing homes was deemed negligible.

[58] It is assumed that the additional duct work required to install an ASHP in an existing home with electric baseboard heaters is prohibitive.

estimated to be 50% relative to baseboard heaters. In the Labrador Interconnected region, the more severe winters reduced the savings estimate to 43% relative to baseboard heaters. LTHPs can also provide space cooling in summer months at no incremental capital cost, which can improve the CCE slightly.

Typical installed costs in new dwellings are approximately $8,000 to $12,000, including duct work (the lower number has been used in the model, as more representative of a mature market price), and units can last from 15-25 years.[59]

- ❑ **Ground Source Heat Pumps for New Homes**

Measure Profile	
Applicable Dwelling Type(s)	Single detached
Vintage	New
Costs	$18,200 incremental cost
Savings	65% of space heating energy in Island houses 62% of space heating energy in Labrador houses
Useful Life	20 years

Ground source heat pumps (GSHP) utilize the relatively constant temperature properties of the earth or ground water to provide heating and cooling to homes. Although they offer further savings relative to other heat pump types, they are expensive and cannot be used in many urban applications.[60]

Typical HSPF values for regions in Canada experiencing a winter similar to St John's are 8.9-10.6, which equates to energy savings of 65% relative to baseboard heaters in new homes. Typical HSPF values for regions in Canada experiencing a more severe winter such as in Labrador are 8-10, which equates to energy savings of 62% relative to baseboard heaters.[61] In both regions GSHP save approximately 30% to 45% compared to ASHP in new buildings.

Installed costs are approximately $20,000 for a closed loop system in a typical dwelling, or $18,200 more than a conventional system.[62]

Again, the addition of cooling at no incremental cost can improve the savings relative to the baseline.

[59] Heating seasonal performance factors (HSPF), savings, costs and lifetimes from NRCan Office of Energy Efficiency, *Heating and Cooling with a Heat Pump*. Data checked with manufacturers and contractors.
[60] In most urban locations, there is insufficient room for trenching to install horizontal ground loops for GSHPs. At best, there may be room to drill the vertical holes for vertical ground loops. In many locations, there is no space even for that. In some cases where there is room, it is impossible to gain access with the drilling rig because of surrounding structures.
[61] Ibid.
[62] Earth Energy Society of Canada. http://www.earthenergy.ca/saving.html.

❑ Low-temperature Air Source Heat Pumps for Apartments

Measure Profile	
Applicable Dwelling Type(s)	Apartments
Vintage	Existing and new
Costs	\$1.80 to \$2.50/ft^2 incremental cost
Savings	56% to 59% of space heating and cooling energy
Useful Life	15 years

When outdoor air temperatures drop below freezing, standard air source heat pump systems switch to auxiliary electric resistance heaters to meet the space heating requirements. This limitation has served to minimize the penetration of air source heat pumps in cold climates. However, as indicated earlier, Hallowell International's low-temperature air source heat pump is capable of operating at 0°F with a COP of greater than two. At this temperature, standard air source heat pumps operate less efficiently, produce less than half their rated capacity and rely primarily on backup electric resistance heaters to maintain comfort.

The LTHP features a two-speed, two-cylinder compressor for efficient operation, a backup booster compressor that allows the system to operate efficiently down to 15ºF and a plate heat exchanger called an "economizer" that further extends the performance of the heat pump to well below 0ºF.

This measure involves upgrading a standard HVAC system with an equivalent LTHP system. This could include, for example, replacing a standard ASHP system with a LTHP system. The target market is both residential and small commercial buildings and the baseline is electric resistance heating and direct expansion cooling. This technology is applicable to existing buildings (at the end of HVAC life cycle) and new construction. The incremental cost ranges between \$1.80 and \$2.50 per square foot, the savings range between 56% and 59% of space heating and cooling energy and the service life is 15 years.

Currently, the LTHP is available only as a 3.0 and 3.5 ton split system, however Hallowell International expects to launch an expanded product line targeting the commercial market including a packaged rooftop heat pump and a packaged terminal heat pump (PTHP) as early as 2008.[63]

[63] Conversation with James Bryant of Hallowell International, [September, 2007]

❑ Ground Source Heat Pumps for Apartments

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	Existing & new
Costs	$4.90/ft^2 incremental cost
Savings	61% to 64% of space heating & cooling energy
Useful Life	20 years

Ground source heat pump (GSHP) systems are more efficient than conventional heat pump systems, with higher COPs and energy-efficiency ratios (EERs). GSHPs also replace the need for a boiler in winter by utilizing heat stored in the ground; this heat is upgraded by a vapour-compressor refrigeration cycle. In summer, heat from a building is rejected to the ground, eliminating the need for a cooling tower or a heat rejector. They also lower operating costs because the ground is cooler than the outdoor air.

Water-to-air heat pumps are typically installed throughout a building with duct work serving only the immediate zone; a two-pipe water distribution system conveys water to and from the ground source heat exchanger. The heat exchanger field consists of a grid of vertical boreholes with plastic u-tube heat exchangers connected in parallel.

This measure involves upgrading a standard HVAC system with a GSHP system and is applicable to existing building (at the end of HVAC life cycle) and new construction. The baseline is a commercial building with standard electric resistance heating and direct expansion cooling. The incremental cost is $4.90 per square foot, the savings range between 61% and 64% of heating and cooling energy and the service life is 20 years.

❑ Integrated Heating and Hot Water (Heat Pump)

Measure Profile	
Applicable Dwelling Type(s)	Single detached
Vintage	New and existing
Costs	$1,000 incremental on top of GSHP costs
Savings	35% DHW plus heating savings as above
Useful Life	20 years

GSHP can also reduce DHW energy consumption through the addition of a desuperheater. A desuperheater is a small, refrigerant/water heat exchanger that transfers superheated gases from the heat pump's compressor to a water pipe that runs to a home's hot water storage tank. In the cooling season, the desuperheater uses excess heat extracted from the home and in the heating season it uses any excess heat that is not needed for space heating. At peak heating times a conventional water heater can meet additional needs.

A desuperheater can purportedly result in DHW energy savings of 25%-50%[64] (35% has been used in the model, as an approximate midpoint) and costs approximately $1,000.[65]

- **High-efficiency Heat Recovery Ventilators (HRV)**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New
Costs	$650 incremental cost
Savings	7% of HVAC energy
Useful Life	15 years

Heat recovery ventilators (HRV) are installed to recover wasted heat energy from centralized exhausts. Such units typically result in a 13% reduction in space heating costs.[66] New, high-efficiency HRV units recover approximately 50% more of the energy escaping in ventilation air, resulting in an additional 7%[67] reduction in space heating costs.

This analysis assumes that a high-efficiency HRV costs approximately $3,150[68] compared to a standard unit, which costs $2,500. The technology has an estimated life of 15 years. New HRV also have an energy-efficiency option, utilizing a variable speed DC motor instead of the less efficient PSC motor, cutting consumption from 150 Watts to less than 50 Watts on low speed.

- **Electronically Commutated Permanent Magnet (ECPM) Furnace Fan Motor**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	New and existing
Costs	$140 incremental cost
Savings	40% of ventilation energy
Useful Life	20 years

Furnace fan motors are typically designed with permanent split capacitors (PSC) and achieve efficiencies in the range of 50%-60%. In contrast, ECPM motors have operating efficiencies in the range of 80%. Furnace fan motors are used in houses with central,

[64] NRCan Office of Energy Efficiency, *Heating and Cooling with a Heat Pump*.
[65] Earth Energy Society of Canada http://www.earthenergy.ca/saving.html.
[66] The standard HRV is not a separate measure in this analysis. Based on discussions with local contractors, installing HRVs is becoming standard practice in electrically heated new homes in Newfoundland and Labrador. It should be noted, however, that, for the existing vintage, with an installed cost of $2,500 (nearly four times the incremental cost of the above measure) and savings of 13% (only double the savings of the above measure), the standard HRV would not pass the CCE test.
[67] E Source Heating Technology Atlas.
[68] Cost based on discussions with contractors.

forced air heating systems. When operated exclusively in space heating mode, ECPM motors reduce fan motor electricity use[69] by approximately 40%.[70]

Typical installed costs are approximately $140[71] more than for a standard fan motor. ECPM motors also reduce fan noise.

- **Oil-fired Forced Air Heating System for New Homes[72]**

Measure Profile	
Target Segments	All
Vintage	New
Costs	$4,300 incremental cost
Electricity Savings	Approximately 95%[73]
Useful Life	15 years

Space heating in new homes can be provided by an ENERGY STAR (83% efficiency) oil-fired furnace instead of electric baseboard heating. The installed cost of a direct vent forced air furnace with oil tank and duct work in a new single family home is in the range of $6,500 to $7,000. This compares with an estimated installed cost of up to $2,700 for electric baseboard heating, which includes the cost of a larger electrical panel, wiring, heaters and thermostats. The oil-fired system also uses approximately 420 kWh of fan electricity (in this analysis, assumed to be powered by an ECPM motor).

- **Premium Motors for Apartment Building Ventilation systems**

Measure Profile	
Applicable Dwelling Type(s)	Apartment buildings
Vintage	Existing & new
Costs	20% incremental cost
Savings	1.4% of ventilation energy
Useful Life	10 years

Premium efficiency motors typically have reduced losses of 10%-40%, thereby increasing motor efficiency by 1%-10%.[74] In a retrofit situation it is considered best

[69] As noted in earlier sections, this end use is currently the focus of extensive research efforts. Recent end-use metering results suggest that, in heating mode, ECPM motor savings are fully offset by increased space heating fuel consumption. This is because waste heat generated by the fan motor is captured in the distributed hot air. Therefore, if the fan motor's waste heat is reduced due to increased efficiency, the primary heating fuel must make up the difference. If used to distribute cooled air, the increased fan motor efficiency (i.e., reduced waste heat) would reduce both motor consumption and the total cooling load.
[70] Canadian Centre For Housing Technology, *Effects of ECM Furnace Motors on Electricity and Gas Use*.
[71] Canadian Centre for Housing Technology, *Effects of ECM Furnace Motors on Electricity and Gas Use*, and discussion with retailers.
[72] This measure has been included as it may offer a net benefit to the NLH system. This is because a portion of the electricity generated will be from thermal sources if the Island and Isolated service region remains an isolated grid.
[73] Electricity savings require use of another fuel, assumed to be oil in this case; residual electricity use is for circulation fan operation.
[74] BC Hydro. *Power Smart Tips & Practices*.

practice to replace failed motors with new premium efficiency motors rather than rewind them since motor rewinding often degrades motor efficiency by 1%-3%.

This measure involves upgrading an induction motor with an equivalent premium efficiency motor. It is applicable to both existing buildings (at end of motor life cycle) and new construction. The baseline is a standard efficiency induction motor. The incremental cost is estimated to be 20% relative to a standard efficiency motor, the savings are 1.4% and the service life is 10 years.

- **Building Recommissioning – Apartment Buildings**

Measure Profile	
Applicable Dwelling Type(s)	Apartment buildings
Vintage	Existing
Costs	$0.60 per ft^2
Savings	20% of HVAC energy use
Useful Life	5 years

Recommissioning is a quality assurance process for ensuring that a building's complex array of mechanical and electrical systems is operated to perform according to the design intent and current operational needs of the building. The process generally involves monitoring and simulation of building systems to gain a thorough understanding of current operation and possibilities for optimization. Energy savings generally result from equipment repairs, air and water rebalancing and control optimization.

Recommissioning is applicable to existing buildings only. The baseline is a typical office building with an electricity intensity of 26 kWh/ft^{2}yr. The full cost is estimated to be $0.60/ft^2, the savings are 20% of HVAC energy use and the service life is 5 years.

4.3.4 Domestic Hot Water

Domestic hot water (DHW) refers to the heated water used for showers, baths, hand washing and clothes and dishwashing (DHW savings for clothes and dishwashers are treated separately in Section 4.3.5). Four[75] energy-efficiency upgrade options were identified and assessed for this end use, of which three are discussed below:

- Low-flow shower heads and faucets
- Water tank insulation
- Pipe insulation.

[75] The potential for heat traps was deemed negligible in the context of this study due to the relatively high replacement rate of DHW tanks in the Newfoundland residential marketplace (often after 6 years). The discussion was removed accordingly.

❑ Low-flow Showers and Faucets

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$25 incremental cost
Savings	11% of DHW energy in existing
Useful Life	12 years

Energy-efficient showers and faucets have aerators and flow restrictors to reduce water use. DHW used for general use (including showers and faucets) is assumed to account for approximately 35% of total DHW energy.

This analysis estimates that reductions in hot water usage are in the range of 30% relative to traditional models, or 11% of total DHW use. Installed costs are approximately $25 for a single-family dwelling. This measure has an expected life of 12 years.[76]

❑ Hot Water Tank Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$30 full cost
Savings	6% of DHW energy
Useful Life	10 years

Very energy-efficient water heater storage tanks will have an insulation value of at least RSI-4.2. Adding insulation to an existing hot water tank, purchased before 2004, can reduce standby heat losses resulting in energy savings of 4%–9% (6% has been used in the model as an approximately midpoint).[77]

Pre-cut tank jackets (blankets) are readily available and cost around $15-20[78] in central Canada but are more expensive in Newfoundland and Labrador (approximately $30). They last for 10-15 years. Space limitations restrict the applicability of this measure in some cases. The potential is rapidly eroding as tanks are replaced.

[76] Data used in the BC Hydro 2007 Conservation Potential Review, and in the 2006 Terasen Gas CPR Study. Similar assumptions are used in the American Council for an Energy-Efficient Economy (ACEEE) and Energy Efficiency and Renewable Energy (EERE) *Consumer Tip Sheets* and have been confirmed for 2007.
[77] U.S. Department of Energy. http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13070.
[78] From Canadian retailers.

❑ Hot Water Pipe Insulation

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing
Costs	$4 incremental cost
Savings	3% of DHW energy
Useful Life	6 years

Hot water pipe insulation reduces the distribution losses for DHW, which account for approximately 5%-10% of the total water heater electricity consumption.

This analysis estimates that hot water pipe insulation reduces total DHW energy consumption by 3%. The materials cost an average of $4 per house and are assumed to be installed by the homeowner. The measure has an expected life of 6 years.[79]

4.3.5 Major Appliances

- Microwave/convection oven
- ENERGY STAR refrigerator
- High-efficiency freezer
- ENERGY STAR dishwasher
- ENERGY STAR front loading clothes washer
- ENERGY STAR top loading clothes washer
- Switch to propane gas for cooking.

❑ Microwave/Convection Oven

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	$1,400 incremental
Savings	25%
Useful Life	20 years

New stove models combine conventional, microwave and convection ovens into a single appliance. Relative to a conventional oven, these designs provide electricity savings of about 25% and faster cooking times. Typical incremental costs are about $1,400 relative to conventional models and the units have a life of approximately 20 years.

[79] Savings data based on earlier analysis conducted for Terasen Gas. Cost data gathered from retailer scan.

❑ ENERGY STAR Refrigerator

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost $50-$100
Savings	15% -20%
Useful Life	17 years

ENERGY STAR refrigerators achieve substantial savings in electricity consumption through improved insulation and compressor efficiency, as well as better quality door seals and load sensors.[80] ENERGY STAR refrigerators must use 15% less energy than current standards dictate for an upright model, and 20% less energy for a compact design. Incremental cost for an ENERGY STAR fridge is $50-$100.[81]

❑ ENERGY STAR Freezer

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost $50-$100
Savings	10%
Useful Life	17 years

The performance efficiency of freezers has increased significantly over the last 10 years through improved insulation and compressor efficiency. ENERGY STAR freezers must use 10% less energy than current standards dictate. Incremental cost for an ENERGY STAR freezer is $50-$100.[82]

❑ Manual Defrost Freezer

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost $0
Savings	30%
Useful Life	17 years

Freezers without an automatic defrost cycle use approximately 30%[83] less electricity than comparable freezers with the defrost cycle; they also cost the same or less. Chest freezers

[80] A potential pitfall with refrigerator replacement initiatives is that some customers will retain the old refrigerator. For example, it may get moved to the basement and used as a beer fridge. This phenomenon may also affect freezer initiatives. Other utilities have addressed this issue through programs that offer a "bounty" to customers who surrender old second refrigerators and freezers.
[81] Based on scan of retailers.
[82] Based on scan of retailers.
[83] Canadian ENERGY STAR Calculator.

experience only limited amount of frost build up over time and rarely require defrosting and, therefore, for the purposes of this study, the level of service provided is assumed to remain virtually unchanged.

- **ENERGY STAR Dishwasher**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	Incremental cost $50
Savings	41% of DHW and mechanical dishwasher energy
Useful Life	10 years

ENERGY STAR dishwashers save energy by using improved technology for the primary wash cycle and by using less hot water to clean. Construction includes more effective washing action, energy-efficient motors and other advanced technologies, such as sensors, that determine the length of the wash cycle and the temperature of the water necessary to clean the dishes. In addition, some advanced dishwashers can sense and adjust for the amount of soil on dishes, using only as much water as necessary.

As of January 1, 2007 the ENERGY STAR level for dishwashers was changed with a corresponding increase in energy efficiency from 26% better than standard to 41% better. These savings affect both the mechanical energy of the dishwasher and the energy used for heating the water. The incremental cost of a unit meeting these new criteria is assumed to be $50.[84] The estimated life of a dishwasher is 10 years.[85]

- **ENERGY STAR Front Loading Clothes Washer**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	Incremental cost $550
Savings	70% of DHW used for clothes washing 50% of mechanical energy 35% of dryer energy
Useful Life	15 years

Compared to standard models, front loading (horizontal axis) washing machines reduce hot water use by 60%-80% (70% has been used in the model, as an approximate midpoint). Mechanical energy use is also reduced by about 50% and, due to their faster spin speed, they also reduce dryer energy by about 35%.[86]

This analysis assumes the energy savings outlined above. Incremental costs are assumed to be about $550 more than a standard vertical axis machine, although some high-end

[84] Based on discussion with retailers.
[85] Canadian ENERGY STAR Calculator.
[86] Savings data based on earlier analysis conducted for Terasen Gas.

models have incremental costs of about $1,000.[87] They are assumed to have a life of 15 years.

- **ENERGY STAR Top Loading Clothes Washer**

Measure Profile	
Applicable Dwelling Type(s)	Single detached and attached
Vintage	Existing and new
Costs	Incremental cost $250
Savings	60% of DHW used for clothes washing 50% of mechanical energy 35% of dryer energy
Useful Life	15 years

ENERGY STAR clothes washers use approximately 60%[88] less hot water and 50% less mechanical energy per load than standard models. Because ENERGY STAR clothes washers spin faster, there are additional savings in dryer energy of approximately 35%. In January 2007, the ENERGY STAR standard for clothes washers was increased. However, the base regulation was also increased and the savings above the baseline, therefore, remain the same.

The change in standards has, however, resulted in a reduction of the number of qualifying models to only top of the range units and the incremental cost has therefore increased to about $250.[89] The estimated life of a clothes washer is 15 years.

- **Switch to Propane Gas for Cooking[90]**

Measure Profile	
Target Segments	All
Vintage	New
Costs	$245 installed cost for a tank plus $105/yr. rental $400 installed cost for piping
Electricity Savings	100% of on-site cooking electricity [91]
Useful Life	15 years

Propane cooking stoves offer the same perceived advantages in cooking convenience offered by natural gas stoves. Typical installed cost is $645 more than an electric stove due to piping costs (typically $400-500) and the cost of installing a propane tank ($245). The propane tank is typically a rental, costing an additional $105 per year.

[87] Cost data based on retailer scan.
[88] Canadian and U.S. ENERGY STAR Calculator.
[89] From retailer scan.
[90] This measure is not an efficiency measure but has been included for the same reasons as outlined previously in footnote 72, Section 4.3.3, for oil-fired space heating.
[91] Electricity savings require use of another fuel, assumed to be propane in this case.

4.3.6 Household Electronics

Improvements to household electronics enhance the efficacy of entertainment items such as TVs and computers, while maintaining service levels. Four[92] energy-efficiency upgrade options were identified and assessed for this end use as follows:

- Reduction in standby losses
- ENERGY STAR compliant computer
- ENERGY STAR television
- LCD television.

❑ **Standby Losses**

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	$40 per dwelling
Savings	16% for computers, 8% for TVs and other electronics, 73% for TV peripherals
Useful Life	10 years

Standby losses, consumed by electrical appliances when they are turned off or not in use, represent a significant component of residential electricity consumption. They account for 16% of computer energy use, 8% of the electricity used by TV and other electronics such as games consoles, and 73% of the electricity use of TV peripherals such as set-top boxes.[93] Technically, these standby losses can be reduced to zero by use of a power bar to completely remove power to the appliance.

In practice, the interaction between the power bar and the electronic device will often need to be more sophisticated than a simple shut-off. Some TVs need fan runtime after the screen is shut off, to avoid heat damage. Some set-top boxes require time to boot up and reconnect to their network before use, suggesting that to avoid user inconvenience they should be turned on in advance of prime viewing hours with a timer. Smart power bars with these capabilities are now making inroads in the marketplace. Over the study period, technical advances will improve these features and, in some cases, may move them from the power bar into the electronic appliance itself.

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[92] LCD monitors have become the standard technology and the measure was dropped accordingly.

[93] Alan Fung, Adam Aulenback, Alex Ferguson and V Ismet Ugurssal. *Standby Power Requirements of Household Appliances in Canada*, April 2002.

