CONSERVATION AND DEMAND MANAGEMENT (CDM) POTENTIAL

NEWFOUNDLAND and LABRADOR

Residential, Commercial and Industrial Sectors

–Summary Report–

Prepared for:

Newfoundland & Labrador Hydro and Newfoundland Power

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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.

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.

1.2 STUDY SCOPE

The scope of this study is summarized below.

- **Sector Coverage:** This study addresses the Residential, Commercial[1] and Industrial sectors. Consistent with the study's agreed upon scope, the Industrial sector is treated at a higher level than the Residential and Commercial sectors.

[1] The Commercial sector analysis includes street lighting.

- **Geographical Coverage**: The study addresses the customers of 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 were 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 year 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; 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 electric demand. The study also provides a high-level treatment of selected demand management measures, such as direct control of space heating loads.[2]

1.3 MAJOR ANALYTIC STEPS

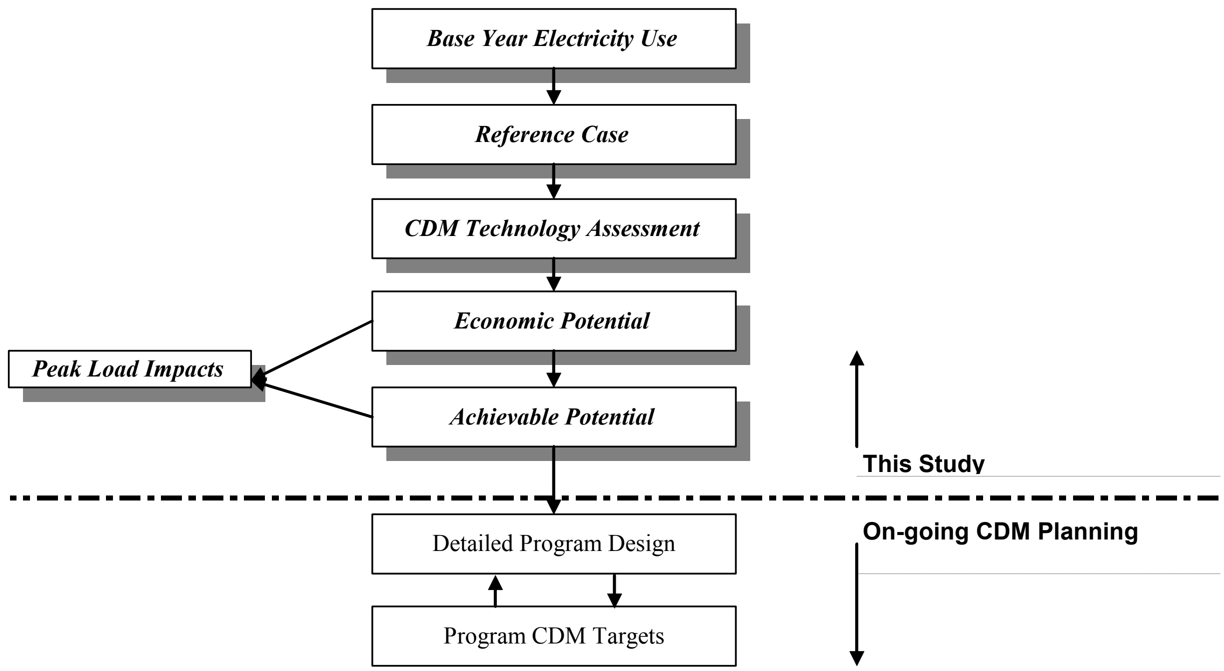
The major steps involved in the analysis are shown in Exhibit 1.1 and are discussed in greater detail in Section 1 of the individual sector reports. As illustrated in Exhibit 1.1, the results of this study, and in particular the estimation of Achievable Potential,[3] support the Utilities on-going work.

It should, however, be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific targets or with program design. Both of these activities require additional market-specific investigation and planning.

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

[3] The proportion of savings identified that could be achieved within the study period assuming specific customer, program and market conditions. Additional details are provided in the individual sector reports.

Exhibit 1.1: Study Approach - Major Analytical Steps



The analysis conducted within each of the three sectors followed a similar set of steps, as outlined below.

Step 1: Develop Base Year Calibration Using Actual Utilities Sales Data

The Base Year (2006) is the starting point for the analysis. It provides a detailed description of "where" and "how" electricity is currently used, based on actual electricity sales.

The consultants compiled the best available data and used sector-specific macro models to estimate electricity use; they then compared the results to the Utilities actual billing data to verify their accuracy.

Step 2: Develop Reference Case

The Reference Case uses the same sector-specific macro models to estimate the expected level of electricity consumption that would occur over the study period with no new (post-2006) Utilities' CDM initiatives. The Reference Case includes projected increases in electricity consumption based on expected rates of population and economic growth, using the growth rates included in the NLH 2006 load forecast.[4] The Reference Case also makes an estimate for some "natural" conservation, that is, conservation that occurs without Utilities' CDM programs. The Reference Case provides the point of comparison for the calculation of Economic and Achievable electricity saving potentials.

[4] Newfoundland & Labrador Hydro Long Term Planning (PLF) Review Forecast, Summer/Fall 2006.

Step 3: Assess CDM Technologies

The consultants researched a wide range of commercially available CDM technologies and practices that can enable the Utilities' customers to use electricity more efficiently. In each case, the consultants assessed how much electricity the CDM measures could save together with the expected cost, including purchase (capital), operating and maintenance costs.

For each CDM measure the consultants calculated a value for the cost per year per kilowatt-hour of saved electricity, referred to as the Cost of Conserved Energy (CCE). The CCE is calculated as the annualized incremental cost (including operating and maintenance) of the measure divided by the annual kilowatt-hour savings achieved, excluding any administrative or program costs to achieve full use of the measure. This approach allowed the consultants to compare a standardized cost for new technologies and measures with the cost of new electricity supply, or other electricity conserving measures, and to determine whether or not to include the CDM measure in the Economic Potential Forecast.

Step 4: Estimate Economic Electricity Savings Potential

To forecast the potential electricity savings that are defined as economic, the consultants used the sector-specific macro models to calculate the level of electricity consumption that would occur if the Utilities' customers installed all "cost-effective" technologies. "Cost effective" for the purposes of this study means that the CCE is less than or equal to the estimated cost of new electricity supply.

NLH determined that the 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[5].

