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a nalcor energy company

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September 15, 2015

The Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, Newfoundland & Labrador
A1A 5B2

Attention: Ms. Cheryl Blundon
Director Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Recommendation 2.16: Liberty Consulting Group Supply Issues and Power Outages Review Island Interconnected System addressing Newfoundland and Labrador Hydro

In response to Recommendation #2.16 in the *Report on Island Interconnected System to Interconnection with Muskrat Falls addressing Newfoundland and Labrador Hydro* by Liberty Consulting Group, dated December 17, 2014, enclosed is a copy of the planned demand management analysis completed for Newfoundland and Labrador Hydro and Newfoundland Power (the Utilities).

This Conservation and Demand Management (CDM) Potential Study 2015 (the Study) is the third such study completed by the Utilities. Previous CDM Potential Studies were completed in early 1990's and in 2008, and also filed with the Board. Similar to the previous work, this study was completed by an external consultant, and results are presented by Residential Sector; Commercial Sector; and Industrial Sector. The Study provides an analysis of energy conservation and load management technologies that are cost effective in comparison to the marginal costs of supply. The Study is not a conservation and demand management plan but is used by the Utilities to develop the Five-Year Conservation and Demand Management Plan: 2016-2020.

The Study informs that energy efficiency measures offer the largest potential for demand reduction on the Island Interconnected System, as well as the primary function of energy conservation. The main reason for this is that electric heat is the predominate driver of electric load on the Island Interconnected System. Therefore, measures that contribute to efficiencies with respect to electric heating and reducing heat loss will also contribute to reduced loading. The Study also recognizes that approximately 100 MW of capacity assistance is currently in place through the Utilities existing load curtailment programs and arrangements with their respective large commercial and industrial customers.

The Utilities are presently completing the Five-Year Conservation and Demand Management Plan: 2016-2020 and anticipate filing it with the Board in October. As with previous five-year plans, the 2016-2020 Plan will provide a portfolio of economically viable program offerings, and allow for continued assessment of CDM potential during the planning period.

Enclosed are copies of the *Newfoundland and Labrador Conservation and Demand Management Potential Study: 2015* for each of the Residential Sector; Commercial Sector; and Industrial Sector. Should you require additional information, please contact the undersigned.

Please note that following communications with the Board, they have approved the electronic file of the appendices only due to the volume of material. The original and copies are filed without the appendices. However, it is agreed that hard copies of the appendices can be provided upon request.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey L. Pennell
Legal Counsel

TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
ecc: Roberta Frampton Benefiel – Grand Riverkeeper Labrador
Thomas Johnson – Consumer Advocate
Thomas O' Reilly – Cox & Palmer
Danny Dumaresque

Newfoundland and Labrador Conservation and Demand Management Potential Study: 2015

Industrial Sector Final Report

June 2015

Submitted to:
Newfoundland Power Inc.
Newfoundland and Labrador Hydro

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Executive Summary

Background and Objectives

Since the initial launch of takeCHARGE, NL's Conservation and Demand Management (CDM) market has changed both naturally and as a result of the Utilities' planned interventions. Since the last CDM Potential Study, energy efficient technologies have evolved and the takeCHARGE programs have impacted the province's awareness and adoption of CDM measures. In addition, new codes & standards have been drafted or come into effect.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency and conservation all have a significant potential to reduce energy consumption, energy costs and emissions.

The objective of this CDM Potential Study, referenced as *CDM Potential Study 2015*, is to identify the achievable, cost-effective electric energy efficiency and the demand management potential in the province. Similar to the 2007 Study, the information in this report will be critical to developing the next generation of takeCHARGE programs that are equally responsive to customer expectations, support efforts to be responsible stewards of electrical energy resources and is consistent with provision of least cost, reliable electricity service. The *CDM Potential Study 2015*, provides a resource for the Utilities to develop a comprehensive vision of the province's future energy service needs.

Scope

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses three sectors: residential households (Residential sector), commercial and institutional buildings (Commercial sector), and small, medium, and large industry (Industrial sector).

- **Geographical Coverage:** The study addresses all regions of NL that are served by the Utilities. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. The study results are estimated for three distinct regions: Newfoundland, Labrador, and Isolated Diesel.

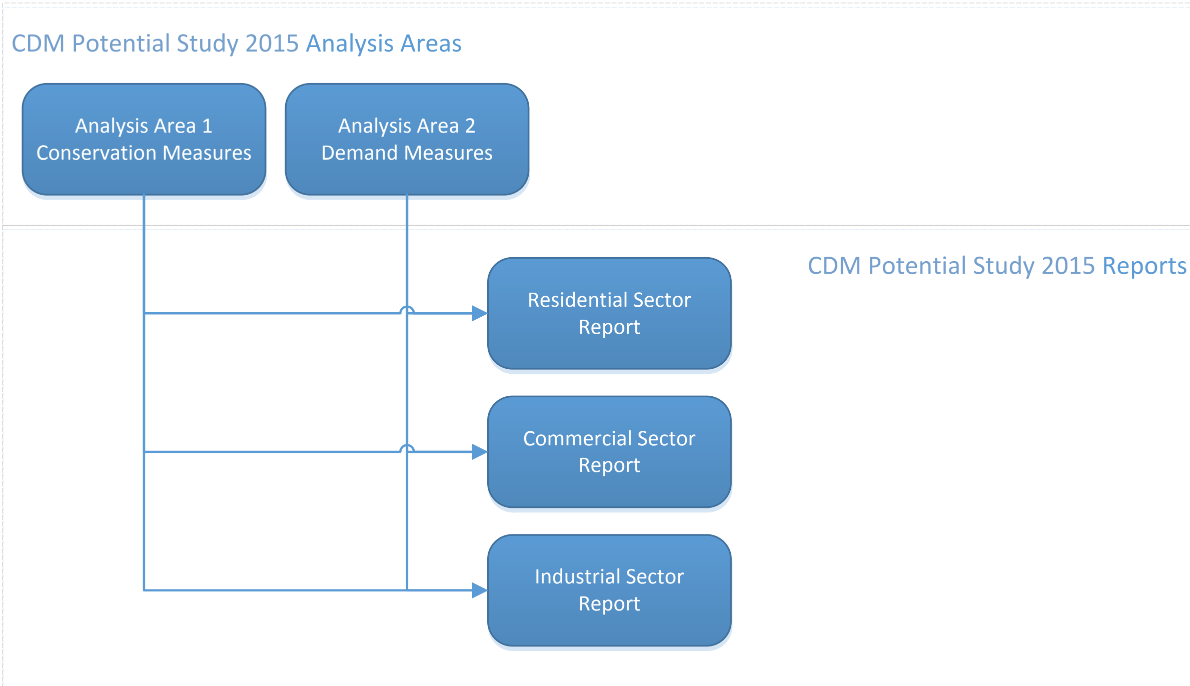
- **Study Period:** This study addresses a 15 year period. The Base Year for the study is the calendar year 2014. The Base Year of 2014 was calibrated to the 2014 actual sales data. The study milestone years will be 2017, 2020, 2023, 2026 and 2029.

  It is recognized that the weather conditions in 2014 were not typical. The CDM Potential Study 2015 follows the same assumptions as in the Utilities' Load Forecast.

- **Technologies:** This study addresses a range of electricity conservation and demand management (CDM) measures and includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2029 as well as peak load reduction technologies.

CDM Potential Study 2015 has been organized into two analysis areas and the results are presented in three reports, as show in Exhibit ES 1, below.

Exhibit ES 1 Overview of CDM POTENTIAL STUDY 2015 Organization – Analysis Areas and Reports

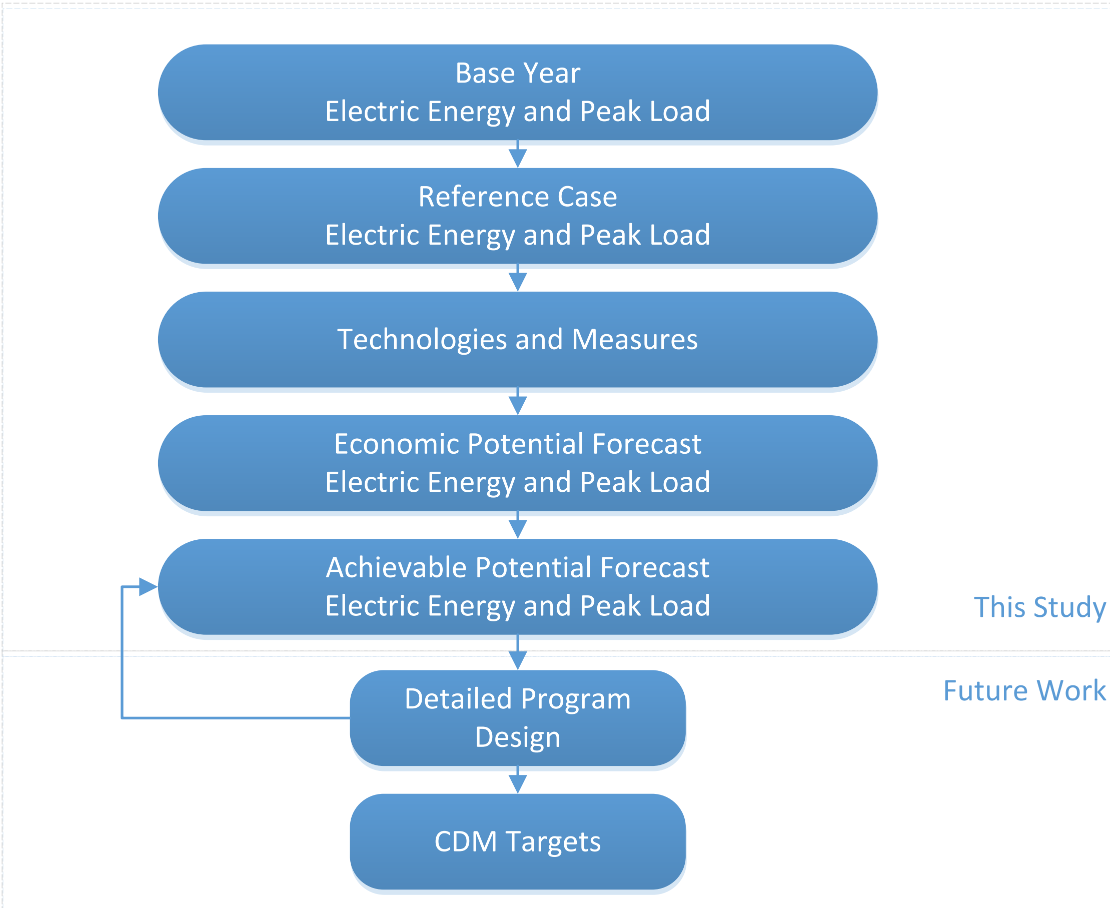


This report presents the results of both Analysis Area 1: Energy-efficiency Technologies and operation and maintenance (O&M) practices and Analysis Area 2: Demand Measures, for Industrial sector customers. This report addresses all commercially available electric energy-efficiency and peak load reduction measures that are applicable to NL's Industrial sector. It includes the potential for electrical efficiency and peak load reduction technologies expected to be commercially viable by the year 2029; residential customer behaviour measures and commercial and industrial operation and maintenance (O&M) practices are also addressed.

Approach

The assessment for this sector begins with a custom spreadsheet-based industrial analysis, which establishes how electricity is consumed in different industrial sub-sectors and how this breakdown of electricity consumption is forecast to change over the study period. This initial analysis feeds into the study's primary modelling platform, ISEEM (Industrial Sector Energy End-use Model), an ICF in-house spreadsheet-based macro model, where the potential savings from various technologies and measures are considered under different scenarios.

Exhibit ES 2 CDM POTENTIAL STUDY 2015: Main Analytic Steps



The major steps involved in the analysis are shown in Exhibit ES 2 and are discussed in greater detail in Section 2 of this report. As illustrated in Exhibit ES 2, the results of *CDM Potential Study 2015*, and in particular the estimation of Achievable Potential,[1] support on-going conservation and demand management (CDM) work; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific CDM targets or with program design.

Overall Industrial Study Findings

As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future industrial growth are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the NL utilities. However, the reader is referred to a number of caveats throughout the main text of the report. Given these assumptions, the CDM Potential Study 2015 findings confirm the existence of significant potential cost-effective opportunities for electricity consumption and peak load savings in NL's industrial sector.

Efficiency improvements would provide between 244 and 545 GWh/yr. of electricity consumption savings by 2029 in, respectively, the Lower and Upper Achievable Potential scenarios. Large

[1] The proportion of savings identified that could realistically be achieved within the study period.

industrial facilities (mining and processing, pulp and paper, and oil refining) represent 91% and 89% of these Lower and Upper Achievable Potential 2029 savings, respectively. The remainder of electricity savings are split between small-medium industrial facilities (fishing and fish processing, manufacturing, water systems, and other). This is in line with the Reference Case, where large industry accounts for 91% of sector electricity consumption by 2029, up slightly from 2014.

One key finding is the significant gap between the Upper and Lower Achievable Potential scenarios. This is a factor of what each scenario represents. For many measures, that are not new technologies, the Lower Achievable Potential represents that existing CDM programming has made limited progress towards the full potential for conservation. Conversely, the Upper Achievable Potential represents that there is significant potential for further adoption of measures if expanded CDM programs can help overcome key barriers.

The largest end-use to target in terms of Achievable Potential savings opportunities is pumping. In addition, there are significant savings to be found for fans and blowers, lighting, and process specific consumption, as well as several other important end uses.

The electricity consumption savings would provide associated peak load reductions of approximately 23 to 50 MW during NL's winter peak period by 2029 in, respectively, the Lower and Upper Achievable Potential scenarios. Demand reduction measures would provide further peak load reductions of approximately 96 to 116 MW by 2029 in, respectively, the Lower and Upper Achievable Potential scenarios. All told, this amounts to peak load reduction potential of between 32% and 44% with respect to the Reference Case industrial peak period load.

The demand response curtailment measure is the largest source of peak load reductions, representing approximately 93% of the potential from demand-specific measures, with much of this potential already in place through existing utility curtailment programs.

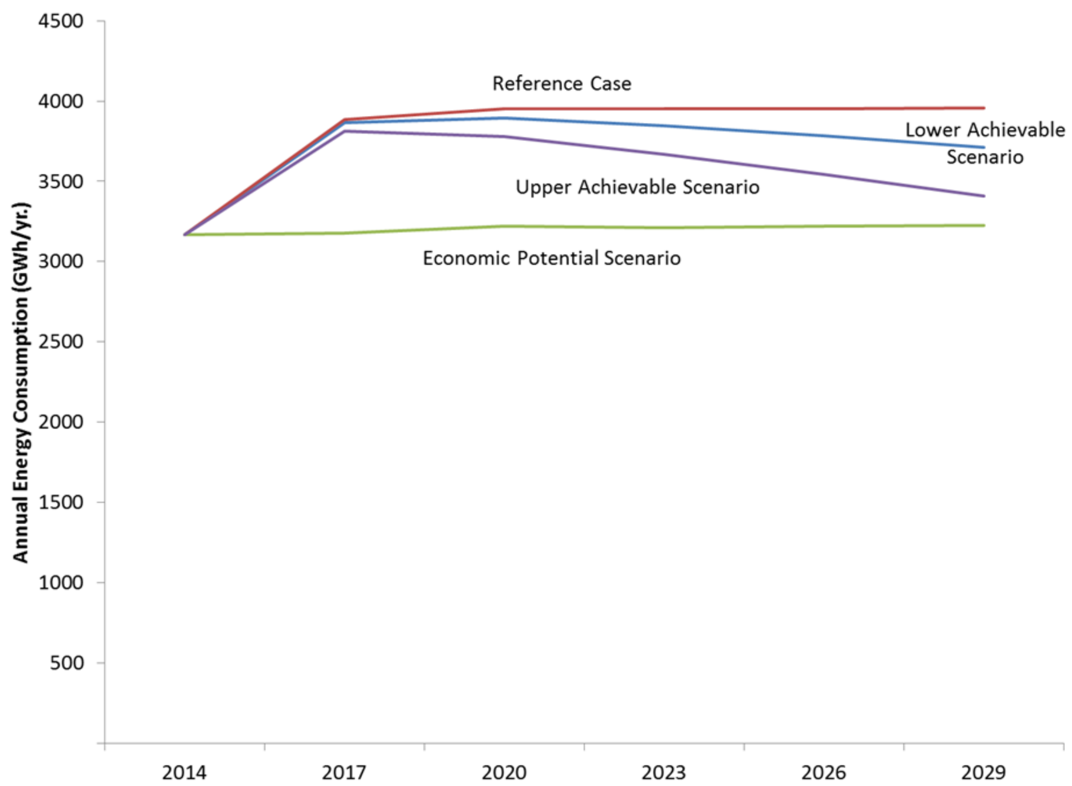
Summary of Electric Energy Savings in the Industrial Sector

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CDM Potential Study 2015 is presented in Exhibit ES 3 and Exhibit ES 4, by milestone year.

Exhibit ES 3 Electricity Savings by Milestone Year for Three Scenarios (GWh/yr.)

	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
Year	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case
2017	709	18%	73	1.9%	19	0.5%
2020	729	19%	171	4.4%	57	1.5%
2023	743	19%	285	7.3%	108	2.8%
2026	735	19%	409	10.5%	170	4.4%
2029	728	19%	545	14.0%	244	6.3%

Exhibit ES 4 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Industrial Sector, (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2014, NL's industrial sector consumed about 3,169 GWh/yr. Exhibit ES 5 shows that in the base year, process specific consumption represents about 22% of end-use consumption. This exhibit also highlights that motors and motor driven equipment, including compressed air systems, use close to 60% of all the electricity in industry. Within this group of end uses pumps account for 18% of base year end-use electricity, other motors account for 18%, and fans/blowers account for 15%.

Exhibit ES 5 also presents the Reference Case consumption by end use in 2029, at the end of the study period, for comparison. Overall, NL's Industrial sector is forecast to rise to about 3,956 GWh/yr. by 2029 in the absence of new utility CDM initiatives.

Exhibit ES 6 shows the distribution of Base Year electricity consumption by sub-sector. As illustrated, large industrial facilities account for the majority (89%) of industrial sector Base Year electricity use. The same exhibit also presents the Reference Case consumption by sub-sector in 2029, at the end of the study period, for comparison.

Reference Case – Electric Energy

Exhibit ES 5 Reference Case Electricity Use by End Use, Industrial Sector

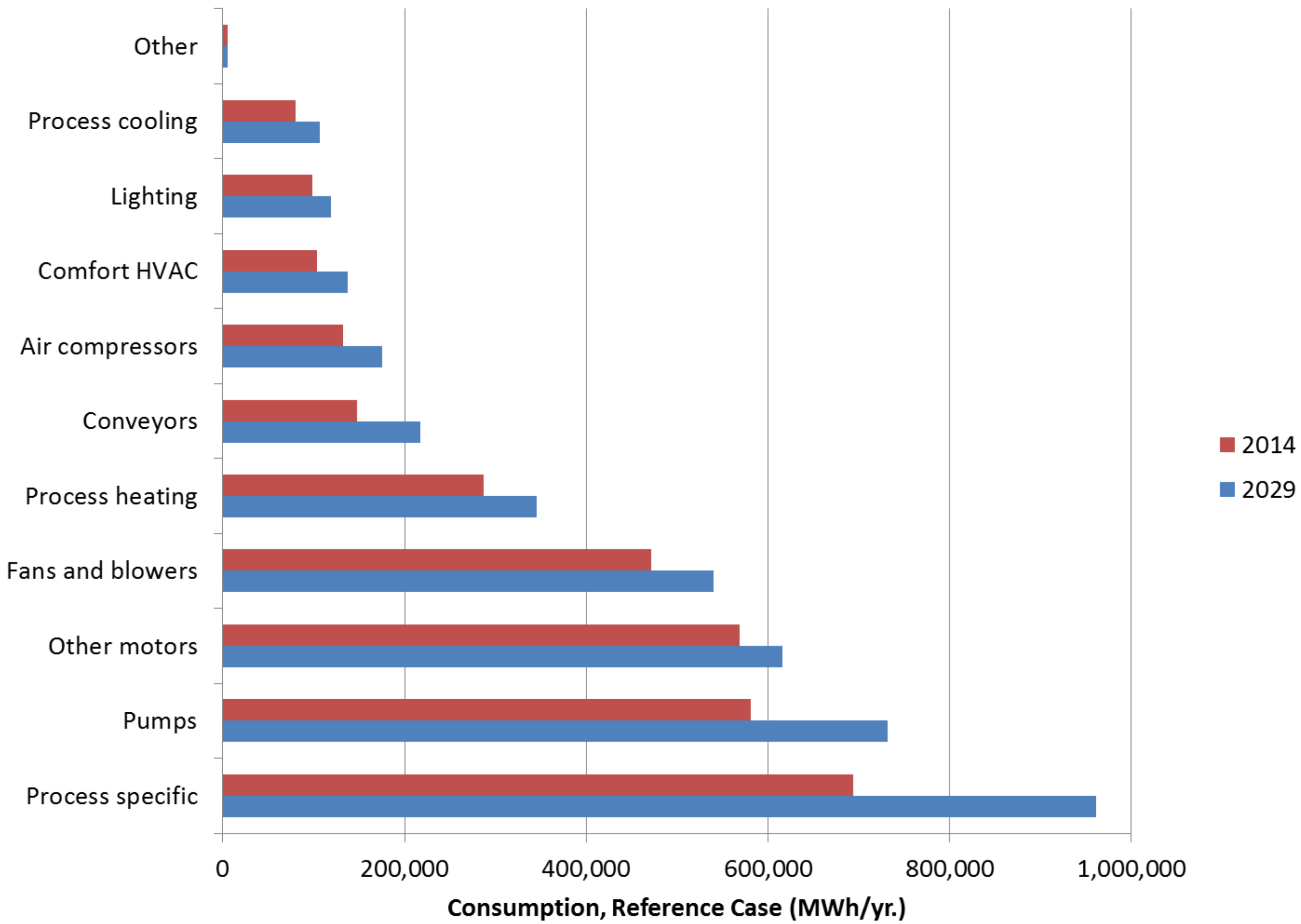
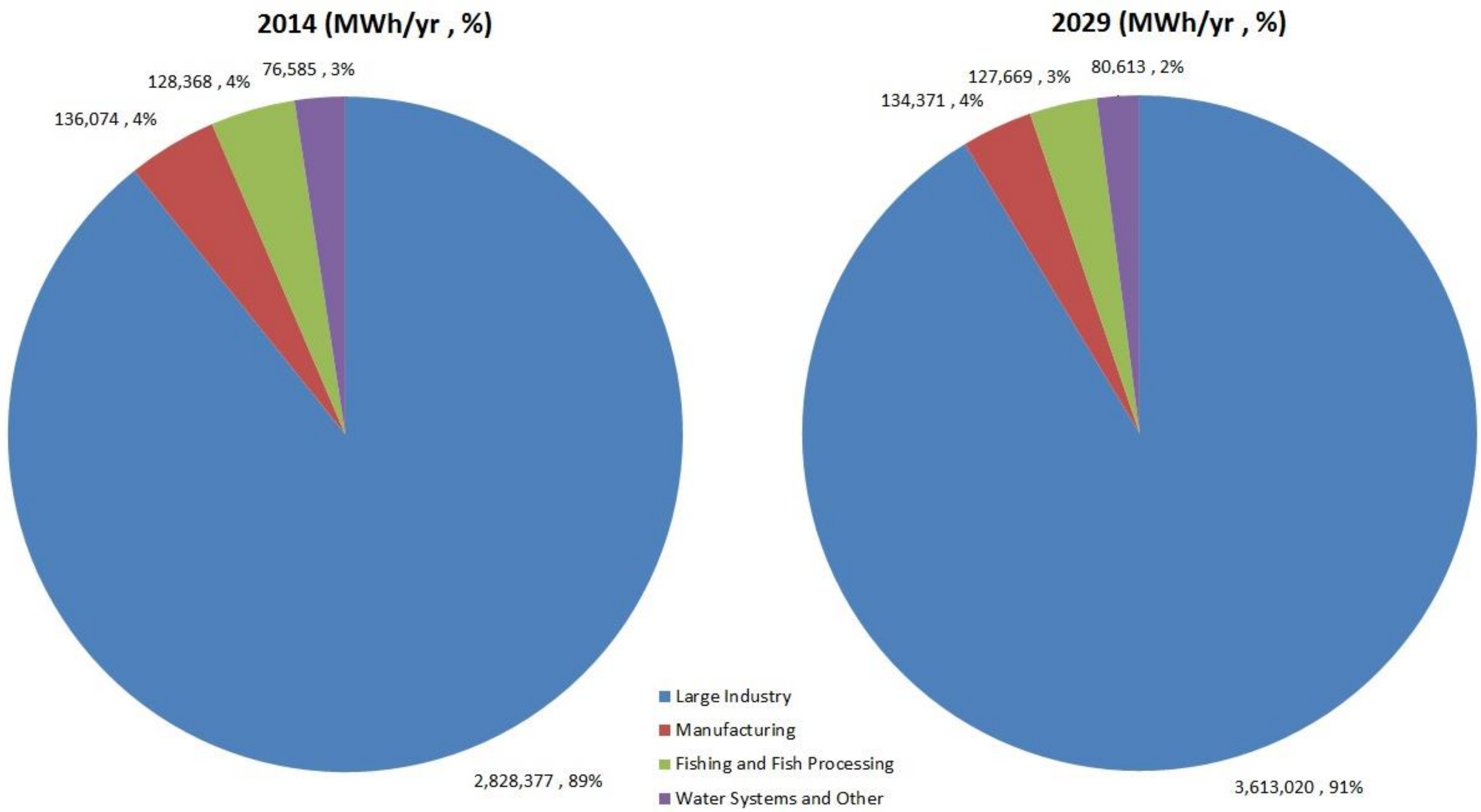


Exhibit ES 6 Reference Case Electricity Use by Sub-Sector, Industrial Sector



Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential scenario,[2] the study estimated that electricity consumption in the industrial sector would decrease to approximately 3,244 GWh/yr. by 2029. Savings relative to the Reference Case would be approximately 712 GWh/yr. or about 18%, with the majority of the savings achieved by 2017. The Economic Potential savings are dominated by measures that are cost-effective based on their full cost (versus the “do-nothing” option), and therefore within the definitions of the scenario they would be adopted immediately and provide savings starting in the first milestone period.