❑ ENERGY STAR Compliant Computer

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost negligible
Savings	60%
Useful Life	8 years

The ENERGY STAR specification for computers was revised in October 2006 and came into effect in July 2007. The previous specification only addressed energy use during a computer's sleep mode and was not demanding even in this respect with approximately 98% of available computers carrying the ENERGY STAR label. The energy savings were also dependent on the operating mode set by the user. The requirements have been seriously revised in an attempt to offer greater differentiation for innovative, truly energy-efficient models and now address all modes of operation in order to have automatic savings that are not dependent on user behaviour. It is estimated that the new specification will mean that ENERGY STAR computers and computer peripherals use, on average, 60% less energy than conventional models.[94] This premium performance comes at a price that remains comparable to conventional computer models.

❑ ENERGY STAR Television

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost $50
Savings	30%
Useful Life	20 years

ENERGY STAR qualified televisions must use one Watt or less in standby mode, which equates to approximately 30% less energy use annually[95] than a non-qualifying product. An ENERGY STAR TV may be CRT, LCD or plasma technology. The incremental cost of a 32" LCD ENERGY STAR qualified TV compared to its standard counterpart was found to be $20-$100 ($50 has been used in the model, as an approximate midpoint).[96]

[94] ENERGY STAR Press Release, 2006.
[95] Canadian and U.S. ENERGY STAR Calculator.
[96] From retailer scan.

❑ LCD Television

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	$400 incremental cost
Savings	40%
Useful Life	20 years

Like LCD computer monitors, LCD TVs typically use less energy than CRTs, both when running and when in standby mode. A 27" LCD TV uses approximately 80-100 Watts[97] of power in "on" mode compared to an equivalent CRT monitor, which uses 150 Watts. Energy savings are thus in the order of 40%. LCD TVs are $300-$500[98] more expensive than the CRT equivalents ($400 has been used, as an approximate midpoint). One aspect of consumer behaviour that may complicate analysis of this measure is that people tend to buy larger LCD TVs than CRTs, potentially reducing the savings. We have not included this effect at this stage of the analysis.

4.3.7 Lighting

Lighting improvements enhance the efficacy of lighting fixtures, while maintaining service levels. Seven energy-efficiency upgrade options were identified and assessed for this end use as follows:

- Replacement of incandescent lamps with compact fluorescent lights (CFLs)
- White LED lamp
- Replacement of T12s with T8s (mainly in apartment building common areas)
- Redesign with high-performance T8 lighting systems
- LED holiday lighting
- Lighting timers
- Motion sensors.

❑ Replacement of Incandescent Lamps with Compact Fluorescent Lights[99]

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Incremental cost $3
Savings	75%
Useful Life	9 years

[97] Marbek Resources Consultants Ltd. *Consumer Electronics Report*.
[98] From review of retailers.
[99] This measure is the replacement of incandescent lamps in standard applications with relatively long hours of use and no requirement for special shapes or dimming capability. A second compact fluorescent measure was added to the model, to address specialty applications where the lamp is more expensive or the hours of use are shorter. Incremental cost for the specialty CFL measure is $9. All other profile assumptions remain the same.

Compact fluorescent lights (CFLs) can be used to replace incandescent bulbs in most applications. A 13-Watt CFL provides a light output similar to that of a 60-Watt incandescent lamp and consumes approximately 75% less electricity. CFLs have come down a lot in price in recent years with the top end of the price range now being about \$3-\$10[100] for one CFL compared to no more than \$1 for an incandescent bulb (\$3 has been used as an incremental cost in the model, as representative of the majority of standard, low-cost applications). A CFL lasts approximately eight to ten times longer.

- **White LED Lamp**

Measure Profile	
Applicable Building Types	All
Vintage	Existing and new
Costs	Full \$43/lamp; incremental \$38/lamp
Savings	75% of lighting energy
Useful Life	12 years

This upgrade is a white light-emitting diode (LED) array that displays 800 lumens at 50 lumens per Watt and has a full cost of \$43. Relamping a 65-Watt incandescent reflector lamp with this upgrade results in savings of 75% while producing an equivalent amount of light. In addition, white LEDs currently have a life of 35,000 hours compared to the shorter life of incandescent lamps; this provides additional benefits in the form of lower maintenance and lamp replacement costs. However, this technology is in the early stages of market entry and therefore improvements to the technology in terms of cost and efficacy should be expected in the coming years.

- **Replacement of Existing T12 Lamps and Magnetic Ballasts with T8 Fluorescent Lamps and Electronic Ballasts**

Measure Profile	
Applicable Dwelling Type(s)	Detached, attached and apartment
Vintage	New and existing
Costs	Standard: Full \$41/fixture; incremental \$0 High-performance: Full \$50/fixture; incremental \$9/fixture
Savings	Standard T8 lamp and ballast: 26% High-performance T8 lamp and ballast: 39%
Useful Life	16 years

T12 fluorescent lamps and magnetic ballasts can be replaced with standard 32-Watt T8 fluorescent lamps and electronic ballasts or the newer so called “high-performance” T8 lamps and ballasts. T12s still remain in limited applications in detached and attached homes, and in apartment building lobbies and corridors. Standard T8 lighting systems provide savings of approximately 26% relative to the conventional T12 systems in existing buildings. High-performance systems have even greater savings (39%) resulting

[100] From a retailer scan. \$10 is now quite expensive for a singe CFL and might be paid only for a “daylight” model. Lowest prices were in the range of \$3 for one lamp.

from a possible reduction in the number of lamps used due to the superior lumen output of this lighting. In new apartment buildings and other residential applications, the choice of high-performance T8s over standard T8s can save up to 17%.

Typical installed cost can be as little as nothing, when considering the incremental cost of a standard T8 system compared to a T12 system, or $41 per fixture if considering the full cost of a standard T8 system. Typical installed cost can be as little as $9 per fixture when considering the incremental cost of a high-performance T8 system compared to a T12 system, or $50 per fixture if considering the full cost of a high-performance T8 system.

- ❑ **Redesign with High-performance T8 Lighting Systems**

Measure Profile	
Applicable Building Types	All
Vintage	Existing
Costs	Full $1.72/ft^2; incremental $0.48/ft^2
Savings	62% of lighting energy
Useful Life	16 years

The combination of lighting redesign to lower light levels and next generation T8 lighting systems results in savings of 62% and a lower incremental cost (due to fewer fixtures) relative to baseline T12 systems.

Measure Profile	
Applicable Building Types	All
Vintage	New
Costs	Full $1.72/ft^2; incremental $0.01/ft^2
Savings	48% of lighting energy
Useful Life	16 years

This technology upgrade is the same as previously described in the T12 upgrades discussion above. However, in this case the savings are 48% relative to the baseline standard T8 systems.

- ❑ **Replacement of Incandescent Holiday Lights with LED Holiday Lights**

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	$2 incremental cost
Savings	91%
Useful Life	20 years

LED seasonal decorative lights (including Christmas lights) can replace existing incandescent light strings. A string of LED holiday lights uses 14 Watts on average compared to a string of incandescent lights, which uses 150 Watts on average. LED strings thus consume less than 10% of the electricity used by a comparable string of incandescent holiday lights.

LED holiday lights are now available in most hardware stores at an incremental cost of about $1 to $3 ($2 has been used in the model, as an approximate midpoint). LED holiday lights can also last up to 10 times longer than incandescent holiday lights.

- **Lighting Timers**

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Full cost $20
Savings	60%
Useful Life	10 years

Outdoor security lights or aesthetic lights are often fitted with a photo-sensor to run from dusk until dawn. However, if exterior lighting is only required until a certain hour (e.g., 11 pm), a timer can be installed to turn the light off automatically.

This analysis assumes that in the base case an outdoor light operates from dusk to dawn (on average 10 hours a night over the course of the year[101]) and a timer reduces this to an average of 4 hours a night. Energy savings are, therefore, in the range of 60%. Outdoor light timers cost approximately $20.[102]

- **Motion Sensors**

Measure Profile	
Applicable Dwelling Type(s)	All
Vintage	New and existing
Costs	Full cost $50
Savings	95%
Useful Life	10 years

Motion sensors for residential security lighting are designed to switch on the light only if there is movement. This reduces the time that the light is actually on to 30-60 minutes per night on average and results in energy savings of approximately 95%. Motion sensors cost approximately $50.[103]

[101] Marbek Resource Consultants Ltd., *Dusk to Dawn Luminaires*.
[102] From retailer scan.
[103] From retailer scan.

4.4 SUMMARY OF ENERGY-EFFICIENCY RESULTS

The energy-efficiency measures and associated CCEs are summarized in Exhibit 4.2. Note that the negative values shown for selected lighting upgrades indicate that the annualized capital cost of the energy-efficiency measure is less expensive than the baseline technology.

The building-level measures for apartment buildings and their associated CCEs were derived from the results found for the Commercial sector. These are presented in Exhibit 4.3 (numbered Exhibit 4.2 in the Commercial sector report). Note that some measures in this table are not applicable to residential buildings. Measures that apply within the apartment suites are included in Exhibit 4.2 below.

Exhibit 4.2: Residential Energy-efficiency Technologies and Measures – Cost of Conserved Energy

Summary of CCE's - Residential Sector

End Use		Technology	Dwelling Type	Vintage	Sp heating fuel	CCEs (¢/kWh) 4.0% DR Full	4.0% DR Incr.	6.0% DR Full	6.0% DR Incr.	8.0% DR Full	8.0% DR Incr.
Lighting	Upgrade 1	Replace incandescent with CFL	All Detachments	New & Exist.	Elec. & Non-elec.	0.7	-2.3	0.8	-2.3	0.9	-2.3
	Upgrade 2	Replace incandescent with CFL - Specialized applications	All Detachments	New & Exist.	Elec. & Non-elec.	6.3	-3.8	6.9	-3.3	7.5	-2.9
	Upgrade 3	Replace incandescent with white LED	All Detachments	New & Exist.	Elec. & Non-elec.	16.6	16.5	19.0	18.8	21.5	21.2
	Upgrade 4	Replace T12 with T8	Detached/Attached	New & Exist.	Elec. & Non-elec.	4.2		4.8		5.5	
	Upgrade 5	Replace T12 with T8	Apartment	New & Exist.	Elec. & Non-elec.	0.6		0.7		0.8	
	Upgrade 6	Replace porchlight with CFL	Detached/Attached	New & Exist.	Elec. & Non-elec.	0.2	-0.7	0.2	-0.7	0.3	-0.7
	Upgrade 7	Replace porchlight with white LED	Detached/Attached	New & Exist.	Elec. & Non-elec.	5.0	4.9	5.7	5.6	6.5	6.4
	Upgrade 8	Exterior and holiday lights	All Detachments	New & Exist.	Elec. & Non-elec.	5.6	-9.7	6.6	-9.1	7.7	-8.5
	Upgrade 9	Motion Sensor	All Detachments	New & Exist.	Elec. & Non-elec.	3.0		3.3		3.6	
	Upgrade 10	Lighting Timer	All Detachments	New & Exist.	Elec. & Non-elec.	1.9		2.1		2.3	
Existing Building Envelope - Island & Isolated	Upgrade 1	High-performance glazings	Detached	New	Elec		4.2		5.2		6.2
	Upgrade 1	High-performance glazings	Row	New	Elec		3.7		4.5		5.4
	Upgrade 1	High-performance glazings	Detached	Exist.	Elec		3.4		4.2		5.0
	Upgrade 1	High-performance glazings	Row	Exist.	Elec		3.9		4.7		5.7
	Upgrade 2	ENERGYSTAR glazings	Detached	New	Elec		1.6		2.0		2.3
	Upgrade 2	ENERGYSTAR glazings	Row	New	Elec		1.5		1.8		2.1
	Upgrade 2	ENERGYSTAR glazings	Detached	Exist.	Elec		2.4		3.0		3.6
	Upgrade 2	ENERGYSTAR glazings	Row	Exist.	Elec		2.9		3.6		4.3
	Upgrade 3	Wall Insulation	Detached	New	Elec		14.7		18.0		21.5
	Upgrade 3	Wall Insulation	Row	New	Elec		16.1		19.6		23.5
	Upgrade 3	Wall Insulation	Detached	Exist.	Elec		11.7		14.2		17.1
	Upgrade 3	Wall Insulation	Row	Exist.	Elec		15.3		18.8		22.5
	Upgrade 4	Attic Insulation	Detached	New	Elec		10.2		12.5		14.9
	Upgrade 4	Attic Insulation	Row	New	Elec		11.7		14.3		17.2
	Upgrade 4	Attic Insulation	Detached	Exist.	Elec		5.7		6.9		8.3
	Upgrade 4	Attic Insulation	Row	Exist.	Elec		7.6		9.3		11.1
	Upgrade 5	Foundation Insulation	Detached	New	Elec		5.9		7.2		8.6
	Upgrade 5	Foundation Insulation	Row	New	Elec		3.7		4.5		5.4
	Upgrade 5	Foundation Insulation	Detached	Exist.	Elec		6.9		8.4		10.1
	Upgrade 5	Foundation Insulation	Row	Exist.	Elec		4.7		5.7		6.8
	Upgrade 5	Crawlspace Insulation	Detached	New	Elec		2.0		2.5		3.0
	Upgrade 5	Crawlspace Insulation	Row	New	Elec		3.5		4.3		5.1
	Upgrade 5	Crawlspace Insulation	Detached	Exist.	Elec		2.2		2.7		3.2
	Upgrade 5	Crawlspace Insulation	Row	Exist.	Elec		4.0		4.9		5.9
	Upgrade 6	Air leakage sealing	Detached	New	Elec		8.9		9.8		10.7
	Upgrade 6	Air leakage sealing	Row	New	Elec		9.8		10.8		11.8
	Upgrade 6	Air leakage sealing	Detached	Exist.	Elec		9.1		10.2		11.4
	Upgrade 6	Air leakage sealing	Row	Exist.	Elec		10.1		11.3		12.6

Exhibit 4.2: Residential Energy-efficiency Technologies and Measures – Cost of Conserved Energy (cont'd)

End Use		Technology	Dwelling Type	Vintage	Sp heating fuel	CCEs (¢/kWh)					
						4.0% DR		6.0% DR		8.0% DR	
						Full	Incr.	Full	Incr.	Full	Incr.
Existing Building Envelope - Labrador Interconnected	Upgrade 1	High-performance glazings	Detached	New	Elec		2.6		3.2		3.8
	Upgrade 1	High-performance glazings	Row	New	Elec		2.4		2.9		3.5
	Upgrade 1	High-performance glazings	Detached	Exist.	Elec		2.5		3.1		3.7
	Upgrade 1	High-performance glazings	Row	Exist.	Elec		2.4		3.0		3.5
	Upgrade 2	ENERGYSTAR glazings	Detached	New	Elec		1.0		1.2		1.4
	Upgrade 2	ENERGYSTAR glazings	Row	New	Elec		0.9		1.1		1.4
	Upgrade 2	ENERGYSTAR glazings	Detached	Exist.	Elec		1.7		2.1		2.5
	Upgrade 2	ENERGYSTAR glazings	Row	Exist.	Elec		1.9		2.3		2.7
	Upgrade 3	Wall Insulation	Detached	New	Elec		12.8		15.7		18.8
	Upgrade 3	Wall Insulation	Row	New	Elec		9.2		11.2		13.5
	Upgrade 3	Wall Insulation	Detached	Exist.	Elec		4.4		5.3		6.4
	Upgrade 3	Wall Insulation	Row	Exist.	Elec		5.5		6.7		8.1
	Upgrade 4	Attic Insulation	Detached	New	Elec		6.8		8.3		9.9
	Upgrade 4	Attic Insulation	Row	New	Elec		6.0		7.3		8.8
	Upgrade 4	Attic Insulation	Detached	Exist.	Elec		2.5		3.1		3.7
	Upgrade 4	Attic Insulation	Row	Exist.	Elec		3.1		3.8		4.6
	Upgrade 5	Foundation Insulation	Detached	New	Elec		1.6		2.0		2.3
	Upgrade 5	Foundation Insulation	Row	New	Elec		1.0		1.2		1.4
	Upgrade 5	Foundation Insulation	Detached	Exist.	Elec		2.0		2.4		2.9
	Upgrade 5	Foundation Insulation	Row	Exist.	Elec		1.5		1.9		2.2
	Upgrade 5	Crawlspace Insulation	Detached	New	Elec		1.0		1.2		1.4
	Upgrade 5	Crawlspace Insulation	Row	New	Elec		1.8		2.2		2.6
	Upgrade 5	Crawlspace Insulation	Detached	Exist.	Elec		1.3		1.6		1.9
	Upgrade 5	Crawlspace Insulation	Row	Exist.	Elec		2.3		2.9		3.4
	Upgrade 6	Air leakage sealing	Detached	New	Elec		3.0		3.2		3.5
	Upgrade 6	Air leakage sealing	Row	New	Elec		3.2		3.5		3.8
	Upgrade 6	Air leakage sealing	Detached	Exist.	Elec		3.7		4.1		4.6
	Upgrade 6	Air leakage sealing	Row	Exist.	Elec		3.9		4.4		4.9
Space Heating and Ventilation Equipment	Upgrade 1	Prog. Tstat - High Cons.	All Detachments	New & Exist.	Elec	0.5		0.6		0.6	
	Upgrade 1	Prog. Tstat - Med Cons.	All Detachments	New & Exist.	Elec	1.0		1.2		1.3	
	Upgrade 1	Prog. Tstat - Low Cons.	All Detachments	New & Exist.	Elec	1.6		1.7		1.9	
	Upgrade 1	Eff. Tstat - High Cons.	All Detachments	New & Exist.	Elec	0.4		0.5		0.5	
	Upgrade 1	Eff. Tstat - Med Cons.	All Detachments	New & Exist.	Elec	0.9		1.0		1.1	
	Upgrade 1	Eff. Tstat - Low Cons.	All Detachments	New & Exist.	Elec	1.3		1.5		1.7	
	Upgrade 1	Air source heat pump	All Detachments - Island	New	Elec	11.7	9.6	13.9	11.4	16.2	13.3
	Upgrade 2	Air source heat pump	All Detachments - Lab	New	Elec	4.7	3.9	5.6	4.6	6.6	5.4
	Upgrade 3	Ground source heat pump	All Detachments - Island	New	Elec	18.0	16.4	21.4	19.4	25.0	22.7
	Upgrade 1	Ground source heat pump	All Detachments - Lab	New	Elec	7.3	6.6	8.6	7.9	10.1	9.2
	Upgrade 3	Integrated Space/DHW heating	All Detachments - Island	New	Elec	15.7	14.4	18.6	17.0	21.8	19.9
	Upgrade 1	Integrated Space/DHW heating	All Detachments - Lab	New	Elec	7.1	6.5	8.4	7.7	9.8	9.0

Exhibit 4.2: Residential Energy-efficiency Technologies and Measures – Cost of Conserved Energy (cont'd)

End Use		Technology	Dwelling Type	Vintage	Sp heating fuel	CCEs (¢/kWh) 4.0% DR Full	4.0% DR Incr.	6.0% DR Full	6.0% DR Incr.	8.0% DR Full	8.0% DR Incr.
Space Heating and Ventilation Equipment	Upgrade1	Electronically commutated permanent magnet motors (ECPM) - High Cons	Detached/Attached	New/Existing	Elec. & Non-elec.		3.7		4.4		5.1
	Upgrade1	Electronically commutated permanent magnet motors (ECPM) - Low Cons	Detached/Attached	New/Existing	Elec. & Non-elec.		7.4		8.7		10.2
	Upgrade1	Electronically commutated permanent magnet motors (ECPM) - Continuous	Detached/Attached	New/Existing	Elec. & Non-elec.		0.9		1.1		1.3
	Upgrade2	Heat Recovery Ventilator - High Cons	Detached/Attached	New & Exist.	Elec. & Non-elec.	15.2	3.1	17.4	3.6	19.7	4.1
	Upgrade2	Heat Recovery Ventilator - Med Cons	Detached/Attached	New & Exist.	Elec. & Non-elec.	35.1	7.2	40.2	8.3	45.6	9.4
	Upgrade2	Heat Recovery Ventilator - Low Cons	Detached/Attached	New & Exist.	Elec. & Non-elec.	39.7	8.2	45.4	9.4	51.5	10.6
Domestic Hot Water	Upgrade1	Efficient shower/faucet	All Detachments	Exist.	Elec DHW	0.9		1.0		1.1	
	Upgrade2	DHW tank insulation	Detached	New & Exist.	Elec DHW	1.9	1.9	2.1	2.1	2.3	2.3
	Upgrade2	DHW tank insulation	Attached	New & Exist.	Elec DHW	4.1	4.1	4.5	4.5	5.0	5.0
	Upgrade 3	Heat trap	All Detachments	New & Exist.	Elec DHW	18.4	18.4	19.2	19.2	20.1	20.1
	Upgrade 4	Pipe Insulation	Detached/Attached	New & Exist.	Elec DHW	0.4	0.4	0.4	0.4	0.5	0.5
Major Appliances	Upgrade 1	Energy Star top-loading clothes washer + Dryer energy	All Detachments	New & Exist.	Elec DHW		7.5		8.6		9.8
	Upgrade 2	Horizontal axis clothes washer + Dryer Energy	All Detachments	New & Exist.	Elec DHW		16.6		19.0		21.5
	Upgrade 3	New Energy Star dishwasher	All Detachments	New & Exist.	Elec DHW		17.4		19.6		21.9
	Upgrade 4	Highest efficiency dishwasher	All Detachments	New & Exist.	Elec DHW		1.5		1.7		1.9
	Upgrade 5	Energy Star 18 Cu Ft New	Detached/Attached	New & Exist.	Elec. & Non-elec.		4.5		5.2		6.1
	Upgrade 6	Highest efficiency refrigerator	Detached/Attached	New & Exist.	Elec. & Non-elec.		74.1		88.1		103.2
	Upgrade 7	Energy Star compact	Apartment	New & Exist.	Elec. & Non-elec.		4.3		5.1		5.9
	Upgrade 8	High efficiency freezer	Detached/Attached	New & Exist.	Elec. & Non-elec.		7.6		8.9		10.3
	Upgrade 9	High efficiency freezer	Apartment	New & Exist.	Elec. & Non-elec.		12.5		14.6		16.9
	Upgrade 10	Microwave/convection oven	All Detachments				50.6		59.9		70.0
Household Electronics	Upgrade 1	ENERGY STAR Computer	All Detachments	New & Exist.	Elec. & Non-elec.		0.0		0.0		0.0
	Upgrade 2	LCD monitors	All Detachments	New & Exist.	Elec. & Non-elec.		-0.8		0.1		1.0
	Upgrade 3	ENERGY STAR television	All Detachments	New & Exist.	Elec.		4.9		5.8		6.8
	Upgrade 3	LCD Television	All Detachments	New & Exist.	Elec.		29.0		34.3		40.1
	Upgrade 4	Miscellaneous reduced standby	All Detachments	New & Exist.	Elec. & Non-elec.		1.4		1.6		1.9
New Building Design	Upgrade 1	R2000 housing	Detached	New	Elec.	252.4	6.8	317.1	8.5	387.8	10.4
	Upgrade 2	EGH 80	Detached	New	Elec.	249.4	3.7	313.3	4.6	383.0	5.7
Fuel Switching	Upgrade 1	Oil Furnace, New Island Detached	Detached	New	Elec.		13.6		14.1		14.6
	Upgrade 1	Oil Furnace, New Labrador Detached	Detached	New	Elec.		10.8		11.0		11.2
	Upgrade 1	Oil Furnace, New Island Attached	Attached	New	Elec.		12.8		13.2		13.7
	Upgrade 1	Oil Furnace, New Labrador Attached	Attached	New	Elec.		10.2		10.4		10.6
	Upgrade 2	Propane Cooking Range	All Detachments	New & Exist.	Elec.		49.0		50.3		51.8