The Economic Potential Forecast incorporates all the CDM measures reviewed that have a CCE equal to or less than the avoided costs noted above. This forecast does not yet incorporate consideration of the many practical considerations that affect a customer's willingness to implement the CDM measures. Rather, it provides a valuable interim step towards determining the Achievable Potential (see Step 5).

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 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, the consultants undertook a high-level financial sensitivity analysis.

[5] 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.

Step 5: Estimate Achievable Electricity Savings Potential

The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecast that could 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, therefore, presented within an "upper" and "lower" range.[6]

The Upper Achievable Potential assumes a very 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

It is important to note that the Upper and Lower Achievable numbers are intended to bracket savings which could be expected to be attainable given the assumptions and scope of the study. As noted previously, Achievable Potential, although complementary, is not synonymous with the actual CDM targets that are established as part of the more detailed CDM program design process (which is beyond the scope of this current study).

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)[7]. 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 during the December to March period; this is a total of 36 hours per year.*

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[6] 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.

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

The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end use electricity use 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*.

1.4 CAVEATS

The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout each of the main sector reports. Specific areas are noted below.

1.4.1 Data Quality and Assumptions

As in any study of this type, the results presented 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 judgment of the consultant team, Utilities personnel and local experts. The reader should use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the individual sector reports.

1.4.2 Interactive Effects

A systems approach was used to model the energy impacts of the CDM measures presented in the Economic and Achievable Potential phases of the study. In the absence of a systems approach, an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible.

One of the reasons that this approach is necessary is to ensure that the interactive effects are appropriately considered. For example, in the Residential sector, 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 kWh to 70 kWh in this jurisdiction, depending on housing dwelling type and geographical location. This is higher than the ratio of approximately 0.5 that is typical of other jurisdictions and is related largely to the length of the heating season, rather than 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.

1.4.3 Program Design and Implementation Costs

The study results presented in this Summary Report and in the individual sector reports do not yet include expenditures related to program design and implementation. These costs are considered at the detailed program design phase, which will be completed following this study[8].

1.5 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 three individual reports that 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*

The results of the individual sector reports are combined into this Summary Report. Finally, the study also prepared a brief CDM program evaluation report, which is presented under separate cover and is entitled:

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

1.5.1 Summary Report Outline

This report presents a summary of the study results and is organized as follows:

- Section 2 presents the combined electricity and peak load savings for the three sectors.

[8] Addition of these costs may negatively impact the economic attractiveness of some measures currently included in the Achievable Potential estimates.

- Sections 3, 4 and 5 present a summary of the electricity and peak load savings for, respectively, the Residential, Commercial and Industrial sectors.

- Section 6 presents conclusions and next steps.

2. SUMMARY OF STUDY FINDINGS

The study findings confirm the existence of significant potential cost-effective opportunities for CDM in Newfoundland and Labrador's Residential, Commercial and Industrial sectors.

2.1 ELECTRICITY SAVINGS POTENTIAL

Exhibits 2.1 and 2.2 summarize the total combined electricity savings for the Residential, Commercial and Industrial sectors that have been identified in each of the individual sector reports for, respectively, the Island and Isolated and the Labrador Interconnected service regions.[9]

Highlights of the results for the Island and Isolated service region are shown in Exhibit 2.1. They include:

- In the Reference Case, total electricity consumption for the Island and Isolated service region increases from approximately 6,468 GWh/yr. in 2006 to about 7,685 GWh/yr. by 2026, an increase of about 19%
- In the Upper Achievable Potential scenario, electricity savings for the Island and Isolated service region are about 211 GWh/yr. in 2011 and increase to about 951 GWh/yr. by 2026. The electricity savings of 951 GWh/yr. in 2026 means that total electricity consumption would increase to about 6,737 GWh/yr., a decrease of about 12% relative to the Reference Case
- In the Lower Achievable Potential scenario, electricity savings for the Island and Isolated service region are about 117 GWh/yr. in 2011 and increase to about 556 GWh/yr. by 2026. The electricity savings of 556 GWh/yr. in 2026 means that total electricity consumption would increase to about 7,129 GWh/yr., a decrease of about 7% relative to the Reference Case.

Exhibit 2.1: Achievable Electricity Savings Potential for the Island and Isolated Service Region

Milestone Year	Reference Case	Achievable Savings (GWh/yr.)		Achievable Savings As % of Reference Case	
		Upper	*Lower*	*Upper*	*Lower*
2006	6,468	-	-	-	-
2011	6,888	211	117	3.1	1.7
2016	7,139	437	261	6.1	3.7
2021	7,427	679	414	9.1	5.6
2026	7,685	951	556	12.4	7.2

9 Analysis for the two service regions was combined for the Industrial sector. Industrial reference electricity use and savings are included in Exhibit 2.1 only and refer exclusively to purchased electricity.

Highlights of the results for the Labrador Interconnected service region are shown in Exhibit 2.2. They include:

- In the Reference Case, total electricity consumption for the Labrador Interconnected service region increases from approximately 465 GWh/yr. in 2006 to about 540 GWh/yr. by 2026, an increase of about 16%
- In the Upper Achievable Potential scenario, electricity savings for the Labrador Interconnected service region are about 12 GWh/yr. in 2011 and increase to about 51 GWh/yr. by 2026. The electricity savings of 51 GWh/yr. in 2026 means that total electricity consumption for the Labrador Interconnected service region would increase to about 489 GWh/yr., a decrease of about 9% relative to the Reference Case
- In the Lower Achievable Potential scenario, electricity savings for the Labrador Interconnected service region are about 8 GWh/yr. in 2011 and increase to about 31 GWh/yr. by 2026. The electricity savings of 31 GWh/yr. in 2026 means that total electricity consumption for the Labrador Interconnected service region would increase to about 509 GWh/yr., a decrease of about 6% relative to the Reference Case.

Exhibit 2.2: Achievable Electricity Savings Potential for the Labrador Interconnected Service Region

Milestone Year	Reference Case	Achievable Savings (GWh/yr.)		Achievable Savings As % of Reference Case	
		Upper	*Lower*	*Upper*	*Lower*
2006	465	-	-	-	-
2011	499	12	8	2.4	1.6
2016	512	24	16	4.7	3.1
2021	525	37	23	7.0	4.4
2026	540	51	31	9.4	5.7

2.2 PEAK LOAD SAVINGS

The electricity savings noted above also result in a reduction in peak load requirements (MW), which can be of particular value to the Utilities during periods of high electricity demand[10].