Achievable Potential – Electric Energy

The Achievable Potential is the portion of the Economic Potential savings that could realistically be achieved within the study period.[3] In the industrial sector, the Achievable Potential for electricity savings was estimated to be 244 and 545 GWh/yr., respectively, in the Lower and Upper Achievable Potential scenarios. The savings in the intervening milestone years show a more realistic ramp-up pattern than that observed in the Economic Potential scenario.

The largest end-use to target in terms of Achievable Potential savings opportunities is pumping. In addition, there are significant savings to be found for fans and blowers, lighting, and process specific consumption, as well as several other important end uses. The top five measures in terms of Achievable Potential are pump control with ASDs, fan control with ASDs, energy management information systems (EMIS), optimization of pumping systems, and high efficiency lights (LEDs).

Summary of Peak Load Savings

A summary of the levels of annual peak period demand reductions contained in each of the forecasts addressed by CDM Potential Study 2015 is presented in Exhibit ES 7 and Exhibit ES 8, by milestone year. Based on discussions with utility personnel, the following peak period definition was used for this study:

Peak Period – 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.[4]

[2] 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 economic threshold value, which has been set at different prices per kWh for the different regions. (One kWh from the Labrador hydroelectric grid is much less expensive than one kWh from an isolated diesel grid.)
[3] The 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 lower and upper.
[4] Source: NL (Feb 2014) http://hydroblog.nalcorenergy.com/meeting-peak-demand/

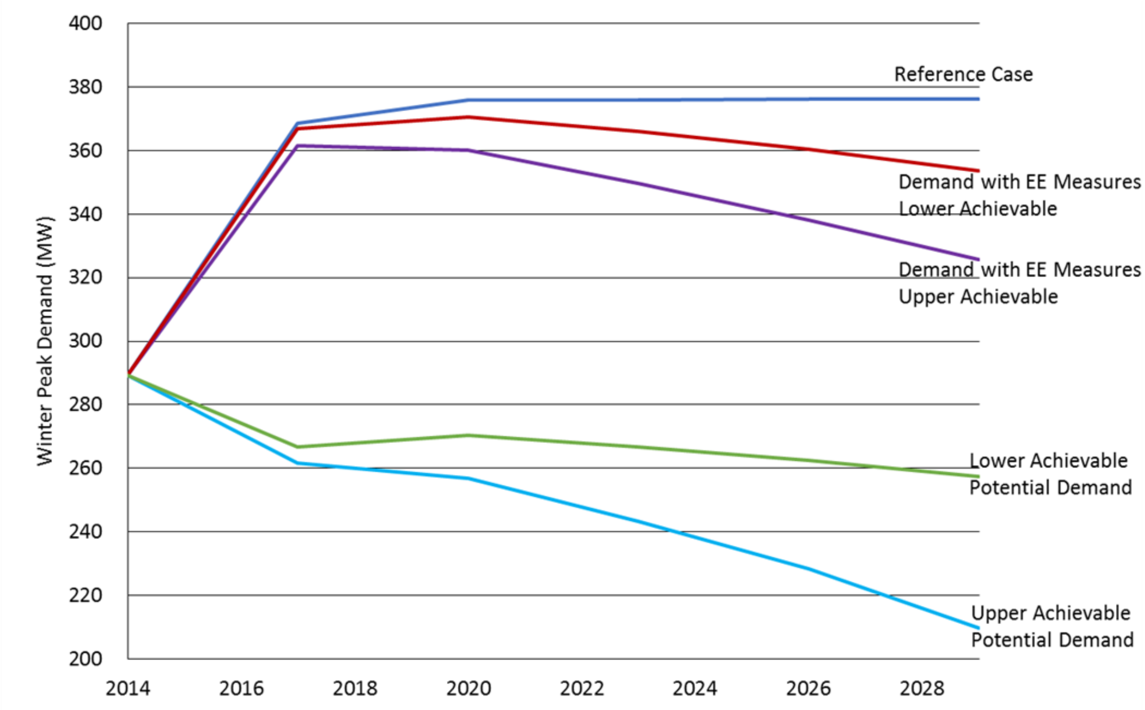
Exhibit ES 7 Peak Demand Reductions by Milestone Year for Three Scenarios (GWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Peak Demand Reduction (MW)	% Reduction Relative to Reference Case	Potential Peak Demand Reduction (MW)	% Reduction Relative to Reference Case	Potential Peak Demand Reduction (MW)	% Reduction Relative to Reference Case
2017	176	48%	107	29%	102	28%
2020	178	47%	119	32%	105	28%
2023	180	48%	133	35%	109	29%
2026	180	48%	148	39%	114	30%
2029	182	48%	166	44%	119	32%

Exhibit ES 8 provides a graphical view of the Upper and Lower Achievable Potential peak load reductions from both the energy efficiency measures and from measures targeted specifically at load management. More details on peak load reduction opportunities are provided in the main body of the report. Highlights of the findings include the following:

- The study estimates that the industrial sector peak load would grow to 376 MW by 2029, an increase of approximately 30%.
- Electricity savings offered by the Lower and Upper Achievable Potential scenarios would provide peak load reductions of approximately 23 to 50 MW by 2029, a decrease of between 6% and 13% relative to the Reference Case.
- Demand reduction measures under the Lower and Upper Achievable Potential scenarios would provide peak load reductions of an additional 96 to 116 MW by 2029, a decrease of a further 26% to 31%.
- Demand reduction potential is dominated by the reductions associated with demand response curtailment measure, with much of this potential already in place through existing utility curtailment programs.

Exhibit ES 8 Peak Demand of Reference Case, Lower Achievable Potential and Upper Achievable Potential in Industrial Sector (MW)



Base Year Demand

In the Base Year of 2014, NL's industrial sector demand was approximately 289 MW, averaged over the 36-hour peak period. This may be compared against the overall average industrial demand for the year, which is:

*3,169 GWh / 8760 hours * 1000 MW/GW = 361 MW*

Exhibit ES 9 shows that the process specific end use is the largest industrial component of peak demand, at 21%. Process specific end use is also the largest in terms of annual electrical consumption and tends to be significant in the large industrial facilities, which operate at a fairly steady level year round, including the winter when the NL system peaks. Pumps and other motors are the second and third largest industrial components of peak demand (21% and 16%), once again matching the order of largest consumption end uses. Process heating is the fifth largest industrial contributor to peak demand at 11%. This is an increase from the end use's 9% share of industrial consumption, which makes sense given the additional heating requirements during peak winter periods. Similarly, HVAC rises from 3% portion of consumption to a 5% portion of Base Year peak demand.

The same exhibit also presents the Reference Case consumption by end use in 2029, at the end of the study period, for comparison. Overall, NL's Industrial sector is forecast to rise to about 376 MW by 2029 in the absence of new utility CDM initiatives, an increase of approximately 30%.

Exhibit ES 10 shows the distribution of Base Year electric peak demand by sub-sector. As illustrated, large industrial facilities account for the largest share (91%) of industrial sector Base Year peak demand. The same exhibit also presents the Reference Case demand by sub-sector in 2029, at the end of the study period, for comparison.

Reference Case – Electric Peak Demand

Exhibit ES 9 Electric Peak Demand by End Use, Industrial Sector, 2014 and 2029

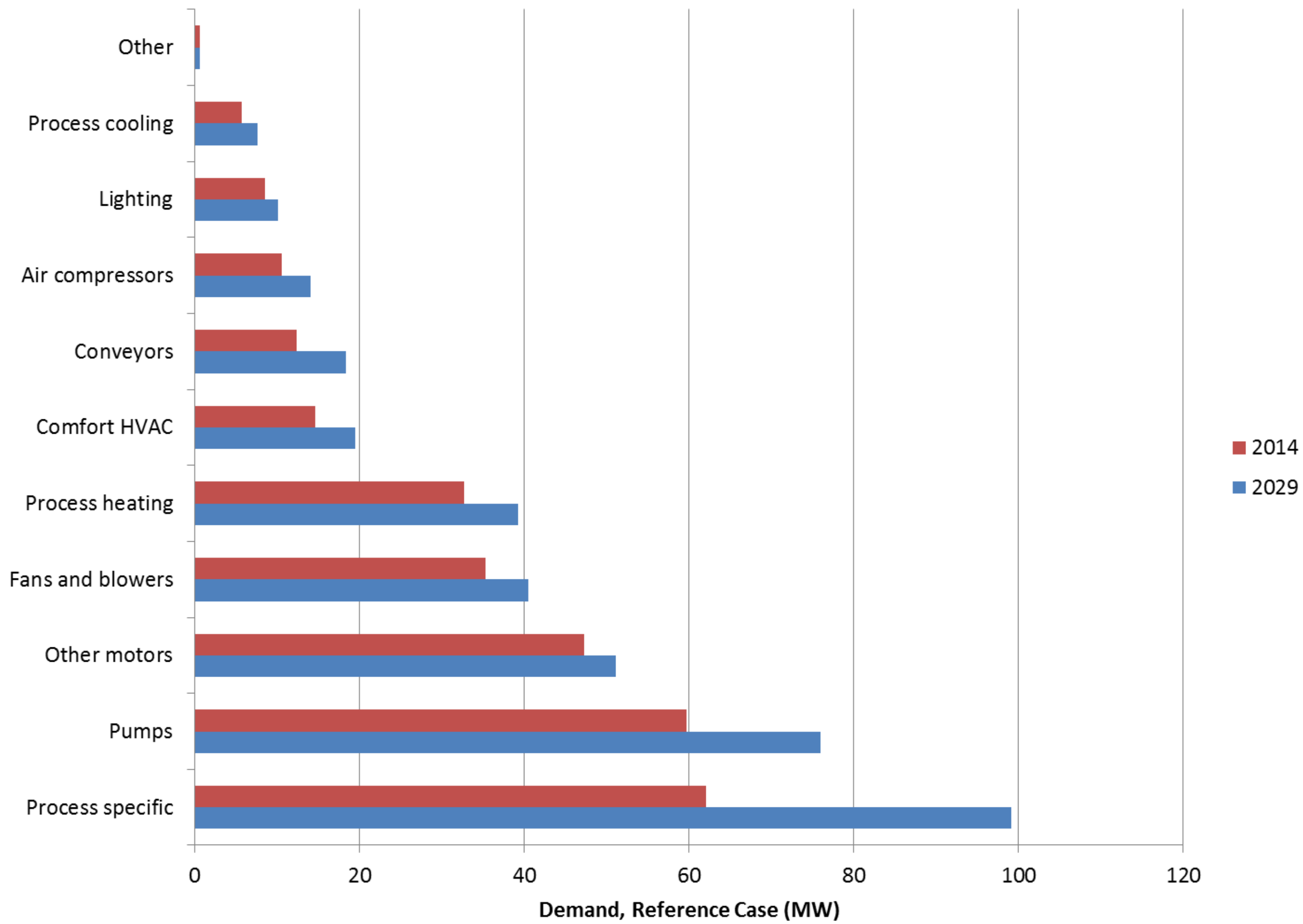
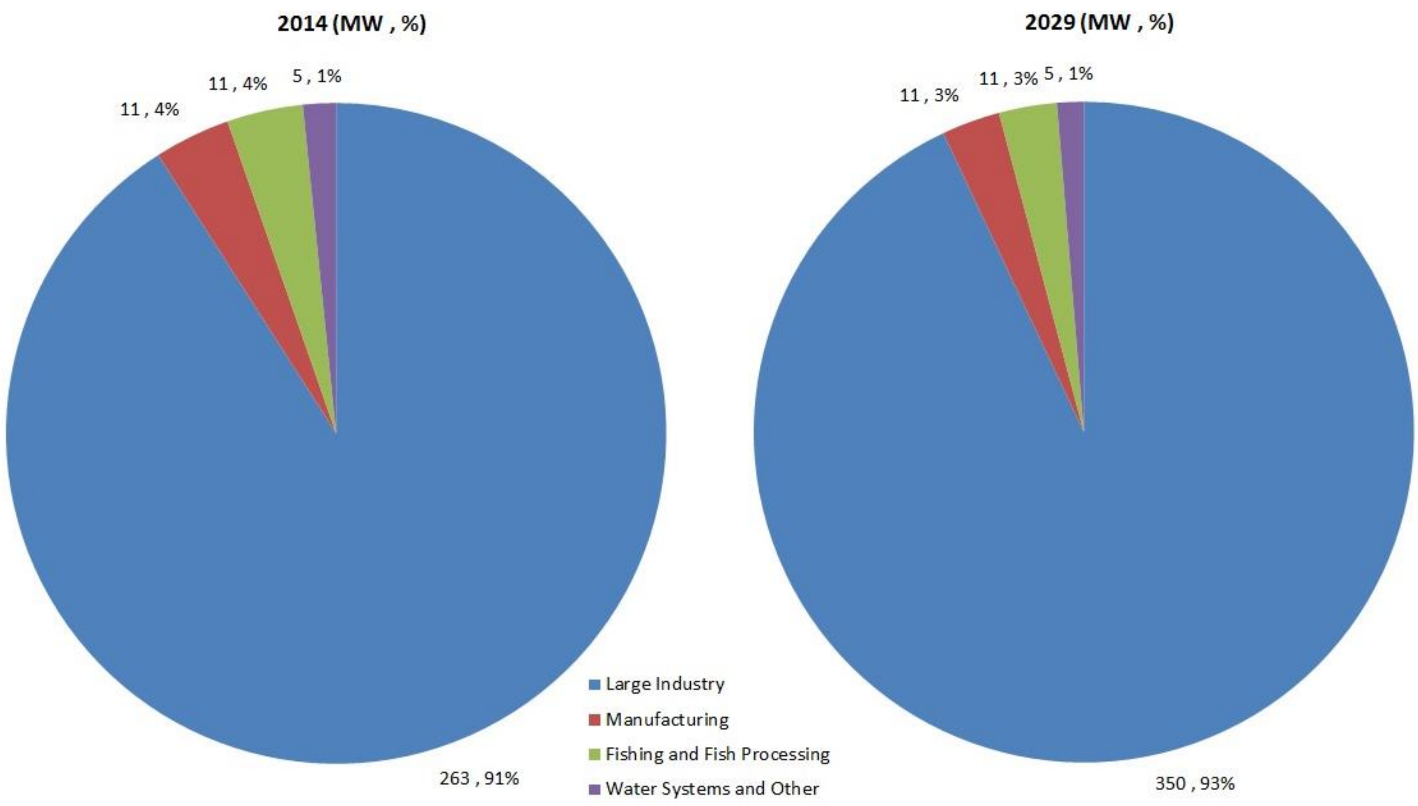


Exhibit ES 10 Electric Peak Demand by Sub Sector, Industrial Sector, 2014 and 2029



Economic Potential Forecast – Electric Peak Demand

Under the conditions of the Economic Potential scenario,[5] the study estimated that electric peak demand in the industrial sector would decrease to approximately 194 MW by 2029. Reductions relative to the Reference case would be approximately 182 MW or about 48%, with the majority of the reductions achieved by 2017. The Economic Potential reductions are dominated by measures that are cost-effective relative to the Utilities' cost of new capacity based on their full cost (versus the "do-nothing" option), and therefore within the definitions of the scenario they would be adopted immediately and provide reductions starting in the first milestone period.

Achievable Potential – Electric Peak Demand

The Achievable Potential is the portion of the Economic Potential reductions that could realistically be achieved within the study period. In the industrial sector, electricity savings offered by the Lower and Upper Achievable Potential scenarios would provide peak load reductions of approximately 23 to 50 MW by 2029, a decrease of between 6% and 13% relative to the reference case. Demand reduction measures under the Lower and Upper Achievable Potential scenarios would provide peak load reductions of an additional 96 to 116 MW by 2029, a decrease of a further 26% to 31%. The demand reduction potential is dominated by the reductions associated with demand response curtailment measure. The reductions in the intervening milestone years reflect that much of this potential already in place through existing utility curtailment programs, but that there will be a ramp-up period for demand reductions from electricity savings.

[5] The Economic Potential Electric Peak Load Forecast is the expected electric peak load that would occur in the defined peak period if demand is reduced by the reductions associated with the energy efficiency measures in the Economic Potential Electricity Efficiency Forecast, and all peak load reduction measures that are cost effective against the future avoided cost of new capacity in NL were also fully implemented.

Table of Contents

List of Exhibits

1 Introduction

Newfoundland Power Inc. and Newfoundland and Labrador Hydro have been successfully delivering electricity conservation programs to their customers since 2009 under the joint brand, takeCHARGE.

Since the initial launch of takeCHARGE, NL's CDM market has changed both naturally and as a result of the Utilities' planned interventions. Since the last CDM Potential Study, energy efficient technologies have evolved and the takeCHARGE programs have impacted the province's awareness and adoption of CDM measures. In addition, new codes & standards have been drafted or come into effect.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency and conservation have a significant potential to reduce energy consumption, energy costs and emissions.

The objective of this CDM Potential Study, referenced as *CDM Potential Study 2015*, is to identify the achievable, cost-effective electric energy efficiency and demand management potential in province. Similar to the 2007 Study, the information in this report will be critical to developing the next generation of takeCHARGE programs that are equally responsive to customer expectations, support efforts to be responsible stewards of electrical energy resources and is consistent with provision of least cost, reliable electricity service. The *CDM Potential Study 2015*, provides a resource for the Utilities to develop a comprehensive vision of the province's future energy service needs.

1.1 Study Scope

The scope of this study is summarized below:

- **Sector Coverage:** This study addresses three sectors: residential households (Residential sector), commercial and institutional buildings (Commercial sector), and small, medium, and large industry (Industrial sector).

- **Geographical Coverage:** The study addresses all regions of NL that are served by the Utilities. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. The study results are estimated for three distinct regions: Newfoundland, Labrador, and Isolated Diesel.

- **Study Period:** This study addresses a 15 year period. The Base Year for the study is the calendar year 2014. The Base Year of 2014 was calibrated to the 2014 actual sales data. The study milestone years will be 2017, 2020, 2023, 2026 and 2029.

  It is recognized that the weather conditions in 2014 were not typical. The CDM Potential Study 2015 follows the same assumptions as in the Utilities' Load Forecast.

- **Technologies:** This study addresses a range of electricity conservation and demand management (CDM) measures and includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2029 as well as peak load reduction technologies.

1.1.1 Data Caveat

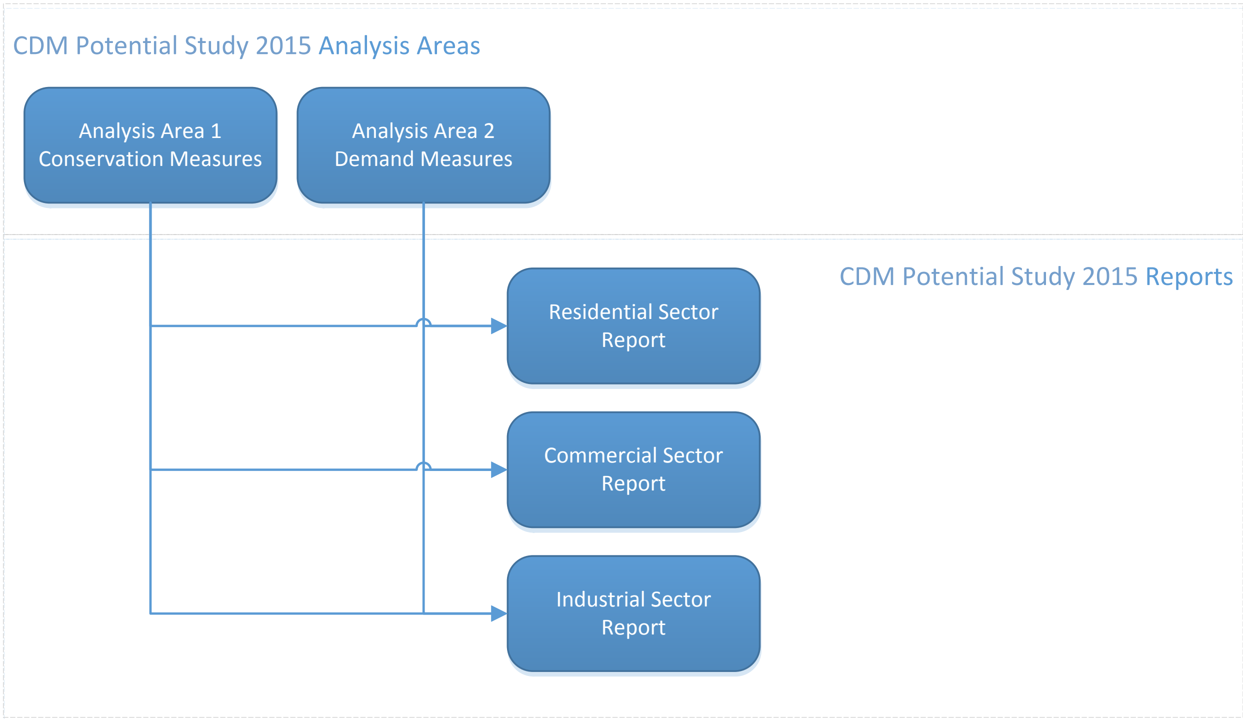
As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future industrial growth and customer willingness to implement new energy-efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the Utilities and the Government of Newfoundland and are based on best available information, which in many cases includes the professional judgment of the consultant team, client 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.