Exhibit 4.3: Commercial (Apartment Buildings) Energy-efficiency Technologies and Measures – Cost of Conserved Energy[104]

Measure/Technology			Vintage	CCEs (¢/kWh)					
				4.0% DR		6.0% DR		8.0% DR	
				Full	Incr.	Full	Incr.	Full	Incr.
Lighting	T12	Standard T8s	Existing	5.4	0.0	6.3	0.0	7.2	0.0
		Low BF T8s	Existing	3.9	0.0	4.6	0.0	5.2	0.0
		High-performance T8s	Existing	4.2	0.5	4.9	0.7	5.7	0.8
		Redesign with standard T8s	Existing	5.1	-2.0	5.9	-2.3	6.8	-2.6
		Redesign with high-performance T8s	Existing	4.9	-1.3	5.6	-1.6	6.4	-1.8
	T8	High-performance T8s	Existing & New	13.1	1.7	15.3	2.1	17.6	2.5
		Redesign with high-performance T8s	Existing & New	8.4	0.0	9.8	0.0	11.2	0.0
		Fully integrated lighting and controls	Existing & New	29.6	22.0	34.3	25.4	39.3	29.2
		Occupancy sensors	Existing & New	6.0	4.3	6.6	4.7	7.2	5.1
	Inc	Compact fluorescent lamps	Existing & New	2.7	-1.1	2.9	-1.0	3.2	-0.8
		Induction lighting	Existing & New	4.5	0.4	4.9	0.7	5.4	1.1
		White LEDs	Existing & New	0.1	-3.5	0.4	-3.2	0.8	-2.8
		Halogen IR	Existing & New	10.1	-4.8	10.5	-4.7	10.8	-4.6
		Ceramic metal halide	Existing & New	4.7	-4.6	5.1	-4.4	5.6	-4.1
		LED exit signs	Existing	1.7	na	2.0	na	2.4	na
	HID	Pulse-start metal halide	Existing & New	9.5	0.3	10.9	0.3	12.5	0.4
		High intensity fluorescents	Existing & New	4.1	0.4	4.8	0.5	5.4	0.5
HVAC		Low temperature heat pumps - Island	Existing & New	na	5.5	na	6.0	na	6.6
		Low temperature heat pumps - Labrador	Existing & New	na	4.8	na	5.3	na	5.8
		Ground source heat pumps - Island	Existing & New	na	6.2	na	7.3	na	8.6
		Ground source heat pumps - Labrador	Existing & New	na	4.5	na	5.4	na	6.3
		Infrared heaters - Island	Existing & New	6.7	6.7	7.4	7.4	8.1	8.1
		Infrared heaters - Labrador	Existing & New	4.8	4.8	5.3	5.3	5.8	5.8
		High-efficiency chillers - Island	Existing & New	na	6.1	na	7.4	na	8.9
		High-efficiency chillers - Labrador	Existing & New	na	8.1	na	9.9	na	11.8
		High-efficiency AC units - Island	Existing & New	na	11.3	na	12.9	na	14.7
		High-efficiency AC units - Labrador	Existing & New	na	18.7	na	21.5	na	24.3
		Adjustable speed drives	Existing & New	5.0	5.0	5.6	5.6	6.1	6.1
		Premium efficiency motors	Existing & New	19.5	2.9	21.5	3.2	23.5	3.6
		Building recommissioning	Existing	4.0	na	4.3	na	4.5	na
		Advanced BAS	Existing & New	4.3	na	4.7	na	5.1	na
		Programmable thermostats - Island	Existing & New	1.8	0.9	2.0	1.0	2.2	1.1
		Programmable thermostats - Labrador	Existing & New	1.6	0.8	1.8	0.9	1.9	1.0
DHW		Low-flow aerators & shower heads	Existing & New	2.6	na	2.8	na	2.9	na
		Tankless water heaters	Existing & New	na	37.4	na	41.2	na	45.2
Building Envelope		High-performance glazings - Island	Existing & New	na	5.5	na	6.5	na	7.5
		High-performance glazings - Labrador	Existing & New	na	3.3	na	4.0	na	4.6
		Wall insulation - Island	Existing & New	na	6.0	na	7.4	na	8.8
		Wall insulation - Labrador	Existing & New	na	4.2	na	5.1	na	6.1
		Roof insulation - Island	Existing & New	na	6.9	na	8.5	na	10.1
		Roof insulation - Labrador	Existing & New	na	4.4	na	5.3	na	6.4
		Air curtains - Island	Existing & New	5.1	5.1	5.8	5.8	6.6	6.6
		Air curtains - Labrador	Existing & New	3.3	3.3	3.8	3.8	4.3	4.3
New Construction		New buildings - 25% more efficient	New	na	0.9	na	1.1	na	1.4
		New buildings - 40% more efficient	New	na	2.5	na	3.1	na	3.8

104 This exhibit is produced from the measure summary in the Commercial report.

4.5 PEAK LOAD REDUCTION MEASURES

4.5.1 Overview

Electric utilities are typically interested in peak load reduction measures as a means to avoid or defer the costs of capacity expansion. Capacity costs refer to a wide range of capital-based investments, including generating stations (new and upgraded), transmission lines, distribution lines, substations, transformers and other infrastructure required to deliver power.

From the customer's perspective, adoption of peak load reduction measures is typically dependent on the overall benefits to them, such as direct incentive payments or rate benefits. Under most current rate structures, residential customers are billed only for electricity (kWh) regardless of when it is used, and not for "demand." Consequently, in the absence of specific peak-based rate structures, peak load reduction measures that do not also reduce overall energy consumption do not provide financial benefits to customers.

The current trend throughout much of the North American utility industry is towards more specific pricing, such as time-of-use and even hourly pricing, or peak incentives that pass along some of the utility benefits to customers on a performance basis. These new pricing structures provide incentive for even residential customers to implement measures or to participate in utility peak load reduction programs, as long as the differential between peak and off-peak prices is sufficient to provide a noticeable financial benefit to the customer. To date, effective implementation of many of the potential peak load reduction options has been limited by the availability and cost of suitable metering and data communications technology.

Currently, several Canadian jurisdictions[105] are in the early stages of implementing pilot Residential sector load reduction initiatives. These initiatives are designed to test:

- New metering technologies, such as advanced meters (also referred to as "smart meters")
- New rate structures, such as real-time feedback, pay-as-you-go billing and critical peak pricing
- Direct load control.

Most conventional meters monitor electricity consumption (kWh) but do not track *when* the electricity is used. Instead, conventional meters are occasionally read and reported to electric utilities, which then bill customers every one or two months. As a result, customers only find out their electricity usage after the fact.

In contrast, advanced meters (known in some industry circles as "smart meters") record how much electricity is used and when. Advanced meters, through their interval metering

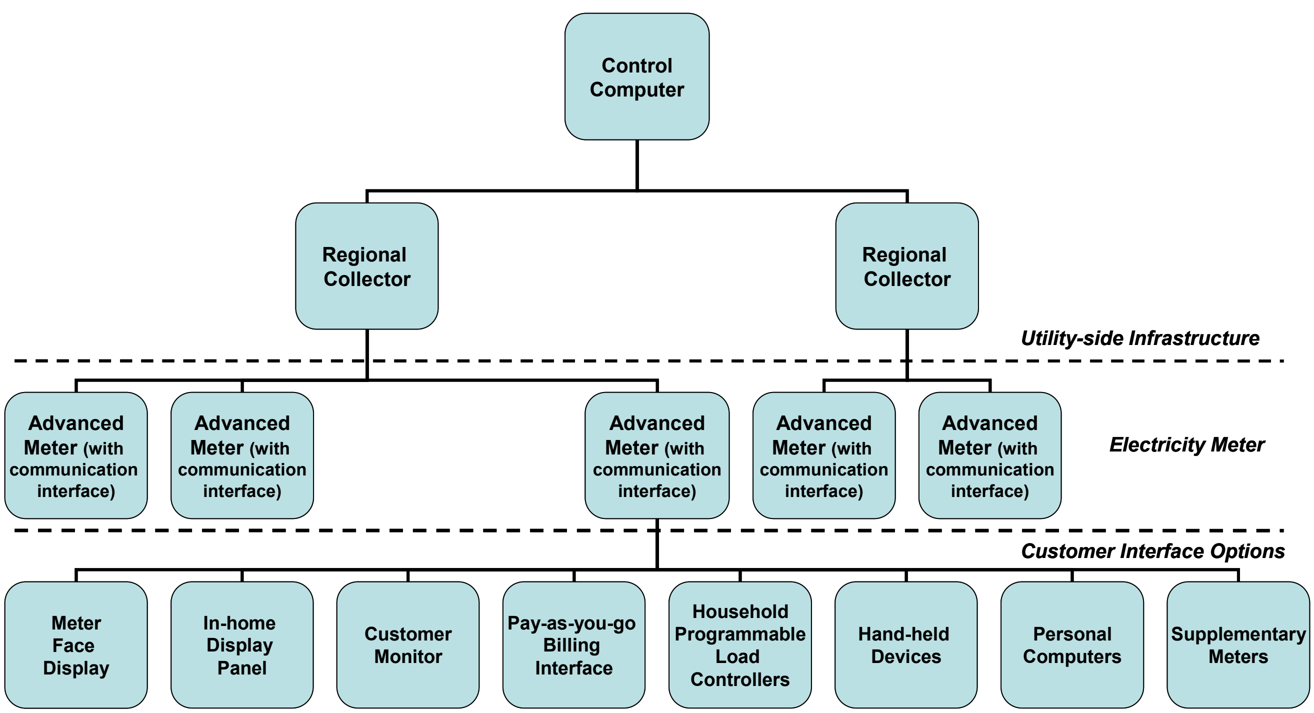
[105] Marbek Resource Consultants; *Technology & Market Assessment of Residential Electricity Advanced Metering In Canada*. Prepared for Natural Resources Canada, November 2006.

and two-way communications, allow the implementation of numerous utility programs and services that encourage customers to reduce or shift (i.e., change the time of) their electricity consumption, particularly away from peak times when the cost of supply is becoming increasingly more expensive.

Exhibit 4.4 presents an illustrative schematic of an advanced metering system. As illustrated, there are three major levels of system components:

- **Customer Interface Options** — The hardware interfaces that can be used for the advanced meter to communicate with the customer and, to a certain extent, any applicable electrical load controllers in the customer's household.
- **Electricity Meter** — The advanced meter itself, equipped with a communication interface to facilitate communication to other devices and the utility.
- **Utility-side Infrastructure** — The infrastructure required for two-way communication between the utility and the advanced meter.[106]

Exhibit 4.4: Illustrative Schematic of an Advanced Metering System



[106] Ibid, *Technology & Market Assessment of Residential Electricity Advanced Metering In Canada*. page 4

As illustrated in Exhibit 4.4, there is wide range of technical options available at each level in a typical advanced metering system. This is particularly the case at the customer interface level where there is a growing number of devices that can be used to provide real-time feedback to customers in a convenient and understandable manner. Typically, these devices provide a numerical or graphical display that is either wired into the same room as the meter, wired next to the main thermostat, or is a wireless panel that can be placed anywhere in the home. Alone, none of these devices save energy per se, though the information provided may enable consumer behaviour change.

In summary, new electric metering and customer interface technologies, when combined with the applicable utility infrastructure, have the potential to support a wide range of utility-sponsored peak load reduction and load shifting initiatives via pricing and promotional initiatives. Within the agreed study scope, it is not feasible to provide further specific rate design or system infrastructure specifications. However, further information is provided below on selected direct load control options.

4.5.2 Peak Load Reduction Measures – Direct Load Control

Consistent with the agreed study scope, the information provided below is based on existing secondary data sources and does not include a detailed analysis of specific peak load conditions of the Utilities. Much of the information provided draws from work that the consultant team recently completed for BC Hydro.[107] To that end, the material presented is intended to be indicative of general trends and costs but would also need to be adjusted for specific application to NLH/NP peak load conditions.[108]

The remainder of this subsection provides an overview of the following Residential sector peak load reduction measures:

- Utility control of space heating equipment using remote thermostat or switch
- Utility control of DHW heater using remote switch.

❑ **Utility-Based Control of Space Heating Equipment**

Utility-based control of space heating equipment can be thermostat-based or switch-based. Thermostat-based control typically applies to those applications where there is one thermostat that controls a central furnace (or air conditioner) that provides space conditioning for the entire home. Switch-based control, on the other hand, applies to those applications where space heating is provided by baseboard heaters with individual (or multiple) thermostats. As virtually all of the residential electric space heating in Newfoundland and Labrador is baseboard heating, the remainder of this discussion focuses on switch-based space heating load control.

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[107] Marbek Resource Consultants and Applied Energy Group. *BC Hydro Conservation Potential Review – 2007*. Prepared for BC Hydro, 2007.

[108] As both BC Hydro and NLH/NP are winter peaking utilities and both are hydro-based with fossil fuel plants serving peak load conditions, the information provided is expected to be generally applicable to the NLH/NP context.

Switch-based space heating load control is accomplished by the installation of a remote control switch on either the heating unit itself or on the circuits controlling the heating unit. This measure primarily addresses units where temperature control is on each room unit, without a central thermostat capability. Typically this would include baseboard units with individual controls or where one or more units are controlled from an electrical circuit. Typically, units are not shut off for the entire control period but rather "cycled" to limit the on time to a predetermined number of minutes per control cycle. Installations are also equipped with an owner-operated override to ensure that the customer's comfort is not adversely impacted.

The control technology is commercially available and has been implemented in millions of sites in the U.S. However, in the overwhelming majority of applications, this control technology has been applied to air conditioning loads, not space heating loads.

The research conducted for the BC Hydro study[109] noted that switches cost approximately $285 ($170 device plus $115 installation), plus 10% annual equipment maintenance ($12/year). The installation cost is higher for the switch because it involves a high voltage connection and would thus require a higher skilled installer (in many locales this would be a licensed electrician). Installation costs are the same in both new and existing homes.

Actual peak load reduction is difficult to predict due to the impacts of customer override to mitigate adverse comfort impacts, which depend heavily on the degree of over- or under-sizing of the units as well as the overall thermal characteristics of the home. Override control is critical to ensure that customers with undersized systems, poor insulation or low tolerance for cold would not be too adversely affected.

On a household basis, the BC Hydro study concluded that the potential peak load reduction (during the 8 am to 1 pm period on a typical winter peak day) would be in the range of 0.74-0.92 kW per single-family dwelling (annual space heat load of about 13,000 kWh), assuming a comparable level of overrides and system failures to current thermostat programs. Previous experience has also shown that reductions may erode over time due to a number of factors, including signal strength losses and customer overrides.

Based on a one-time cost of approximately $285 ($170 device plus $115 installation), plus 10% annual equipment maintenance ($12/year), and estimated annual impacts of 0.74-0.92 kW per household, the BC Hydro study estimated that the cost would be in the range of about $30-$40[110] per kW/year when applied to single-family dwellings with 100% electric fuel use. Utility infrastructure costs as well as program promotion or incentive costs are in addition.

Caveat

The experience in this technology has primarily been for central air conditioning and water heater load control. As there are no customer benefits inherent in the technology, a

[109] Op. cit., BC Hydro Conservation Potential Review – 2007, p. 140.
[110] Assumes 15-year life, 6% discount rate.

cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both).

- ❑ **Utility Control of Domestic Hot Water Heater Using Remote Switch**

Switch-based water heater load control is accomplished by the installation of a remote control switch on either the water heater itself or on the circuits controlling the water heater. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the water heater under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In the systems that are currently offered, pager-based communications is used. An even more economic solution is to piggyback off an existing communications system. For example, if space heat control already exists, water heat control can be added via a hard-wired or wireless connection. This can reduce the total cost of the water heater control by up to 40%.

Depending upon the length of the control and the size of the water heater tank, units can be shut off for the entire control period or "cycled" to limit the on time to a predetermined number of minutes per control cycle. Water heat control is commercially available and implemented in hundreds of thousands of sites in the U.S.

Applicable dwelling types should have a water heater that has at least a 40-gallon tank. The size of the tank is important because it provides hot water during times when the control is in effect. The larger the water heater tank, the longer the control can be in place without disrupting the customer's comfort.

Switches cost about $100 per unit, plus $150 for installation, plus maintenance. Costs are reduced to $150 (i.e., $50 incremental installation) if the control switch can be added to an existing control system at the same time, including one-way/two-way thermostats and switches for space heating. Installation costs are the same in both new and existing homes.[111]

On a household basis, the BC Hydro study concluded that the potential peak load reduction (during the 8 am to 1 pm period on a typical winter peak day) would be about 0.66 kW. This assumes annual DHW electricity consumption of about 3,300 kWh/yr. per household.

Based on a one-time cost of approximately $250, ongoing maintenance of 5% (about $12/year) and estimated annual impacts of 0.63-0.70 kW, the BC Hydro study estimated that the cost would be in the range of about $49-$55[112] per kW/year when applied to single-family dwellings. As an incremental option to space heating load control, the installation costs would be reduced by $100 and the resulting cost of electric peak reduction (CEPR) would be $35-$39 per kW. Utility infrastructure costs as well as program promotion or incentive costs are in addition.

[111] Op. cit., BC Hydro Conservation Potential Review – 2007, p. 146.
[112] Assumes 15-year life, 6% discount rate.

Because there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way thermostat systems due to the lack of confirmation and higher incidence of removals and failures.

Caveat

This water heater control measure would not provide customers with any ancillary benefits and thus the only incentive for their participation would be monetary, likely on a per annum or per control event basis.

5. ECONOMIC POTENTIAL ELECTRICITY FORECAST

5.1 INTRODUCTION

This section presents the Residential sector Economic Potential Forecast for the study period 2006 to 2026. The Economic Potential Forecast estimates the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the long run avoided cost of electricity in the Newfoundland Labrador service area. In this study, "cost effective" means that the technology upgrade cost, referred to as the cost of conserved energy (CCE) in the preceding section, is equal to, or less than, the economic screen.[113]

The discussion in this section is organized according to the following sub sections:

- Avoided Cost Used for Screening
- Major Modelling Tasks
- Technologies Included in Economic Potential Forecast
- Summary of Results
- CDM Measure Supply Curves.

5.2 AVOIDED COST USED FOR SCREENING

NLH has determined that the primary avoided costs of new electricity supply to be used for this analysis are $0.0980/kWh for the Island and Isolated service region and $0.0432/kWh for the Labrador Interconnected service region. These avoided costs represent a future in which the Lower Churchill project is not built and there is no DC link from Labrador to the Island.[114]

Therefore, the Economic Potential Forecast incorporates all the CDM measures reviewed in Section 4 that have a CCE equal to or less than the avoided costs.

NLH is currently studying the Lower Churchill/DC Link project. However, a decision on whether to proceed is not expected until 2009 and, even if the project proceeds, the earliest completion date would be in late 2014. This means that, regardless of the decision, the avoided cost values shown above will be in effect until the approximate mid point of the study period.

If the Lower Churchill/DC Link project does proceed, the avoided costs presented above are expected to change. To provide insight into the potential impacts of the Lower Churchill/DC Link project on this study, it was agreed that the consultants would provide a high-level sensitivity analysis.

[113] Costs related to program design and implementation are not yet included.
[114] The avoided costs draw on the results of the earlier study conducted by NERA Economic Consulting, which is entitled: Newfoundland and Labrador Hydro. *Marginal Costs of Generation and Transmission*. May 2006. The avoided costs used in this study include generation, transmission and distribution.

5.3 MAJOR MODELLING TASKS

By comparing the results of the Residential sector Economic Potential Electricity Forecast with the Reference Case, it is possible to determine the aggregate level of potential electricity savings within the Residential sector, as well as identify which specific dwelling and end uses provide the most significant opportunities for savings.