The resulting peak load savings are presented in Exhibit 2.3.[11] As illustrated, the total peak load savings were estimated to be 154 MW and 89 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.

[10] See Section 1.3 for peak period definition.

[11] Peak load impact was analyzed for the residential and commercial sectors only. Exhibit 2.3 presents the combined results for these two sectors.

Exhibit 2.3: Total Achievable Peak Load Savings Potential

Service Region	Milestone Year	Peak Load Savings (MW)	
		Upper Achievable	Lower Achievable
Island and Isolated	2011	27	14
	2016	60	36
	2021	99	61
	2026	144	83
Labrador Interconnected	2011	1.4	0.9
	2016	3.8	2.4
	2021	6.4	3.8
	2026	9.7	5.5

3. RESIDENTIAL SECTOR

The Residential sector includes single-family homes, attached dwellings and apartments as well as a small number of isolated and other dwellings.

3.1 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 in the general approach to the study are outlined in Section 1.3 above (*Major Analytic Steps*). Specific procedures for the Residential sector were as follows:

- **Modelling of Base Year –** The consultants used the Utilities' customer data to break down the Residential sector by four factors:

  - Type of dwelling (single detached, attached, apartment, etc.)
  - Heating category (electric or non-electric heat)
  - The age of the building (new versus existing)
  - Service region.

  To estimate the electricity used for space heating, the consultants factored in building characteristics such as insulation levels, floor space and airtightness using a variety of data sources, including the Energuide for Houses database, Utilities' billing data, local climate data and discussions with local contractors. They also used the results of Utilities' customer surveys that provided data on type of heating system, number and age of household appliances, renovation activity, etc. Based on the available data sources, the consultants calculated an average electricity use by end use for each dwelling type. The consultant's models produced a close match with actual Utilities' sales data.

- **Reference case calculations –** For the Residential sector, the consultants developed profiles of new buildings for each type of dwelling. They estimated the growth in building stock using the same data as that contained in the Utilities' most recent load forecast and estimated the amount of electricity used by both the existing building stock and the projected new buildings and appliances. As with the Base Year calibration, the consultants' projection closely matches the Utilities own 2006 forecast of future electricity requirements.

- **Assessment of CDM measures** –To estimate the economic and achievable electricity savings potentials, the consultants assessed a wide range of commercially available CDM measures and technologies such as:

  - Improved lighting systems
  - Thermal upgrades to the walls, roofs and windows of existing buildings
  - More efficient space heating equipment and controls
  - Measures to reduce hot water usage

- Improved designs for new buildings
- Reduced standby losses in computers and electronic equipment
- More efficient household appliances and other plug-in equipment.

3.2 ELECTRICITY SAVINGS

In, respectively, the Upper and Lower Achievable Potential scenarios, Residential Sector electricity savings are estimated to be between 439 and 236 GWh/yr. by 2026 in the Island and Isolated service region.[12]

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by the study is presented in Exhibits 3.1 and 3.2, by milestone year, and discussed briefly in the paragraphs below.

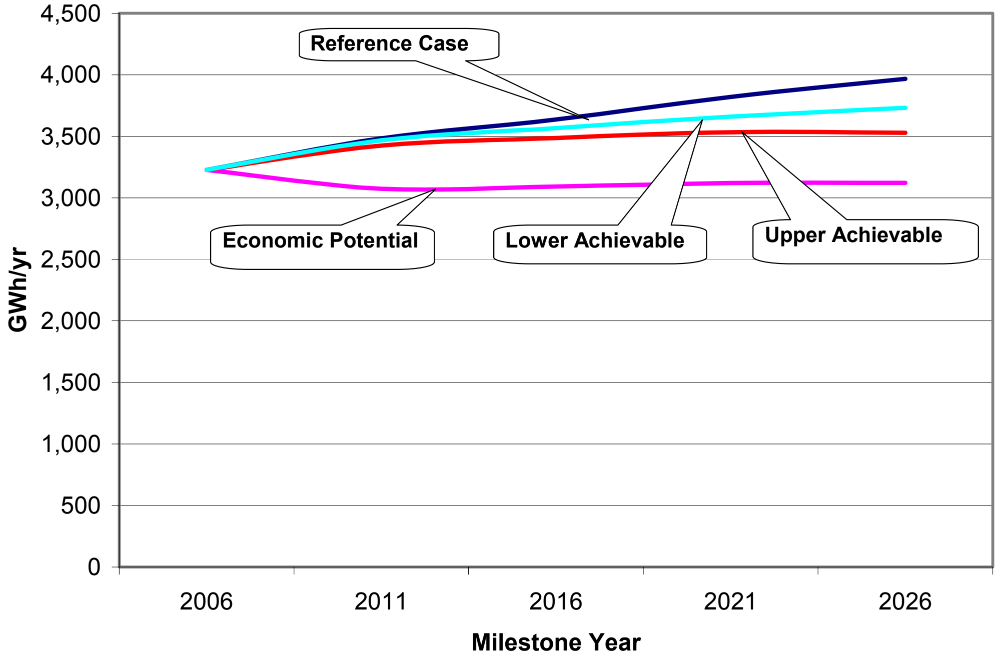
Exhibit 3.1: Summary of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Residential Sector (GWh/yr.)

Annual Consumption (GWh/yr.)				Potential Annual Savings (GWh/yr.)	
Milestone Year	Reference Case	Achievable		Achievable	
		Upper	Lower	Upper	Lower
2006	3,228				
2011	3,483	3,425	3,468	58	16
2016	3,637	3,486	3,568	151	69
2021	3,821	3,533	3,660	288	161
2026	3,968	3,529	3,732	439	236

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

[12] The comparable results in 2026 for the Labrador Interconnected service region are between 24 and 12 GWh/yr. in, respectively, the Upper and Lower achievable scenarios. Additional details are provided in the Residential sector report and accompanying appendices.