1.2 Study Organization

Exhibit 1 presents an overview of the study's organization; as illustrated, the study has been organized into two analysis areas and four individual reports.

A brief description of each analysis area and its report content is provided below.

Exhibit 1 Overview of *CDM Potential Study 2015* Organization – Analysis Areas and Reports



1.2.1 Analysis Area 1 – Conservation Measures

This area of the *CDM Potential Study 2015* assesses electric energy[6] reduction opportunities that could be provided by electrical efficiency technologies that are expected to be commercially viable by the year 2029; operation and maintenance (O&M) practices are also addressed. The results of Analysis Area 1 are presented in three individual sector reports and summarized in a Summary Report.

1.2.2 Analysis Area 2 – Demand Measures

This area of the *CDM Potential Study 2015* assesses peak load reduction opportunities that could be provided by peak load reduction technologies that are expected to be commercially viable by the year 2029; operational practices are also addressed. The results of Analysis Area 2 are presented in three individual sector reports and summarized in a Summary Report.

1.3 Report Organization

This report presents the Industrial sector results. It is organized and presented as follows:

- Section 2 presents an overview of the study methodology, including a definition of key terms and an outline of the major analytic steps involved.
- Section 3 presents a profile of Industrial sector Base Year electricity use in NL.

[6] The term “electric energy” is used in this report to distinguish electricity consumption (in units of kWh or MWh) from electricity demand during a specific period (in units of MW).

- Section 4 presents a profile of Industrial sector Base Year electric peak load, including the definition of peak periods that are included in this study.
- Section 5 presents the Reference Case, which provides a detailed estimate of electricity use in NL's Industrial sector over the study period 2014 to 2029, in the absence of new utility CDM program initiatives.
- Section 6 presents the Reference Case electric peak loads, which provide a detailed estimate of peak load requirements in NL's Industrial sector over the study period 2014 to 2029, in the absence of new utility CDM program initiatives.
- Section 7 identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Industrial sector.
- Section 8 presents the Industrial sector Economic Potential Electricity Forecast for the study period 2014 to 2029.
- Section 9 identifies and assesses the economic attractiveness of selected Industrial sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electricity use.
- Section 10 presents the estimated upper and lower Achievable Potential for electric energy savings for the study period 2014 to 2029.
- Section 11 lists sources and references.
- Section 12 is the Glossary.

1.4 Results Presentation

The preparation of CDM Potential Studies involves the compilation and analysis of an enormous amount of market and technology data and a nearly infinite number of ways of organizing and presenting the results. It is recognized that readers will have differing levels of needs with respect to the level of detail provided. Consequently, the results of this CDM Potential Study are presented at three levels of detail.

- **Main report body.** The main body of the report provides a relatively high-level reporting of the main steps involved in undertaking each stage of the study together with a concise summary of results, including comments and interpretation of key findings. It is assumed that the content and level of detail in the main report body is suitable for the majority of readers who wish to gain an understanding of the potential contribution of CDM options to NL's long-term electricity requirements.
- **Appendices.** A separate appendix accompanies each major section of the main report. Each appendix provides more detailed information on the methodology employed, including major assumptions or sample calculations as applicable, together with additional levels of results. It is assumed that this presentation is better suited to CDM analysts and managers wishing a more thorough understanding of the study results.
- **Software.** All of the data generated by the study is provided in two custom-designed Excel models: Data Manager and the measure TRM (technical resource manual) Workbook.

- **Data Manager** is a custom-designed Excel workbook with query protocols that enable the user to search and report the study results in a virtually infinite number of combinations. Data Manager is intended to support the most detailed level of CDM activity such as program design, preparation of regulatory submissions, etc.

- **The measure TRM Workbook** is a custom-designed model that provides comprehensive profiles of the CDM measures assessed within the study. Because the information is provided in software form, any changes to economic, financial or performance data inputs can be easily accommodated and revised results generated automatically.

2 Study Methodology

This section provides an overview of the methodology employed for this study. More specifically, it addresses:

- Definition of terms
- Major analytic steps
- Analytic models.

2.1 Definition of Terms

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.

A brief description of some of the most important terms and their application within this study is included below.

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 building stock. Building electricity use simulations were undertaken for the major sub-sector 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 2014.
Base Year Electric Peak Load Profile	Electric peak load profiles refer to one specific time period throughout the year when NL's generation, transmission and distribution system experiences particularly high levels of electricity demand. This period is of particular interest to system planners; improved management of electricity demand during this peak period may enable deferral of costly system expansion. This study addresses one specific peak periods, as outlined in the main text.
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-2014) utility-based CDM initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable electricity savings potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the sub-sectors, estimation of the expected growth in building stock, and finally an estimation of "natural" changes affecting electricity consumption over the study period. The Reference Case is calibrated to the Utilities most recent load forecast, minus the impacts of new, future CDM initiatives.
Reference Case Electric Peak Load Profile	The Reference Case peak load profile estimates the expected electric peak loads in the defined peak period over the study period in the absence of new utility CDM program initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable Potentials for peak load reduction.

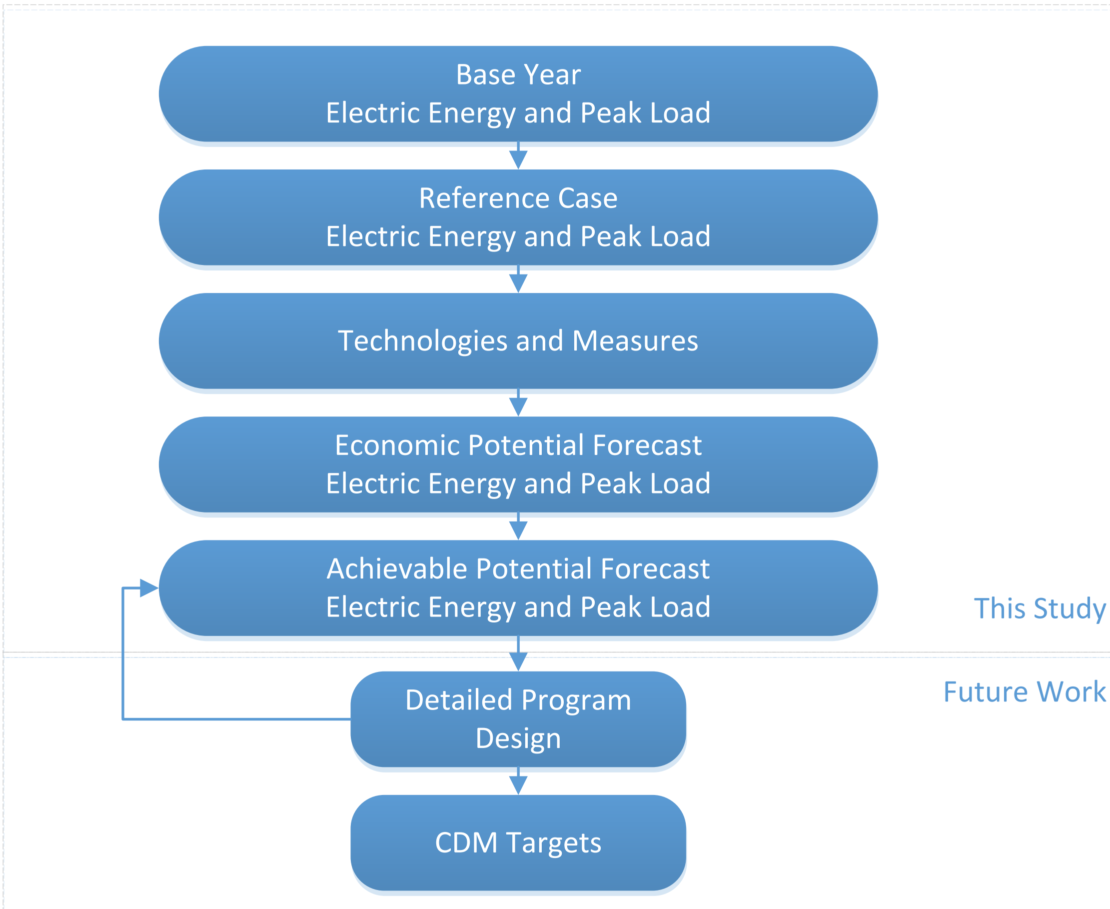
Conservation and Demand Management (CDM) Measures	CDM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace load off of grid). Customer –side generation and fuel switching are not included in this study.
The Cost of Conserved Energy (CCE)	The CCE is calculated for each energy-efficiency technology measure. 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.
The Cost of Electric Peak Reduction (CEPR)	The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.
Electric Capacity-Only Peak Load Reduction Measures	Capacity-only measures are technologies or activities that result in the shifting of certain electrical loads from periods of peak system demand to periods of lower system demand.
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 economic threshold value[7], which has been set at different prices per kWh for the different regions. (One kWh from the Labrador hydroelectric grid is much less expensive than one kWh from an isolated diesel grid.) All the energy-efficiency upgrades included in the technology assessment that had a CCE equal to, or less than, the economic threshold value for a given supply system were incorporated into the Economic Potential Forecast.
Economic Potential Electric Peak Load Forecast	The Economic Potential Electric Peak Load Forecast is the expected electric peak loads that would occur in each of the three defined peak periods if all peak load reduction measures that are cost effective against the future avoided cost of new capacity in NL were fully implemented.
Achievable Potential	The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecasts that could realistically be achieved within the study period. The 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 lower and upper.

[7] The economic threshold value is related to the cost of new avoided electrical supply. The values for each supply system are generally selected to provide the CDM Potential Study with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time. Further discussion is provided in Section 7 of this report.

2.2 Major Analytic Steps

The study was conducted within an iterative process that involved a number of well-defined steps, as illustrated in Exhibit 2.

Exhibit 2 Major Analytic Steps



A summary of the steps is presented below.

Step 1: Develop Base Year Electric Energy and Peak Load Calibration Using Actual Utility Billing Data

Build a model of electric energy and demand for the sector, disaggregated to all the building types and end uses, calibrated to sales of electricity in NL. This includes the following sub-steps:

- Compile and analyze available data on NL'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.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period.

Step 2: Develop Reference Case Electric Energy Use and Peak Load Profile

Extend the base year model to the end of the study period, based on forecast building stock growth and expected natural changes in construction practices, equipment efficiency levels and/or practices. This includes the following sub-steps:

- 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 load forecasting data provided by the Utilities for the study period.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period over the study period.

Step 3: Identify and Assess Energy-efficiency and Peak Load Reduction Measures

Compile information on upgrade measures that can save electric energy and/or reduce peak demand, and assess them for technical applicability and economic feasibility. This includes the following sub-steps:

- Develop list of energy-efficiency upgrade and peak load reduction measures.
- Compile detailed cost and performance data for each measure.
- For energy-efficiency measures, 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.
- For each peak load reduction measure, identify the affected end use, the potential load reduction or off-peak shifting and determine the CEPR.
- Based on the above results, prepare summary tables that show the amount of potential peak load reduction provided by each measure and at what cost ($/kW/yr.).
- Apply each peak load reduction measure to the affected end use, regardless of cost, and determine total peak reduction.
- Summarize the peak load reduction impacts in a supply curve.

Step 4: Estimate Economic Electric Energy Savings Potential

Develop an estimate of the electric energy savings potential that would result from implementing all of the economically feasible measures in all the buildings where they are applicable. This includes the following sub-steps:

- Compile utility economic data on the forecast cost of new electricity generation and set an economic threshold value; different economic threshold values were selected for each supply system (hydroelectric and diesel grids).
- 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

Develop an estimated range for the portion of economic potential savings that would likely be achievable within realistic CDM programs. This includes the following sub-steps:

- Bundle the electric energy 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, trade allies and technical experts to reach general agreement on the upper and lower range of Achievable Potential.

Step 6: Estimate Peak Load Impacts of Electricity Savings

Develop an estimate for the peak load impacts associated with the measures that save electric energy. This includes the following sub-steps:

- The electricity (electric energy) savings (MWh) calculated in the preceding steps were converted to peak load (electric demand) savings (kW).[8]
- 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.

2.3 Analytical Models

The analysis of the Industrial sector employs one main modelling platform:

- ISEEM (Industrial Sector Energy End-use Model), an ICF proprietary spreadsheet-based macro model.

The assessment of the Industrial sector begins with a separate customized ICF spreadsheet analysis. This includes an end use breakdown analysis to gather key information from a variety of sources and balance them so as to define the driving inputs for the subsequent modeling. This analysis is based on survey results, audit reports, utility billing data, utility load forecasts, previous studies, and project team experience. It addresses:

- How electricity is consumed in different industrial sub-sectors
- How this breakdown of electricity consumption is forecast to change over the study period

This information is used to generate archetypes for each sub-sector, which represent all of the plants in that sub-sector. Exhibit 3 illustrates how these archetypes combine sub-sector, end use, and fuel share data to generate the energy use forecasts used in the study. The generic plant construct is used to define an electricity consumption profile representative of a ‘typical’ or archetype plant within a given industry sub-sector (or a specific type of plant within a given sub-sector if there are

[8] Peak load savings were modelled using the Cross-Sector Load Shape Library Model (LOADLIB).

substantial process differences). The generic plant is a composite of energy use patterns, energy intensities, and consumption levels within the particular target sub-sector. The candidate energy management measures are applied to the generic plant to model energy savings potential.

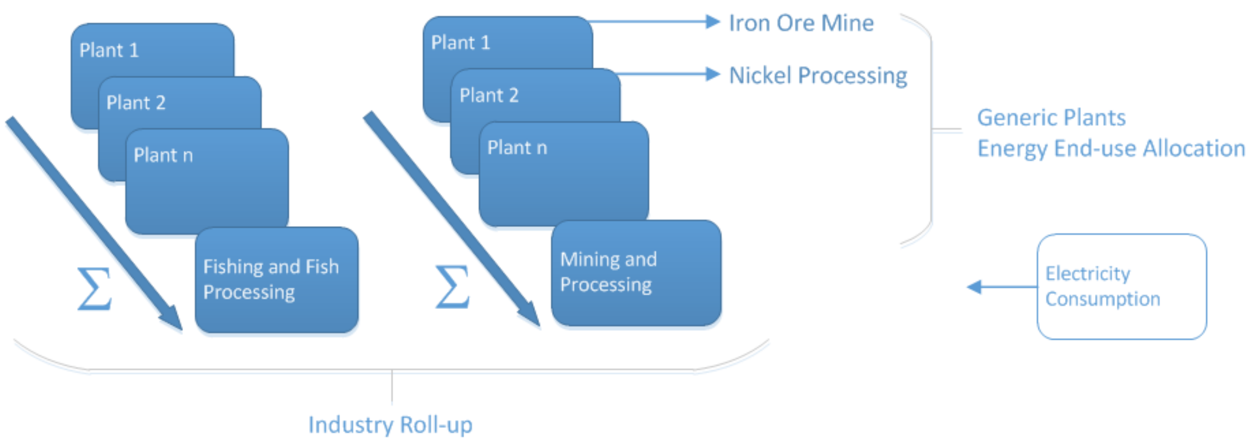
The outputs from the end use breakdown analysis also provide the energy-use intensity (EUI) inputs for the archetype module of ISEEM. ISEEM consists of two modules:

- A general parameters module that contains general sector data (e.g., number of facilities, growth rates, etc.)
- An end use module that contains data on end use saturation levels, fuel shares, unit electricity use, etc.

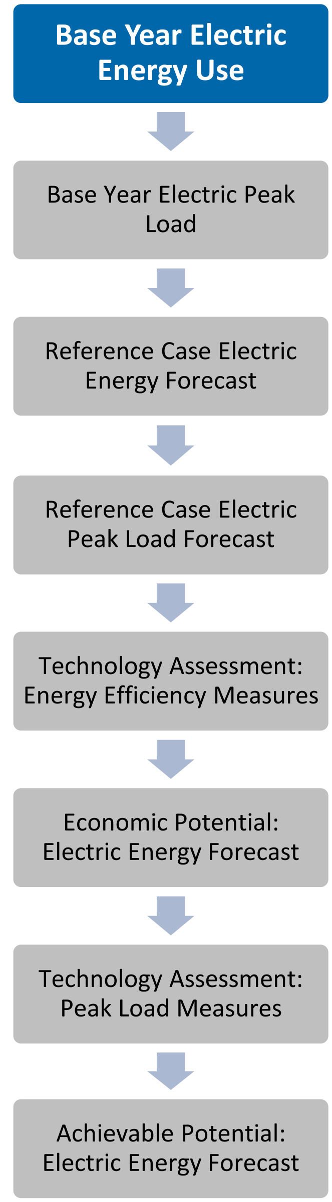
ISEEM combines the data from each portion of the analysis and provides total use of electricity by service region, sub-sector, and end use. ISEEM also enables the analyst to estimate the impacts of the electrical efficiency measures on a utility's on-peak system demand.

ICF's approach has been successfully employed in numerous domestic and international conservation and demand management projects. ICF is recognized as a global leader in CDM Potential studies and evolves it's techniques to stay on the leading edge. The deployment of ISEEM in this project will ensure that results of the industrial study integrate seamlessly with the outputs from the commercial and residential models, CSEEM and RSEEM. This will provide the Utilities with a more powerful Data Manager tool to help with future conservation and demand management planning.

Exhibit 3 Industrial Plant Archetypes



3 Base Year (2014) Electric Energy Use



3.1 Introduction

This section provides a profile of Base Year (2014) electricity use in NL's Industrial sector. The discussion is organized into the following sub-sections:

- Segmentation of Industrial sector
- Definition of end uses
- Development of electricity use profiles
- Summary of Industrial base year electricity use

This study is based on the total electricity use by industrial facilities in Newfoundland and Labrador. The study does not separate out a portion of this electricity use to reflect the self-generation capacity owned by some large industrial facilities. While some of these facilities do include combined heat and power (CHP) and hydroelectric generation, this capacity is all grid-connected.

Conversations with the Utilities indicated their preference to consider total electricity use, which is in line with how the organizations track consumption and load forecasts. Considering total electricity use reflects the full potential for conservation and demand management measures in the Industrial Sector. In summary, all electricity used by equipment at industrial facilities is included in this study, regardless of whether or not it was self-generated.

3.2 Segmentation of Industrial Sector

The first major task in developing the profile of Base Year electricity use involved the segmentation of the industrial accounts into specific sub-sectors. The choice of sub-sectors was determined by the combination of four factors:

- Data availability
- The need to maintain customer confidentiality
- The need to facilitate subsequent analysis of potential electrical efficiency improvements, which means that there must be similarity in terms of major design and operating considerations, such as manufacturing process, hours of operation and product type

The Industrial sub-sectors that are used to present the results of this study are shown in Exhibit 4 below. While modeling will be conducted separately for each of the six sub-sectors named in the right column of this exhibit, the presentation of results will contain a single 'Large Industrial' category that aggregates results from the three corresponding sub-sector models. This aggregation was included to ensure that confidentiality of facility information is maintained.

Exhibit 4 Industrial Sub-Sectors

Level of Electricity Consumption	Study Sub-Sectors
Large Industrial	Pulp and Paper, Mining and Processing, Oil Refining
Small and Medium Industrial	Fishing and Fish Processing
	Manufacturing
	Water Systems and Other

A brief description of the industrial customers included in each of the sub-sectors shown in Exhibit 4 is provided below.

- **Large Industrial**: The Large Industrial classification is based on the amount of electricity used and not on production volumes or number of employees. Facilities classified as such are those expected to use more than 50 GWh of electricity annually. There are five transmission level customers who fall into this group from the following sub-sectors: Mining and Processing, Pulp and Paper, and Oil Refining. These three sub-sectors will be modeled separately but the results will be presented together. It should also be noted that because the Mining and Processing sub-sector also contains some small and medium sized mining operations, the modeling results from these smaller facilities will also be included within the Large Industrial category.

- **Small and Medium Industrial**: Similar to the Large Industrial category, this category is based on the amount of electricity and includes facilities that are expected to use less than 50 GWh/yr. These sub-sectors were selected to align with the categories the Utilities use to track small-medium industrial consumption. The following sub-sectors are included here:

  - **Fishing and Fish Processing**: This sub-sector consists of approximately 600 metered accounts. This sub-sector's monthly electricity consumption is seasonal (monthly consumption peaking in July and August; minimum usage from January to March). The monthly peak consumption is almost 3 times more than the minimum monthly consumption.

  - **Manufacturing**: This sub-sector consists of approximately 1025 metered accounts; monthly electricity consumption is relatively stable throughout the year, with a bit of an increase in winter months.

  - **Water Systems and Other:** This sub-sector includes all the other industrial facilities using less than 50 GWh/yr that are not included under the Fishing or Manufacturing sub-sectors. The main sub-sectors included are: Municipal Water and Sewer Facilities, Commercial and Utility Water Systems, and Sawmills. Approximately 1425 metered accounts are included in this sub-sector and the monthly electricity consumption is relatively consistent throughout the year.

The modeling of energy use was executed at the sub-sector level, with archetypes for each of the three Large and three Small and Medium Industrial sub-sectors. A summary of the distribution of NL's industrial sub-sectors is provided in Exhibit 5. The first exhibit provides details of the estimated breakdown by sub-sector and region. The column chart shows the breakdown by sub-sector type graphically. Note that there are only five customers that meet the Large Industrial designation, but the numbers in the exhibit below reflect the inclusion of metered accounts from small-medium mining operations within this category.

Exhibit 5 Existing Newfoundland Industrial Metered Accounts by Sub-Sector and Region

Sub Sectors	Island	Labrador	Isolated	Grand Total
Large Industry	88	44	-	132
Fishing and Fish Processing	558	1	40	599
Manufacturing	1,008	12	7	1,027
Water Systems and Other	1,251	72	102	1,425
Grand Total	**2,905**	**129**	**149**	**3,183**

As illustrated in Exhibit 5:

- The NL electric utilities currently service about 3,183 industrial metered accounts.
- Approximately 91% of industrial metered accounts are in the Island Interconnected region, approximately 4% are in the Labrador Interconnected region, and the remaining 5% are on various isolated diesel grids.
- 45% of the industrial metered accounts are designated as water systems and other, approximately 32% are manufacturing accounts, approximately 19% are fishing and fish processing accounts, and the remaining 4% of accounts are primarily made up of small-medium mining accounts, as well as the 5 large industrial accounts.
- It should be noted that high metered accounts numbers in certain sub-sectors will not necessarily translate into those sub-sectors accounting for a large portion of industrial consumption. The base year highlights that the size of customers, and not the number of customers, is the key determining factor driving which sub-sectors account for the largest portion of electricity consumption.

3.3 Definition of End Uses

Electricity use within each of the sub-sectors 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.” As discussed in the introduction, this study is focused on the full potential for conservation, which is dependent on how consumption can be reduced at the end use level. This analysis does not remove a portion of electricity use to reflect the self-generation capacity of some facilities, as all of the equipment at those facilities is still a target for conservation, and this would underrepresent the potential for conservation in the province.

A summary of the major industrial sector end uses used in this study is provided in Exhibit 6, together with a brief description of each.