To develop the Residential sector Economic Potential Forecast, the following tasks were completed:

- The CCE for each of the energy-efficient upgrades presented in Exhibits 4.2 and 4.3 were reviewed, using the 6% (real) discount rate. [115]

- Technology upgrades that had a CCE equal to, or less than, the avoided cost threshold were selected for inclusion in the economic potential scenario, either on a "full cost" or "incremental" basis. It is assumed that technical upgrades having a "full cost" CCE that met the cost threshold were implemented in the first forecast year. It is assumed that those upgrades that only met the cost threshold on an "incremental" basis are being introduced more slowly as the existing stock reaches the end of its useful life.

- Electricity use within each of the dwelling types was modelled with the same energy models used to generate the Reference Case. However, for this forecast, the remaining "baseline" technologies included in the Reference Case forecast were replaced with the most efficient "technology upgrade option" and associated performance efficiency that met the cost threshold of $0.0980/kWh for the Island and Isolated service region and $0.0432/kWh for the Labrador Interconnected service region.

- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the electrical load. For example, measures to reduce the overall DHW load (e.g., low-flow showerheads and more efficient dishwashers) were applied before the heat pump water heater. Similarly, the cost effectiveness of the heat pump water heater was tested at the new, lower annual load and included only if it continued to meet the CCE threshold.

- The economic potential analysis includes full consideration of interaction between measures and interaction between end uses. Measures applied to the same end use are applied sequentially, so that there is no "double-counting" of savings. The second measure applied to an end use takes its savings from the energy consumption remaining after the first measure has been applied. Interaction between end uses affects space heating, because measures that reduce internal loads (lighting, appliances, electronics, etc.) tend to increase the space heating consumption. In extreme cases, where few space heating measures are applied and the savings in other end uses are large, the space heating may actually increase.

[115] See Section 4.2.

- A sensitivity analysis was conducted using preliminary avoided cost values that assume development of the Lower Churchill/DC Link.

5.4 TECHNOLOGIES INCLUDED IN ECONOMIC POTENTIAL FORECAST

Exhibits 5.1 and 5.2 provide a listing of the technologies selected for inclusion in this forecast for, respectively, the Island and Isolated and Labrador Interconnected service regions. In each case, the exhibits show the following:

- End use affected
- Upgrade option(s) selected
- Dwelling types to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

Exhibit 5.1: Technologies Included in Economic Potential Forecast for the Island and Isolated Service Region

End Use	Upgrade Option	Applicability of Upgrade Options by Dwelling Type	Rate of Stock Introduction
Existing Building Envelope	ENERGY STAR Windows	Detached and Attached	New construction, immediate Existing homes, at rate of window replacement
	Super high-performance windows	Detached and Attached	New construction, immediate Existing homes, at rate of window replacement
	Air leakage sealing	Detached and Attached	Immediate
	Attic insulation	Detached and Attached	Immediate
	Wall insulation	Detached and Attached	Immediate where insulation can be blown in; where rigid foam external insulation is needed, at rate of siding replacement
	Foundation insulation	Detached and Attached	At rate of installation or replacement of finished basement walls
New Building Design	New house designed to an EG80 rating	Detached and Attached	Immediate
	New apartment building designed to 40% better energy consumption than current standard	Apartment	Immediate
Space Heating and Ventilation Equipment	Efficient (programmable and highly accurate) thermostats	All Residential	Immediate
	High-efficiency HRV	Detached and Attached	New construction, immediate Existing homes, at rate of unit replacement
	Cold climate heat pumps	Apartment	Immediate in new construction
Domestic Hot Water	DHW pipe wrap	Detached and Attached	Immediate
	Low-flow shower heads and faucets	All Residential	Immediate
Major Appliances	ENERGY STAR fridge	All Residential	At rate of unit replacement
	Energy-efficient freezer	All Residential	At rate of unit replacement
	ENERGY STAR top loading clothes washer	All Residential	At rate of unit replacement
Lighting	CFLs, including both standard and specialized	All Residential	Immediate
	LED holiday lights	All Residential	At rate of unit replacement
	Outdoor lighting timer	Detached and Attached	Immediate
	Motion sensor	Detached and Attached	Immediate
	T8 lighting in common areas	Apartment	New construction, immediate Existing, at rate of renovation
Computers & Peripherals	ENERGY STAR computer	All Residential	At rate of unit replacement
	Reduce standby losses	All Residential	Immediate
Television	ENERGY STAR TV	All Residential	At rate of unit replacement
	Reduce standby losses	All Residential	Immediate

End Use	Upgrade Option	Applicability of Upgrade Options by Dwelling Type	Rate of Stock Introduction
Television Peripherals	Reduce standby losses	All Residential	Immediate
Other Electronics	Reduce standby losses	All Residential	Immediate

Exhibit 5.2: Technologies Included in Economic Potential Forecast for the Labrador Interconnected Service Region

End Use	Upgrade Option	Applicability of Upgrade Options by Dwelling Type	Rate of Stock Introduction
Existing Building Envelope	ENERGY STAR Windows	Detached and Attached	New construction, immediate Existing homes, at rate of window replacement
	Super high-performance windows	Detached and Attached	New construction, immediate Existing homes, at rate of window replacement
	Air leakage sealing	Detached and Attached	Immediate
	Attic insulation	Detached and Attached	Immediate
	Wall insulation	Detached and Attached	Immediate where insulation can be blown in; where rigid foam external insulation is needed, at rate of siding replacement
	Foundation insulation	Detached and Attached	At rate of installation or replacement of finished basement walls
Space Heating and Ventilation Equipment	Efficient (programmable and highly accurate) thermostats	All Residential	Immediate
	Cold climate heat pumps	Apartment	Immediate in new construction
Domestic Hot Water	DHW pipe wrap	Detached and Attached	Immediate
	Low-flow shower heads and faucets	All Residential	Immediate
Lighting	CFLs, standard only	All Residential	Immediate
	Outdoor lighting timer	Detached and Attached	Immediate
	Motion sensor	Detached and Attached	Immediate
	T8 lighting in common areas	Apartment	New construction, immediate Existing, at rate of renovation
Computers & Peripherals	ENERGY STAR computer	All Residential	At rate of unit replacement
	Reduce standby losses	All Residential	Immediate
Television	Reduce standby losses	All Residential	Immediate
Television Peripherals	Reduce standby losses	All Residential	Immediate
Other Electronics	Reduce standby losses	All Residential	Immediate

5.5 SUMMARY OF RESULTS[116]

This section compares the Reference Case and Economic Potential Electricity Forecast levels of residential electricity consumption for the two service regions. In each case, the results are presented as electricity savings that would occur at the customer's point-of-use. The results are presented in the following exhibits:

- Exhibits 5.3 and 5.4 present the results by end use, dwelling type and milestone year for, respectively, the Island and Isolated and Labrador Interconnected service regions.

[116] All results are reported at the customer's point-of-use and do not include line losses.

Exhibit 5.3: Total Potential Electricity Savings by End Use, Dwelling Type and Milestone Year for the Island and Isolated Service Region (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Electronics	Small Appliances & Other
Detached	2011	330.28	48.79	2.50	35.97		0.00	0.00		0.00	0.00	138.91	23.97	4.93	73.00	2.22	
	2016	440.92	98.72	2.86	40.89		3.23	1.70		1.44	11.95	142.22	52.60	8.43	74.69	2.18	
	2021	568.49	159.79	3.21	53.98		6.63	3.65		2.90	24.04	145.00	65.73	14.34	87.11	2.11	
	2026	688.16	223.58	3.23	67.62		9.39	5.39		4.36	36.19	147.50	80.37	21.26	87.26	2.02	
Attached	2011	40.62	0.35	0.20	4.26		0.00	0.00		0.00	0.00	16.79	3.44	0.64	14.66	0.29	
	2016	54.57	5.40	0.23	4.91		0.60	0.00		0.14	1.16	17.41	7.65	1.11	15.69	0.28	
	2021	70.22	12.49	0.26	6.61		1.25	0.00		0.29	2.36	17.99	9.69	1.91	17.11	0.28	
	2026	86.25	20.63	0.27	8.44		1.78	0.00		0.44	3.59	18.55	12.01	2.87	17.39	0.27	
Apartment	2011	27.64	3.03	0.79	2.24		0.00	0.00		0.00	0.00	8.82	2.26	0.43	9.89	0.19	
	2016	38.48	5.88	0.80	3.98		0.37	0.00		0.07	0.52	9.26	5.04	0.75	11.62	0.19	
	2021	49.82	10.03	0.81	5.80		0.84	0.00		0.13	1.06	9.68	6.43	1.30	13.55	0.19	
	2026	58.07	12.25	0.82	7.68		1.30	0.00		0.21	1.62	10.17	8.01	1.97	13.85	0.19	
Isolated	2011	5.36	0.12	0.02	0.81		0.00	0.00		0.00	0.00	3.04	0.23	0.07	1.04	0.03	
	2016	6.31	0.22	0.02	0.91		0.04	0.05		0.03	0.24	3.09	0.51	0.12	1.05	0.03	
	2021	7.49	0.33	0.02	1.19		0.08	0.11		0.05	0.47	3.14	0.63	0.20	1.22	0.03	
	2026	8.52	0.44	0.02	1.48		0.11	0.16		0.08	0.71	3.19	0.77	0.30	1.22	0.03	
Other	2011	2.16	-0.10	0.01	0.00		0.00	0.00		0.00	0.00	2.26	0.00	0.00	0.00	0.00	
	2016	2.18	-0.10	0.01	0.00		0.00	0.00		0.00	0.00	2.27	0.00	0.00	0.00	0.00	
	2021	2.18	-0.10	0.01	0.00		0.00	0.00		0.00	0.00	2.27	0.00	0.00	0.00	0.00	
	2026	2.18	-0.09	0.01	0.00		0.00	0.00		0.00	0.00	2.26	0.00	0.00	0.00	0.00	
Vacant and Partial	2011	2.98	-0.12	0.01	0.00		0.00	0.00		0.00	0.00	3.09	0.00	0.00	0.00	0.00	
	2016	2.96	-0.11	0.01	0.00		0.00	0.00		0.00	0.00	3.06	0.00	0.00	0.00	0.00	
	2021	2.93	-0.11	0.01	0.00		0.00	0.00		0.00	0.00	3.03	0.00	0.00	0.00	0.00	
	2026	2.91	-0.10	0.01	0.00		0.00	0.00		0.00	0.00	3.00	0.00	0.00	0.00	0.00	
TOTAL	2011	409.05	52.07	3.51	43.28		0.00	0.00		0.00	0.00	172.91	29.89	6.07	98.59	2.73	
	2016	545.41	110.01	3.93	50.69		4.25	1.76		1.67	13.86	177.31	65.80	10.40	103.04	2.69	
	2021	701.13	182.43	4.32	67.57		8.80	3.76		3.37	27.93	181.11	82.48	17.76	118.99	2.61	
	2026	846.09	256.72	4.36	85.22		12.58	5.55		5.09	42.11	184.67	101.17	26.40	119.72	2.50	

Notes: 1) Savings for dishwasher and clothes washer are for mechanical energy only; hot water savings are reported in DHW. All savings at customer's point-of-use. 2) Any differences in totals are due to rounding. 3) Negative values in the space heating end use for "Other" and "Vacant and Partial" dwellings are a result of interaction between end uses; the reduction in internal heat gains due to lighting measures is greater than the savings from space heating measures.

Exhibit 5.4: Total Potential Electricity Savings by End Use, Dwelling Type and Milestone Year for the Labrador Interconnected Service Region (GWh/yr.)

		Residential															
Dwelling Type	Milestone Year	Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Electronics	Small Appliances & Other
Detached	2011	33.69	24.78	0.02	1.73							4.62	0.61	0.12	1.76	0.05	
	2016	40.43	31.36	0.02	1.09							4.69	1.33	0.11	1.78	0.05	
	2021	47.92	38.46	0.02	0.81							4.76	1.65	0.11	2.06	0.05	
	2026	55.82	46.22	0.02	0.53							4.82	2.01	0.11	2.06	0.05	
Attached	2011	6.39	3.29	0.01	0.53							1.42	0.21	0.04	0.87	0.02	
	2016	8.05	4.84	0.01	0.33							1.44	0.47	0.04	0.91	0.02	
	2021	9.87	6.55	0.01	0.25							1.46	0.58	0.04	0.97	0.02	
	2026	11.80	8.42	0.01	0.16							1.48	0.71	0.03	0.97	0.02	
Apartment	2011	0.60	0.11	0.01	0.06							0.20	0.02	0.01	0.20	0.00	
	2016	0.72	0.19	0.01	0.05							0.20	0.03	0.01	0.23	0.00	
	2021	0.84	0.27	0.01	0.04							0.21	0.04	0.01	0.26	0.00	
	2026	0.93	0.36	0.01	0.03							0.22	0.05	0.01	0.26	0.00	
Other	2011	0.19	0.09	0.00	0.00							0.10	0.00	0.00	0.00	0.00	
	2016	0.19	0.09	0.00	0.00							0.10	0.00	0.00	0.00	0.00	
	2021	0.20	0.10	0.00	0.00							0.10	0.00	0.00	0.00	0.00	
	2026	0.20	0.10	0.00	0.00							0.10	0.00	0.00	0.00	0.00	
TOTAL	2011	40.87	28.27	0.04	2.32							6.33	0.84	0.17	2.83	0.07	
	2016	49.39	36.48	0.04	1.47							6.43	1.83	0.16	2.91	0.07	
	2021	58.82	45.37	0.04	1.10							6.52	2.27	0.15	3.29	0.07	
	2026	68.75	55.09	0.04	0.73							6.62	2.77	0.15	3.29	0.07	

Notes: 1) Savings for dishwasher and clothes washer are for mechanical energy only; hot water savings are reported in DHW. All savings at customer's point-of-use. 2) Any differences in totals are due to rounding.

5.5.1 Interpretation of Results

Highlights of the results presented in the preceding exhibits are summarized below.

❑ **Electricity Savings by Service Region**

The Island and Isolated service region accounts for 92% of the potential savings.

❑ **Electricity Savings by Milestone Year**

Approximately 48% of the savings are available by the first milestone year because some of the efficiency upgrades are economically attractive at full replacement cost. Under the economic scenario, therefore, they are implemented immediately.

❑ **Electricity Savings by Segment**

Single-family detached dwellings account for more than 80% of the potential savings, which reflects their dominant market share within the overall Residential sector and their generally higher electrical intensity per dwelling.

❑ **Electricity Savings by End Use – Island and Isolated Service Region**

- Space heating accounts for 30% of the total electricity savings in the Economic Potential Forecast. Of this, approximately 53% come from foundation insulation, 13% come from more efficient windows, 9% come from programmable thermostats and 8% come from improved new building design. It should be noted that space heating savings are substantially reduced by decreases in internal loads associated with savings to electronics, lighting and appliances within the home.

- The new buildings account for a larger fraction of space heating savings than of other end use savings. Savings in new buildings are 37% of space heating savings, whereas savings in new buildings are 21% of overall savings. This is because the new building design measures save a disproportionate amount of space heating energy.

- Four electronic end uses (computers, televisions, television peripherals and other electronics) account for 30% of the total electricity savings in the Economic Potential Forecast. Of this, reducing standby losses accounts for 58% of the savings and ENERGY STAR computers account for 34%.

- Savings from lighting account for 22% of the total electricity savings in the Economic Potential Forecast. Of this, compact fluorescent lamps (both standard and specialized) account for over 90% of the savings.

- DHW accounts for 10% of the total electricity savings in the Economic Potential Forecast. Of this, nearly 83% are from DHW savings associated with ENERGY STAR clothes washers.

❑ **Electricity Savings by End Use – Labrador Interconnected Service Region**

- Space heating accounts for 81% of the total electricity savings in the Economic Potential Forecast. Approximately 67% of space heating savings are from foundation insulation and approximately 23% are from air leakage sealing.

- Lighting and the four electronic end uses referred to above each account for approximately 9% of the savings in the Economic Potential Forecast.

- Appliance measures are not included in the economic potential results for the Labrador Interconnected Service Region. The lower electricity rates in that region caused those measures to fail the CCE test.

5.5.2 Caveats

A systems approach was used to model the energy impacts of the CDM measures presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible. More specifically, there are two particularly important considerations:

- **More than one upgrade may affect a given end use**. For example, improved insulation reduces space heating electricity use, as does the installation of new energy-efficient windows. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of "bundles of measures" that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

- **There are interactive effects among end uses**. For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, this appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system.

- The magnitude of the interactive effects can be significant. Based on selected building energy use simulations, a 100 kWh savings in appliance or lighting electricity use could result in an increased space heating load of 50 to 70 kWh, depending on housing dwelling type and geographical location. This is higher than the ratio of approximately 0.5 more typical of other jurisdictions. It is credible that the fraction would be higher in Newfoundland and Labrador because it is dependent more on the length of the heating season than on its severity. Newfoundland and Labrador experience more months in which heating is required than most other jurisdictions in Canada. Nonetheless, given that some fraction of the heat energy from lighting and other end uses escapes to the outside, the simulation may somewhat overstate the interaction. A ratio of 0.6 has been incorporated into the model to account for this uncertainty.

5.5.3 Sensitivity Analysis – Alternative Avoided Costs

A sensitivity analysis was conducted using preliminary avoided cost values that assume development of the Lower Churchill/DC link. The sensitivity analysis reviewed the scope of measures that would pass or fail the economic screen under the changed avoided costs. Based on the preliminary avoided cost values assessed, the analysis concluded that any impacts would be modest.

5.6 CDM MEASURE SUPPLY CURVES

A supply curve was constructed for each of the two service regions based on the economic potential savings associated with the above measures. The following approach was followed:

- Measures are introduced in sequence to see incremental impact and cost
- Sequence is determined by principle of 1) reduce load 2) meeting residual load with most efficient technology
- Is organized by CCE levels.

Exhibits 5.5 and 5.6 show the supply curves for, respectively, the Island and Isolated and the Labrador Interconnected service regions. Exhibits 5.7 and 5.8 show the measures included in each of the supply curves.

Exhibits 5.5 and 5.6 both show measures with CCEs above the thresholds for the two regions. This is because the economic screening process did not consider either interaction between measures or interaction between end uses. All measures were included in the analysis if their CCE values were below the threshold, excluding interactive effects. In the economic potential analysis itself, however, these interactive effects are included in full. Measures that apply to the same end use are applied in sequence, as described above, substantially reducing the savings available to those applied later. Furthermore, measures that reduce the internal heat loads produced by lighting, electronics and appliances tend to increase the need for space heating. This space heating penalty is applied against the savings from those measures. For consistency with previous exhibits, the supply curve shows all the measures that were included in the economic potential analysis, including those that now exceed the economic threshold.