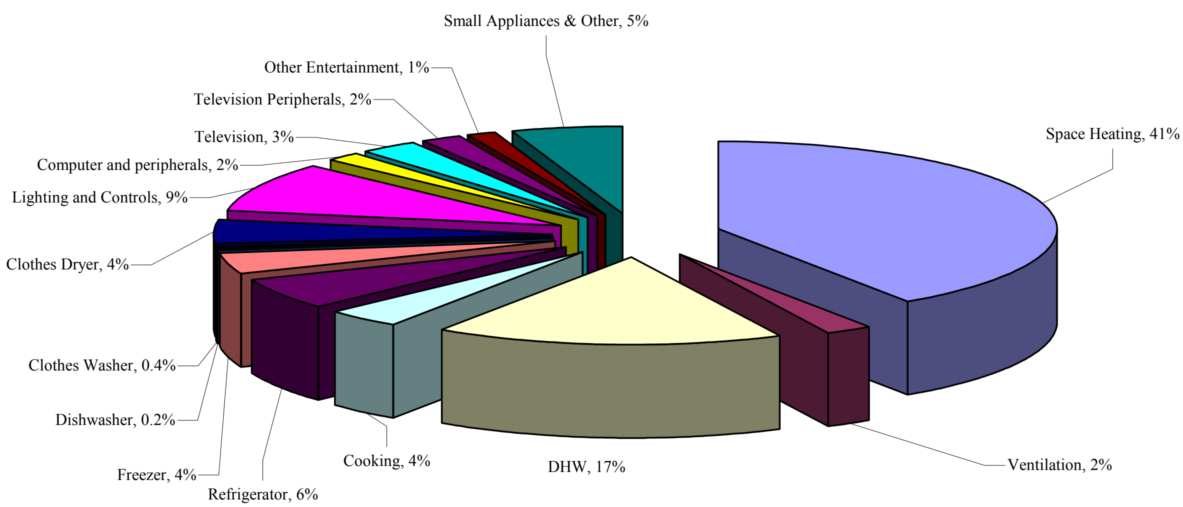
Exhibit 3.2: Graphic of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Residential Sector (GWh/yr.)



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 3.3 shows that space heating accounts for about 41% of total residential electricity use.[13] 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 3.3: Base Year Electricity Use by End Use in the Island and Isolated Service Region, Residential Sector[14]



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

[14] Values may not add to 100% due to rounding.

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 Utilities' 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,[15] 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 846 GWh/yr. or about 21%.

Achievable Potential

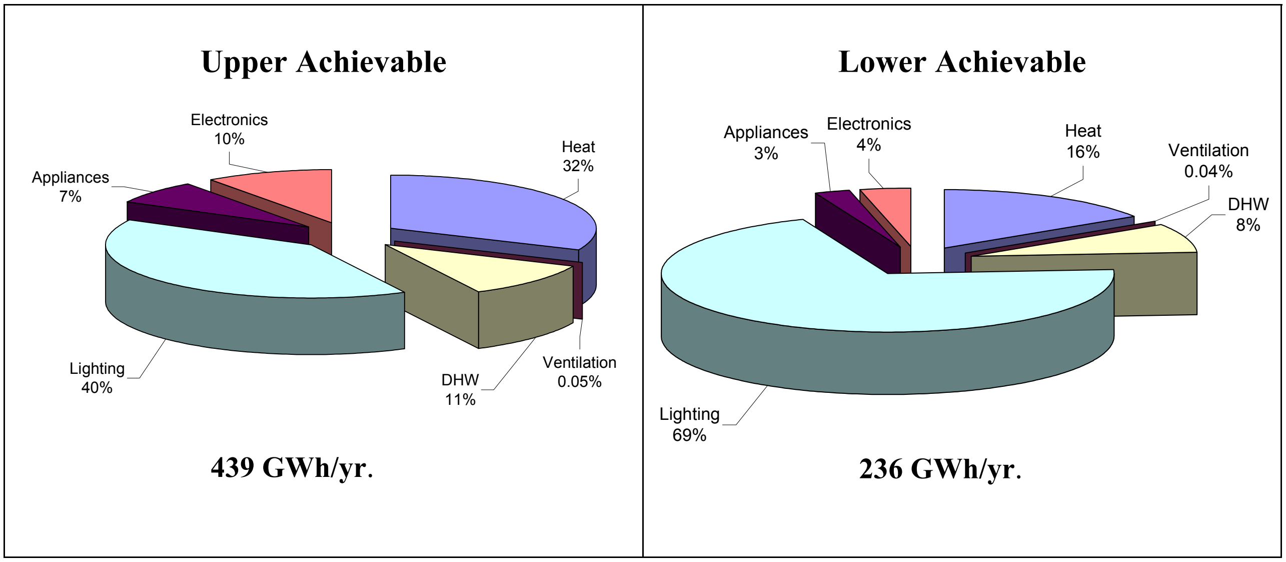
The Achievable Potential is the proportion of the economic electricity savings (as noted above) that could realistically be achieved within the study period. In the Residential sector within the Island and Isolated service region, the Achievable Potential for electricity savings was estimated to be 439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

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.

Exhibit 3.4 shows the distribution of electricity savings in 2026 by end use in the Upper and Lower Achievable Potential scenarios.

[15] 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 3.4: Distribution of Electricity Savings by Major End Use in the Upper and Lower Achievable Scenarios, Island and Isolated Service Region, Residential Sector[16]



3.3 PEAK LOAD SAVINGS

The electricity savings noted above also result in a reduction in peak load requirements (MW), which can be of particular value to the Utility during periods of high electricity demand[17].

The resulting Residential sector peak load savings for the Island and Isolated service region are presented in Exhibit 3.5.

Exhibit 3.5: 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

As illustrated in Exhibit 3.5, the Residential sector peak load savings was estimated to be 91 MW and 49 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.[18]

[16] Values may not add to 100% due to rounding.

[17] See Section 1.3 for peak period definition.

[18] The comparable results for the Labrador Interconnected service region are between 6.5 and 3.3 MW in, respectively, the Upper and Lower achievable scenarios. Additional details are provided in the Residential sector report and accompanying appendices.

4. COMMERCIAL SECTOR

The Commercial sector includes office and retail buildings, hotels and motels, restaurants, warehouses and a wide variety of small buildings. In this study, it also includes buildings that are often classified as "institutional," such as hospitals and nursing homes, schools and universities. Street lighting is also included in the Commercial sector.

Throughout this report, use of the word "commercial" includes both commercial and institutional buildings unless otherwise noted.

4.1 APPROACH

The detailed end-use analysis of electrical efficiency opportunities in the Commercial sector employed two linked modelling platforms: **CEEAM** (Commercial Electricity and Emissions Analysis Model), a Marbek in-house simulation model developed in conjunction with Natural Resources Canada (NRCan) for modelling electricity use in commercial/institutional building stock, and **CSEEM** (Commercial Sector Energy End-use Model), an 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 in the general approach to the study were outlined earlier in Section 1.3 (*Major Analytic Steps*). Specific procedures for the Commercial sector were as follows:

- **Modelling of Base Year –** Marbek compiled data that defines "where" and "how" electricity is currently used in existing commercial buildings. The consultants then created building energy use simulations for each type of commercial building and calibrated the models to reflect actual Utilities' customer sales data. Estimated savings for the Small Commercial, Other and Isolated categories were derived from the results of the modelled segments. They did not directly model those categories because they are extremely diverse and the electricity use of individual categories is relatively small. The consultant's model produced a close match with actual Utilities' sales data.