Exhibit 6 Industrial Electric End Uses

Electricity End Use		Description
Process heating		Process heating, including hot water and steam production and distribution
Process cooling / refrigeration / freezing		Process related cooling, refrigeration and freezing
Motors and motor driven equipment	**Compressed air**	Compressed air utilities, including compressors and compressed air distribution system
	Pumps	Process pumps
	Fans and blowers	Fans and blowers

Exhibit 6 Continued: Industrial Electric End Uses

Electricity End Use		Description
	Conveyors	Conveyors and material handling
	Other motors	Motors not included in other categories, for example, motors in grinding, stamping, pressing equipment
Process specific		Processes and equipment not included in the other process categories and are specific to a sub-sector
Building envelope and comfort	**Lighting**	Lighting systems
	Heating, ventilation and air conditioning (HVAC)	HVAC for comfort and work space climate control
Other		End uses not included in the other categories. These include supporting end uses, office equipment, and other assorted equipment that might be found at a facility.

3.4 Development of Industrial Electricity Use Profiles

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. For sub-sectors where the differences between facilities in each region were clearly understood, the profiles were customized for each of the study's regions. 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, in each region.

The archetype profiles developed for large industry were based on the results of a survey of the facilities included in these sub-sectors. In all but one case site personnel provided data, which included both the allocation of electricity use by end use and general best practices implemented at the sites. The other archetype end use profiles were developed based on audit reports from NL's commercial end use survey, and experience from previous industry studies in NL and other Canadian jurisdictions. The resulting end use breakdowns can be found in Appendix A. Differences from the equivalent breakdowns included in the 2008 study are mainly driven by changes to the facilities that make up the sub-sectors (for example, the large industrial landscape has shifted) and by additional data that was available for this study.

3.5 Summary of Industrial Base Year Electricity Use

This section combines the electricity end use profiles with the utility consumption data to produce a summary of the breakdown of electricity use in NL's Industrial sector in the Base Year. The results are presented in five separate exhibits:

- Exhibit 7 presents the results in tabular form by sub-sector and end use
- Exhibit 8, Exhibit 9, and Exhibit 10 present the model results graphically by sub-sector, by region, and by end use, respectively
- Exhibit 11 and Exhibit 12 present the model results as a series of stacked bars, showing the percentage or MWh, consumed by end use for each sub-sector.

Additional highlights are provided below.

By Sub-Sector

Large Industry (Mining and Processing, Pulp and Paper, and Oil Refining) accounts for 89% of overall industrial consumption in the base year. The remaining consumption is split relatively evenly between Fishing and Fish Processing (4%), Manufacturing (4%), and Water Systems and Other (3%).

By Region

The Labrador Interconnected region accounts for approximately 51% of industrial electricity consumption in the base year. The Island Interconnected region accounts for about the same portion of the base year, at approximately 49% of industrial electricity consumption. Isolated diesel grids account for a very small portion of industrial consumption, at less than 1%.

By End Use

Motors and motor driven equipment, including compressed air systems, use close to 60% of all the electricity in industry. Within this group of end uses other motors account for about 18% of end-use electricity, pumps also account for 18%, and fans/blowers account for 15%.

By Sub-Sector and End Use

The last exhibit in this section highlights the differences among sub-sectors. The breakdown of energy consumption varies significantly by sub-sector. For example, Fishing and Fish Processing is around 53% process cooling, while Water Systems and Other is dominated by pumping consumption.

These differences also translate into significant variation between the results for each region, based on the facilities specific to that area. These base year results can be analyzed from many different perspectives in the Data Manager files, which are discussed below.

Data Manager – Final Edition

As part of this report, an Excel application called Data Manager is provided. This Excel workbook includes all the exhibits that were produced using the Data Manager for Chapters 3, 4, 5, and 6, and the corresponding Appendices. It also has the ability to produce charts and tables looking at the data filtered and segmented in other ways. For example:

- The user can produce a pie chart of electricity consumption by end use for an individual sub-sector of interest, such as Fishing and Fish Processing.
- The user can produce separate charts for each region.
- The user can produce a column chart showing the electricity consumption for all motive power end uses in each of several sub-sectors, with each sub-sector as a separate column and the different motive power consumption values shown stacked on top of each other.
- The user can produce a line chart showing consumption for a particular sub-sector by year.
- The user can produce a column chart showing the consumption of different sub-sectors in each rate class (different rate classes within industrial distinguish between facility size, for example).

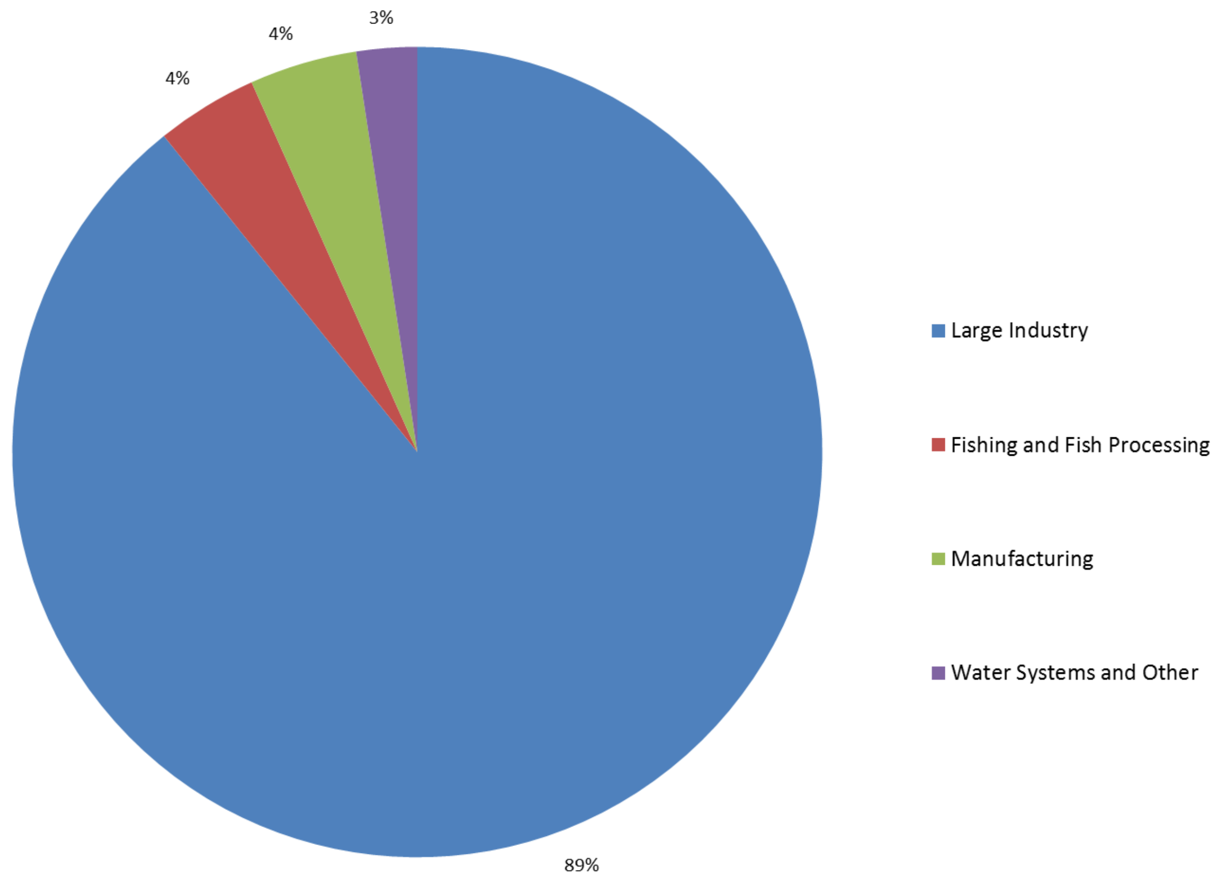
Data Manager has a user interface designed for someone with basic knowledge of Excel.

Exhibit 7 Electricity Consumption by End Use and Sub-Sector in the Base Year (2014), (MWh/yr.)

Sub-Sector	Reference Case Consumption (MWh/yr.)					
	Air compressors	Comfort HVAC	Conveyors	Fans and blowers	Lighting	Other
Large Industry	114,864	63,253	139,539	451,374	66,231	1,816
Fishing and Fish Processing	3,662	15,927	5,100	1,266	8,878	1,663
Manufacturing	13,359	22,895	2,544	11,100	20,518	1,061
Water Systems and Other	742	2,013	39	7,221	2,437	883
Grand Total	132,627	104,087	147,222	470,962	98,064	5,424

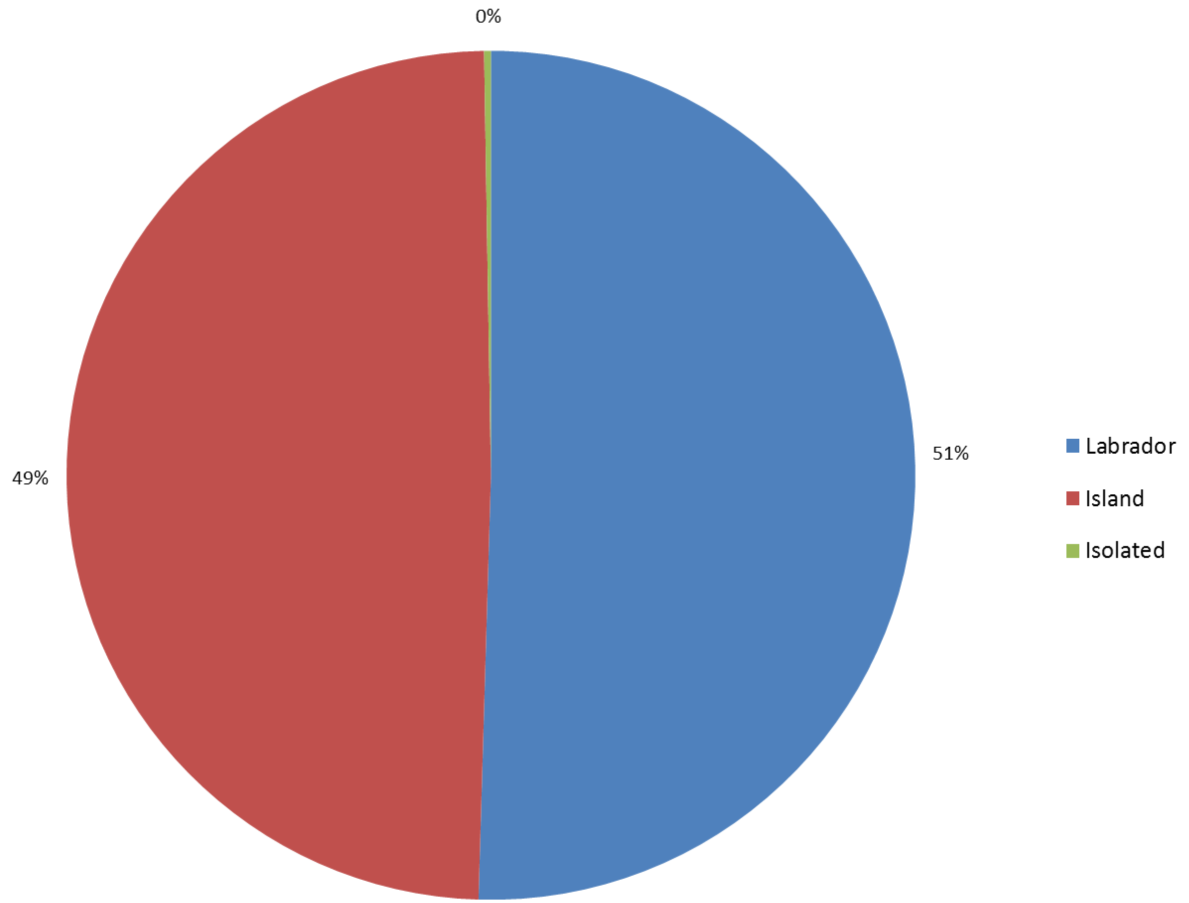
Sub-Sector	Reference Case Consumption (MWh/yr.)					
	Other motors	Process cooling	Process heating	Process specific	Pumps	Grand Total
Large Industry	516,357	3,880	271,244	681,186	518,634	2,828,377
Fishing and Fish Processing	5,339	68,032	9,830	2,014	6,656	128,368
Manufacturing	39,644	7,951	4,121	4,759	8,121	136,074
Water Systems and Other	7,692	-	2,228	5,814	47,516	76,585
Grand Total	569,033	79,863	287,423	693,774	580,927	3,169,404

Exhibit 8 Distribution of Electricity Consumption, by Sub-Sector in the Base Year (2014)



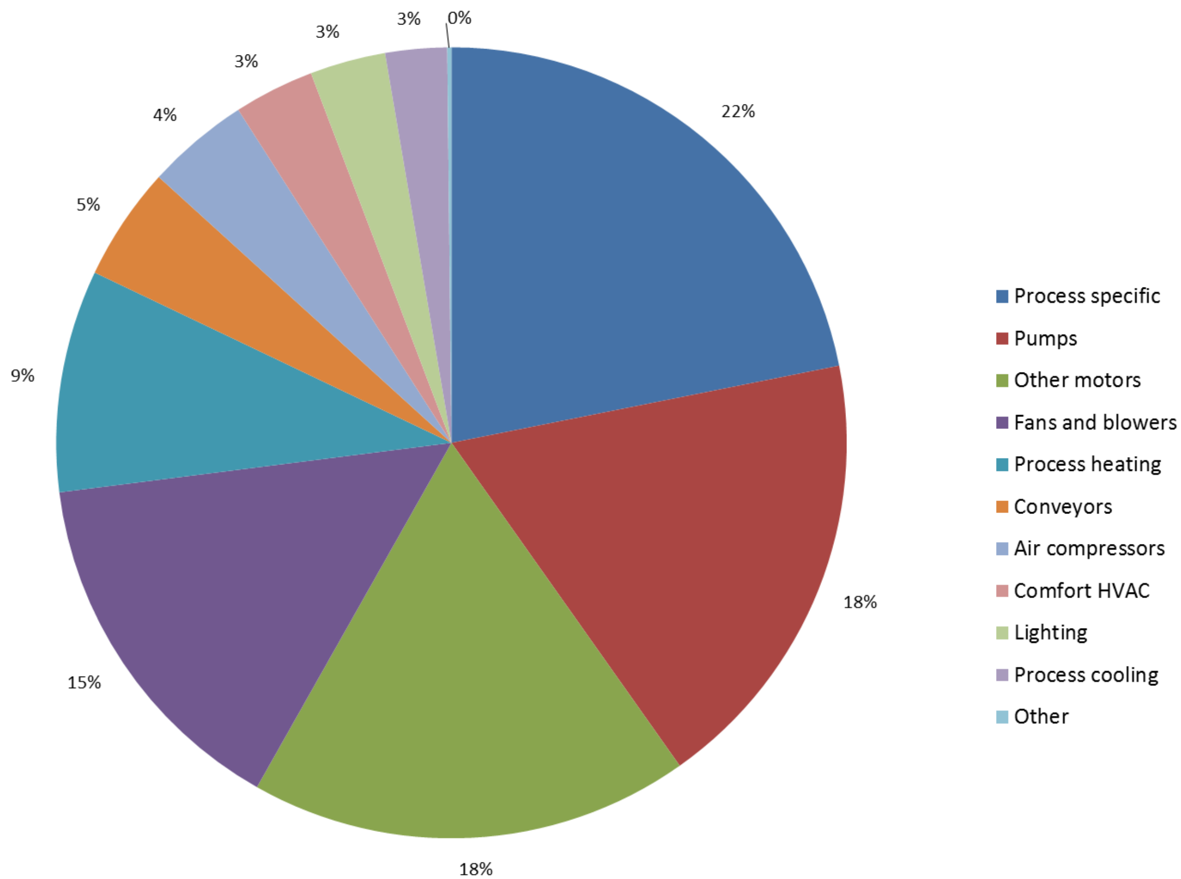
Totals may not add to 100% due to rounding.

Exhibit 9 Distribution of Electricity Consumption, by Region in the Base Year (2014)



Totals may not add to 100% due to rounding.

Exhibit 10 Distribution of Electricity Consumption, by End Use in the Base Year (2014)



Totals may not add to 100% due to rounding.

Exhibit 11 Distribution (%) of Electricity Consumption, by Sub-Sector and End Use in the Base Year (2014)

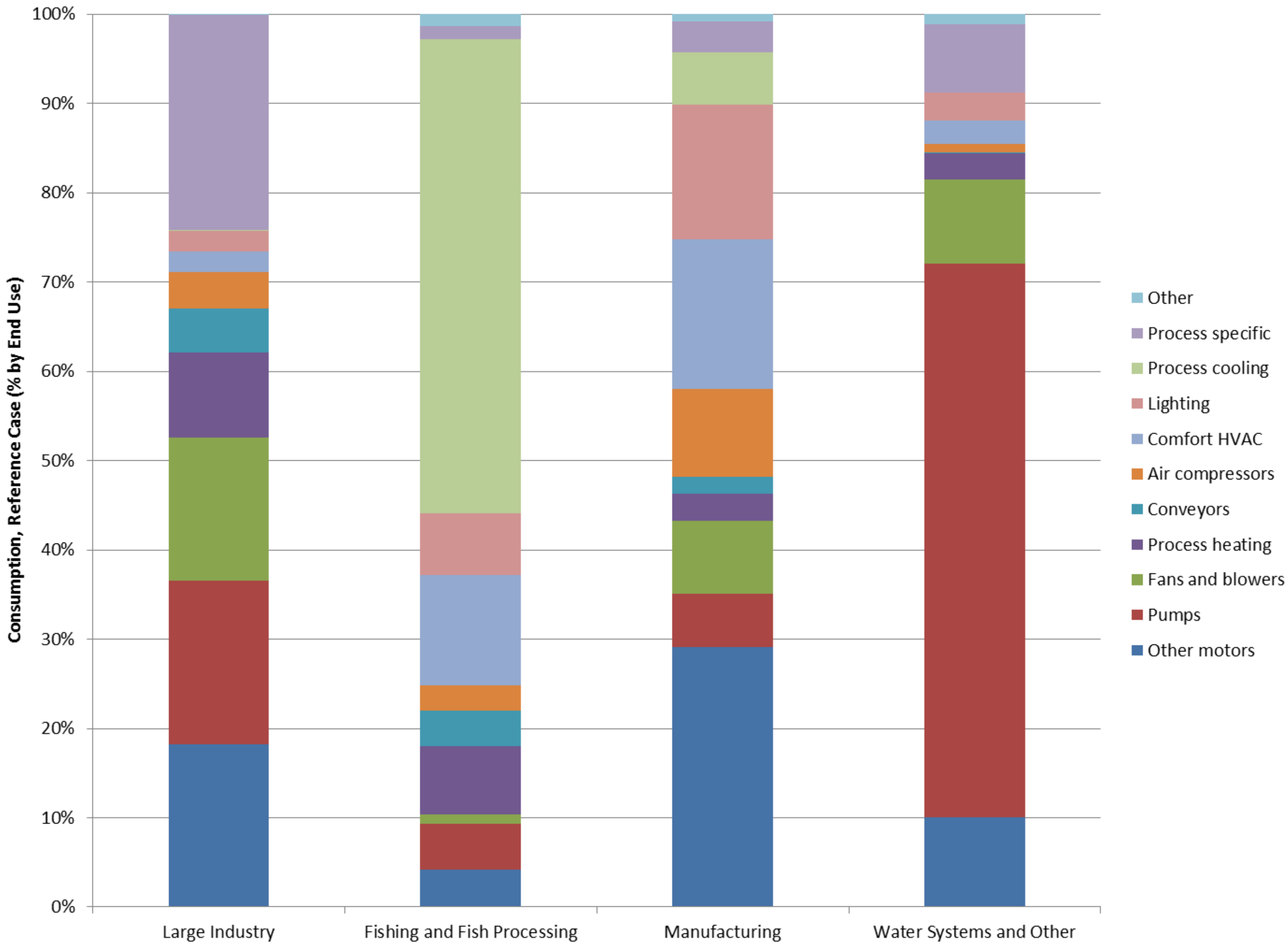
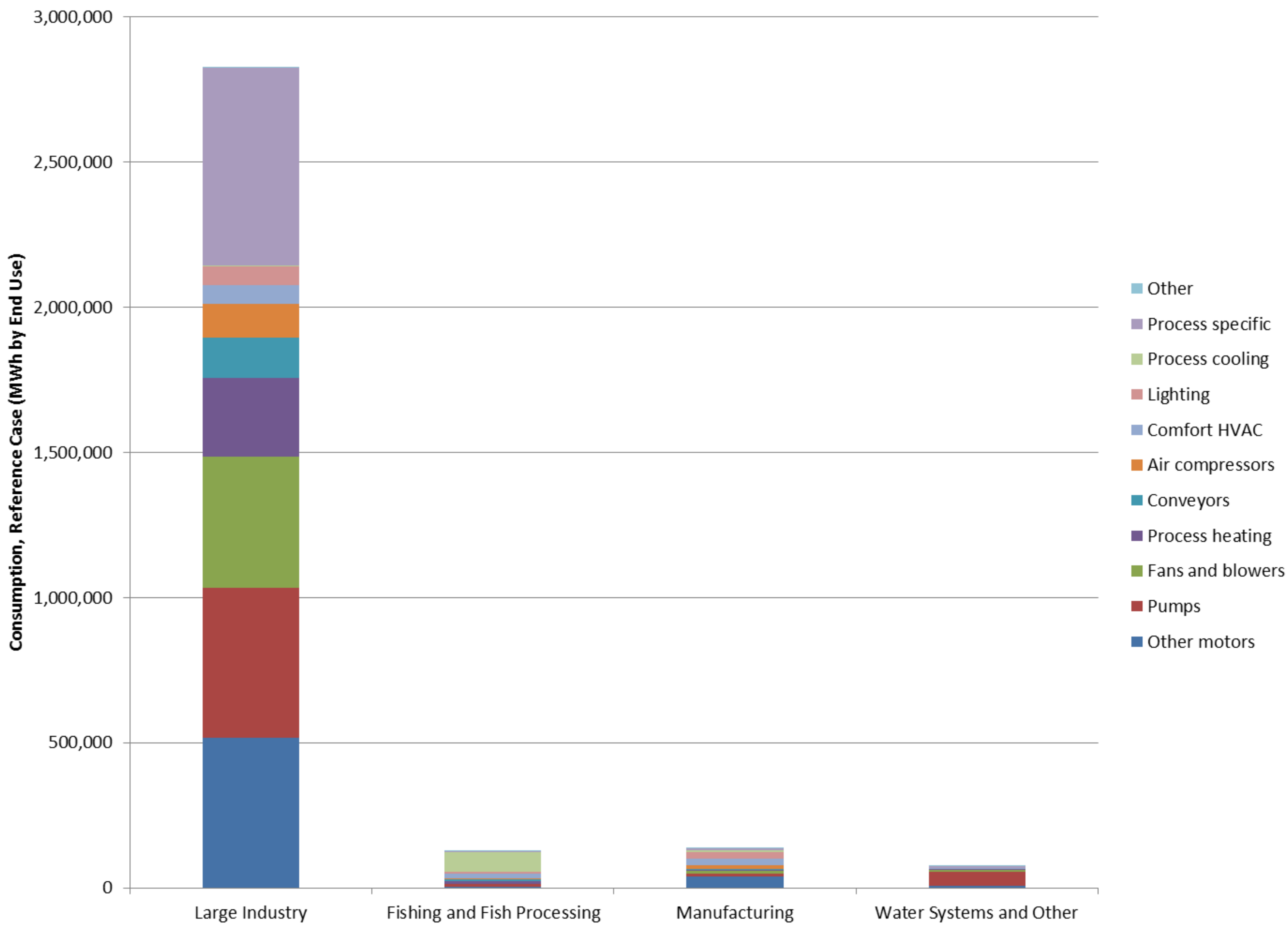
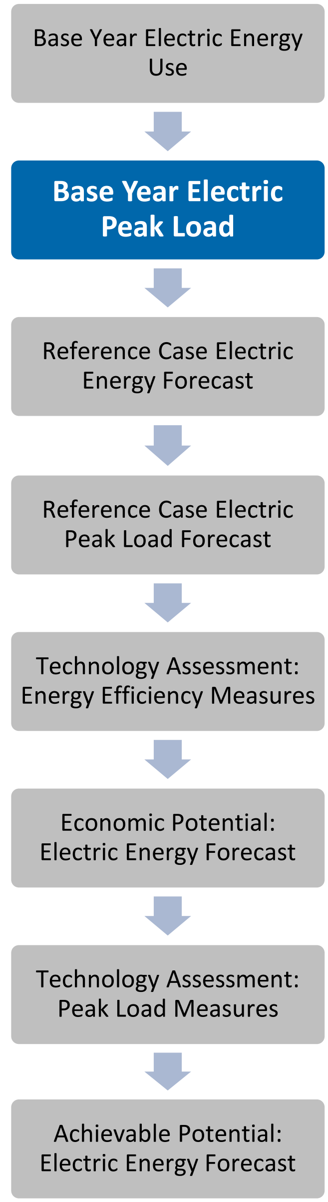


Exhibit 12 Distribution (MWh) of Electricity Consumption, by Sub-Sector and End Use in the Base Year (2014)



4 Base Year (2014) Electric Peak Load



4.1 Introduction

This section provides a profile of the Base Year electric peak load for NL's Industrial sector. The discussion is organized into the following sub-sections:

- Peak period definitions
- Methodology
- Summary of results.