Exhibit 5.5: Supply Curve for Residential Sector, Island and Isolated Service Region, 2026

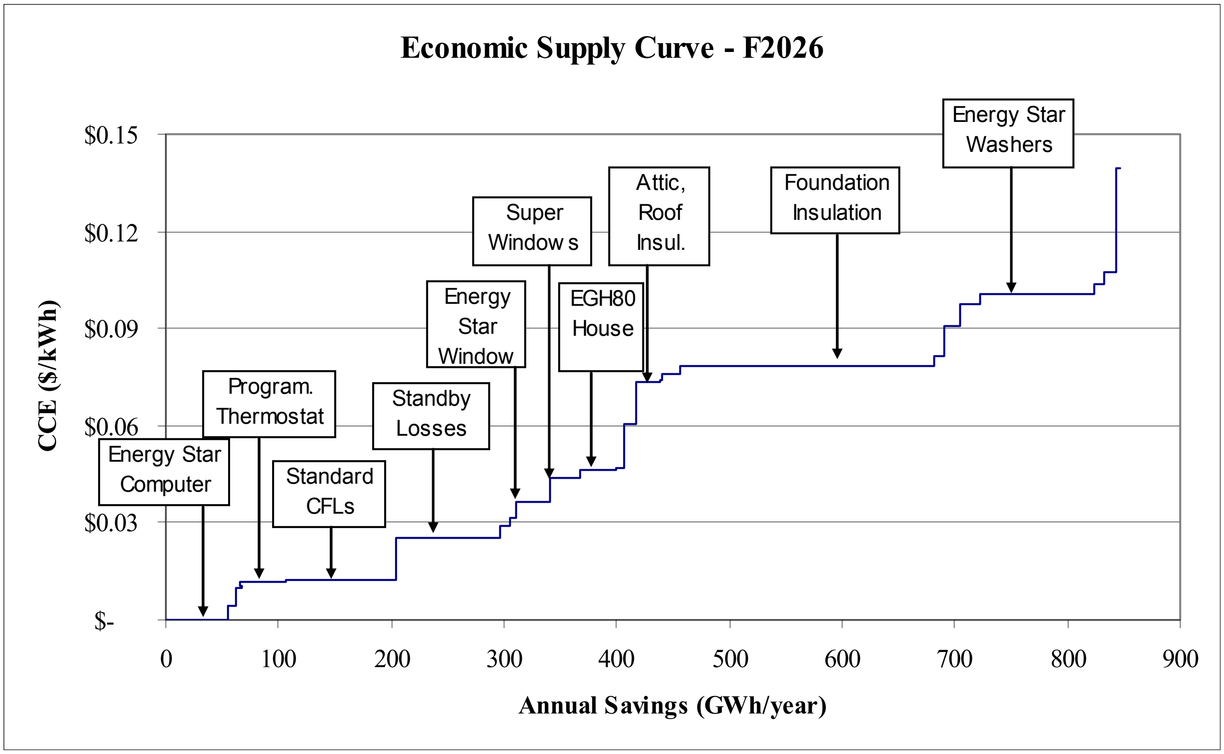


Exhibit 5.6: Supply Curve for Residential Sector, Labrador Interconnected Service Region, 2026

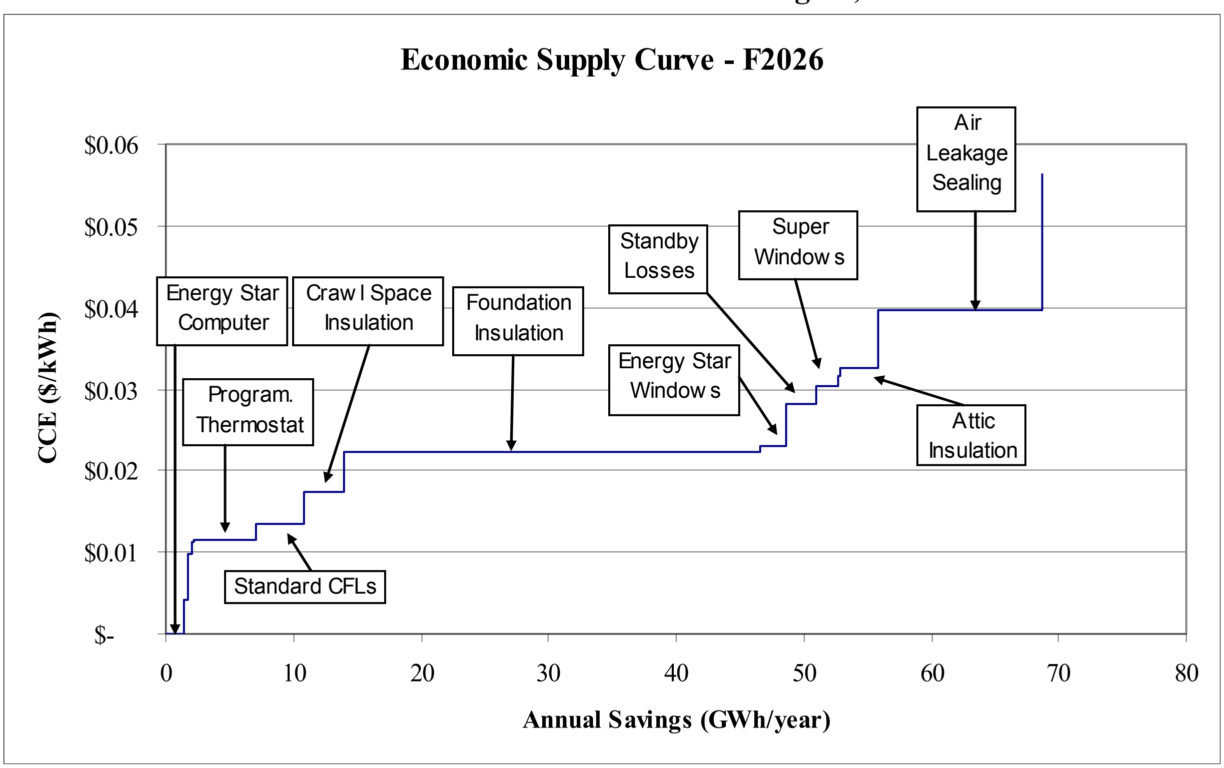


Exhibit 5.7: Summary of Residential Sector Energy-efficiency Measures, Island and Isolated Service Region 2026[117]

Measure	Average CCE ($/kWh)	Annual Savings (GWh/year)
Energy Star Computer	$0.00	55
DHW Pipe Wrap	$0.00	7
Low-Flow Showerheads and Faucets	$0.01	6
Standard T8 Lighting - Common Areas	$0.01	0.1
25% Lower Energy Apartment Building	$0.01	-1
Programmable Thermostats	$0.01	40
CFLs - Standard	$0.01	97
Standby Losses	$0.03	92
Crawl-space Insulation	$0.03	10
40% Lower Energy Apartment Building	$0.03	4
Timer	$0.03	1
Energy Star Windows , Advanced Glazing	$0.04	29
Super High Performance Windows	$0.04	28
New House Designed to an EGNH 80 Rating	$0.05	32
Building recommissioning	$0.05	6
Motion Sensor	$0.05	1
Air Source Heat Pump	$0.06	11
Ground Source Heat Pump	$0.07	0.4
Attic Insulation, Roof Insulation	$0.07	21
Wall Insulation	$0.07	1
High Efficiency HRV	$0.08	16
Foundation Insulation	$0.08	225
Energy Star Fridge	$0.08	8
Redesign with high performance T8s	$0.09	1
Energy Star TV	$0.09	13
Air Leakage Sealing	$0.10	19
Energy Star Top Loading Clothes Washer	$0.10	102
LED Holiday Lights	$0.10	9
CFLs Specialised	$0.11	10
Energy Efficient Freezer	$0.14	4

[117] The above exhibit includes measures with a CCE that exceeds the study's avoided cost threshold. The increased CCE is due to the impact of interactive effects. The measures are shown to maintain consistency with previous exhibits. The inclusion of interaction between measures has a particularly large effect on space heating savings. More efficient lighting and appliances contribute less waste heat to the home and therefore the space heating requirement is greater. In the 25% Lower Energy Apartment Building, for example, the savings in space heating energy are actually overwhelmed by the increased load because the lights and appliances are more efficient. This is less of an issue in Labrador, where fewer appliance measures pass the economic screen.

Exhibit 5.8: Summary of Residential Sector Energy-efficiency Measures, Labrador Interconnected Service Region 2026[118]

Measure	Average CCE ($/kWh)	Annual Savings (GWh/year)
Redesign with high performance T8s	-$0.03	0.004
Energy Star Computer	$0.00	1
DHW Pipe Wrap	$0.00	0.4
Low-Flow Showerheads and Faucets	$0.01	0.3
25% Lower Energy Apartment Building	$0.01	0.1
Standard T8 Lighting - Common Areas	$0.01	0.002
Programmable Thermostats	$0.01	5
CFLs - Standard	$0.01	4
Crawl-space Insulation	$0.02	3
Foundation Insulation	$0.02	33
Energy Star Windows , Advanced Glazing	$0.02	2
Standby Losses	$0.03	2
Super High Performance Windows	$0.03	2
40% Lower Energy Apartment Building	$0.03	0.1
Attic Insulation, Roof Insulation	$0.03	3
Timer	$0.04	0.02
Air Leakage Sealing	$0.04	13
Building recommissioning	$0.04	0.1
Motion Sensor	$0.06	0.03

[118] The above exhibit includes measures with a CCE that exceeds the study's avoided cost threshold. The increased CCE is due to the impact of interactive effects. The measures are shown to maintain consistency with previous exhibits. The measure for redesign with high-performance T8s has a negative CCE for the Labrador Interconnected service region because the only circumstance under which it passes for Labrador is when a renovation is planned that already involves lighting replacement. The advanced T8s with redesign would incorporate fewer fixtures than a standard lighting replacement and therefore capital cost would actually be lower. In the Island and Isolated service region, there would certainly be cases where the measure would be installed as part of an already planned renovation (and hence would have a negative incremental cost), but the measure passes at full cost as well, so the average CCE is $0.09/kWh.

6. ACHIEVABLE POTENTIAL

6.1 INTRODUCTION

This section presents the Residential sector Achievable Potential electricity savings for the study period (2006 to 2026). The Achievable Potential is defined as the proportion of the savings identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The remainder of this discussion is organized into the following subsections:

- Description of Achievable Potential
- Approach to the Estimation of Achievable Potential
- Workshop Results
- Summary of Achievable Electricity Savings
- Peak Load Impacts.

6.2 DESCRIPTION OF ACHIEVABLE POTENTIAL

Achievable Potential recognizes that it is difficult to induce all customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. For example, customer decisions to implement energy-efficient measures can be constrained by important factors such as:

- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability
- Consumer awareness.

The rate at which customers accept and purchase energy-efficient products can be influenced by a variety of factors including the level of financial incentives, information and other measures put in place by the Utilities, governments and the private sector to remove barriers such as those noted above.

Exhibit 6.1 presents the level of electricity consumption that is estimated in the Achievable Potential scenarios. As illustrated, the Achievable Potential scenarios are “banded” by the two forecasts presented in previous sections, namely, the Economic Potential Forecast and the Reference Case.

Electricity savings under Achievable Potential are typically less than in the Economic Potential Forecast. In the Economic Potential Forecast, efficient new technologies are assumed to fully penetrate the market as soon as it is financially attractive to do so. However, the Achievable Potential recognizes that under “real world” conditions, the rate at which customers are likely to implement new technologies will be influenced by additional practical considerations and will, therefore, occur more slowly than under the assumptions employed in the Economic Potential Forecast. Exhibit 6.1 also shows that future electricity consumption under the Reference Case is greater than in either of the two Achievable Potential forecasts. This is because the Reference Case represents a "worst case" situation in which there are no additional utility market interventions and hence no additional electricity savings beyond those that occur "naturally."

Exhibit 6.1 presents the achievable results as a band of possibilities, rather than a single line. This recognizes that any estimate of Achievable Potential over a 20-year period is necessarily subject to uncertainty and that there are different levels of potential CDM program intervention.

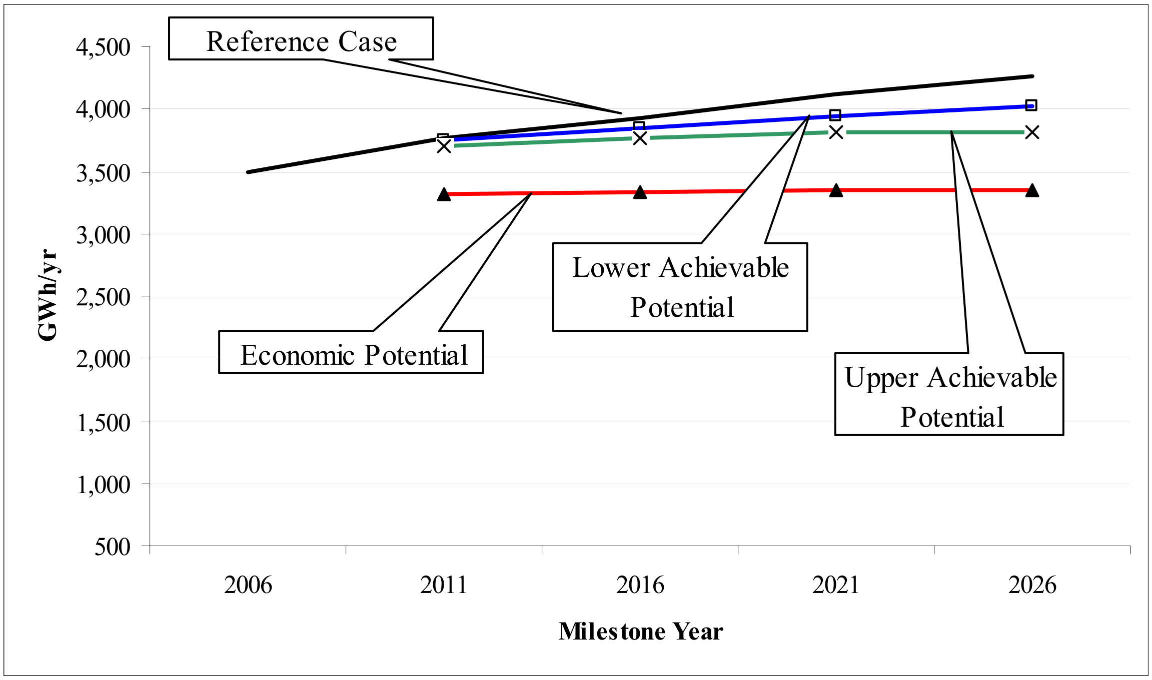
- **The Upper Achievable Potential** assumes both an aggressive program approach and a very supportive context, e.g., healthy economy, very strong public commitment to climate change mitigation, etc.

  However, the Upper Achievable Potential scenario also recognizes that there are limits to the scope of influence of any electric utility. It recognizes that some markets or submarkets may be so price sensitive or constrained by market barriers beyond the influence of CDM programs that they will only fully act if forced to by legal or other legislative means. It also recognizes that there are practical constraints related to the pace that existing inefficient equipment can be replaced by new, more efficient models or that existing building stock can be retrofitted to new energy performance levels

  For the purposes of this study, the Upper Achievable Potential can, informally, be described as: "*Economic Potential less those customers that "can't" or "won't" participate."*

- **The Lower Achievable Potential** assumes that existing CDM programs and the scope of technologies addressed are expanded, but at a more modest level than in the Upper Achievable Potential. Market interest and customer commitment to energy efficiency and sustainable environmental practices remain approximately as current. Similarly, federal, provincial and municipal government energy-efficiency and GHG mitigation efforts remain similar to the present.

Exhibit 6.1: Annual Electricity Consumption – Illustration of Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector (GWh/yr.)



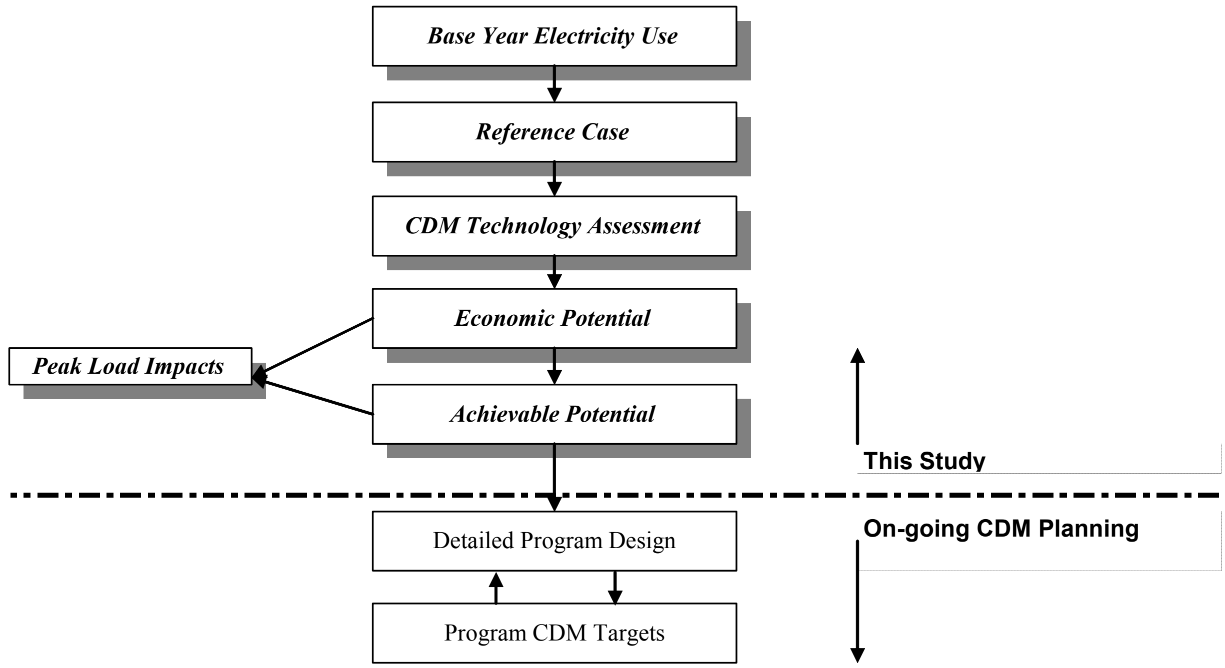
❑ Achievable Potential versus Detailed Program Design

It should also be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.[119]

Exhibit 6.2 illustrates the relationship between Achievable Potential and the more detailed program design.

[119] The Achievable Potential savings assume program start-up in 2007. Consequently, electricity savings in the first milestone year of 2011 will need to be adjusted to reflect actual program initiation dates. This step will occur during the detailed program design phase, which will follow this study.

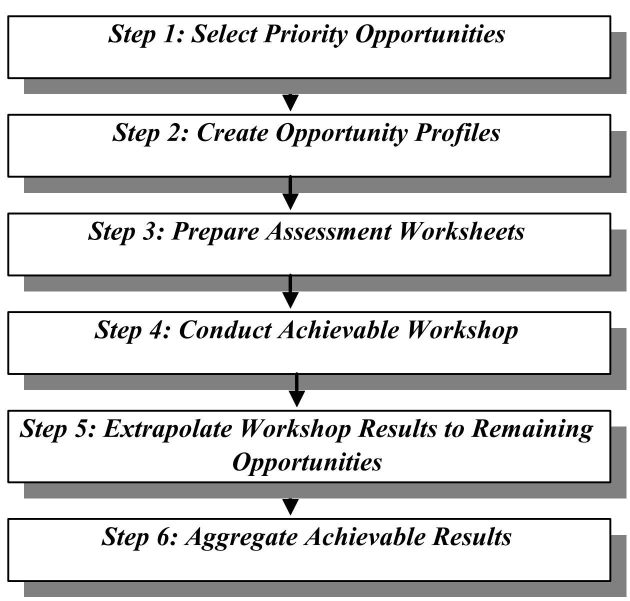
Exhibit 6.2: Achievable Potential versus Detailed Program Design



6.3 APPROACH TO THE ESTIMATION OF ACHIEVABLE POTENTIAL

Achievable Potential was estimated in a six-step approach. A schematic showing the major steps is shown in Exhibit 6.3 and each step is discussed below.

Exhibit 6.3: Approach to Estimating Achievable Potential



❑ Step 1: Select Priority Opportunities

The first step in developing the Achievable Potential estimates required that the energy saving opportunities identified in the Economic Potential Forecasts be "bundled" into a set of opportunity areas that would facilitate the subsequent assessment of their potential market penetration.

The amount of time available in the Achievable Potential workshop for the discussion of energy-efficiency opportunities was limited. Consequently, the energy-efficiency opportunity areas shown in Exhibit 6.4 were selected based primarily on the basis that they represent a significant portion of the energy savings potential identified in the Economic Potential Forecast. Where two or more opportunities offered similar levels of potential energy savings, consideration was also given to whether discussion of the selected opportunity area in the workshop would provide insights into the participation rates to be used for related opportunities that could not be covered during the workshop.

Nine energy-efficiency opportunity areas were selected for discussion in the Residential sector workshop that was held on October 30, 2007. Exhibit 6.4 identifies the opportunity areas and shows the approximate percentage that each represents of the total Residential sector potential contained in the Economic Potential Forecast.

Exhibit 6.4: Residential Sector Opportunity Areas

Opportunity Area	Title	Approximate % of Economic Savings Potential
R1	Programmable thermostats	5%
R2	Convert incandescent lighting to CFL	11%
R3	Foundation insulation	28%
R4	Air leakage sealing	3%
R5	Efficient windows	6%
R6	EnerGuide 80 (EG80) for new housing	3%
R7	Power bar with integrated timer	10%
R8	ENERGY STAR computer	6%
R9	ENERGY STAR clothes washer	11%
	Total	83%

❑ Step 2: Create Opportunity Profiles

The next step involved the development of brief profiles for the priority opportunity areas noted above in Exhibit 6.4. A sample profile for Opportunity R1 (programmable thermostats) is presented in Exhibit 6.5; the remaining Opportunity Profiles are provided in Appendix B.

The purpose of the Opportunity Profiles was to provide a "high-level" logic framework that would serve as a guide for participant discussions in the achievable workshop. These Profiles state technical and program assumptions upon which to base an estimate of potential market penetration. The intent was to define a broad rationale and direction without getting into the much greater detail required of program design, which, as noted previously, is beyond the scope of this project.

Exhibit 6.5: Sample Opportunity Profile

R1: Programmable Thermostat

Overview:

Digital programmable thermostats provide improved temperature setting accuracy and are capable of multiple time settings. When combined with an assumed 4ºC temperature setback during night and unoccupied periods, typical space heat savings are in the range of 10% to 15% relative to the baseline, depending on the type of dwelling and its vintage.

Other utility studies have indicated that a lower savings percentage should be used to reflect the fact that the thermostat's setback capabilities do not completely reflect how they are used, e.g., some home occupants reliably set back manual thermostats, and some home occupants do not use the setback features on their electronic thermostats. Accordingly a value of 6% savings has been used in this study.

Target Technologies and Dwelling Types:

- The programmable setback thermostat is a mature technology
- This technology is applicable to all dwelling types but is most easily applied where a limited number of thermostats can be used to control all the heating devices in the dwelling.

Opportunity Costs and Savings Profile:

- This technology is assumed to cost an average of $70 per dwelling.
- In single-family dwellings with baseboard electric heating, it is possible, in most cases, to combine more than one baseboard per thermostat so that three to four thermostats can be used.[120] In dwellings with forced air systems, one thermostat will usually control the whole dwelling.
- Customer payback is approximately one year, somewhat longer in Labrador.
- The CCE for this measure in detached dwellings ranges from 0.6 in Labrador to 1.2 on the Island, or somewhat higher for attached dwellings and apartments.
- Potential energy performance or technology price trends affecting this opportunity include:
- Pricing and performance are relatively stable for this technology.
- For homes with a need for more thermostats because of multiple baseboards, another option is the high-efficiency (more accurate) thermostat, which is lower cost but is still expected to save approximately 3%.
- There is added uncertainty in the savings estimates for this technology because of the behavioural aspect.

Target Audience(s)& Potential Delivery Allies:

- Homeowners and renters
- HVAC contractors and retailers

Constraints & Challenges:

- Some consumers still think a thermostat behaves like a gas pedal (the higher you set it, the faster the house warms up!)
- Tendency for some users to override the setback
- Installation is simple for central thermostats on 24-V loops, but not for in-line thermostats controlling a powerful baseboard.

Opportunities & Synergies:

- Could build on/expand previous thermostat rebate programs
- Could be offered in conjunction with other programs, through trade allies or even used as a premium to entice consumers to participate in other programs
- Amenable to use of point-of-sale rebates or other in-store promotions.

Experience Related to Possible Participation Rates:

[120] Workshop discussion found that the use of one thermostat to control multiple baseboard heaters was rarely practical.