- **Reference case calculations –** For the Commercial sector, Marbek developed detailed profiles of new buildings in each of the building segments, estimated the growth in building stock and estimated "natural" changes affecting electricity consumption over the study period. As with the Base Year calibration, the consultants' projection closely matches the Utilities 2006 forecast of future electricity requirements.

- **Assessment of CDM Measures** – To estimate the economic and achievable electricity savings potentials, the consultants assessed a wide range of commercially available CDM measures and technologies such as:

  - More efficient lighting systems and office equipment
  - Improved construction in new buildings
  - Upgraded heating, ventilating and cooling systems.

4.2 ELECTRICITY SAVINGS

In, respectively, the Upper and Lower Achievable Potential scenarios, Commercial Sector electricity savings are estimated to be between 387 and 261 GWh/yr. by 2026 in the Island and Isolated service region.[19]

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by the study is presented in Exhibits 4.1 and 4.2, by milestone year, and discussed briefly in the paragraphs below.

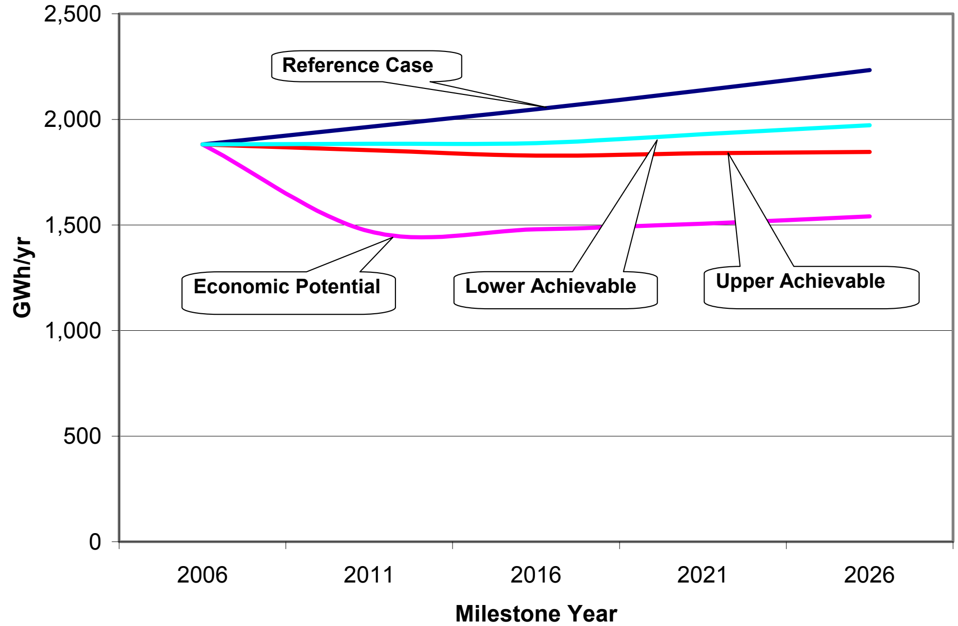
Exhibit 4.1: Summary of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Commercial Sector (GWh/yr.)

Annual Consumption (GWh/yr.) Commercial Sector						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
2006	1,881	1,881						
2011		1,965	1,471	1,855	1,884	494	110	80
2016		2,048	1,479	1,828	1,888	569	220	160
2021		2,138	1,506	1,840	1,930	632	298	209
2026		2,233	1,541	1,846	1,972	693	387	261

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

[19] The comparable results for the Labrador Interconnected service region are between 27 and 19 GWh/yr. in, respectively, the Upper and Lower achievable scenarios. Additional details are provided in the Commercial sector report and accompanying appendices.

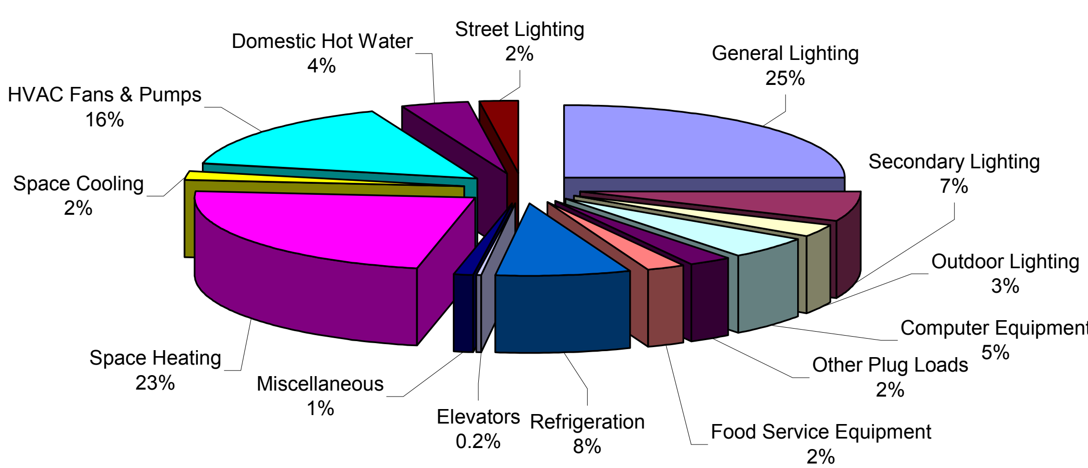
Exhibit 4.2: Graphic of Forecast Results for the Island and Isolated Service Region – Annual Electricity Consumption, Commercial Sector (GWh/yr.)



Base Year Electricity Use

In the Base Year of 2006, the Commercial sector in the Island and Isolated service region consumed about 1,881 GWh. Exhibit 4.3 shows that space lighting accounts for about 32% of total commercial electricity use, space heating accounts for about 23%, followed by HVAC fans and pumps (16%) and refrigeration (8%).

Exhibit 4.3: Base Year Electricity Use by End Use in the Island and Isolated Service Region, Commercial Sector[20]



20 Values may not add to 100% due to rounding.

In the Island and Isolated Service Region, the Small commercial sub sector accounts for the largest share of the total electricity consumption at 28%, followed by Office at 17%, Other Buildings at 8% and Food Retail at 7%.