Additional details are provided in Appendix B.

4.2 Peak Period Definitions

Based on discussions with utility personnel, the peak period of interest was the same as in the 2007-2008 study:

Peak Period – 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.[9]

The system capacity constraints are very dependent on cold weather. The NL utilities are do not currently experience capacity constraints in the summer. In future, there may be financial advantages to reducing system demand in summer in order to market more power to summer-peaking utilities in the U.S. That possibility was not explored in this study.

4.3 Methodology

The electric peak load profile converts the annual electric energy use (MWh) presented in Section 3 to hourly demand (MW). Development of the electric peak load estimates employs four specific factors, which are described below and shown graphically in Exhibit 13.

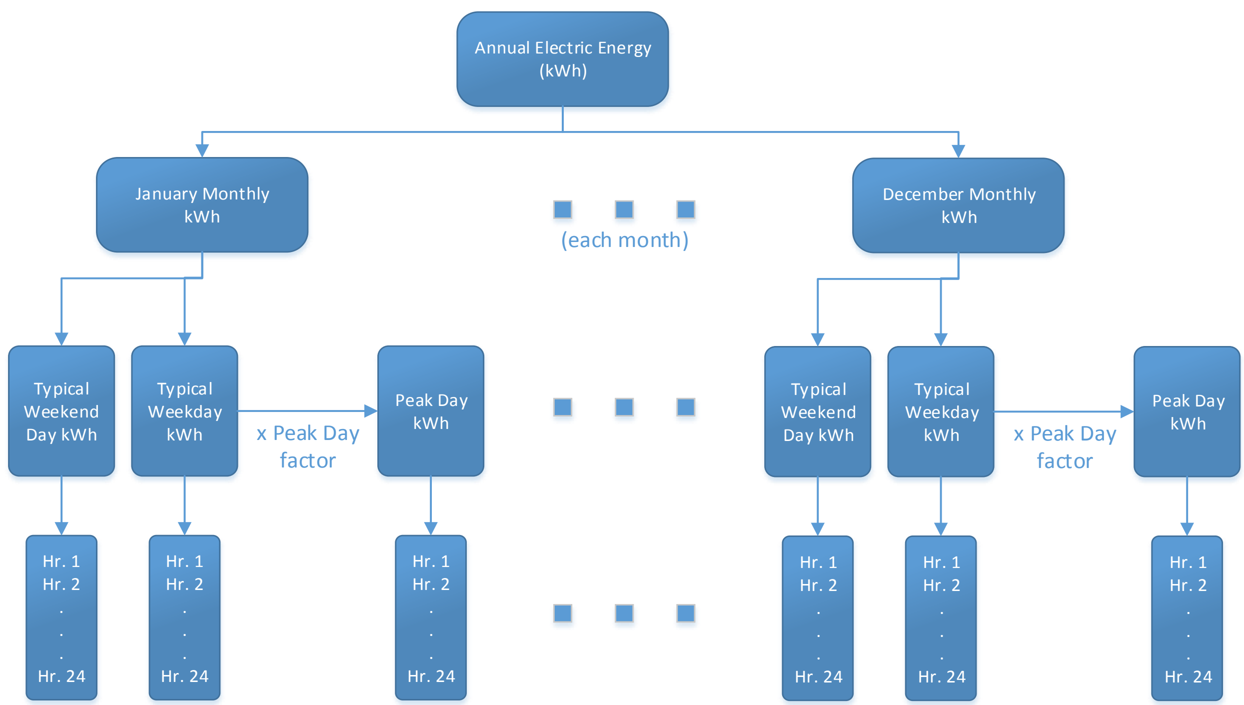
- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. In decreasing order of priority, this allocation factor can be obtained from either:
    - Monthly consumption statistics from end-use load studies
    - Monthly seasonal sales (preferably weather normalized) obtained by subtracting a "base" month from winter and summer heating and cooling months, or
    - Heating or cooling degree days applied to an appropriate base.

- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.

[9] Source: NL (Feb 2014) http://hydroblog.nalcorenergy.com/meeting-peak-demand/

- **Peak Day Factor:** This factor reflects 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.
- **Per Unit Hourly Factor:** This factor reflects the operating hours of the electric equipment or end uses among different hours of the day for each day type (weekday, weekend day, peak day) and for each month. For example, for lighting, this would be affected by time of day and season (affected by daylight).

Exhibit 13 Overview of Peak Load Profile Methodology



4.4 Summary of Results

The factors defined above provided the basis for converting the annual industrial electricity use presented in Section 3 to aggregate peak loads in the peak period.

Exhibit 14 presents the results for the Industrial sector Base Year. The results are presented here for the total Newfoundland service territory, but individual results for each of the three regions in NL are available in the Data Manager file. The results show the contribution of Industrial sector demand that is coincident with the total demand in the peak period.

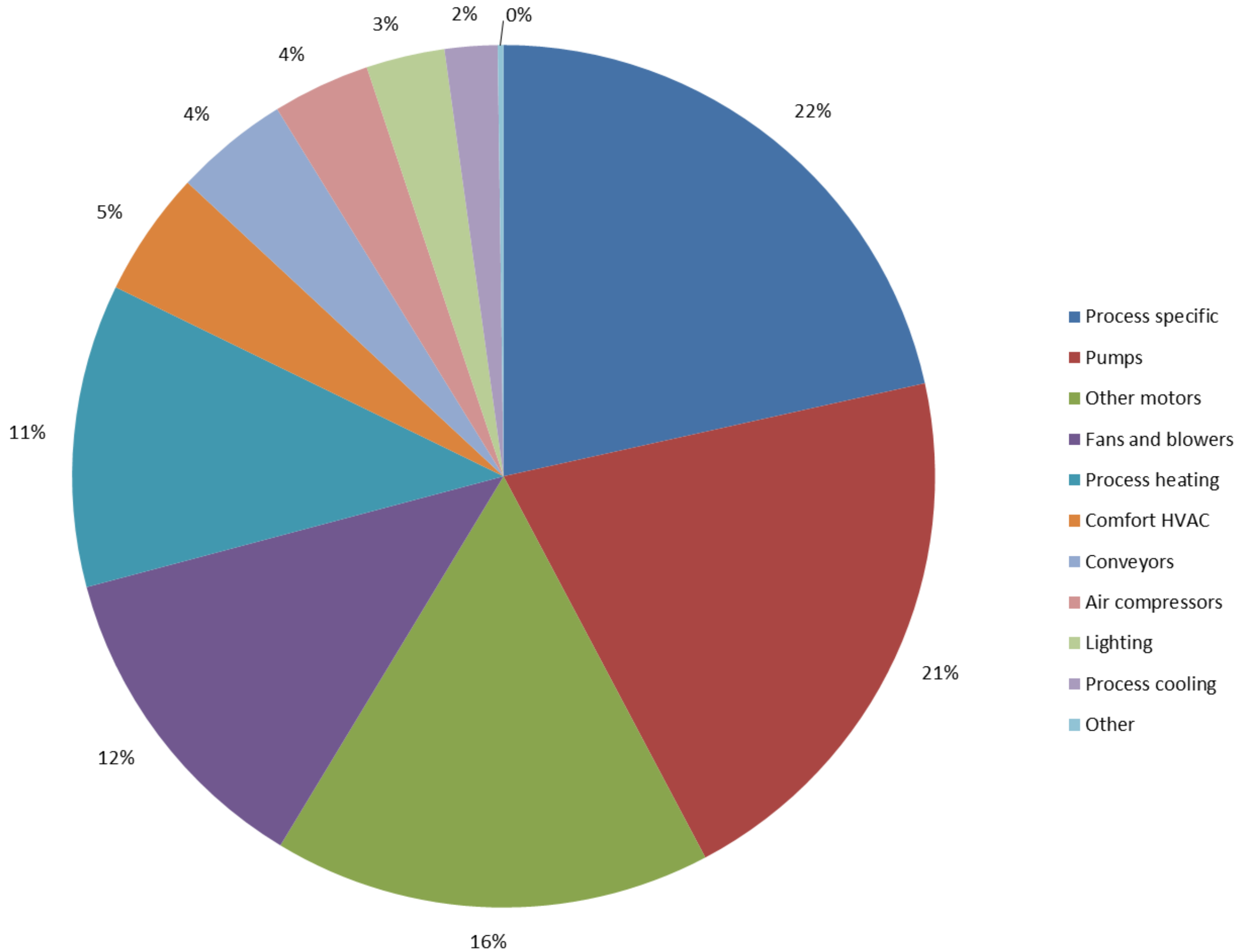
Exhibit 14 Industrial Sector Base Year (2014) Aggregate Peak Demand, All Regions (MW)

Sub Sectors	Reference Case Peak Demand (MW)
Large Industry	258
Fishing and Fish Processing	11
Manufacturing	11
Water Systems and Other	5
Grand Total	**285**

Exhibit 15 shows the contribution, by end use, to the industrial component of the peak demand. Some key observations may be made:

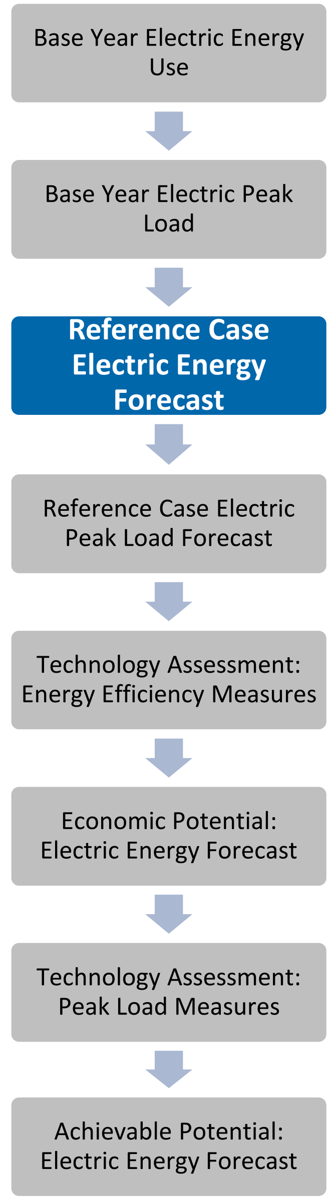
- Process specific end use is the largest industrial component of peak demand. As shown in the previous section, process specific end use is also the largest in terms of annual electrical consumption. It also tends to be significant in the large industrial facilities, which operate at a fairly steady level year round, including the winter when the NL system peaks.
- Pumps and other motors are the second and third largest industrial components of peak demand, once again matching the order of largest consumption end uses.
- Process heating is the fifth largest industrial contributor to peak demand at 11%. This is an increase from the end use's 9% share of industrial consumption, which makes sense given the additional heating requirements during peak winter periods. Similarly, HVAC rises from 3% portion of consumption to a 5% portion of base year peak demand.
- While Fishing and Fish Processing facilities operate seasonally, with a large fluctuation in their consumption, their largest electricity requirements are in the summer months, resulting in less impact on the Utilities' winter peak period.

Exhibit 15 Contribution by End Use to Industrial Aggregate Peak Demand (%)



Additional detail is provided in Appendix B.

5 Reference Case Electric Energy Forecast



5.1 Introduction

This section presents the Industrial sector Reference Case for the study period (2014 to 2029). 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 Reference Case, therefore, provides the point of comparison for the calculation of electricity saving opportunities associated with each of the scenarios that are assessed within this study.

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

- Methodology
- Summary of model results.

5.2 Methodology

Development of the Reference Case involved the following six steps:

Step 1: Electricity consumption was forecast for each sub-sector in each region.

Step 2: The impact of anticipated growth in different facilities and rate classes was factored into sub-sector end use profiles.

Step 3: Impacts from 'natural conservation changes' were estimated in the sub-sector end use profiles.

Exhibit 16 shows the estimated industrial electricity consumption in each milestone period, by sub-sector. The estimates shown are derived from the Utilities' load forecasts.

As growth across different facilities and sub-sectors is uneven, certain sub-sector end use profiles needed to be adjusted to match these differences. More specifically, for sub-sectors like Mining and Processing, which contain a blend of distinct large and small-medium facilities, that each has their own end use profile, the relative growth of these different elements needed to be accounted for in the weighted average sub-sector end use profile. This ensured that if a single large facility was growing faster than the rest of the facilities in its sub-sector, that the end use profile used in the reference case for all of the sub-sector's facilities would reflect the increased portion of consumption at the growing facility.

At the same time, expectations for naturally occurring conservation were built into the sub-sector end use profiles to match typical values found by ICF in previous studies. It should be noted that since the Reference Case is being calibrated to the Utilities' load forecasts, natural conservation estimates did not reduce the overall consumption levels. Instead, their impact changes the relative importance of different end uses over the course of the study period.

Exhibit 16 Industrial Consumption Growth by Sub-Sector and Milestone Year

Year	Sub-Sectors	Industrial Consumption - All Regions (MW/yr.)
2014	Large Industry	2,828,377
	Fishing and Fish Processing	128,368
	Manufacturing	136,074
	Water Systems and Other	76,585
	Year Total	3,169,404
2017	Large Industry	3,545,751
	Fishing and Fish Processing	128,129
	Manufacturing	135,714
	Water Systems and Other	76,818
	Year Total	3,886,412
2020	Large Industry	3,610,520
	Fishing and Fish Processing	128,005
	Manufacturing	135,364
	Water Systems and Other	77,802
	Year Total	3,951,691
2023	Large Industry	3,611,310
	Fishing and Fish Processing	127,889
	Manufacturing	135,024
	Water Systems and Other	78,920
	Year Total	3,953,143
2026	Large Industry	3,612,167
	Fishing and Fish Processing	127,777
	Manufacturing	134,693
	Water Systems and Other	79,717
	Year Total	3,954,354
2029	Large Industry	3,613,020
	Fishing and Fish Processing	127,669
	Manufacturing	134,371
	Water Systems and Other	80,613
	Year Total	3,955,674

A detailed discussion of the methodology employed in each of the remaining steps is provided in Appendix C.

5.3 Summary of Results

This section presents the results of the model runs for the entire study period. They are presented in four exhibits:

- Exhibit 17 presents the model results in tabular form, by sub-sector, end use, and milestone year
- Exhibit 18 presents the model results for 2029 by sub-sector

- Exhibit 19 presents the model results for 2029 region
- Exhibit 20 presents the model results for 2029 by end use
- Exhibit 21 and Exhibit 22 show the evolving relative contribution (% or MWh) of different end uses towards the total consumption in different sub-sectors

Selected highlights of electricity use in 2029 are provided below.

By Sub-Sector

The Large Industry sub-sector accounts for the majority of industrial electricity use in Newfoundland and Labrador, increasing its share of consumption to 91% in 2029. The remaining consumption continues to be split relatively evenly between Manufacturing (4%), Fishing and Fish Processing (3%), and Water Systems and Other (2%).

By Region

The Island Interconnected region is expected to have the most growth, and grows from 49% of the industrial total in 2014 to 56% in 2029. The Labrador Interconnected region accounts for approximately 44% of industrial electricity consumption in 2029, with isolated diesel grids continuing to account for less than 1%. The increasing Island Interconnected portion of consumption is due to significant growth in this region, and not decreasing consumption in Labrador.

By End Use

In 2029, the process specific end use increases and remains the largest end use at 24%. All end uses see a slight rise in their share of total industrial electricity between 2014 and 2029, with the exception of other motors and fans and blowers.

By Sub-Sector and End Use

The last exhibit in this section shows the trends in consumption by end uses. The following key observations can be made:

- The most significant changes are seen in the Large Industry sub-sector, which is highlighted by a growing process specific portion.
- The distribution of electricity consumption is expected to remain relatively stable in most of the small-medium sub-sectors.
- Once again, the large differences between the breakdowns for different sub-sectors will translate into significant variation between the results for each region, based on the facilities specific to that area.

Exhibit 17 Reference Case Electricity Consumption, All Regions, Modelled by End Use, Sub-Sector and Milestone Year (MWh/yr.)

Sub-Sectors	Year	Industrial Consumption (MWh/yr.) Process specific	Pumps	Other motors	Fans and blowers	Process heating	Conveyors
Large Industry	2014	681,186	518,634	516,357	451,374	271,244	139,539
	2017	922,564	654,995	555,649	515,495	321,743	203,247
	2020	943,517	669,107	559,068	520,651	326,781	208,330
	2023	945,199	668,351	560,019	520,567	327,443	208,742
	2026	946,890	667,598	560,971	520,484	328,108	209,155
	2029	948,562	666,836	561,924	520,398	328,771	209,564
Fishing and Fish Processing	2014	2,014	6,656	5,339	1,266	9,830	5,100
	2017	2,016	6,642	5,343	1,265	9,840	5,105
	2020	2,019	6,633	5,352	1,265	9,860	5,114
	2023	2,023	6,625	5,361	1,265	9,879	5,124
	2026	2,026	6,618	5,370	1,264	9,899	5,134
	2029	2,030	6,610	5,379	1,264	9,919	5,143
Manufacturing	2014	4,759	8,121	39,644	11,100	4,121	2,544
	2017	4,767	8,111	39,711	11,098	4,129	2,549
	2020	4,775	8,102	39,778	11,096	4,138	2,553
	2023	4,783	8,092	39,845	11,094	4,146	2,558
	2026	4,791	8,082	39,912	11,092	4,154	2,563
	2029	4,799	8,072	39,980	11,090	4,162	2,568
Water Systems and Other	2014	5,814	47,516	7,692	7,221	2,228	39
	2017	5,848	47,653	7,737	7,249	2,241	40
	2020	5,939	48,256	7,857	7,348	2,277	40
	2023	6,041	48,942	7,992	7,460	2,316	41
	2026	6,118	49,427	8,094	7,542	2,347	41
	2029	6,203	49,973	8,206	7,633	2,380	42

Sub-Sectors	Year	Industrial Consumption (MWh/yr.) Air compressors	Comfort HVAC	Lighting	Process cooling	Other	Grand Total
Large Industry	2014	114,864	63,253	66,231	3,880	1,816	2,828,377
	2017	152,838	93,985	95,149	28,248	1,838	3,545,751
	2020	158,049	96,443	96,250	30,364	1,959	3,610,520
	2023	157,957	96,510	94,172	30,386	1,965	3,611,310
	2026	157,867	96,577	92,138	30,408	1,971	3,612,167
	2029	157,773	96,642	90,147	30,427	1,976	3,613,020
Fishing and Fish Processing	2014	3,662	15,927	8,878	68,032	1,663	128,368
	2017	3,657	15,921	8,678	67,995	1,666	128,129
	2020	3,654	15,930	8,489	68,017	1,671	128,005
	2023	3,652	15,939	8,305	68,041	1,675	127,889
	2026	3,649	15,948	8,124	68,065	1,680	127,777
	2029	3,647	15,957	7,948	68,089	1,684	127,669
Manufacturing	2014	13,359	22,895	20,518	7,951	1,061	136,074
	2017	13,350	22,908	20,072	7,953	1,064	135,714
	2020	13,342	22,921	19,636	7,956	1,067	135,364
	2023	13,333	22,934	19,210	7,959	1,070	135,024
	2026	13,324	22,947	18,792	7,962	1,072	134,693
	2029	13,315	22,960	18,384	7,965	1,075	134,371
Water Systems and Other	2014	742	2,013	2,437	-	883	76,585
	2017	745	2,022	2,394	-	889	76,818
	2020	754	2,051	2,374	-	904	77,802
	2023	766	2,084	2,358	-	920	78,920
	2026	774	2,108	2,333	-	933	79,717
	2029	782	2,135	2,310	-	947	80,613