As illustrated in Exhibit 6.5, each Opportunity Profile addresses the following areas:

- ***Overview*** – provides a summary statement of the broad goal and rationale for the opportunity.
- ***Target Technologies and Dwelling Types*** **–** highlights the major technologies and the dwelling types where the most significant opportunities have been identified in the Economic Potential Forecast.
- ***Opportunity Costs and Savings Profile*** – provides information on the financial attractiveness of the opportunity from the perspective of both the customer and NLH or NP.
- ***Target Audiences and Potential Delivery Allies*** **–** identifies key market players that would be expected to be involved in the actual delivery of services. The list of stakeholders shown is intended to be "indicative" and is by no means comprehensive.
- ***Constraints and Challenges*** **–** identifies key market barriers that are currently constraining the increased penetration of energy-efficient technologies or measures. Interventions for addressing the identified barriers are noted. Again, it is recognized that the interventions are not necessarily comprehensive; rather, their primary purpose was to help guide the workshop discussions.
- ***Opportunities and Synergies*** **–** identifies information or possible synergies with other opportunities that may affect workshop participant views on possible customer participation rates.
- ***Experience Related to Possible Participation Rates*** – provides benchmark data on the past performance of the Utilities' programs, where available.

❑ Step 3: Prepare Draft Opportunity Assessment Worksheets

A draft Assessment Worksheet was prepared for each Opportunity Profile in advance of the workshop. The Assessment Worksheets complemented the information contained in the Opportunity Profiles by providing quantitative data on the potential energy savings for each opportunity as well as providing information on the size and composition of the eligible population of potential participants. Energy impacts and population data were taken from the detailed modelling results contained in the Economic Potential Forecast.

A sample Assessment Worksheet for Opportunity R1 – Programmable Thermostats is presented in Exhibit 6.6 (worksheets for the remaining opportunity areas are provided in Appendix B). As illustrated in Exhibit 6.6, each Assessment Worksheet addresses the following areas:

- ***Economic Potential Annual Savings*** **–** shows the total economically attractive potential for electricity savings, by milestone period, for the measures included in the opportunity area.

- ***Cumulative Thousands of Dwellings Affected*** – shows the total population of potential participants that could theoretically take part in the opportunity area. Numbers shown are from the eligible populations used in the Economic Potential Forecasts. The definition of "participant" varies by opportunity area. In the example shown, a participant is defined as a "dwelling."

- ***Achievable Participation*** **–** show the percentage of economic savings that workshop participants concluded could be achieved in each milestone period. As noted in the introduction to this section, two achievable scenarios are shown: Lower and Upper. For example, Exhibit 6.6 shows a participation rate of 20% (Lower) and 90% (Upper) in existing single-family dwellings by the year 2026. This means that by 2026, between 20% and 90% of the potential savings contained in the Economic Potential Forecast could be achieved.

- ***Achievable Potential Annual Savings*** **–** shows the calculated electricity savings in each milestone period based on the savings and participation rates presented in the preceding columns of the Worksheet.

- ***Achievable Thousands of Dwellings Affected*** – shows the number of participants that would be affected in order to achieve the electricity savings shown.

Exhibit 6.6: Sample Residential Sector Opportunity Assessment Worksheet[121]

*R1: Space heating, Programmable Thermostats: Economic Scenario, Residential Sector, Island and Isolated Region **

Existing/Renovated

Building Type	Economic Potential Annual Savings (GWh)		Cumulative Thousands of Dwellings Affected		Lower Achievable Scenario: Achievable Participation		Lower Achievable Scenario: Achievable Potential Annual Savings (GWh)		Lower Achievable Scenario: Achievable Thous. Dwellings Affected		Upper Achievable Scenario: Achievable Participation		Upper Achievable Scenario: Achievable Potential Annual Savings (GWh)		Upper Achievable Scenario: Achievable Thous. Dwellings Affected	
	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026
Detached	31	27	79	79		20%		5		16		90%		24		71
Attached	5	5	10	10												
Apartment	3	2	10	10												
Other	1	1	11	11		20%		0		2						
Total	40	35	110	109				6		18				24		71

New

Curve B Curve C

Building Type	Economic Potential Annual Savings (GWh)		Cumulative Thousands of Dwellings Affected		Lower Achievable Scenario: Achievable Participation		Lower Achievable Scenario: Achievable Potential Annual Savings (GWh)		Lower Achievable Scenario: Achievable Thous. Dwellings Affected		Upper Achievable Scenario: Achievable Participation		Upper Achievable Scenario: Achievable Potential Annual Savings (GWh)		Upper Achievable Scenario: Achievable Thous. Dwellings Affected	
	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026	2011	2026
Detached	2	5	3	12	20%	20%	0	1	1	2	20%	20%	0	1	1	2
Attached	0	1	1	2	20%	20%	0	0	0	0	20%	20%	0	0	0	0
Apartment	0	1	1	2	20%	20%	0	0	0	0	20%	20%	0	0	0	0
Other	0	0	0	0	20%	20%	0	0	0	0	20%	20%	0	0	0	0
Total	3	7	5	16			1	1	1	3			1	1	1	3
Grand Total	42	41	114	125			1	7	1	21			1	25	1	74

NOTES:
* Includes savings of heating and ventilation.

[121] This exhibit shows the worksheet as it was after the workshop. Discussion focused on the existing detached dwellings for the Island and Isolated service region, developing Upper and Lower participation estimates for the milestone year 2026, and a curve shape between 2006 and 2026. All other percentage values shown are either left blank or are placeholders that were in the worksheet before the workshop. Only the values for existing detached Island and Isolated dwellings were transferred to the RSEEM model. Values for other types of dwellings were based on those and on the discussions with workshop participants about how participation might vary between regions, housing types, and vintages. Any differences in totals are due to rounding.

❑ **Step 4: Achievable Potential Workshop**

The most critical step in developing the estimates of Achievable Potential was the one-day workshop held October 30, 2007. Workshop participants consisted of core members of the consultant team, program personnel from the Utilities and local trade allies.

The purpose of this workshop was twofold:

- Promote discussion regarding the technical and market conditions confronting the identified energy-efficiency opportunities

- Compile participant views related to how much of the identified economic savings could realistically be achieved over the study period.

The discussion of each opportunity area began with a brief consultant presentation. The floor was then opened to participant discussion. Key areas that were explored for each opportunity area included:

- Target audiences and potential delivery allies
- Constraints, barriers and challenges
- Potential opportunities and synergies
- Estimates of Lower Achievable and Upper Achievable for milestone years
- Guidelines for consultants for extrapolating to related sub sectors.

Following discussion of the broad market and intervention conditions affecting each opportunity area, workshop participant views were recorded on Lower and Upper customer participation rates. To facilitate this portion of the workshop, the discussion of the Residential sector opportunity areas focused initially on single-family detached dwellings in the Island and Isolated service region. The following process was employed:

- The participation rate for the Upper Potential in 2026 was estimated. As noted previously, this participation rate was "roughly" defined as 100% of the Economic Potential minus the market share represented by the "can't" or 'won't" population.

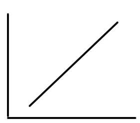
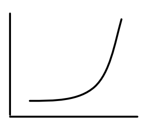
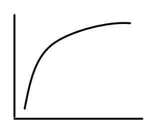
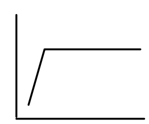
- The shape of the adoption curve was selected for the Upper scenario. Rather than seek consensus on the specific values to be employed in each of the intervening milestone years, workshop participants selected one of four curve shapes that best matched their view of the appropriate "ramp-up" rate for each opportunity.

- The preceding process was repeated for the Lower scenario.

Exhibit 6.7 shows the four curves that were used in the workshop discussions.

- **Curve A** represents a steady increase in the expected participation rate over the 20-year study period
- **Curve B** represents a relatively slow participation rate during the first half of the 20-year study period followed by a rapid growth in participation during the second half of the 20-year study period
- **Curve C** represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the 20-year study period
- **Curve D** represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first milestone period of the 20-year study period.

Exhibit 6.7: Adoption Curve Shapes (2006 to 2026)

Curve A	Curve B	Curve C	Curve D
			

Finally, as applicable, workshop participants provided guidelines to the consultants for extrapolating the results of the workshop discussion to the remaining sub sectors and service regions.

❑ Step 5: Extrapolate Workshop Results to Remaining Opportunities

As noted earlier, it was not possible to fully address all opportunities in the one-day workshop. Consequently, the workshop focused on the "big ticket" opportunities. Participation rates for the remaining opportunities were completed by the consultants, guided by the workshop results and discussions. The values shown in the summary tables incorporate the results of the two sets of inputs.

❑ Step 6: Aggregate Achievable Potential Results

The final step involved aggregating the results of the individual opportunity areas to provide a view of the potential Achievable savings for the total Residential sector.

6.4 WORKSHOP RESULTS

The following subsection provides a summary of the participation rates established by the workshop participants for each of the opportunity areas discussed during the workshop.[122] As noted previously, the Residential sector opportunity areas were:

- R1 - Programmable thermostats
- R2 - Convert incandescent lighting to CFL
- R3 - Foundation insulation
- R4 - Air leakage sealing
- R5 - Efficient windows
- R6 - EnerGuide 80 (EG80) for new housing
- R7 - Power bar with integrated timer
- R8 - ENERGY STAR computer
- R9 - ENERGY STAR clothes washer.

Further detail on each of the above opportunity areas is provided below; as applicable, the following information is provided for each:

- Summary of Upper and Lower Achievable participation rates
- Shape of Adoption Curve selected by the workshop participants
- Highlights of key issues arising during the workshop discussions
- Summary of major assumptions employed by the consultants for extrapolating the workshop results to other sub sectors.

6.4.1 R1 – Programmable Thermostats

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 90% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve C represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 20% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. Participation rates in the

[122] Measures from the Commercial sector that were applicable to apartment buildings were discussed in the commercial Achievable workshop. Refer to the companion report on the Commercial sector for details on the workshop discussions. Apartment measures discussed in the commercial Achievable workshop included: C1, Standard T8 Lighting and Redesign with High-performance T8s - Common Areas, Existing Buildings; C2, Redesign with high-performance T8s, New Buildings; C4, High-performance glazings; C5, Building recommissioning; C6, Ground source heat pumps; and C7, 40% Lower Energy Apartment Building.

Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.

Selected highlights:

- Discussion focused on the high-efficiency thermostats with accuracy within 0.5ºC. Programmable thermostats were regarded as having much lower potential because of the low incidence of electrically heated houses that can be controlled with a small number of thermostats (such as one thermostat controlling a forced air system). The cost of a large number of programmable thermostats to control individual baseboards would generally not be justified.
- Behaviour is a major factor in savings from programmable thermostats (e.g., some people with manual thermostats diligently set them back, and some people with programmable thermostats do not).
- Humidity control is a concern with set-back strategies in some houses, where condensation on windows can cause damage and mould. Ability to adopt temperature setback could be a selling point for efficient windows.
- The presence of thermostats accurate to within 1ºC was estimated to be approximately 65% of existing stock, with lower penetration in rural areas. Many rural houses have baseboards installed with only the built-in thermostatic control on the baseboard itself.
- There is potential for using the high-efficiency thermostats through most of the house and installing programmable thermostats in main living areas (such as the living room or the most-used bedroom).

6.4.2 R2 – Convert Incandescent Lighting to CFLs

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 98% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 90% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve A represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. Participation rates in the Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.

Selected highlights:

-
- There are fewer barriers to uptake of CFLs than for other measures. There is continuing improvement in quality and the suitability of lamps to more applications continues to broaden.
- There are still issues around disposal, light quality, product quality and lighting levels, some of them real and some of them perceptions based on earlier products. Workshop participants expected these issues to be addressed during the timeframe of the study.
- Uptake of CFLs has been high in Labrador. It tends to be lower in rural areas.

The preceding results were used as a reference point for estimating participation rates related to other opportunities in the Residential sector.

Highlights:

- Participation rates for standard CFLs were also applied to LED holiday lighting, motion sensors and timers.
- Participation rates for specialized CFLs were also informed by the discussion on standard CFLs.
- Other technologies that are well established in the marketplace were estimated to have similar uptake if supported by the Utilities' program activity. These included ECPM furnace fan motors, low-flow showerheads and faucets, DHW tank insulating blankets and DHW piping insulation.
- T8 lighting in apartment buildings drew on the participation rates identified during the Commercial sector workshop (see Section 6.4.1 in the companion Commercial report.

6.4.3 R3 – Insulate Foundations

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 75% in existing single-family detached homes and up to 98% in new single-family detached homes could be achieved in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B for existing homes and Curve C for new homes represented the best fits with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 25% in existing single-family detached homes and up to 55% in new single-family detached homes could be achieved in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B for existing homes and Curve A for new homes represented the best fits with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. The measure is not applicable to apartment buildings. Participation rates in the Labrador Interconnected service region were assumed to be somewhat lower than those for the Island and Isolated service region because there are fewer basements and more crawl spaces. If the program could be broadened to include crawl space insulation, overall savings potential in the Labrador Interconnected service region would be increased.

Selected highlights:

- Code for basement insulation is often ignored (up to 90%) because of lack of enforcement. Insulation is often installed within a few years as part of basement refinishing
- NP has had surprisingly good uptake for a program on foundation insulation, without a great deal of marketing. NLH has had smaller uptake in Labrador Interconnected due to the lack of financial drivers
- There were concerns about encouraging consumers to install insulation as a do-it-yourself project (e.g., consumers may not be familiar with code)
- Technical innovation is a possibility in future, lowering the installation cost and the payback.

The preceding results were used as a reference point for estimating participation rates related to other insulation opportunities in the Residential sector.

Highlights:

- Participation rates for foundation insulation were also applied to crawl space insulation
- The estimate of participation for attic insulation was also informed by the discussion of foundation insulation.

6.4.4 R4 – Seal Air Leaks

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 90% could be achieved in new single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 55% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

The workshop discussions focused on single-family detached homes and did not include consideration of other dwelling types. Participation rates in the Labrador Interconnected service region were assumed to be somewhat lower than those for the Island and Isolated service region, because of lower electricity prices.

Selected highlights:

- Opinions ranged widely on the capital cost of undertaking this upgrade, from as little as $400 to over $1,000 per house. Opinions on savings ranged from 10% of heating energy to as much as 15%
- For the purposes of discussion, reduction of leakage to 1.75 air changes per hour was considered a target
- Improved comfort in the home is likely to be an attractive selling feature.

6.4.5 R5 – Upgrade to ENERGY STAR Windows at Time of Window Replacement or New Installation

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 100% could be achieved in both existing and new single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B in existing homes and Curve C in new homes represented the best fits with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 80% in existing single-family detached homes and up to 85% in new single-family detached homes could be achieved in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B for existing homes and Curve C for new homes represented the best fits with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. The measure is replaced by the high-performance glazing commercial measure in apartment buildings. Participation rates in the Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.

Selected highlights:

- Workshop participants questioned the assumption that incremental cost of high-efficiency windows in the replacement (retail) market is higher than it is in the new construction (wholesale) market. Although high mark ups on the increment are the pattern in other jurisdictions, workshop participants said that retailers in Newfoundland and Labrador are not following that pattern. The measure already passes the economic screens with the current assumptions so this change would not increase the potential.

The preceding results were used as a reference point for estimating participation rates related to other window opportunities in the Residential sector.

Highlights:

- Participation rates for the super high-performance windows were assumed to trail participation rates for ENERGY STAR windows by approximately 10 years.

6.4.6 R6 – Construct New Houses to Achieve EG80 Rating

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 98% could be achieved in new single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve D represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario. Curve D rises linearly and reaches a plateau; for this technology and scenario, that is assumed to occur in 2015.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 10% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve A represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. Participation rates in the Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.

Selected highlights:

- A relatively small number of builders can be targeted for program activity (approximately 15-20 builders construct 50% of the homes each year)
- Provincial legislation may change the building code to require this level of energy performance at some point in the study period. That change is occurring in Nova Scotia as of 2011
- In the absence of legislation, education will be a critical program component. It is particularly important to involve the real estate community.

6.4.7 R7 – Reduce Standby Losses for Household Electronics using Power Bar Timers

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 25% could be achieved in single-family detached homes in the Island and Isolated service region by 2021; these rates would then descend to 0% as the technology is superseded by features built into the electronic devices. Workshop participants created Adoption Curve E to represent this bell curve shape.

The Lower Achievable scenario was assumed to be similar to the Upper Achievable scenario for this technology.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. Participation rates in the Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.
Selected highlights:

- Discussions focused on a specific technology solution to standby losses, namely a power bar with a built-in timer that controls several of the outlets. These power bars are available in the marketplace. Discussion also focused on the television and its peripherals (especially set-top boxes), although the approach is applicable to other household electronics
- There were concerns that this device may not be suitable for some television peripherals, because power loss will erase their programming
- Workshop participants believed that a combination of technology improvements and energy standards would result in manufacturers incorporating power management features into the electronic devices themselves, eventually rendering this technology obsolete.

6.4.8 R8 – Upgrade to New ENERGY STAR Computer at Time of Replacement or New Purchase

Workshop participants concluded that, under the conditions represented by the Upper Achievable scenario, participation rates up to 80% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Upper Achievable scenario.

Under the more modest market conditions represented by the Lower Achievable scenario, participation rates up to 15% could be achieved in single-family detached homes in the Island and Isolated service region by 2026. Workshop participants agreed that Adoption Curve B represented the best fit with the pace of participation in the intervening years from 2007 to 2026 under this Lower Achievable scenario.

Based on the workshop discussions, it was assumed that participation rates in the remaining dwelling types would be similar to the above values. Participation rates in the Labrador Interconnected service region were assumed to be similar to those for the Island and Isolated service region.

Selected highlights:

- ENERGY STAR for most appliances has generally been lower in Newfoundland and Labrador than in other jurisdictions, partly because of poor product availability. ENERGY STAR computers may fare somewhat better because there is no incremental cost.

The preceding results were used as a reference point for estimating participation rates related to other opportunities in the Residential sector.

Highlights:

- The discussion of ENERGY STAR computers informed the participation rates used for ENERGY STAR appliances, such as fridges, freezers, clothes washers and televisions.

6.4.9 R9 – Upgrade to New ENERGY STAR Clothes Washer at Time of Replacement or New Purchase

Workshop participants did not discuss this measure separately, but did discuss ENERGY STAR appliances in general during the discussion of computers. The clothes washer measure, although it has a large potential, has a CCE very close to the threshold. This leaves very little room for program activity or incentives. It would therefore be difficult to achieve significant penetration. Further, the efficient top loading clothes washer is the one that passes the CCE test. It is very rare in the marketplace, with only one or two models available in Canada. The front loading washer is more available and is even more efficient, but is also more expensive and does not pass the CCE test. For these reasons this measure was seen as a lower priority for workshop discussion.

6.4.10 Extrapolated Participation Rates – Remaining Energy-efficiency Opportunities

As noted previously, the workshop results and follow up email responses were used as a reference point, combined with consultant experience, to estimate participation rates for the remaining energy-efficiency opportunities that are contained in the Economic Potential Forecast.

Exhibits 6.8 and 6.9 provide, respectively, a summary of the estimated Upper and Lower participation rates for the remaining energy-efficiency opportunities. As illustrated, each exhibit shows:

- Workshop reference number, which refers to the package of Opportunity Profiles that were provided to workshop participants
- The affected technology
- The participation rates for each of the milestone years
- Notes that illustrate sources used by the consultants when estimating the participation rates shown.

Exhibit 6.8: Participation Rates – Upper Achievable Potential[123]

Measure Information		Participation Rates		Notes
Workshop Reference #	Technology	F2026	Curve	
R1	Efficient (More Accurate) Thermostat	90%	B	R1: Workshop input.
R2	CFLs - Standard	98%	B	R2: Workshop input.
R3	Foundation Insulation, Existing	75%	B	R3: Workshop input.
R3	Foundation Insulation, New	98%	A	R3: Workshop input.
R4	Air Leakage Sealing	90%	B	R4: Workshop input.
R5	Energy Star Windows , Existing	100%	B	R5: Workshop input.
R5	Energy Star Windows , New	100%	C	R5: Workshop input.
R6	New House Designed to an EGNH 80 Rating	98%	A	R6: Workshop input.
R7	Standby Losses	0%	E*	R7: Workshop input.
R8	Energy Star Computer	80%	B	R8: Workshop input.
C1	Standard T8 Lighting - Common Areas, Existing Bldgs	97%	A	C1: Workshop input.
C1	Redesign with high performance T8s, Existing Bldgs	40%	A	C1: Workshop input.
C2	Redesign with high performance T8s, New Bldgs	100%	C	C2: Workshop input.
C4	High performance glazings	20%	A	C4: Workshop input.
C5	Building recommissioning	85%	B	C5: Workshop input.
C6	Ground source heat pumps	20%	A	C6: Workshop input.
C7	40% Lower Energy Apartment Building	56%	A/B**	C7: Workshop input.
	Super High Performance Windows	25%		Trail the participation rates for R5 by 10 years.
	Attic Insulation	56%		Similar participation to R3.
	Crawl-space Insulation	75%		Similar participation to R3, but much smaller incidence of crawlspaces.
	Programmable Thermostats	5%		Not much forced air electric heating (cf R1), but install on grouped baseboards in main areas.
	High Efficiency HRV	25%		Advanced version of accepted technology: use rates for Super windows.
	High Efficiency HRV	75%		Advanced version of accepted technology: use rates for Super windows.
	Furnace Fan Motor (ECPMM)	98%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	Low-Flow Showerheads and Faucets	98%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	DHW Tank Insulating Blanket	98%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	DHW Pipe Wrap	98%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	Energy Star Fridge	80%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star Fridge	80%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Efficient Freezer	80%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star Top Loading Clothes Washer	80%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star TV	80%		Based on Energy Star Computer (R8)
	LED Holiday Lights	98%		Based on CFLs (R2).
	Timer	98%		Based on CFLs (R2).
	Motion Sensor	98%		Based on CFLs (R2).
	CFLs Specialised	98%		Based on CFL standard (R2).
	Replace air-source heat pump with a low temperature heat pump	10%		Not available yet. Use 0% until 2011, climb to 10% by 2026.