Reference Case

In the absence of new Utility initiatives, the study estimates that electricity consumption in the Commercial sector will grow from 1,881 GWh/yr. in 2006 to about 2,233 GWh/yr. by 2026 in the Island and Isolated service region. This represents an overall growth of about 19% 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,[21] the study estimated that electricity consumption in the Commercial sector would fall to about 1,541 GWh/yr. by 2026 in the Island and Isolated service region. Annual savings relative to the Reference Case are 693 GWh/yr., or about 31%.

Achievable Potential

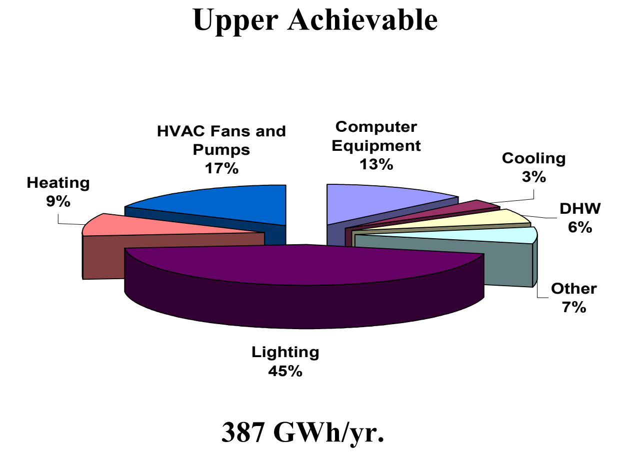
The Achievable Potential is the proportion of the economic electricity savings (as noted above) that could realistically be achieved within the study period. In the Commercial sector within the Island and Isolated service region, the Achievable Potential for electricity savings was estimated to be 387 GWh/yr. and 261 GWh/yr. by 2026 in, respectively, the Upper and Lower scenarios.

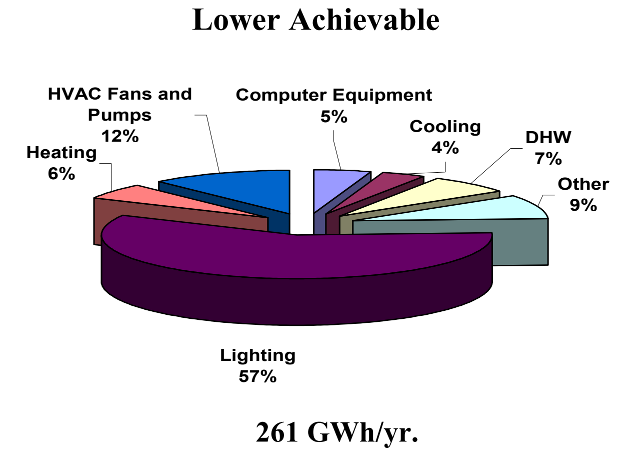
The most significant achievable savings opportunities were in the actions that addressed lighting, HVAC fans and pumps and space heating.

Exhibit 4.4 shows the distribution of electricity savings in 2026 by end use in the Upper and Lower Achievable Potential scenarios.

[21] 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 4.4: Distribution of Electricity Savings by Major End Use in the Upper and Lower Achievable Scenarios, Island and Isolated Service Region, Commercial Sector[22]





4.3 PEAK LOAD SAVINGS

The electricity savings noted above also result in a reduction in peak load requirements (MW), which can be of particular value to the Utility during periods of high electricity demand[23].

The resulting Commercial sector peak load savings are presented in Exhibit 4.5.

Exhibit 4.5: Peak Load Savings from Electricity Savings in the Island and Isolated Service Region, Commercial Sector

Milestone Year	Energy Savings (GWh/yr.)		Peak Demand Reduction (MW)	
	Upper Achievable	Lower Achievable	Upper Achievable	Lower Achievable
2011	110	80	16	11
2016	220	160	32	23
2021	298	209	42	28
2026	387	261	54	35

As illustrated in Exhibit 4.5, the Commercial sector peak load savings were estimated to be 54 MW and 35 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.[24]

[22] Values may not add to 100% due to rounding.

[23] See Section 1.3 for peak period definition.

[24] The comparable results for the Labrador Interconnected service region are between 3.2 and 2.2 MW in, respectively, the Upper and Lower achievable scenarios. Additional details are provided in the Commercial sector report and accompanying appendices.

5. INDUSTRIAL SECTOR

The Industrial sector consists of large transmission level customers from the Mining, Pulp and Paper and Oil Refining sub sectors that use more than 50 GWh of electricity annually and over 400 small and medium facilities that use less than 50 GWh annually, including Fishing and Fish Processing, Manufacturing and Other customer categories.

5.1 APPROACH

The detailed end-use analysis of electrical efficiency opportunities in the Industrial sector employed Marbek's customized spreadsheet model. The model is organized by major industrial sub sector and major end use.

Electricity end-use profiles were developed for the six sub sectors described above. The profiles map proportionally how much electricity is used by each of the end uses for each sub sector. These profiles represent the sub sector archetypes and are used in the model to calculate the electricity used by each end use for each sub sector.

Three archetype profiles were developed for large industry based on the results of a survey of the six facilities included in these sub sectors.[25] In each case, site personnel provided data, which addressed both the allocation of electricity use by end use and general best practices implemented at the sites. A copy of the survey instrument is contained in Appendix A of the industrial sector report.

Experience from previous industry studies in other Canadian jurisdictions provided the necessary archetype end-use profiles for the three Small and Medium industrial sub sectors. These profiles were reviewed by industry experts familiar with industry in Newfoundland and Labrador and were revised to be representative of the province's industrial sub sectors.

The major steps in the general approach to the study are outlined in Section 1.3 above (*Major Analytic Steps*). Specific procedures for the Industrial sector were as follows:

- **Modelling of Base Year** – The consultants compiled data on Newfoundland and Labrador's Industrial sector from the Utilities Load Forecasting Department and from a survey questionnaire that was completed by each of the large customers. The macro model results produced a close match with actual Utilities' sales data.

- **Reference Case calculations -** The consultants prepared a Reference Case forecast based on projected growth forecasts provided by NLH, which includes anticipated closing of existing facilities and opening of new facilities. The possibility of new industrial load on the system, related to the processing of nickel from Voisey's Bay in Labrador, is not included due to the uncertainty with the processing technology. The self-generated electricity consumption was frozen for the 20-year forecast.