Exhibit 18 Distribution of Electricity Consumption in 2029 by Sub-Sector

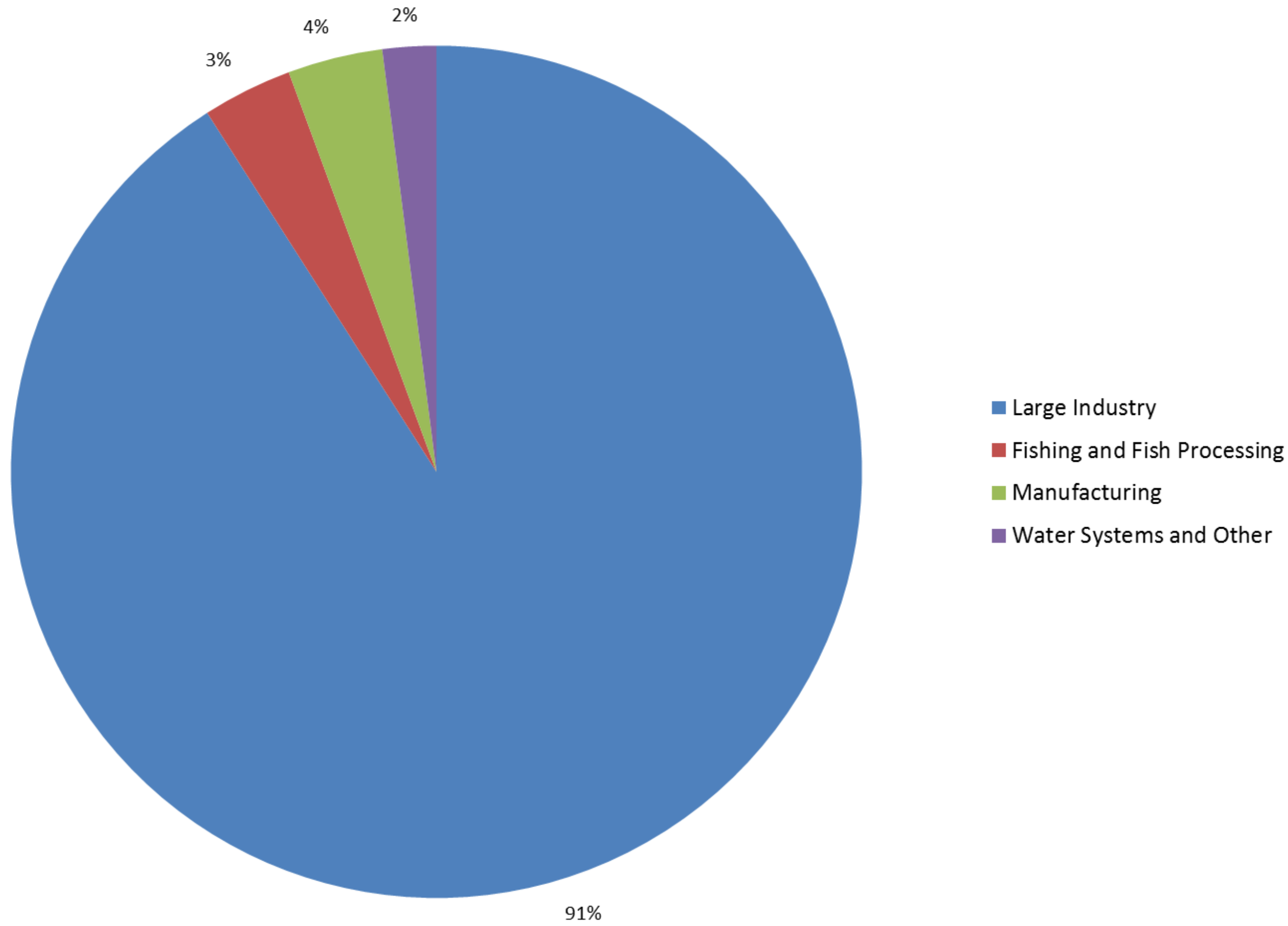


Exhibit 19 Distribution of Electricity Consumption in 2029 by Region

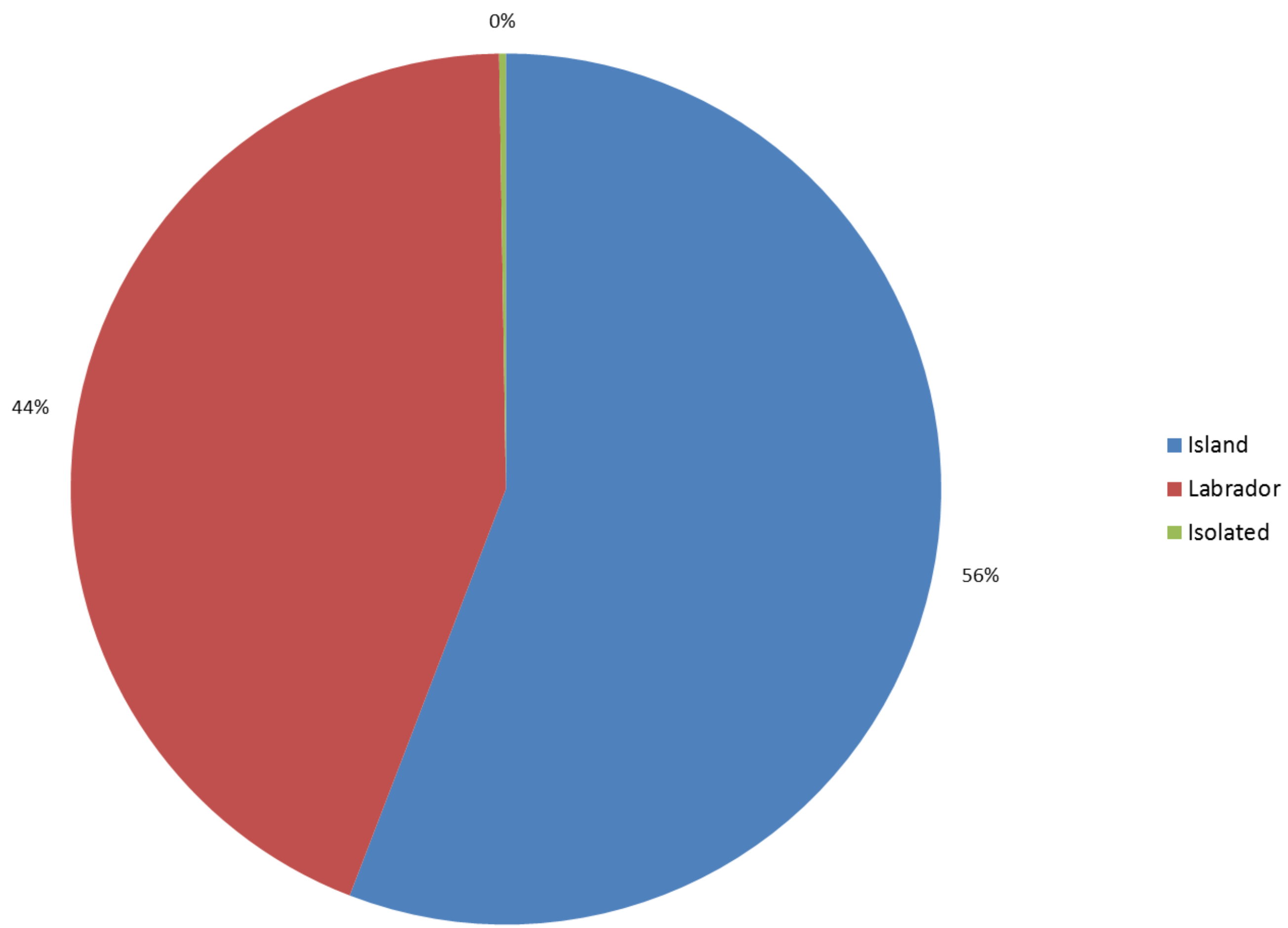


Exhibit 20 Distribution of Electricity Consumption in 2029 by End Use

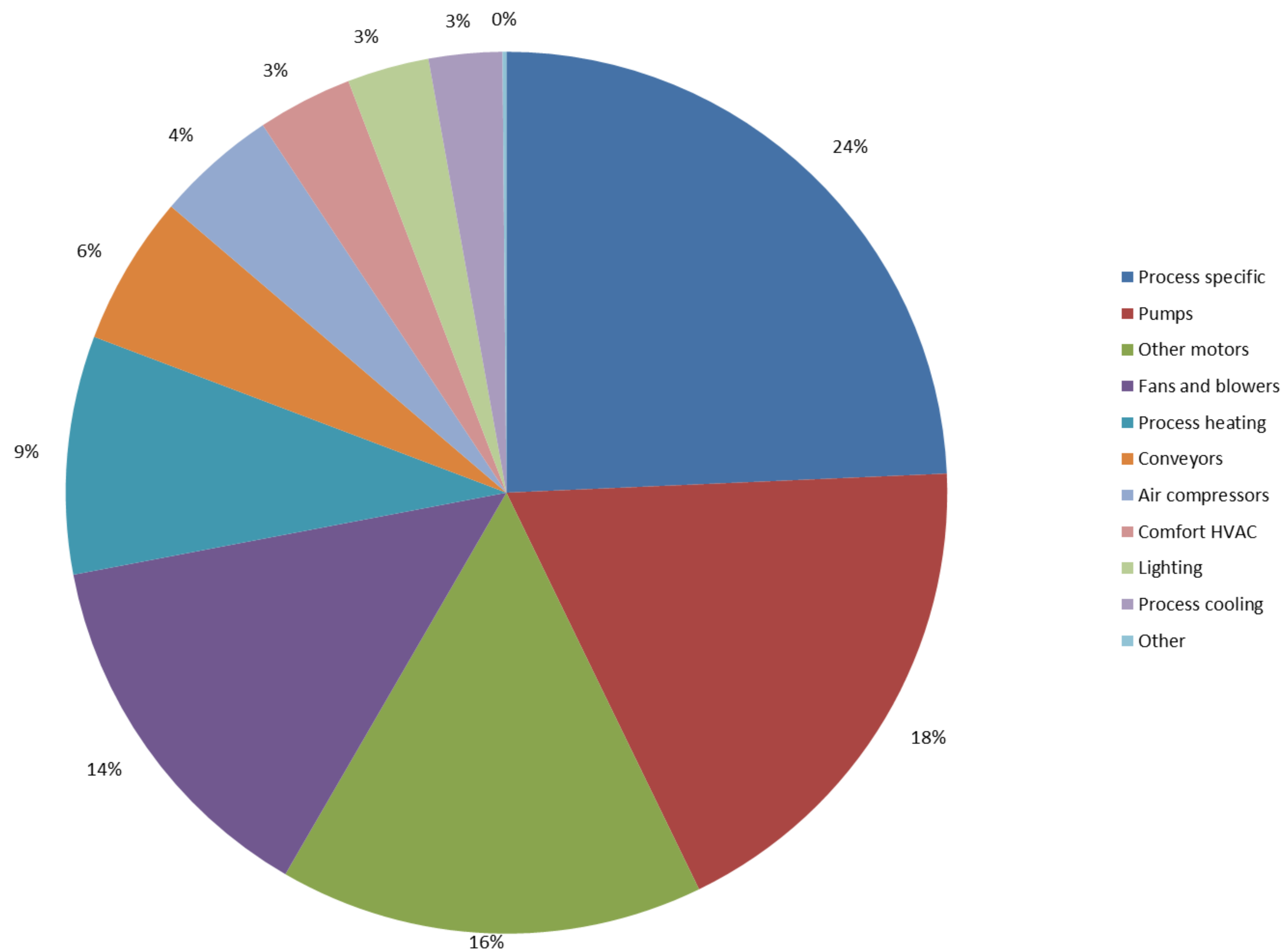


Exhibit 21 Distribution (%) of Electricity Consumption 2014-2029, by Sub-Sector and End Use

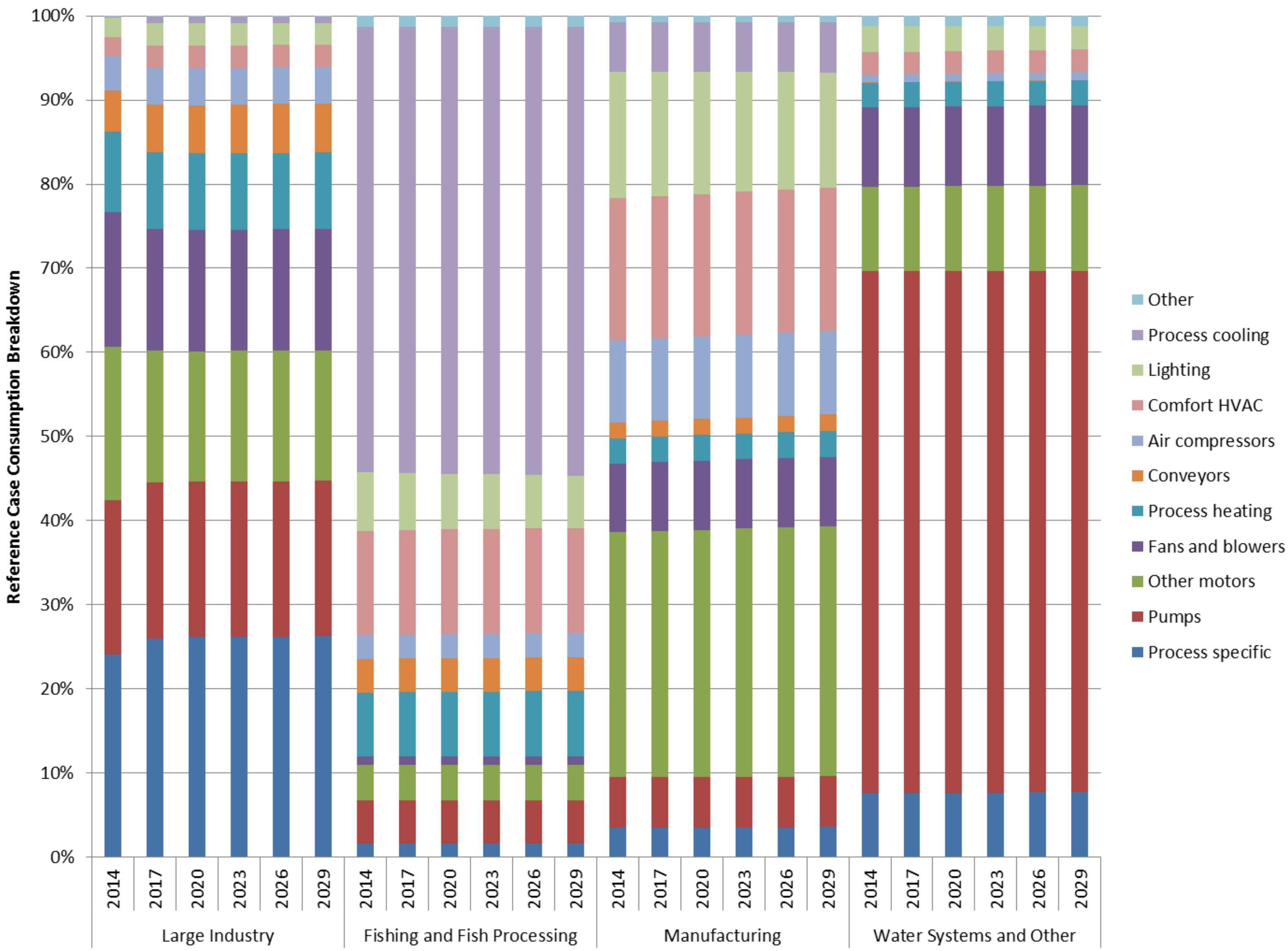
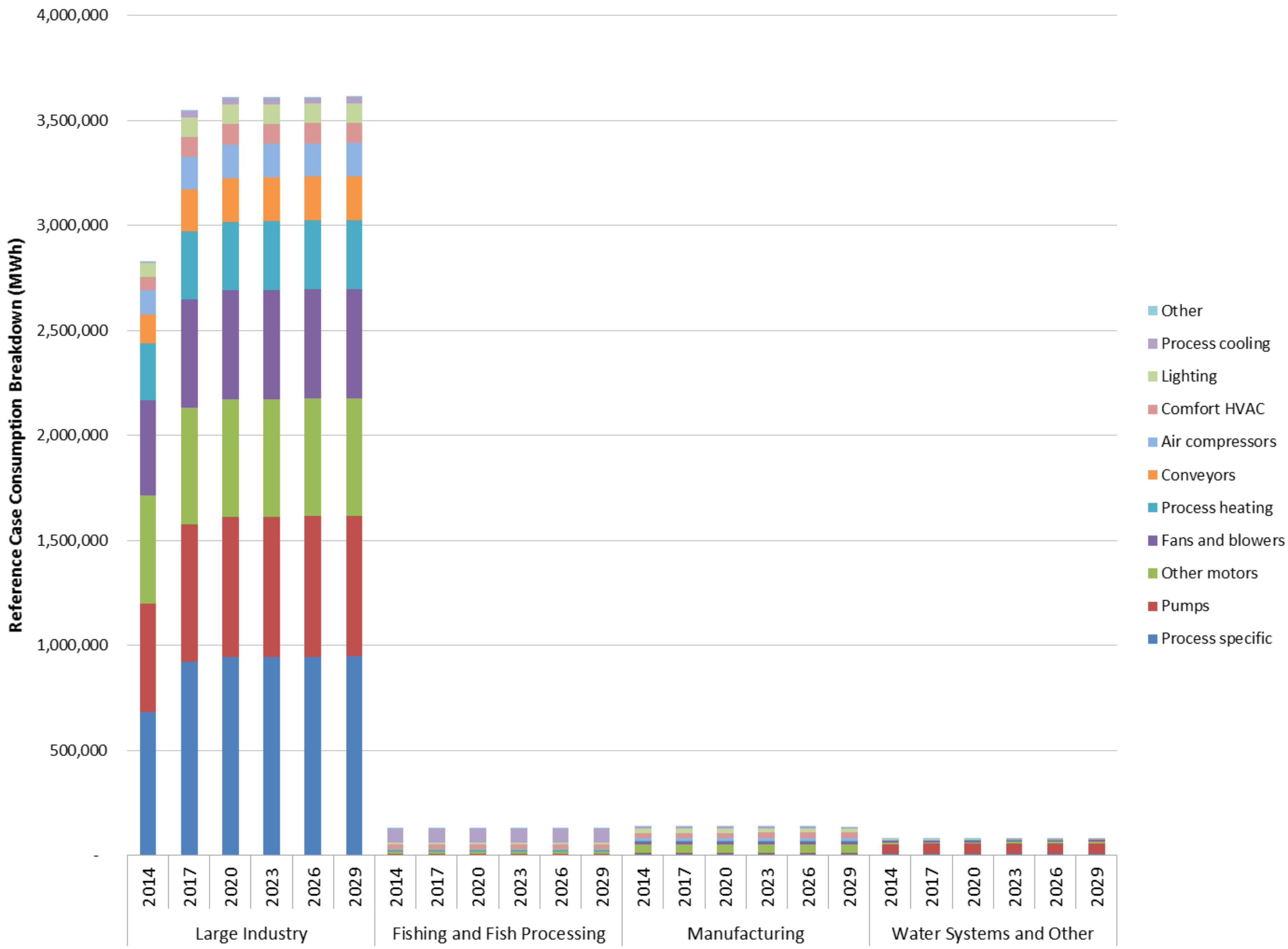
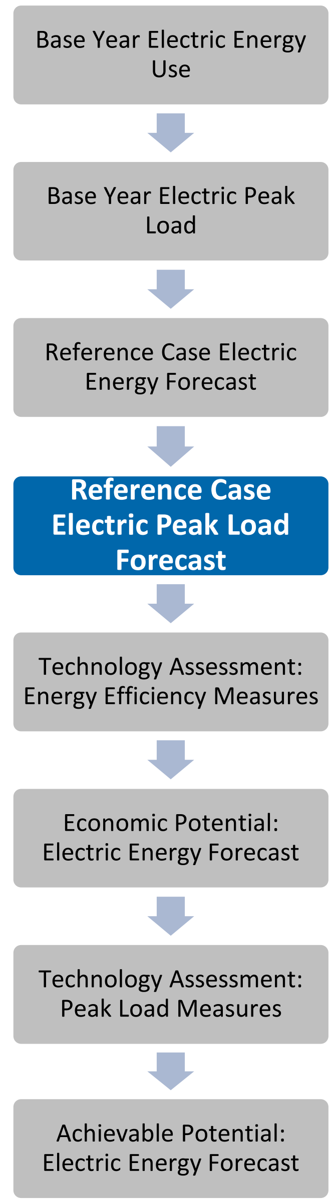


Exhibit 22 Distribution (MWh) of Electricity Consumption 2014-2029, by Sub-Sector and End Use



6 Reference Case Electric Peak Load Forecast



6.1 Introduction

This section provides a profile of the electric peak load for NL's industrial sector over the Reference Case period of 2014 to 2029. The Reference Case peak load profile estimates the expected level of demand in the peak period that would occur over the study period in the absence of new CDM initiatives or rate changes. The Reference Case, therefore, provides the point of comparison for the calculation of peak load savings associated with each of the subsequent scenarios that are assessed within this study.

The discussion is organized into the following sub-sections:

- Methodology
- Summary of results.

6.2 Methodology

The electric peak loads for each combination of end use, sub-sector and milestone year were calculated in exactly the same manner as shown in Section 4, which presented the Base Year peak load profiles.

For this Reference Case, the electric energy consumption (from Section 5) is converted to a demand value for each of the three peak period definitions by dividing the applicable electric energy value for each sub-sector and end use by the corresponding Industrial sector load shape hours-use factors, as presented in Appendix B.

6.3 Summary of Results

A summary of the Reference Case peak load profiles is presented in Exhibit 23

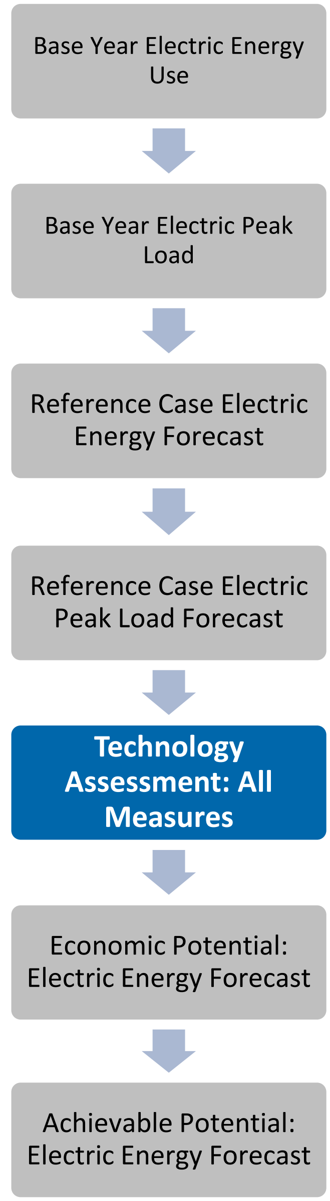
Exhibit 23 Electric Peak Loads, by Milestone Year and Sub-Sector, All Regions (MW)

Sub-Sectors	Year	Reference Case Peak Demand (MW)
Large Industry	2014	258
	2017	337
	2020	344
	2023	344
	2026	344
	2029	344
Fishing and Fish Processing	2014	11
	2017	11
	2020	11
	2023	11
	2026	11
	2029	11
Manufacturing	2014	11
	2017	11
	2020	11
	2023	11
	2026	11
	2029	11
Water Systems and Other	2014	5
	2017	5
	2020	5
	2023	5
	2026	5
	2029	5
Grand Total	2014	285
	2017	363
	2020	370
	2023	370
	2026	371
	2029	371

Selected highlights include:

- Since the hours-use factors applied are not assumed to change during the study period, trends in peak demand contributions for specific sub-sectors are expected to follow the electricity consumption trends for those sub-sectors. Large Industry, for example, will continue to make the largest industrial contribution to peak demand throughout the study period.
- The overall electricity consumption for process specific end use is expected to grow over the study period, and consequently the contribution it makes to the peak demand will also grow, continuing to be the single largest peak demand end use in the Industrial Sector.
- Similarly, peak demand contributions for specific end uses are expected to follow the electricity consumption trends for those end uses. Lighting, because of natural gains in efficiency as LEDs are adopted, will make a gradually declining contribution towards the peak demand.

7 Technology Assessment: All Measures



7.1 Introduction

This section identifies and assesses the economic attractiveness of the selected energy efficiency measures for the Industrial sector. It also identifies and assesses the economic attractiveness of selected Industrial sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electric energy use. The discussion is organized and presented as follows:

- Methodology
- Energy efficiency technologies
- Electric peak load reduction measures
- Summary of unbundled results
- Energy efficiency supply curves
- Demand reduction supply curves.

7.2 Methodology

The following steps were employed to assess the measures:

- Select candidate measures
- Establish technical performance for each option
- Establish the capital, installation and operating costs for each option
- Calculate the cost of conserved energy (CCE) for each energy efficiency technology and O&M measure
- Calculate the cost of electric peak load reduction (CEPR) for each option.

A brief description of each step is provided below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with client personnel based on a combination of 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. In the case of some of the peak load reduction measures, comfort may be affected and the trade-off between benefits (e.g., cost savings) and costs (including reduction in comfort) were judged based on past experience with similar technologies and customer acceptance. Information was collected for typical “small”, “medium”, and “large” equipment, as they relate to each end use.

The measures for each sub-sector use an equipment size (or mix of sizes) that is most representative of what would be found in the sub-sector.

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.