* E - this curve, created by the workshop participants, is a bell-shaped curve that peaks in 2021 and descends back to zero after the technology is superseded by other advances
** A/B - this curve is a hybrid between curves A and B

[123] The low-temperature heat pump measure in this exhibit is for apartment buildings only. Units designed for apartments are under development. The low-temperature heat pumps for single detached homes, which are available, did not pass the economic screen and are not included in this exhibit.

Exhibit 6.9: Participation Rates – Lower Achievable Potential [124]

Measure Information		Participation Rates		Notes
Workshop Reference #	Technology	F2026	Curve	
R1	Efficient (More Accurate) Thermostat	20%	C	R1: Workshop input.
R2	CFLs - Standard	90%	A	R2: Workshop input.
R3	Foundation Insulation, Existing	25%	B	R3: Workshop input.
R3	Foundation Insulation, New	55%	C	R3: Workshop input.
R4	Air Leakage Sealing	55%	B	W4: Workshop input.
R5	Energy Star Windows , Existing	80%	B	R5: Workshop input.
R5	Energy Star Windows , New	100%	C	R5: Workshop input.
R6	New House Designed to an EGNH 80 Rating	10%	D	R6: Workshop input.
R7	Standby Losses	0%	E*	R7: Workshop input.
R8	Energy Star Computer	15%	B	R8: Workshop input.
C1	Standard T8 Lighting - Common Areas, Existing Bldgs	80%	A	C1: Workshop input.
C1	Redesign with high performance T8s, Existing Bldgs	15%	A	C1: Workshop input.
C2	Redesign with high performance T8s, New Bldgs	80%	C	C2: Workshop input.
C4	High performance glazings	7%	A	C4: Workshop input.
C5	Building recommissioning	40%	A/B**	C5: Workshop input.
C6	Ground source heat pumps	2%	B	C6: Workshop input.
C7	40% Lower Energy Apartment Building	38%	A/B**	C7: Workshop input.
	Super High Performance Windows	20%		Trail the rates for R5 by 10 years.
	Attic Insulation	19%		Similar participation to R3.
	Crawl-space Insulation	25%		Similar participation to R3, but much smaller incidence of crawlspaces.
	Programmable Thermostats	2%		Not much forced air electric heating (informed by R1 discussion).
	High Efficiency HRV	20%		Advanced version of accepted technology: use rates for Super windows.
	High Efficiency HRV	25%		Advanced version of accepted technology: use rates for Super windows.
	Furnace Fan Motor (ECPMM)	90%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	Low-Flow Showerheads and Faucets	90%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	DHW Tank Insulating Blanket	90%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	DHW Pipe Wrap	90%		Based on CFLs - standard, where it passes, because it can have high adoption if pushed
	Energy Star Fridge	15%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star Fridge	15%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Efficient Freezer	15%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star Top Loading Clothes Washer	15%		R8 input probably reasonable for participation above E* reference penetration.
	Energy Star TV	15%		Based on Energy Star Computer (R8)
	LED Holiday Lights	90%		Based on CFLs (R2).
	Timer	90%		Based on CFLs (R2).
	Motion Sensor	90%		Based on CFLs (R2).
	CFLs Specialised	90%		Based on CFL standard (R2).
	Replace air-source heat pump with a low temperature heat pump	5%		Not available yet. Use 0% until 2011, climb to 5% by 2026.

* E - this curve, created by the workshop participants, is a bell-shaped curve that peaks in 2021 and descends back to zero after the technology is superseded by other advances
** A/B - this curve is a hybrid between curves A and B

[124] The low-temperature heat pump measure in this exhibit is for apartment buildings only. Units designed for apartments are under development. The low-temperature heat pumps for single detached homes, which are available, did not pass the economic screen and are not included in this exhibit.

6.5 SUMMARY OF ACHIEVABLE ELECTRICITY SAVINGS

Exhibit 6.10 provides a summary of the Achievable electricity savings under both the Lower and Upper scenarios for the Island and Isolated service region.

As illustrated, under the Reference Case residential electricity use would grow from the Base Year level of 3,228 GWh/yr. to approximately 3,968 GWh/yr. by 2026. This contrasts with the Upper Achievable scenario in which electricity use would increase to approximately 3,529 GWh/yr. for the same period, a difference of approximately 439 GWh/yr., or about 11% reduction. Under the Lower Achievable scenario, electricity use would increase to approximately 3,732 GWh/yr. for the same period, a difference of approximately 236 GWh/yr., or about 6% reduction.

Exhibit 6.10: Reference Case versus Upper and Lower Achievable Potential Electricity Consumption in Residential Sector for the Island and Isolated Service Region (GWh/yr.)

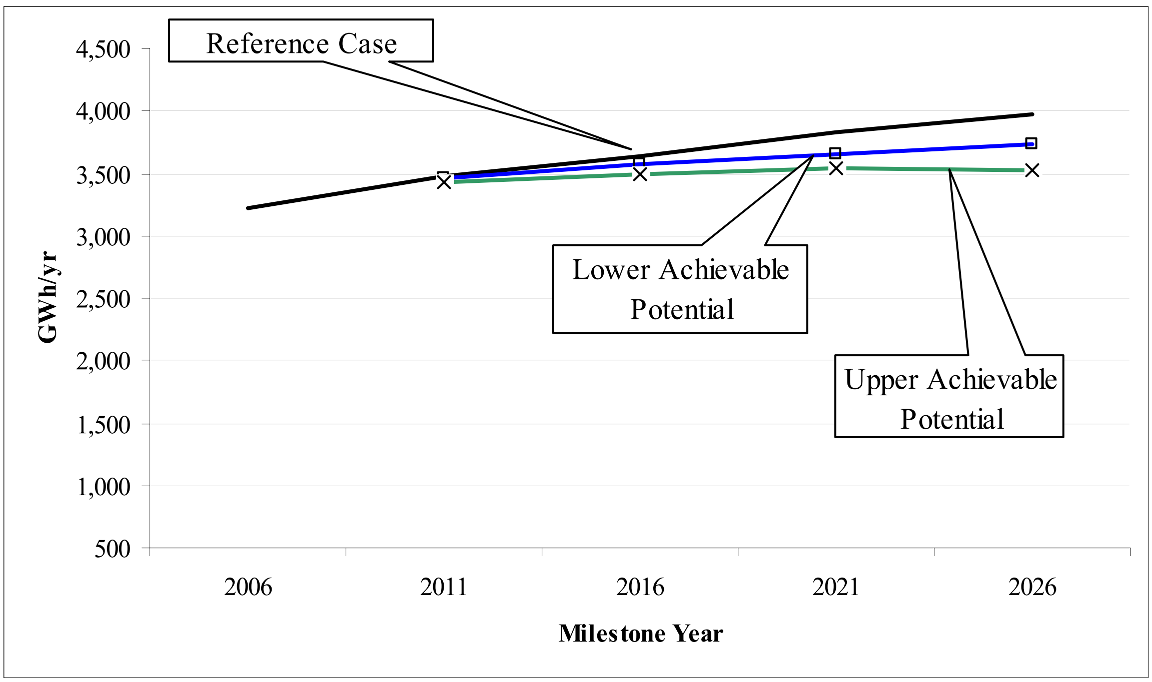
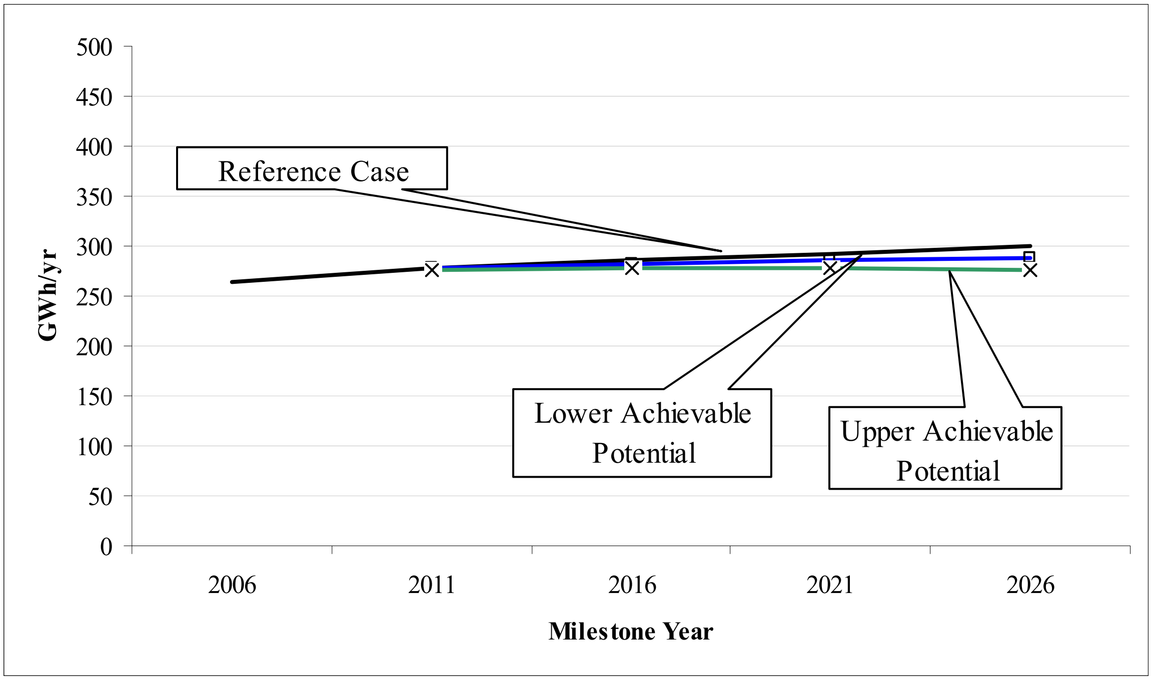


Exhibit 6.11 provides a summary of the achievable electricity savings under both the Lower and Upper scenarios for the Labrador Interconnected service region.

As illustrated, under the Reference Case residential electricity use would grow from the Base Year level of 264 GWh/yr. to approximately 300 GWh/yr. by 2026. This contrasts with the Upper Achievable scenario in which electricity use would increase to approximately 275 GWh/yr. for the same period, a difference of approximately 25 GWh/yr., or about 8% reduction. Under the Lower Achievable scenario, electricity use would increase to approximately 287 GWh/yr. for the same period, a difference of approximately 13 GWh/yr., or about 4% reduction.

Exhibit 6.11: Reference Case versus Upper and Lower Achievable Potential Electricity Consumption in Residential Sector for the Labrador Interconnected Service Region (GWh/yr.)



Further detail on the total potential electricity savings provided by the Achievable Potential forecasts is provided in the following exhibits:

- Exhibits 6.12 and 6.13 present, respectively, the Upper and Lower Achievable results by end use, dwelling type and milestone year for the Island and Isolated service region
- Exhibits 6.14 and 6.15 present, respectively, the Upper and Lower Achievable results by end use, dwelling type and milestone year for the Labrador Interconnected service region
- Exhibits 6.16 and 6.17 present, respectively, the Upper and Lower Achievable savings in 2026 by major end use and dwelling type for the Island and Isolated service region
- Exhibits 6.18 and 6.19 present, respectively, the Upper and Lower Achievable savings in 2026 by major end use and service region for the Labrador Interconnected service region
- Exhibit 6.20 presents the Upper and Lower Achievable savings by milestone year and service region.

Exhibit 6.12: Summary of Annual Electricity Savings for the Island and Isolated Service Region by End Use and Dwelling Type, Upper Achievable Potential (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Electronics	Small Appliances & Other
Detached	2011	47.1	1.9	0.0	9.0		0.0	0.0		0.0	0.0	34.4	1.0	0.0	0.7	0.0	
	2016	121.6	15.0	0.1	14.9		0.6	0.3		0.3	2.4	70.2	8.0	1.3	8.2	0.2	
	2021	233.0	45.9	0.1	24.7		2.2	1.2		0.9	7.8	107.0	16.0	4.8	21.8	0.5	
	2026	362.0	116.0	0.2	38.6		4.4	2.6		2.1	17.5	144.6	26.3	9.7	0.0	0.0	
Attached	2011	5.6	0.0	0.0	1.1		0.0	0.0		0.0	0.0	4.2	0.1	0.0	0.1	0.0	
	2016	15.5	1.6	0.0	1.8		0.1	0.0		0.0	0.2	8.6	1.2	0.2	1.7	0.0	
	2021	29.6	4.6	0.0	3.0		0.4	0.0		0.1	0.8	13.3	2.4	0.6	4.3	0.1	
	2026	41.6	10.4	0.0	4.8		0.8	0.0		0.2	1.8	18.2	4.0	1.3	0.0	0.0	
Apartment	2011	3.5	0.3	0.1	0.7		0.0	0.0		0.0	0.0	2.2	0.1	0.0	0.1	0.0	
	2016	9.5	0.6	0.2	1.6		0.1	0.0		0.0	0.1	4.6	0.8	0.1	1.3	0.0	
	2021	18.0	1.2	0.4	3.2		0.3	0.0		0.0	0.3	7.1	1.6	0.4	3.4	0.0	
	2026	25.1	4.5	0.7	5.2		0.7	0.0		0.1	0.8	9.6	2.7	0.9	0.0	0.0	
Isolated	2011	1.0	0.0	0.0	0.2		0.0	0.0		0.0	0.0	0.8	0.0	0.0	0.0	0.0	
	2016	2.2	0.0	0.0	0.3		0.0	0.0		0.0	0.0	1.5	0.1	0.0	0.1	0.0	
	2021	3.7	0.1	0.0	0.5		0.0	0.0		0.0	0.2	2.3	0.2	0.1	0.3	0.0	
	2026	5.0	0.2	0.0	0.8		0.1	0.1		0.0	0.3	3.1	0.3	0.1	0.0	0.0	
Other	2011	0.4	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	0.6	0.0	0.0	0.0	0.0	
	2016	1.0	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	1.1	0.0	0.0	0.0	0.0	
	2021	1.6	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	1.7	0.0	0.0	0.0	0.0	
	2026	2.1	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	2.2	0.0	0.0	0.0	0.0	
Vacant and Partial	2011	0.6	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	0.8	0.0	0.0	0.0	0.0	
	2016	1.4	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	1.5	0.0	0.0	0.0	0.0	
	2021	2.1	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	2.2	0.0	0.0	0.0	0.0	
	2026	2.8	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	2.9	0.0	0.0	0.0	0.0	
TOTAL	2011	58.2	2.0	0.1	10.9		0.0	0.0		0.0	0.0	42.8	1.2	0.1	1.0	0.0	
	2016	151.1	17.0	0.3	18.6		0.8	0.4		0.3	2.8	87.6	10.0	1.6	11.3	0.3	
	2021	287.9	51.6	0.6	31.4		2.9	1.3		1.1	9.1	133.5	20.1	5.9	29.7	0.7	
	2026	438.7	130.9	0.9	49.5		5.9	2.7		2.5	20.5	180.7	33.2	12.1	0.0	0.0	

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Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) A value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value. 4) Negative values in the space heating end use are a result of the reduction in internal heat gains due to lighting and appliance measures being greater than any savings from space heating measures. 5) Savings for television peripherals and other electronics are from standby loss reduction measures. Workshop participants believed that by 2026 advances in the appliances themselves would eliminate the savings available from add-on devices such as timed power bars. Savings in the last milestone period therefore drop to zero.

Exhibit 6.13: Summary of Annual Electricity Savings for the Island and Isolated Service Region by End Use and Dwelling Type, Lower Achievable Potential (GWh/yr.)

Dwelling Type	Milestone Year	Residential															
		Total	Space Heating	Ventilation	DHW	Cooking	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer	Lighting	Computer and peripherals	Television	Television Peripherals	Other Electronics	Small Appliances & Other
Detached	2011	12.2	0.5	0.0	2.2		0.0	0.0		0.0	0.0	8.4	0.3	0.0	0.7	0.0	
	2016	54.8	3.3	0.0	6.0		0.1	0.1		0.1	0.5	33.1	2.5	0.7	8.2	0.2	
	2021	128.2	11.1	0.1	11.0		0.4	0.2		0.2	1.4	74.5	5.3	1.8	21.8	0.5	
	2026	190.8	30.8	0.1	15.3		0.8	0.5		0.4	3.3	132.9	5.0	1.8	0.0	0.0	
Attached	2011	1.5	0.0	0.0	0.3		0.0	0.0		0.0	0.0	1.0	0.0	0.0	0.1	0.0	
	2016	7.2	0.1	0.0	0.7		0.0	0.0		0.0	0.0	4.0	0.4	0.1	1.7	0.0	
	2021	16.6	0.4	0.0	1.3		0.1	0.0		0.0	0.1	9.2	0.8	0.2	4.3	0.1	
	2026	22.3	2.1	0.0	1.9		0.2	0.0		0.0	0.3	16.7	0.8	0.2	0.0	0.0	
Apartment	2011	1.3	0.2	0.0	0.3		0.0	0.0		0.0	0.0	0.6	0.0	0.0	0.1	0.0	
	2016	5.2	0.4	0.1	0.8		0.0	0.0		0.0	0.0	2.3	0.2	0.1	1.3	0.0	
	2021	11.6	0.7	0.2	1.5		0.1	0.0		0.0	0.1	5.0	0.5	0.2	3.4	0.0	
	2026	14.6	2.1	0.3	2.6		0.1	0.0		0.0	0.1	8.7	0.5	0.2	0.0	0.0	
Isolated	2011	0.2	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.2	0.0	0.0	0.0	0.0	
	2016	1.0	0.0	0.0	0.1		0.0	0.0		0.0	0.0	0.7	0.0	0.0	0.1	0.0	
	2021	2.3	0.0	0.0	0.2		0.0	0.0		0.0	0.0	1.6	0.1	0.0	0.3	0.0	
	2026	3.4	0.0	0.0	0.3		0.0	0.0		0.0	0.1	2.9	0.0	0.0	0.0	0.0	
Other	2011	0.1	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.1	0.0	0.0	0.0	0.0	
	2016	0.4	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	0.5	0.0	0.0	0.0	0.0	
	2021	1.1	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	1.2	0.0	0.0	0.0	0.0	
	2026	1.9	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	2.0	0.0	0.0	0.0	0.0	
Vacant and Partial	2011	0.1	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.2	0.0	0.0	0.0	0.0	
	2016	0.6	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	0.7	0.0	0.0	0.0	0.0	
	2021	1.4	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	1.5	0.0	0.0	0.0	0.0	
	2026	2.6	-0.1	0.0	0.0		0.0	0.0		0.0	0.0	2.7	0.0	0.0	0.0	0.0	
TOTAL	2011	15.5	0.7	0.0	2.8		0.0	0.0		0.0	0.0	10.6	0.3	0.1	1.0	0.0	
	2016	69.2	3.7	0.1	7.6		0.2	0.1		0.1	0.6	41.4	3.1	0.8	11.3	0.3	
	2021	161.3	12.0	0.3	14.1		0.5	0.2		0.2	1.7	93.0	6.6	2.3	29.7	0.7	
	2026	235.7	34.8	0.4	20.1		1.1	0.5		0.5	3.8	166.0	6.3	2.2	0.0	0.0	

Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) A value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value. 4) Negative values in the space heating end use are a result of the reduction in internal heat gains due to lighting and appliance measures being greater than any savings from space heating measures. 5) Savings for television peripherals and other electronics are from standby loss reduction measures. Workshop participants believed that by 2026 advances in the appliances themselves would eliminate the savings available from add-on devices such as timed power bars. Savings in the last milestone period therefore drop to zero.

Exhibit 6.14: Summary of Annual Electricity Savings for the Labrador Interconnected Service Region by End Use and Dwelling Type, Upper Achievable Potential (GWh/yr.)