- **Assessment of CDM Measures** –To estimate the economic and achievable electricity savings potentials, the consultants assessed a wide range of commercially available CDM

[25] The results were also compared with those from detailed studies of similar industries undertaken by Marbek and were found to compare well.

measures and technologies such as more efficient systems for pumps, air displacement (fans), compressed air, material conveyance (such as conveyor belts and chains), industrial refrigeration as well as more efficient, industrial lighting, electric motors, etc.

5.2 ELECTRICITY SAVINGS

In, respectively, the Upper and Lower Achievable Potential scenarios, Industrial Sector electricity savings are estimated to be between 125 and 59 GWh/yr. by 2026 in the Island and Isolated and Labrador Interconnected service regions.[26]

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by the study is presented in Exhibits 5.1 and 5.2, by milestone year, and discussed briefly in the paragraphs below.

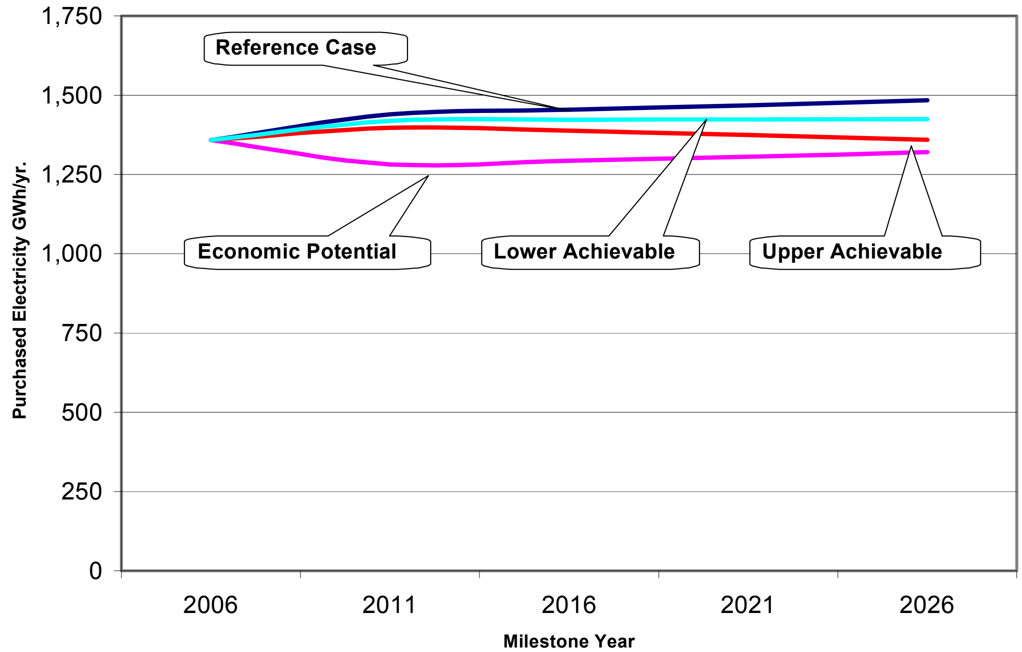
Exhibit 5.1: Summary of Forecast Results for the Island and Isolated and Labrador Interconnected Service Regions – Annual Electricity Consumption, Industrial Sector (GWh/yr.)

Annual Consumption (GWh/yr.) Industrial Sector						Potential Annual Savings (GWh/yr.)		
Milestone Year	Base Year	Reference Case	Economic	Achievable		Economic	Achievable	
				Upper	Lower		Upper	Lower
2006	1,359	1,359						
2011		1,440	1,282	1,397	1,419	158	43	21
2016		1,454	1,293	1,388	1,422	161	66	32
2021		1,468	1,306	1,375	1,424	162	93	44
2026		1,484	1,321	1,360	1,425	164	125	59

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

26 Analysis for the two service regions was combined for the Industrial sector.

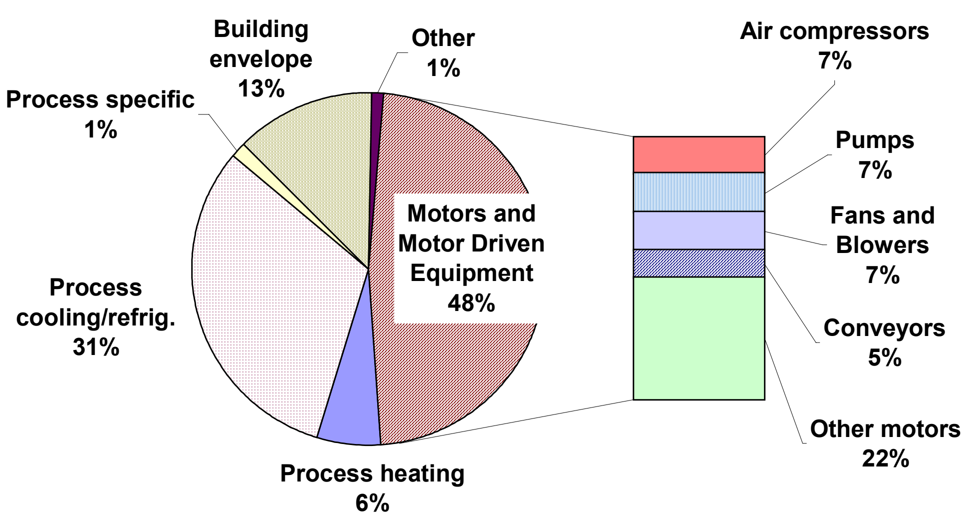
Exhibit 5.2: Reference Case versus Upper and Lower Achievable Potential Electricity Consumption in the Industrial Sector (GWh/yr.)



Base Year Electricity Use

In the Base Year of 2006, the Island and Isolated and Labrador Interconnected Service Regions consumed about 4,558 GWh, of which 1,359 GWh was purchased electricity[27]. The Large industrial sub sector consumed 79% of the total purchased electricity. Exhibit 5.3 shows the purchase electricity use by end use for the Small and Medium industrial sector. Most of the electricity is used by motor and motor drive equipment (48% of the total) and process cooling and refrigeration/freezing (31% of the total).

Exhibit 5.3: Small and Medium Industry Base Year Modelled Annual Purchased Electricity Consumption for the Island and Isolated and Labrador Interconnected Service Regions by End Use, (GWh/yr.)



[27] Self-generated electricity was beyond the study scope.