In the case of energy efficiency measures, 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.[10]

Unlike energy efficiency measures, in which major equipment, such as heating and water heating systems are typically replaced, or thermal envelope measures such as insulation upgrades affect systems directly, capacity-only measures are typically implemented via add-on control equipment, although some built-in control equipment exists. The incremental cost is thus defined as the control equipment itself or incremental cost for a controllable appliance or device relative to the baseline appliance cost (e.g., remote accessible thermostat vs. standard thermostat), plus any required infrastructure (e.g., automatic meter reading or communications gateways). In cases where a more efficient appliance with peak control functions replaces a standard appliance, both electric energy and electric peak reduction are achieved, with some splitting of incremental costs attributable to each function. Where a new or replacement end use is installed that operates off peak, thus achieving electric peak reduction without significant energy impacts, incremental costs for the electric peak reduction device will be compared with standard equipment without assuming any early replacement and, thus, salvage value.

In all 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 2014 dollars.

Step 4 Calculate CCE for Each Energy Efficiency 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 efficiency 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 TRM Workbook is expressed in constant 2014 dollars.

[10] With some exceptions, many measures could conceivably be applied as either a full-cost measure (applicable immediately) or as an incremental cost measure (upon end of service life), depending on how financially attractive it is. Therefore, for all but a few measures, the TRM Workbook is configured to evaluate the measure at full cost and include it on that basis if it passes the screen, then roll to evaluating it on an incremental basis, and only fail it completely if it fails both tests. Where a measure is always full cost (such as the block heater timer, where the baseline technology is the “do nothing” option), the incremental cost option is excluded. Where a measure is always incremental cost (such as high-performance homes, where the baseline technology has to be a standard construction home, not no home at all), the full cost option is excluded.

It is recognized that some measures can be implemented prior to the end of their useful life, that is, early retirement. This intermediate option between full and incremental cost could increase the rate of adoption for some of the incremental measures, raising the Economic Potential savings modestly. However, in this study early retirement is treated as a program option.

The CCE provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). 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 operation and maintenance (O&M)
S is the annual kWh electricity savings

And A is the annualization factor

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

Where:

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

The detailed CCE tables (see TRM Workbook) 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, a discount rate of 7% (real) is used.

Step 5 Calculate CEPR for Each Peak Load Measure

The CEPR for a peak load reduction measure is defined as the annualized incremental cost of the measure divided by the annual peak reduction 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 TRM Workbook is in constant (2014) dollars.

The CEPR provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). The CEPR is calculated according to the following formula:

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

Where:

C_A is the annualized installed cost
M is the incremental annual cost of operation and maintenance (O & M)
S_p is the annual kW load reduction associated with peak definition p.

And A is the annualization factor.

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

Where:

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

Note that the annual O&M cost will include, in some cases, amortized costs associated with infrastructure considered a prerequisite for implementation of the measure. This could include automated metering infrastructure (AMI), such as advanced metering, communications gateways and other related system investments. These costs would typically support multiple applications (e.g., communications gateways could enable control of heating, air conditioning, water heating, and pumping), as well as facilitate time-differentiated rates that would be required for a feasible and cost-effective program implementation (e.g., thermal energy storage). It should also be noted that the measure lifetime is for the control device, function or feature, rather than that of the unit it is controlling. The study does not presume any specific technology or infrastructure, but does assume that a marketplace will develop for such systems, whether or not NL utilities adopt them, or develops access directly or indirectly to customer control equipment.

The CEPR can be compared to benefits, which include the value of reduced peak for the utility (avoided capacity and transmission and distribution (T&D) investment or purchase costs), the customer (e.g., bill savings) and society (e.g., value of environmental benefits) to determine its cost effectiveness from various perspectives (societal, utility, participant and non-participant).

As with the CCE for energy savings, the CEPR calculation is sensitive to the chosen discount rate, which, as for the CCE, used a 7% (real) discount rate. Higher discount rates will tend to reduce savings and decrease cost effectiveness where costs are incurred upfront and benefits accrue over many years.

Step 6 Estimate Approximate Unbundled Electric Energy Savings Potential for Each Energy Efficiency Measure and Demand Reduction for Each Peak Load Measure

The next step in the assessment was to prepare an approximate estimate of the potential unbundled electric energy savings that could theoretically be provided by each energy efficiency measure over the study period, and similarly to prepare an estimate of demand reductions that could be provided by each peak load measure. The term “unbundled” means that the savings for each measure are calculated in isolation from other important factors that ultimately determine the potential for real life savings.

The strength of this approach is that it provides insight into the relative size of the potential electric energy savings or demand reductions associated with individual measures; this perspective is often of particular value to utility CDM program design personnel who may need to consider combinations of measures that differ from those selected for the CDM Potential analysis.

However, it should be noted that the savings from individual measures cannot be used directly to calculate total savings potential or demand reduction. This is due primarily to two factors:

- **More than one upgrade may affect a given end use:** For example, improved refrigeration insulation reduces refrigeration electricity use, as does the installation of a cooling tower to reject heat in the low temperature outdoor environment (free cooling). On its own, each measure will reduce overall cooling 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 air curtains that reduce the space heating load) and then to introduce measures that make the remaining load more efficiently (e.g., a high-efficiency packaged HVAC system). Similarly, more than one peak load measure may affect a given end use, or peak load measures may be applied to the same end use that one or more energy efficiency measures may also affect.

- **There are interactive effects among end uses:** For example, the electricity savings from more efficient lighting result in reduced waste heat. During the space heating season, lighting waste heat contributes to a facility's internal heat gains, which lower the amount of heat that must be provided by the HVAC system. Overall these interactive effects are minimal for the Industrial sector, where process loads typically dominate, and HVAC makes up a relatively small portion of consumption. As such, interactive effects are not modeled for the Industrial sector in this study.

The above factors are incorporated in later stages of the analysis.

Step 7 Prepare Energy Efficiency and Demand Reduction Supply Curves

The final step in the assessment of the selected energy efficiency measures was the generation of an energy efficiency supply curve and a demand reduction supply curve. Energy efficiency supply curves are built up based on the conserved electricity and the CCE for each measure. Similarly, demand reduction supply curves are built up based on the demand reduction and the CEPR for each measure. The ISEEM model was used to model the application of all technically feasible measures, accumulating the electricity savings or demand reduction and associated implementation costs for each sub-sector type.

Measures were applied sequentially to account, at least approximately, for interaction between measures. Similarly, the demand measures were also applied sequentially, but began with the demand reference case, not the demand that would remain after all the efficiency measures were applied. Thus the interaction between energy efficiency and demand reduction is neglected for this supply curve.

The accumulated savings and costs for each measure were added together to present the overall energy efficiency supply curve for the province. They were sorted in order from lowest cost per kWh saved to highest cost, and presented on a graph showing CCE versus electricity savings.

The accumulated demand reduction and costs for each measure were added together to present the overall demand reduction supply curve for the province. They were sorted in order from lowest cost per kW reduction to highest cost, and presented on a graph showing CEPR versus demand reduction.

7.3 Energy Efficiency Technology Assessment

Exhibit 24 shows the energy efficiency technologies and measures that are included in this study. A description and detailed financial and economic assessment of each measure is provided in the TRM Workbook that accompanies this report.

Exhibit 24 Energy Efficiency Technologies Included in this Study

Air Compressors

- Premium Efficiency ASD Compressor
- Use Cooler Air from Outside for Make Up Air
- Optimized Distribution System (Incl. Pressure and Air End Uses)
- Optimized Sizes of Air Receiver Tanks
- Sequencing Control
- Air Leak Survey and Repair

Conveyors

- Optimized Conveyor Motor Control
- Premium Efficiency Conveyor Motors

Fans and Blowers

- Premium Efficiency Fan Control with ASDs
- Synchronous Belts
- Premium Efficiency Motors for Fans and Blowers
- Correctly Sized Fans: Impeller Trimming or Fan Selection
- Optimized Distribution System (Incl. Pressure Losses)

HVAC

- Automated Temperature Control
- Air Compressor Heat Recovery
- Ventilation Heat Recovery
- Ventilation Optimization
- Reduced Temperature Settings
- High-Efficiency Packaged HVAC
- Warehouse Loading Dock Seals
- Improved Building Insulation
- HVAC Air Curtains

Lighting

- High Efficiency Lights (LEDs)
- Automated Lighting Controls
- High-Efficiency Lighting Design

Other Motors

- Correctly Sized Motors
- Optimized Motor Control
- Premium Efficiency Motors

Process Cooling/Refrigeration/Freezing

- Chiller Economizer
- Free Cooling
- Floating Head Pressure Controls
- High Efficiency Chiller
- Optimized Distribution System
- Premium Efficiency Refrigeration Control System and Compressor Sequencing
- Improve Insulation of Refrigeration System
- Smart Defrost Controls
- Improved Ice Production System
- Air Curtains

Process Heating

- Heat Pumps
- Insulation
- Process Heat Recovery to Preheat Makeup Water
- High Efficiency Oven/Dryer/Furnace/Kiln
- High Efficiency Water Heater

Process Specific

- Process Optimization Efforts – Fishing and Fish Processing
- Process Optimization Efforts – Pulp and Paper
- Process Optimization Efforts – Mining and Processing
- Process Optimization Efforts – Oil Refining
- Advanced 'Predictive' Process Control Systems

Pumps

- Optimization of Pumping System
- Premium Efficiency Pump Motor
- Premium Efficiency Pump Control with ASDs
- Correctly Sized Pumps: Impeller Trimming or Pump Selection

System

- Sub-Metering
- Energy Management Information System (EMIS)
- Organizational Energy Management (EM Team)
- Operation and Maintenance (O&M) Program Supporting Efficiency
- Integrated Plant Control System

7.3.1 Technology Screening Results

A summary of the results is provided in Exhibit 25. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis[11] for the CCE that is shown (e.g. full versus incremental)
- The measure's average CCE for each region

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 25 because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility CDM measure is limited only by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces. A measure that passes on a full-cost basis in some sub-sector types and on an incremental cost basis in others is shown as "Full/Incr."

Exhibit 25 Industrial Sector Energy Efficiency Technology Measures, Screening Results[12]

End Use	Measure Name	Basis	Average CCE (¢/kWh)		
			Island	Labrador	Isolated
Air Compressors	Premium Efficiency ASD Compressor	Full/Incr.	3.67	2.91	8.32
	Use Cooler Air from Outside for Make Up Air	Full	0.89	0.60	1.97
	Optimized Distribution System (Incl. Pressure and Air End-Uses)	Full	4.35	3.73	6.97
	Optimized Sizes of Air Receiver Tanks	Full	2.17	1.88	3.48
	Sequencing Control	Full	8.84	4.79	22.71
	Air Leak Survey and Repair	Full	3.63	2.41	7.81
Conveyors	Optimized Conveyor Motor Control	Full	3.16	3.94	2.68
	Premium Efficiency Conveyor Motors	Incr.	3.80	1.52	24.06
Fans and Blowers	Premium Efficiency Fan Control with ASDs	Full	1.80	1.50	2.90
	Synchronous Belts	Full	1.31	1.01	2.25
	Premium Efficiency Motors for Fans and Blowers	Incr.	1.88	1.55	27.03
	Correctly Sized Fans: Impeller Trimming or Fan Selection	Full	0.27	0.22	0.45
	Optimized Distribution System (Incl. Pressure Losses)	Full/Incr.	5.39	4.67	8.84
HVAC	Automated Temperature Control	Full	3.88	3.52	6.64
	Air Compressor Heat Recovery	Full	12.01	12.38	13.24
	Ventilation Heat Recovery	Full	20.73	18.80	35.43
	Ventilation Optimization	Full	43.01	50.16	19.16
	Reduced Temperature Settings	Full	0.00	0.00	0.00
	High-Efficiency Packaged HVAC	Incr.	4.24	3.85	22.52
	Warehouse Loading Dock Seals	Full	18.05	15.51	35.04

[11] See Step 4 in Section 7.2 for a fuller description.
[12] Average CCE does not include program costs.

Exhibit 25 Continued: Industrial Sector Energy Efficiency Technology Measures, Screening Results

End Use	Measure Name	Basis	Average CCE (¢/kWh)		
			Island	Labrador	Isolated
	Improved Building Insulation	Incr.	64.91	63.19	89.85
	HVAC Air Curtains	Full	60.07	54.48	102.68
Lighting	High Efficiency Lights (LEDs)	Full	4.30	4.27	5.27
	Automated Lighting Controls	Full	4.37	4.34	5.35
	High-Efficiency Lighting Design	Full	10.18	10.11	12.48
Other Motors	Correctly Sized Motors	Incr.	-3.95	-3.37	16.19
	Optimized Motor Control	Full	0.71	0.61	1.17
	Premium Efficiency Motors	Incr.	2.38	2.00	6.68
Process Cooling / Refrigeration / Freezing	Chiller Economizer	Full	11.08	11.67	8.01
	Free Cooling	Full	1.50	1.50	1.08
	Floating Head Pressure Controls	Full	1.11	1.13	0.80
	High Efficiency Chiller	Full/ Incr.	5.36	4.86	8.01
	Optimized Distribution System	Full	7.81	8.00	5.65
	Premium Efficiency Refrigeration Control System and Compressor Sequencing	Full	7.47	8.18	5.42
	Improve Insulation of Refrigeration System	Full	12.49	11.90	9.00
	Smart Defrost Controls	Full	0.43	0.25	0.31
	Improved Ice Production System	Full	3.48	0.00	3.48
	Air Curtains	Full	9.53	9.50	6.90
Process Heating	Heat Pumps	Full	34.82	9.82	71.92
	Insulation	Full	0.52	0.25	1.11
	Process Heat Recovery to Preheat Makeup Water	Full	7.69	4.91	13.03
	High Efficiency Oven/Dryer/Furnace/Kiln	Incr.	8.39	5.40	17.46
	High Efficiency Water Heater	Incr.	90.45	54.77	163.46
Process Specific	Process Optimization Efforts - Fishing and Fish Processing	Full	21.09	0.00	21.09
	Process Optimization Efforts - Pulp and Paper	Full	1.31	N/A	N/A
	Process Optimization Efforts - Mining and Processing	Full	2.48	2.48	0.00
	Advanced 'Predictive' Process Control Systems	Full	1.75	11.57	N/A
	Process Optimization Efforts - Oil Refining	Full	0.00	N/A	N/A
Pumps	Optimization of Pumping System	Full	2.46	2.09	5.06
	Premium Efficiency Pump Motor	Incr.	2.33	1.98	7.70
	Premium Efficiency Pump Control with ASDs	Full	1.14	0.97	2.32
	Correctly Sized Pumps: Impeller Trimming or Pump Selection	Full	0.07	0.06	0.15
System	Sub-Metering	Full	0.55	0.29	2.77
	Energy Management Information System (EMIS)	Full	2.69	3.33	8.09
	Organizational Energy Management (EM Team)	Full	1.97	3.42	4.52
	Operation and Maintenance (O&M) Program Supporting Efficiency	Full	1.04	1.90	2.21
	Integrated Plant Control System	Full	3.11	1.87	12.45

7.4 Demand Reduction Technology Assessment

Exhibit 26 shows the demand reduction technologies and measures that are included in this study. A description and detailed financial and economic assessment of each measure is provided in the TRM Workbook that accompanies this report.

Exhibit 26 Demand Reduction Technologies Included in this Study

System

- Operating Changes for Reduced Peak Load (DR Curtailments)
- Peak Shifting Through On-Site Storage
- Power Factor Correction Equipment

7.4.1 Technology Screening Results

A summary of the results is provided in Exhibit 27. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis[13] for the CEPR that is shown (e.g. full versus incremental)
- The measure's average CEPR for each region

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 27 because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility CDM measure is limited only by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces. A measure that passes on a full-cost basis in some sub-sector types and on an incremental cost basis in others is shown as "Full/Incr."

The first demand measure included here, operating changes for reduced peak load, represents the peak demand reductions that the Utilities can achieve through curtailment arrangements with their customers. For Newfoundland Power this represents participation by all general service customers in their curtailable service option. For Newfoundland and Labrador Hydro this represents interruptible power arrangements in place with large industrial customers for peak period curtailment. In both cases this study will consider current and potential future levels of curtailment.

Exhibit 27 Industrial Sector Demand Reduction Technology Measures, Screening Results[14]

Measure Name	Basis	Average CEPR ($/kW)		
		Island	Labrador	Isolated
Operating changes for reduced peak load (DR Curtailments)	Full	32	32	32
Peak shifting through on-site storage	Full	25	78	59
Power factor correction equipment	Full	21	17	60

[13] See Step 4 in Section 7.2 for a fuller description.
[14] Average CEPR does not include program costs.

7.5 Energy Efficiency Supply Curve

This sub-section includes an energy efficiency supply curve for the total Newfoundland service territory. This supply curve shows the avoided cost for each region as a horizontal line. Regional supply curves are available in the Data Manager file, and are also important since the avoided costs and CCE's vary by region. This supply curve is presented for the year 2029, but the Data Manager file can be used to generate supply curves for the other years.

The supply curve were constructed based on the approximate Technical Potential savings associated with the measures listed in Exhibit 25. The following approach was used:

- Measures were introduced in sequence.
- Where more than one measure affects the same end use, the savings shown for the second measure are incremental to those already shown for the first.
- Sequence is determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology. It includes consideration of CCE results from the preceding exhibit, but not for the purposes of economic screening.
- Items appear in order, starting with the lowest average CCE, but do not stop at the avoided cost threshold. Hence, the supply curve presents a type of Technical Potential scenario.

The results are presented in two exhibits:

- Exhibit 28 presents the potential by measure for all regions. The columns provide the savings for the measure, cumulative savings, and CCE, with measures sorted and numbered in order of increasing CCE.
- Exhibit 29 presents the supply curve for all regions. A few of the measures are numbered as landmarks. The numbers match those in Exhibit 28.

Equivalent exhibits specific have been created for each of the three regions in Data Manager, and include a comparison of avoided costs levels of range of reasonableness.

Exhibit 28 All Regions Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
-	Correctly Sized Motors	6,405	6,405	-$0.04[15]
1	Process Optimization Efforts - Oil Refining	-	6,405	$0.00
2	Reduced Temperature Settings	2,715	9,120	$0.00
3	Correctly Sized Pumps: Impeller Trimming or Pump Selection	40,996	50,116	$0.00
4	Correctly Sized Fans: Impeller Trimming or Fan Selection	26,016	76,132	$0.00
5	Insulation	4,876	81,009	$0.00
6	Smart Defrost Controls	1,340	82,348	$0.00
7	Optimized Motor Control	9,329	91,677	$0.01
8	Use Cooler Air from Outside for Make Up Air	2,834	94,511	$0.01

[15] This CCE value is negative since the opportunity involves the selection of a smaller replacement motor at the equipment's end of life, which is actually less expensive than the default of purchasing a new oversized motor.

Exhibit 28 Continued: All Regions Measure Potential and CCE

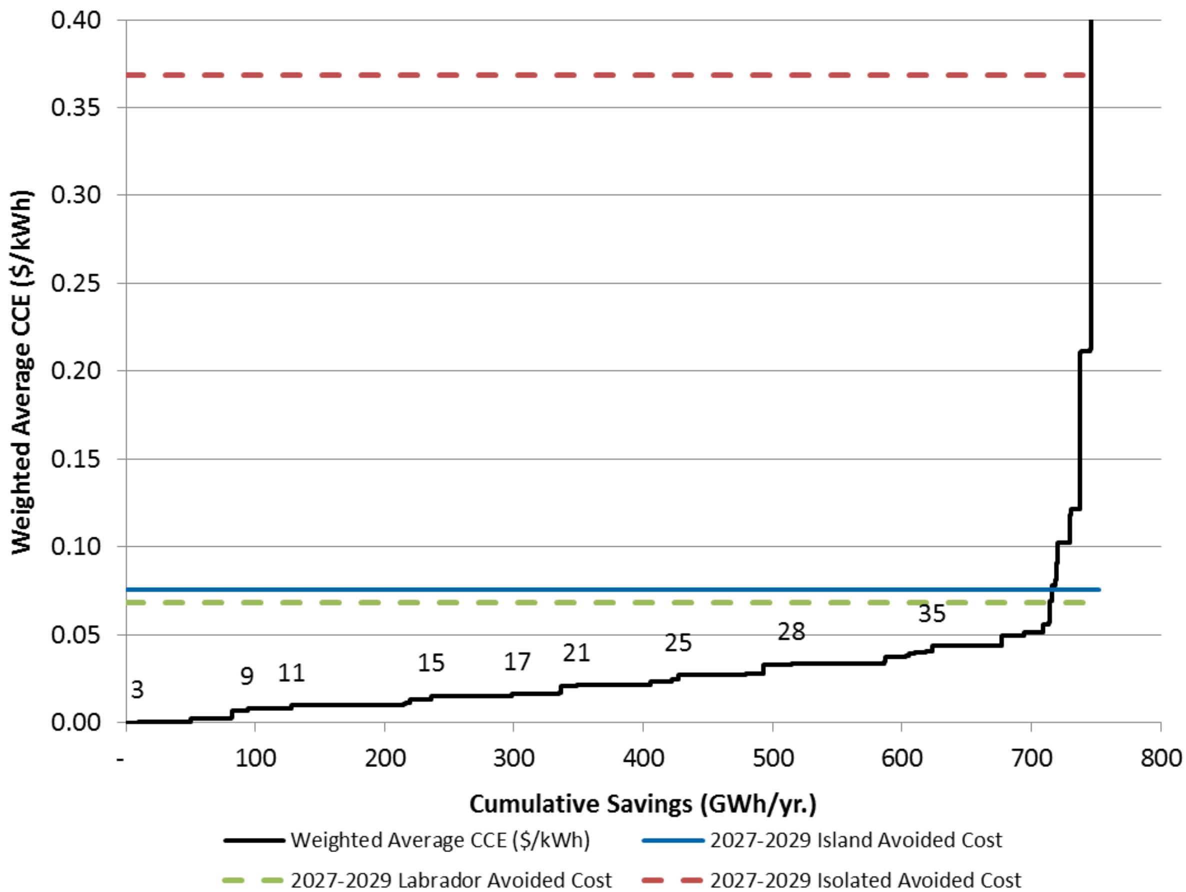
Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
9	Sub-Metering	33,548	128,060	$0.01
10	Floating Head Pressure Controls	318	128,378	$0.01
11	Premium Efficiency Pump Control with ASDs	86,257	214,635	$0.01
12	Synchronous Belts	1,422	216,057	$0.01
13	Free Cooling	3,326	219,383	$0.01
14	Process Optimization Efforts - Pulp and Paper	16,272	235,655	$0.01
15	Premium Efficiency Fan Control with ASDs	62,406	298,061	$0.02
16	Premium Efficiency Motors for Fans and Blowers	4,671	302,733	$0.02
17	Operation and Maintenance (O&M) Program Supporting Efficiency	31,672	334,405	$0.02
18	Premium Efficiency Conveyor Motors	1,920	336,325	$0.02
19	Premium Efficiency Pump Motor	6,542	342,867	$0.02
20	Premium Efficiency Motors	5,796	348,663	$0.02
21	Optimization of Pumping System	56,790	405,453	$0.02
22	Advanced 'Predictive' Process Control Systems	15,610	421,063	$0.02
23	Optimized Sizes of Air Receiver Tanks	1,300	422,363	$0.02
24	Process Optimization Efforts - Mining and Processing	4,485	426,847	$0.02
25	Organizational Energy Management (EM Team)	52,540	479,387	$0.03
26	Air Leak Survey and Repair	13,357	492,744	$0.03
27	Integrated Plant Control System	21,897	514,641	$0.03
28	Energy Management Information System (EMIS)	71,478	586,119	$0.03
29	Improved Ice Production System	1,174	587,292	$0.03
30	Premium Efficiency ASD Compressor	15,783	603,075	$0.04
31	Automated Temperature Control	2,601	605,676	$0.04
32	Optimized Conveyor Motor Control	3,818	609,494	$0.04
33	Optimized Distribution System (Incl. Pressure and Air End-Uses)	8,859	618,352	$0.04
34	High-Efficiency Packaged HVAC	5,111	623,463	$0.04
35	High Efficiency Lights (LEDs)	48,612	672,075	$0.04
36	Automated Lighting Controls	4,892	676,967	$0.04
37	Process Heat Recovery to Preheat Makeup Water	17,501	694,468	$0.05

Exhibit 28 Continued: All Regions Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
38	Optimized Distribution System (Incl. Pressure Losses)	14,679	709,147	$0.05
39	High Efficiency Oven/Dryer/Furnace/Kiln	82	709,229	$0.05
40	Premium Efficiency Refrigeration Control System and Compressor Sequencing	3,719	712,948	$0.06
41	Optimized Distribution System	1,330	714,279	$0.06
42	High Efficiency Chiller	2,014	716,292	$0.07
43	Heat Pumps	2,145	718,437	$0.08
44	Chiller Economizer	1,325	719,762	$0.08
45	Air Curtains	412	720,174	$0.09
46	Improve Insulation of Refrigeration System	1,756	721,930	$0.10
47	High-Efficiency Lighting Design	7,954	729,884	$0.10
48	Sequencing Control	761	730,645	$0.12
49	Air Compressor Heat Recovery	7,284	737,929	$0.12
50	Process Optimization Efforts - Fishing and Fish Processing	148	738,077	$0.21
51	Ventilation Heat Recovery	7,519	745,597	$0.21
52	Warehouse Loading Dock Seals	410	746,006	$0.21
53	Ventilation Optimization	4,154	750,160	$0.43
54	High Efficiency Water Heater	1,536	751,696	$0.54
55	HVAC Air Curtains	160	751,856	$0.62
56	Improved Building Insulation	6,238	758,094	$0.66

The CCE values presented in Exhibit 28 do not always match those presented elsewhere in the report. The CCE values presented in these exhibits are calculated weighted averages, based on the particular mixture of sub-sectors and regions in which the measure is applied at each stage of the analysis. So for example, CCE values presented in this exhibit may differ significantly from those shown in Exhibit 25. The CCE values in Exhibit 25 present a preliminary average for each region, weighted based on the breakdown of consumption by sub-sector in that region. By contrast, the CCE values in Exhibit 28 are based on the technical potential scenario. So the CCE values in this exhibit are more precisely weighted, based on the end-use breakdown, and the applicability/market penetration of measures in each sub-sector. It is also important to note that there is not necessarily a correlation between which region's CCE value from Exhibit 25 is closest to the CCE value in Exhibit 28, and which region accounts for the majority of Technical Potential savings in Exhibit 28.