		Residential															
Dwelling Type	**Milestone Year**	**Total**	**Space Heating**	**Ventilation**	**DHW**	**Cooking**	**Refrigerator**	**Freezer**	**Dishwasher**	**Clothes Washer**	**Clothes Dryer**	**Lighting**	**Computer and peripherals**	**Television**	**Television Peripherals**	**Other Electronics**	**Small Appliances & Other**
Detached	2011	1.8	0.2	0.0	0.4							1.1	0.0		0.0	0.0	
	2016	5.3	2.0	0.0	0.5							2.3	0.2		0.2	0.0	
	2021	11.1	6.1	0.0	0.6							3.5	0.4		0.5	0.0	
	2026	19.2	13.3	0.0	0.5							4.7	0.7		0.0	0.0	
Attached	2011	0.5	0.0	0.0	0.1							0.4	0.0		0.0	0.0	
	2016	1.4	0.3	0.0	0.2							0.7	0.1		0.1	0.0	
	2021	2.8	1.1	0.0	0.2							1.1	0.1		0.2	0.0	
	2026	4.5	2.7	0.0	0.2							1.5	0.2		0.0	0.0	
Apartment	2011	0.1	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.2	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
	2021	0.3	0.0	0.0	0.0							0.2	0.0		0.1	0.0	
	2026	0.4	0.1	0.0	0.0							0.2	0.0		0.0	0.0	
Isolated	2011	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2021	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2026	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
Other	2011	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2021	0.1	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
	2026	0.1	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
TOTAL	2011	2.5	0.2	0.0	0.6							1.6	0.0		0.0	0.0	
	2016	6.9	2.4	0.0	0.7							3.2	0.3		0.3	0.0	
	2021	14.3	7.2	0.0	0.8							4.8	0.5		0.8	0.0	
	2026	24.2	16.1	0.0	0.7							6.5	0.9		0.0	0.0	

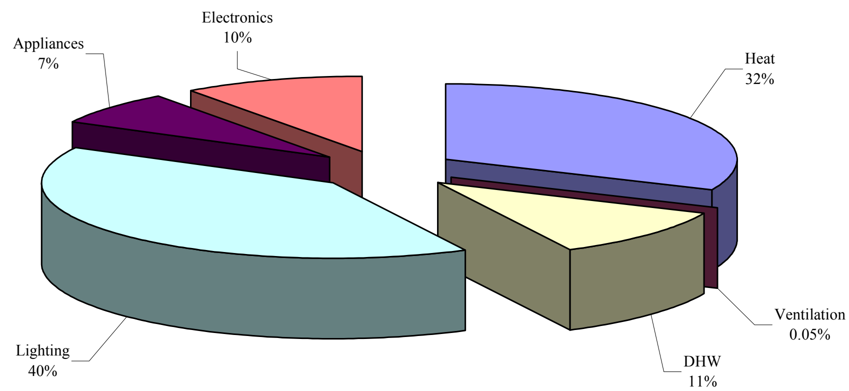
Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) A value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value. 4) Negative values in the space heating end use are a result of the reduction in internal heat gains due to lighting and appliance measures being greater than any savings from space heating measures. 5) Savings for television peripherals and other electronics are from standby loss reduction measures. Workshop participants believed that by 2026 advances in the appliances themselves would eliminate the savings available from add-on devices such as timed power bars. Savings in the last milestone period therefore drop to zero.

Exhibit 6.15: Summary of Annual Electricity Savings for the Labrador Interconnected Service Region by End Use and Dwelling Type, Lower Achievable Potential (GWh/yr.)

		Residential															
Dwelling Type	**Milestone Year**	**Total**	**Space Heating**	**Ventilation**	**DHW**	**Cooking**	**Refrigerator**	**Freezer**	**Dishwasher**	**Clothes Washer**	**Clothes Dryer**	**Lighting**	**Computer and peripherals**	**Television**	**Television Peripherals**	**Other Electronics**	**Small Appliances & Other**
Detached	2011	0.6	0.1	0.0	0.1							0.3	0.0		0.0	0.0	
	2016	2.2	0.6	0.0	0.3							1.1	0.1		0.2	0.0	
	2021	5.3	1.7	0.0	0.4							2.4	0.1		0.5	0.0	
	2026	9.5	4.5	0.0	0.5							4.3	0.1		0.0	0.0	
Attached	2011	0.2	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
	2016	0.6	0.1	0.0	0.1							0.3	0.0		0.1	0.0	
	2021	1.4	0.3	0.0	0.1							0.8	0.0		0.2	0.0	
	2026	2.4	0.9	0.0	0.1							1.3	0.0		0.0	0.0	
Apartment	2011	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.1	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2021	0.2	0.0	0.0	0.0							0.1	0.0		0.1	0.0	
	2026	0.3	0.1	0.0	0.0							0.2	0.0		0.0	0.0	
Isolated	2011	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2021	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2026	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
Other	2011	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2016	0.0	0.0	0.0	0.0							0.0	0.0		0.0	0.0	
	2021	0.1	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
	2026	0.1	0.0	0.0	0.0							0.1	0.0		0.0	0.0	
TOTAL	2011	0.7	0.2	0.0	0.1							0.4	0.0		0.0	0.0	
	2016	2.9	0.7	0.0	0.3							1.5	0.1		0.3	0.0	
	2021	7.0	2.0	0.0	0.6							3.3	0.2		0.8	0.0	
	2026	12.3	5.5	0.0	0.7							6.0	0.2		0.0	0.0	

Notes: 1) Results are measured at the customer's point-of-use and do not include line losses. 2) Any differences in totals are due to rounding. 3) A value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value. 4) Negative values in the space heating end use are a result of the reduction in internal heat gains due to lighting and appliance measures being greater than any savings from space heating measures. 5) Savings for television peripherals and other electronics are from standby loss reduction measures. Workshop participants believed that by 2026 advances in the appliances themselves would eliminate the savings available from add-on devices such as timed power bars. Savings in the last milestone period therefore drop to zero.

Exhibit 6.16: Savings by Major End Use, Upper Achievable – Island and Isolated Service Region 2026 (%)



Totals for Exhibits 6.16 and 6.17 may not add to 100% due to rounding.

Exhibit 6.17: Savings by Major End Use, Lower Achievable – Island and Isolated Service Region 2026 (%)

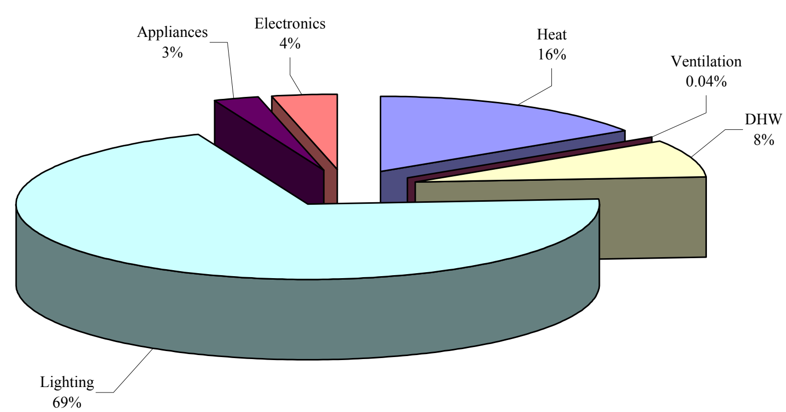
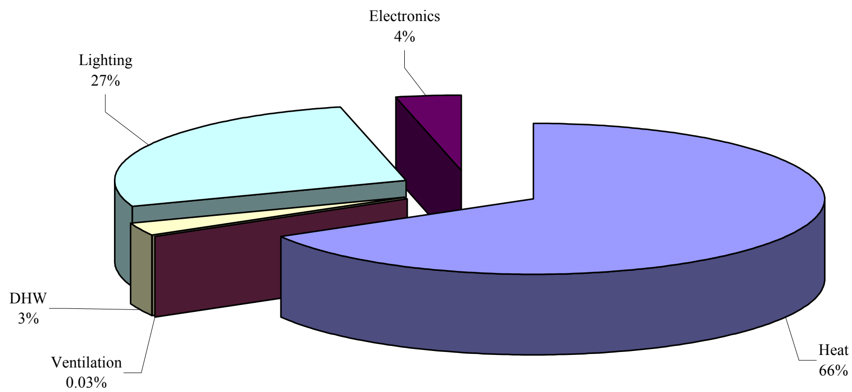


**Exhibit 6.18: Savings by Major End Use,
Upper Achievable – Labrador Interconnected Service Region 2026 (%)**



Totals for Exhibits 6.18 and 6.19 may not add to 100% due to rounding.

**Exhibit 6.19: Savings by Major End Use and Dwelling Type,
Lower Achievable – Labrador Interconnected Service Region 2026 (GWh/yr.)**

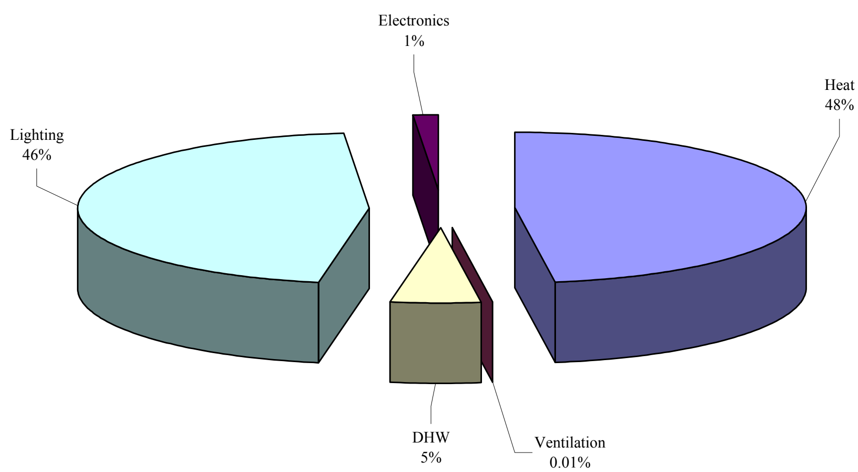
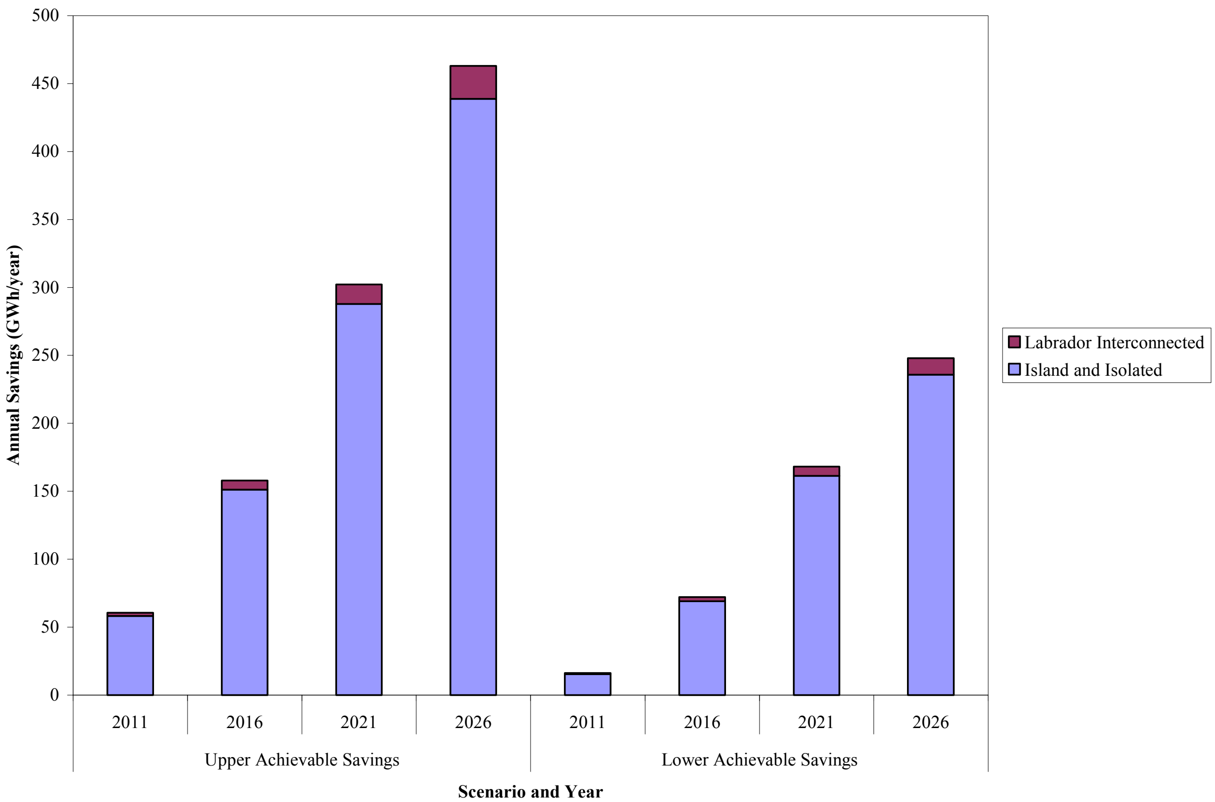


Exhibit 6.20: Savings by Scenario, Milestone Year and Service Region (GWh/yr.)



6.6 PEAK LOAD IMPACTS

The electricity (electric energy) savings (GWh) contained in the preceding scenarios also result in a reduction in electric demand (MW).[125]

The conversion of electricity savings to hourly demand requires the following steps:

- Annual electricity savings for each combination of sub sector and end use are disaggregated *by month*
- Monthly electricity savings are then further disaggregated *by day type* (weekday, weekend day and peak day)
- Finally, each day type is disaggregated *by hour*.

The above steps that convert electricity to electric demand require the development and application of the following four factors (sets of ratios).

[125] Peak load savings were modelled using Applied Energy Group's Cross-Sector Load Shape Library Model (LOADLIB).

- **Monthly Usage Factor**

This factor represents the percentage of annual electricity use that occurs in each month of the year. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. This allocation factor can be obtained from either (in decreasing order of priority): (a) monthly consumption statistics from end-use load studies; (b) monthly seasonal sales (preferably weather normalized) obtained by subtracting a "base" month from winter and summer heating and cooling months; or (c) heating or cooling degree days on an appropriate base.

- **Weekend to Weekday Factor**

This factor is a ratio that describes the distribution of electricity use between weekends and weekdays

- **Peak Day Factor**

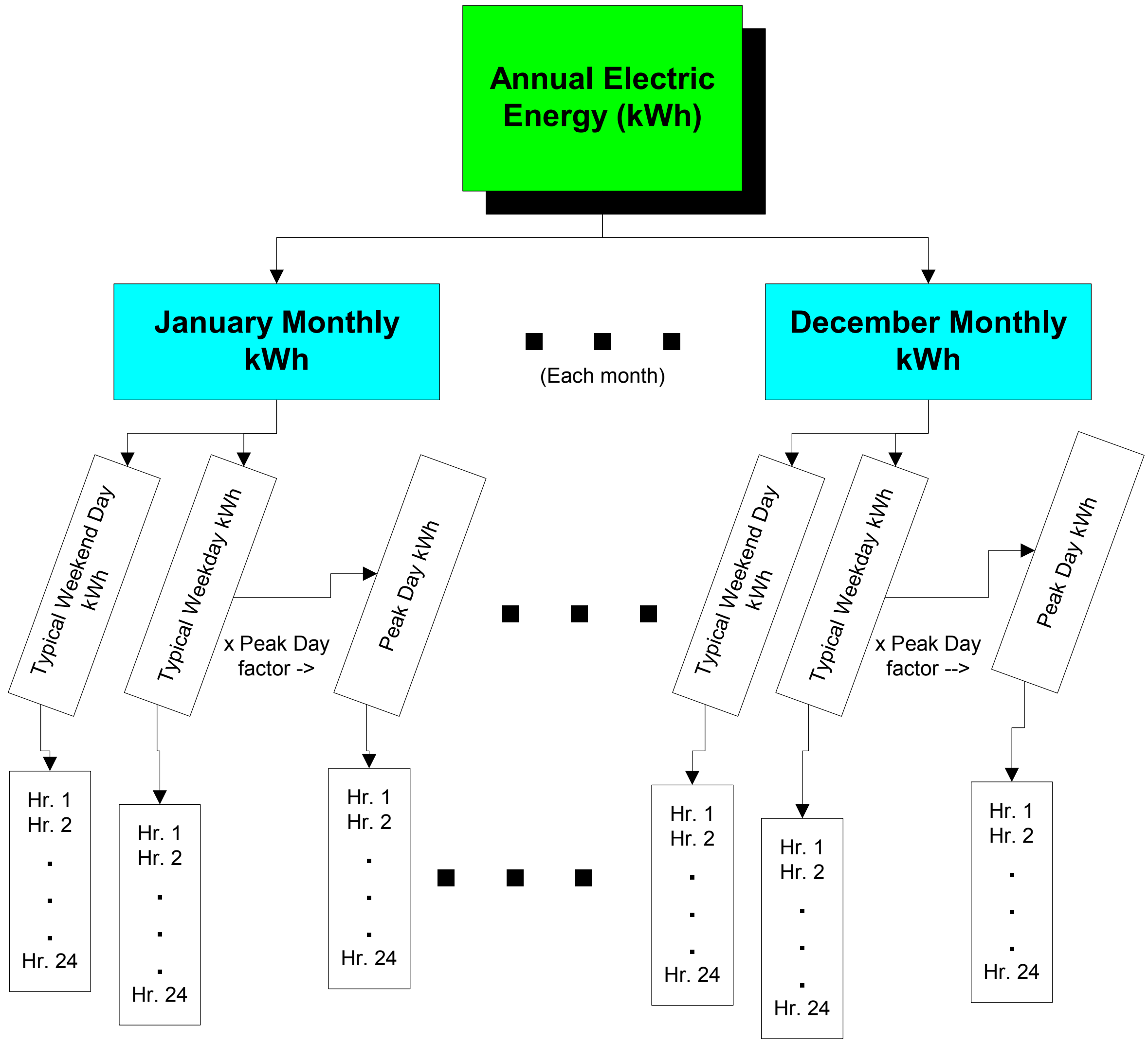
This factor defines the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.

- **Hourly Factor**

This factor describes the typical distribution of daily electricity use for each day type (weekday, weekend day, peak day) and for each month. It reflects the operating hours of the electric equipment or end use by sub sector. For example, for lighting, this would be affected by time of day and season (affected by daylight).

Exhibit 6.21 provides an illustration of the sequential application of the above factors to convert annual electricity to hourly demand. Further description is provided in Appendix C.

Exhibit 6.21: Illustration of Electricity to Peak load Calculation



The study defined the Newfoundland Labrador system peak as:

> *The morning period from 7 am to noon and the evening period from 4 pm to 8 pm on the four coldest days in the December to March period; this is a total of 36 hours per year.*

Exhibit 6.22 presents a summary of the peak load reductions that would occur during the peak period noted above as a result of the electricity savings contained in Upper and Lower Achievable scenarios. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

Exhibit 6.22: Peak load Reductions (MW) Relative to Reference Case by Milestone Year, Service Region and Achievable Scenario

Service Region	Milestone Year	Peak Demand Reduction MW	
		Upper Achievable	Lower Achievable
Island and Isolated	2011	10.8	2.9
	2016	29.1	13.3
	2021	57.8	32.4
	2026	91.1	48.9
Labrador Interconnected	2011	0.6	0.2
	2016	1.8	0.8
	2021	3.8	1.9
	2026	6.5	3.3
TOTAL	2011	11.4	3.1
	2016	30.9	14.1
	2021	61.6	34.3
	2026	97.6	52.2

7. CONCLUSIONS AND NEXT STEPS

This study has confirmed the existence of significant cost-effective CDM potential within Newfoundland and Labrador's Residential sector. The study results provide:

- Specific estimates of the potential CDM savings opportunities, defined by sector, sub sector, end use and, in several cases, specific technology(s)
- A baseline set of energy technology penetrations and energy use practices that can assist in the design of specific programs.

The next step[126] in this process involves the selection of a cost-effective portfolio of CDM programs and the setting of specific CDM targets and spending levels. To provide a preliminary reference point for this next step in the program development process, the study team conducted a brief literature search in an attempt to identify typical CDM spending levels in other jurisdictions. The literature search identified two (relatively) recent studies that had addressed similar issues on behalf of other Canadian utilities. The two studies are:

- *Demand-Side Management: Determining Appropriate Spending Levels and Cost-Effectiveness Testing,* which was prepared by Summit Blue Consulting and the Regulatory Assistance Project for the Canadian Association of Members of Public Utility Tribunals (CAMPUT). The study was completed in January 2006.
- *Planning and Budgeting for Energy Efficiency/Demand-Side Management Programs,* which was prepared by Navigant Consulting for Union Gas (Ontario) Limited. The study was completed in July 2005.

The CAMPUT study, which included a review of U.S. and Canadian jurisdictions, concluded that an annual CDM expenditure equal to about 1.5% of annual electricity revenues might be appropriate for a utility (or jurisdiction) that is in the early stages of CDM[127] programming. This level of funding recognizes that it takes time to properly introduce programs into the market place.

The same study found that once program delivery experience is gained, a ramping up to a level of about 3% of annual electricity revenues is appropriate. The study also notes that higher percentages may be warranted if rapid growth in electricity demand is expected, or if there is an increasing gap between demand and supply due to such things as plant retirements or siting limitations. The current emphasis on climate change mitigation measures would presumably also fall into a similar category of potential CDM drivers.

The CAMPUT study also notes that even those states with 3% of annual revenues as their CDM target have found that there are more cost-effective CDM opportunities than could be met by the 3% funding. The finding is consistent with the situation in British Columbia. In the case of BC Hydro, CDM expenditures over the past few years have been about 3.3% of electricity

[126] Full treatment of these next steps is beyond the scope of the current project.
[127] The CAMPUT study uses the term DSM (demand-side management); DSM is used interchangeably with CDM in this section.

revenues.[128] However, the results of BC Hydro's recently completed study (Conservation Potential Review (CPR) 2007) identified over 20,000 GWh of remaining cost-effective CDM opportunities by 2026. The magnitude of remaining cost-effective CDM opportunities combined with the aggressive targets set out in British Columbia's provincial Energy Plan suggest that BC Hydro's future CDM expenditures are likely to increase significantly if the new targets are to be met.

Additional notes:

- Neither of the studies noted above found any one single, simple model for setting CDM spending levels and targets. Rather, the more general conclusion is that utilities use a number of different approaches that are reasonable for their context. In fact, the CAMPUT report identified seven approaches to setting CDM spending levels:

  - Based on cost-effective CDM potential estimates
  - Based on percentages of utility revenues
  - Based on Mills/kWh of utility electric sales
  - Levels set through resource planning process
  - Levels set through the restructuring process
  - Tied to projected load growth
  - Case-by-case approach.

- The CAMPUT study also notes that, although not always explicit, a key issue in most jurisdictions is resolving the trade off between wanting to procure all cost-effective energy-efficiency measures and concerns about the resulting short-term effect on rates. The study concluded that CDM budgets based on findings from an Integrated Resource Plan or a benefit-cost assessment tend to accept whatever rate effects are necessary to secure the overall resource plan, inclusive of the cost-effective energy-efficiency measures.

[128] CAMPUT, 2006. p. 14.

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