Reference Case

In the absence of new Utilities' CDM initiatives, the study estimates that purchased electricity consumption in the Industrial sector will grow from 1,359 GWh/yr. in 2006 to about 1,484 GWh/yr. by 2026 in the Island and Isolated and Labrador Interconnected service regions. This represents an overall growth of about 9% 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,[28] the study estimated that electricity consumption in the Industrial sector would decline to about 1,321 GWh/yr. by 2026 in the Island and Isolated and Labrador Interconnected Service Regions. Annual savings relative to the Reference Case are 164 GWh/yr. or about 11%.

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 Industrial sector within the Island and Isolated and Labrador Interconnected service regions, the Achievable Potential for electricity savings was estimated to be 125 GWh/yr. and 59 GWh/yr. by 2026 in, respectively, the Upper and Lower scenarios.

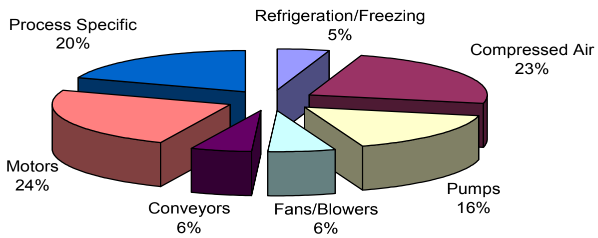
The most significant Achievable savings opportunities were in the actions that addressed motors and compressed air for the Small and Medium Sector, and process specific equipment in the Large industrial sector.

Exhibit 5.4 shows the distribution of electricity savings in 2026 by end use in the Upper and Lower Achievable Potential scenarios.

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

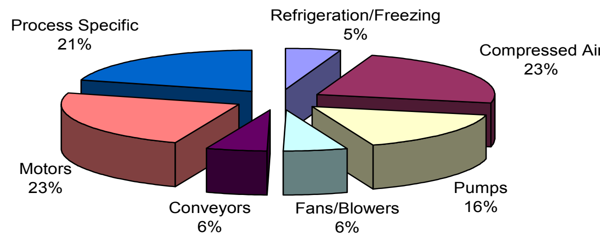
Exhibit 5.4: Distribution of Electricity Savings by Major End Use in the Upper and Lower Achievable Scenarios, Industrial Sector[29]

Upper Achievable



GWh/yr.

Lower Achievable



59 GWh/yr.

5.3 PEAK LOAD SAVINGS

The study did not attempt to estimate peak load savings for the Industrial sector. This approach is consistent with the study scope and recognizes both the greater level of complexity posed by this sector and the absence of the required load shape data.

[29] Values may not add to 100% due to rounding.

6. CONCLUSIONS AND NEXT STEPS

This study has confirmed the existence of significant cost-effective CDM potential within Newfoundland and Labrador's Residential, Commercial and Industrial sectors. 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[30] in this process involves the selection of a cost-effective portfolio of CDM programs and the setting of specific CDM targets and spending levels as well as deciding how to best account for CDM expenditures.

6.1 CDM 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[31] 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.

[30] Full treatment of these next steps is beyond the scope of the current project.

[31] The CAMPUT study uses the term DSM (demand-side management); DSM is used interchangeably with CDM in this section.

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 revenues.[32] 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.

6.2 COST ACCOUNTING OF CDM EXPENDITURES

The benefits of CDM programs include reduced energy costs for customers, reduced capital requirements and improved operating costs for utilities and environmental and economic benefits for society. However, the realization of these benefits can require significant expenditures. CDM expenditures include the cost of the efficient technology or action to the customer and the cost to the utility of the policy or program to encourage its use; in the case of many electric utilities, the related costs of CDM programs may also include revenue losses. The cost accounting of the related CDM expenditures is, therefore, another important consideration in the process of developing and implementing CDM programs.

One of the important considerations in the treatment of CDM expenditures is whether to expense or capitalize them. To provide preliminary insight into this issue, the study conducted a brief

[32] CAMPUT, 2006. p. 14.

literature review and held discussions with personnel involved with BC Hydro's Power Smart program.

The allocation of CDM program costs involves deciding between those that are expensed in the given year, and those that are capitalized and, hence, depreciated over a number of years. The results of the brief literature review indicated that both practices occur throughout jurisdictions in North America.

On the one hand, the expensing of CDM costs tends to be less expensive in the long run because there are no carrying costs included. However, in the short term, especially where programs are being developed for the first time, there may be rate impacts. On the other hand, capitalizing of CDM costs reduces the immediate cost to implement the program but the carrying cost of the non-amortized balances add to the overall costs of implementing the program.[33]

Discussions with BC Hydro Power Smart personnel indicated that the utility wrestled with this issue during the initiation of their CDM programs. The following points provide a rough framework for how that utility addresses this allocation issue:[34]

- Upfront development costs, such as market assessments, program planning, etc., are allocated to annual operation and maintenance (O&M) budgets and are, therefore, expensed.

- Electricity savings that occur as a result of CDM program implementation-related costs are considered to be an asset. Hence, once a CDM program reaches the implementation phase, all related expenses are linked to the acquisition of that electricity saving asset. All related expenses are, therefore, capitalized (deferred capital).

- In theory, the depreciation period for the capital asset (electricity savings) should be approximately the same as the life of the measures being implemented. For example, if the CDM measure promotes implementation of compact fluorescent lamps (CFLs), which have an average life of about five years, then the depreciation period should also be five years.

- In practice, most CDM program initiatives are likely to involve multiple measures, each having a different life span. In response, BC Hydro uses an average depreciation life in the range of 10 to 12 years for all their CDM initiatives.

- Inevitably, "grey" program cost areas will be encountered. In these cases, the experience to date suggests that it may be preferable to err towards capitalizing the cost item. This approach helps to smooth out multi-year CDM program budgets by reducing program exposure in a given year.

Based on the results of the preliminary review undertaken for this study, it appears that the approach to the treatment of future CDM expenditures by the Utilities can be better defined at

[33] *Demand-Side Management: Determining Appropriate Spending Levels and Cost-Effectiveness Testing*. Prepared by Summit Blue Consulting and the Regulatory Assistance Project for the Canadian Association of Members of Public Utility Tribunals (CAMPUT). January 30, 2006. p. 34.

[34] Discussion with Murray Bond, Manager of Evaluation, Measurement and Verification. Power Smart. November 12, 2007.

such time as there is more certainty regarding expenditure levels, funding sources, and potential impacts on customer rates.