Exhibit 29 All Regions Energy Efficiency Supply Curve



7.6 Demand Reduction Supply Curve

This sub-section includes demand reduction supply curves for each of the three regions studied. It is important to present the supply curves for each region separately, because the avoided costs are different. The supply curves presented are for the year 2029, but the Data Manager can be used to generate supply curves for the other years. Each supply curve shows the avoided cost for that region as a horizontal line, with dashed lines showing the upper and lower edge of the range of reasonableness.

The supply curves were constructed based on the approximate Technical Potential savings associated with the measures listed in Exhibit 26. The following approach was used:

- Measures were introduced in sequence
- Where more than one measure affected the same end use, the reduction shown for the second measure are incremental to those already shown for the first
- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology. It included consideration of CEPR results from the preceding exhibit, but not for the purposes of economic screening.
- Items appear in order, starting with the lowest average CEPR, but do not stop at the avoided cost threshold. Hence, the supply curve presents a type of Technical Potential scenario.

The results are presented in two exhibits:

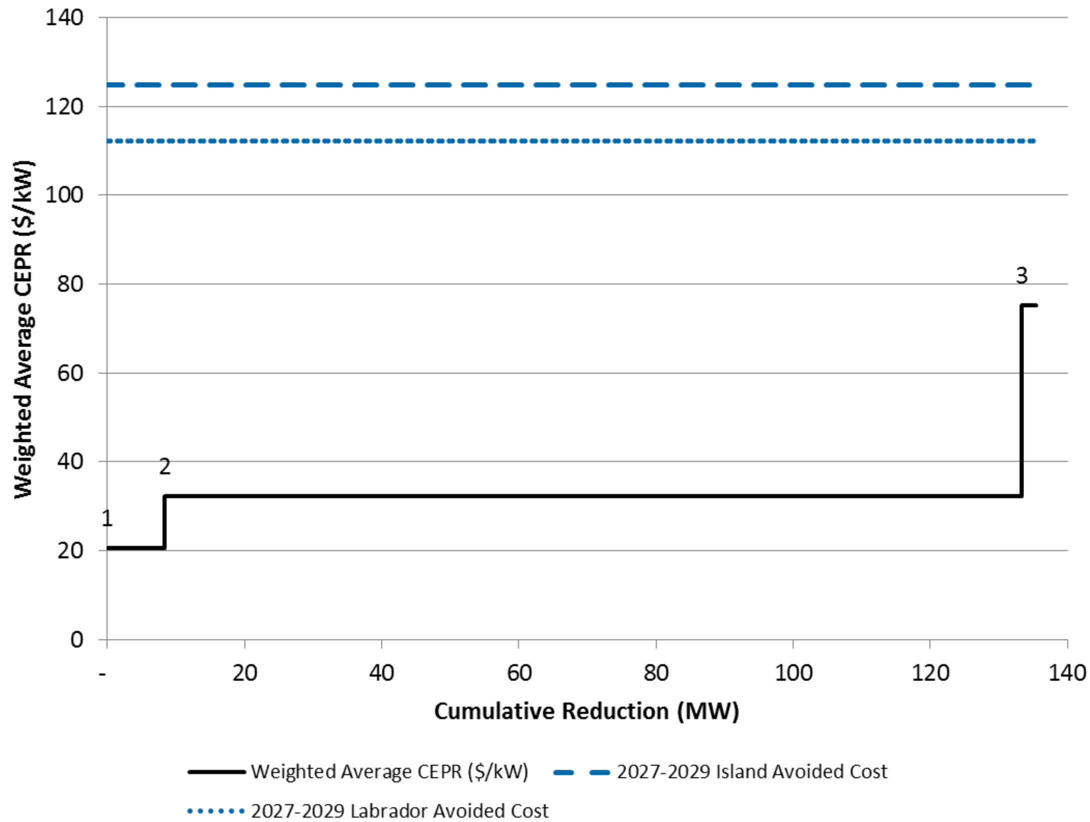
- Exhibit 30 presents the potential by measure for all regions. The columns provide the reduction for the measure, cumulative reduction, and CEPR, with measures sorted and numbered in order of increasing CEPR.
- Exhibit 31 presents the supply curve for all regions. The measures are numbered to match those in Exhibit 30.

As mentioned in Section 7.4.1 the demand response curtailment measure is made up of Newfoundland and Labrador Hydro's interruptible power arrangements with large industrial facilities and Newfoundland Power's curtailment program for general service customers. While most of this potential demand reduction is from large industry, it is worth noting that all of Newfoundland Power's general service curtailment potential is captured in this report. In addition to water system and manufacturing facilities, general service customers participating in the curtailment program also include some facilities like hospitals, which would normally be classified as 'commercial' buildings in this study. Since all of the demand reductions from Newfoundland Power's curtailment program will be captured here, the results will slightly overestimate the potential curtailment from what are otherwise classified as industrial facilities in this report, but this approach aligns with Newfoundland Power's single general service customer category.

Exhibit 30 All Regions Measure Potential and CEPR

Ref #	Measure Name	Demand Reduction (MW)	Cumulative Reduction (MW)	CEPR ($/kW)
1	Power factor correction equipment	8	8	$20.53
2	Operating changes for reduced peak load (DR Curtailments)	125	133	$32.21
3	Peak shifting through on-site storage	2	136	$75.16

Exhibit 31 All Regions Demand Reduction Supply Curve



Equivalent exhibits specific have been created for each of the three regions in Data Manager, and include a comparison of avoided costs levels of range of reasonableness.

8 Economic Potential: Electric Energy and Demand Forecast

8.1 Introduction

This section presents the Industrial sector Economic Potential Forecast for electric energy and demand for the study period 2014 to 2029. The Economic Potential Electric Energy Forecast estimates the level of electricity consumption that would occur if all equipment was retrofitted or upgraded to the level that is cost effective against the economic threshold values for electricity in the three regions in NL. The model also estimates the peak demand implications of applying all the cost-effective efficiency measures. Starting from that point, the Economic Potential Peak Demand Forecast estimates the level of peak demand that would occur if all cost-effective demand reduction measures were also applied. In this study, "cost effective" means that the technology upgrade cost, referred to as the cost of conserved energy (CCE) or the cost of electricity peak reduction (CEPR) in the preceding section, is equal to or less than the economic threshold value for a given region.

The discussion in this section covers the following:

- Avoided costs used for screening
- Major modelling tasks
- Technologies included in Economic Potential Forecast
- Presentation of energy efficiency results
- Interpretation of energy efficiency results
- Summary of peak load reductions from energy efficiency
- Presentation of load reduction results
- Interpretation of load reduction results
- Range of reasonableness.

8.2 Avoided Costs Used For Screening

The Utilities agreed on a set of economic threshold values for electricity supply to be used in this study. The values vary by region and milestone year as shown in Exhibit 32. Each of the values for the years after 2014 represents the average of the three years in the milestone period.

Exhibit 32 Avoided Costs of New Electricity Supply

Year	Avoided Cost per kWh		
	Island Interconnected	Labrador Interconnected	Isolated
2014	$0.108	$0.037	$0.21
2017	$0.125	$0.039	$0.23
2020	$0.050	$0.045	$0.26
2023	$0.059	$0.053	$0.29
2026	$0.068	$0.061	$0.34
2029	$0.076	$0.068	$0.37

The Economic Potential Electric Energy Forecast then incorporates all the electric energy-efficient upgrades that the technology assessment found to have a CCE equal to or less than these thresholds.

The Utilities also agreed on a set of economic threshold values for new generation capacity to be used in this study. These values also vary by region and milestone year as shown in Exhibit 33. Again, each value for the years after 2014 represents an average of the three years in the milestone period. The cost of new capacity for the Isolated region was not available. For the purposes of the study, the higher of the two values for the other two regions was used in each milestone year.

Exhibit 33 Avoided Costs of New Electric Generation Capacity

Year	Avoided Cost per kW		
	Island Interconnected	Labrador Interconnected	Isolated
2014	$50.911	$72.059	
2017	$65.116	$82.527	
2020	$101.821	$91.601	
2023	$115.126	$103.571	
2026	$124.930	$112.390	
2029	$124.907	$112.370	

The Economic Potential Peak Demand Forecast then incorporates all the demand reduction upgrades that the technology assessment found to have a CEPR equal to or less than these thresholds.

The Utilities also provided a range of reasonableness for all of these avoided costs. The lower range for new electricity supply is considered to be 10% below the costs per kWh shown in Exhibit 32 while the upper range is considered to be 30% above those values. The upper range for new electric generation capacity supply is considered to be 10% below the costs per kW shown in Exhibit 33 while the upper range is considered to be 20% above those values. The purpose for establishing the range of reasonableness is to show the sensitivity of the results to varying avoided cost scenarios and to improve the ability of planners to examine options that may become more cost effective over time.

Emerging end-use technology measures are becoming cheaper over time as these markets become more cost effective. This is apparent by examining a range of measures that have become very low cost (e.g., CFLs reduced by a factor of 5-10x since introduction; the same applies to more efficient motors, light sources and appliances). Including these apparently more costly measures in this study allows the review of these measures in the near future, as programs are effective in introducing more competitiveness within these markets. At the same time, new sources of supply are expected to come online during the study period, so it is important to explore the implications of lower avoided costs.

8.3 Major Modelling Tasks

By comparing the results of the Industrial sector Economic Potential Electric Energy and Peak Demand Forecasts with the Reference Case, it is possible to determine the aggregate level of potential electricity savings and demand reductions within the Industrial sector, as well as identify which specific building sub-sectors and end uses provide the most significant opportunities for savings.

To develop the Industrial sector Economic Potential Electric Energy Forecast, the following tasks were completed:

- The CCE for each of the energy-efficient upgrades presented in Exhibit 25 were reviewed, using the 7% (real) discount rate.

- Technology upgrades that had a CCE equal to, or less than, the threshold values for each region and milestone year 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 equipment reaches the end of its useful life.
- Electricity use within each of the sub-sectors was modelled with the same energy models that were 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 thresholds for each region and milestone period.
- When more than one upgrade option was applied to a given end use, the measure order was selected to apply major retrofits first. In our experience the total potential is maximized when the expensive measures are applied first, since having the low CCE measures at the beginning will reduce subsequent measure savings and can make the high CCE measures fail, while low CCE measures at the end will still pass the economic screens.

To develop the Industrial sector Economic Potential Peak Demand Forecast, the following tasks were completed:

- The Economic Potential Electric Energy Forecast was used to generate the reductions in peak demand associated with efficiency improvements. These reductions were applied to the demand Reference Case to generate a Post-Efficiency Case to serve as the starting point for the demand reduction model. This was intended to avoid any double counting of demand reductions.
- The CEPR for each of the load reduction upgrades presented in Exhibit 26 were reviewed, using the 7% (real) discount rate.
- Technology upgrades that had a CEPR equal to, or less than, the threshold values for each region and milestone year 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 CEPR 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.
- Peak demand within each of the sub-sectors was modelled with the same demand models that were 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 thresholds for each region and milestone period.

8.4 Technologies Included in Economic Potential Forecast

Exhibit 34 provides a listing of the efficiency technologies included in this forecast. Exhibit 35 provides a listing of the demand reduction technologies selected for included in this forecast. In each case, the exhibits show the following:

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

Exhibit 34 Efficiency Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Sub-Sector	Rate of Introduction
Air Compressors	Premium Efficiency ASD Compressor	All	At natural rate of replacement
	Use Cooler Air from Outside for Make Up Air	All	Immediate
	Optimized Distribution System (Incl. Pressure and Air End-Uses)	All	Immediate
	Optimized Sizes of Air Receiver Tanks	All	Immediate
	Sequencing Control	All	Immediate
	Air Leak Survey and Repair	All	Immediate
Conveyors	Optimized Conveyor Motor Control	All	Immediate
	Premium Efficiency Conveyor Motors	All	At natural rate of replacement
Fans and Blowers	Premium Efficiency Fan Control with ASDs	All	Immediate
	Synchronous Belts	All	Immediate
	Premium Efficiency Motors for Fans and Blowers	All	At natural rate of replacement
	Correctly Sized Fans: Impeller Trimming or Fan Selection	All	Immediate
	Optimized Distribution System (Incl. Pressure Losses)	All	Immediate
HVAC	Automated Temperature Control	All	Immediate
	Air Compressor Heat Recovery	All	Immediate
	Ventilation Heat Recovery	All	Immediate
	Ventilation Optimization	All	Immediate
	Reduced Temperature Settings	All	Immediate
	High-Efficiency Packaged HVAC	All	At natural rate of replacement
	Warehouse Loading Dock Seals	All	Immediate
	Improved Building Insulation	All	Immediate
	HVAC Air Curtains	All	Immediate
Lighting	High Efficiency Lights (LEDs)	All	Immediate
	Automated Lighting Controls	All	Immediate
	High-Efficiency Lighting Design	All	Immediate
Other Motors	Correctly Sized Motors	All	Immediate

Exhibit 34 Continued: Efficiency Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Sub-Sector	Rate of Introduction
	Optimized Motor Control	All	Immediate
	Premium Efficiency Motors	All	At natural rate of replacement
Process Cooling / Refrigeration / Freezing	Chiller Economizer	All	Immediate
	Free Cooling	All	Immediate
	Floating Head Pressure Controls	All	Immediate
	High Efficiency Chiller	All	At natural rate of replacement / immediate in some sub-sectors
	Optimized Distribution System	All	Immediate
	Premium Efficiency Refrigeration Control System and Compressor Sequencing	All	Immediate
	Improve Insulation of Refrigeration System	All	Immediate
	Smart Defrost Controls	All	Immediate
	Improved Ice Production System	Fishing and Fish Processing	Immediate
	Air Curtains	All	Immediate
Process Heating	Heat Pumps	All	Immediate
	Insulation	All	Immediate
	Process Heat Recovery to Preheat Makeup Water	All	Immediate
	High Efficiency Oven/Dryer/Furnace/Kiln	All	At natural rate of replacement
	High Efficiency Water Heater	All	At natural rate of replacement
Process Specific	Process Optimization Efforts - Fishing and Fish Processing	Fishing and Fish Processing	Immediate
	Process Optimization Efforts - Pulp and Paper	Pulp and Paper	Immediate
	Process Optimization Efforts - Mining and Processing	Mining and Processing	Immediate
	Advanced ‘Predictive’ Process Control Systems	All Large Industry	Immediate
	Process Optimization Efforts - Oil Refining	Refining	Immediate
Pumps	Optimization of Pumping System	All	Immediate
	Premium Efficiency Pump Motor	All	At natural rate of replacement
	Premium Efficiency Pump Control with ASDs	All	Immediate
	Correctly Sized Pumps: Impeller Trimming or Pump Selection	All	Immediate
System	Sub-Metering	All	Immediate

Exhibit 34 Continued: Efficiency Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Sub-Sector	Rate of Introduction
	Energy Management Information System (EMIS)	All	Immediate
	Organizational Energy Management (EM Team)	All	Immediate
	Operation and Maintenance (O&M) Program Supporting Efficiency	All	Immediate
	Integrated Plant Control System	All	Immediate

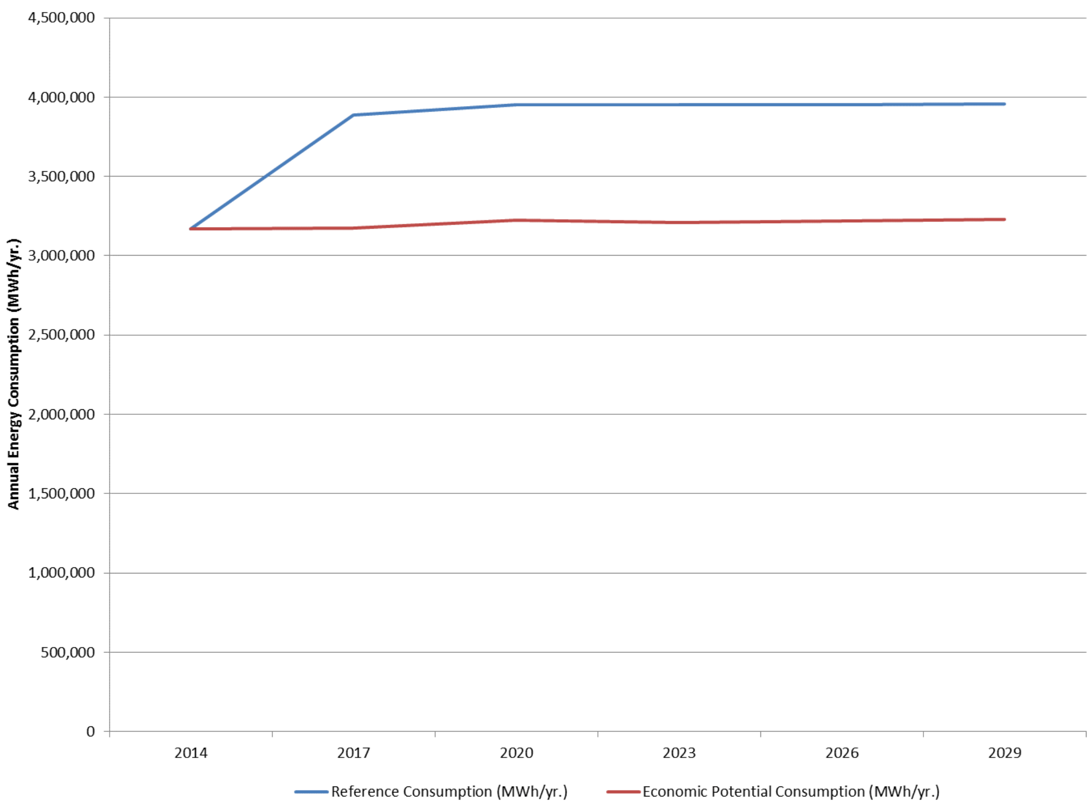
Exhibit 35 Load Reduction Technologies Included in Economic Potential Forecast

End Use Category	Upgrade Option	Sub-Sector	Rate of Introduction
System (all)	Operating changes for reduced peak load (DR Curtailments)	All except refining and fishing/fish processing	Immediate
	Power factor correction equipment	All	Immediate
Process Specific	Peak shifting through on-site storage	Pulp and Paper	Immediate
Cooling / Refrigeration	Peak shifting through on-site storage	Fishing/Fish Processing	Immediate
HVAC	Peak shifting through on-site storage	Manufacturing	Immediate
Pumps	Peak shifting through on-site storage	Water Systems and Other	Immediate

8.5 Summary of Electric Energy Savings

Exhibit 36 compares the Reference Case and Economic Potential Electric Energy Forecast levels of industrial electricity consumption.[16] As illustrated, under the Reference Case industrial electricity use would grow from the Base Year level of 3,169,000 MWh/yr. to approximately 3,956,000 MWh/yr. by 2029. This contrasts with the Economic Potential Forecast in which electricity use would decrease to approximately 3,243,800 MWh/yr. for the same period, a difference of approximately 712,000 MWh/yr., or about 18%. Exhibit 36 shows that the large jump in Reference Case consumption by 2017 (blue line) could largely be negated by the similarly sized Economic Potential savings (red line), with the bulk of these Economic Potential savings available immediately.

Exhibit 36 Reference Case versus Economic Potential Electric Energy Consumption in the Industrial Sector (MWh/yr.)



8.5.1 Electric Energy Savings

Further detail on the total potential electric energy savings provided by the Economic Potential Forecast is provided in the following exhibits:[17]

- Exhibit 37 presents the results by end use, sub-sector type and milestone year
- Exhibit 38 provides a further disaggregation of the savings by technology, and milestone year
- Exhibit 39 presents savings by end use
- Exhibit 40 and Exhibit 41 present savings by end use, and sub-sector

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

[17] MWh/yr. savings shown in the following exhibits are not incremental. For example, the pumping savings in 2029 are not in addition to the pumping savings from the previous milestone years. Rather, they are the difference between the Reference Case pumping consumption in 2029 and the pumping consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 37 Total Economic Potential Electricity Savings by End Use, Sub-Sector and Milestone Year (MWh/yr.)

Sub-Sectors	Year	Annual Economic Potential Savings (MWh/yr.)					
		Pumps	Fans and blowers	Process specific	Lighting	Other motors	Air compressors
Large Industry	2017	215,615	130,543	80,463	42,628	43,378	45,423
	2020	215,814	130,459	80,032	56,379	45,023	46,371
	2023	213,155	135,669	78,568	54,069	46,534	45,706
	2026	210,485	133,962	77,096	51,780	48,049	45,038
	2029	207,799	132,261	75,613	49,505	49,571	44,365
Manufacturing	2017	4,184	5,064	456	12,453	5,152	5,875
	2020	4,162	5,033	451	11,992	5,279	5,827
	2023	4,140	5,019	447	11,732	5,406	5,779
	2026	4,118	4,993	442	11,272	5,534	5,727
	2029	4,098	4,970	439	10,821	5,677	5,676
Fishing and Fish Processing	2017	3,388	450	180	4,902	617	1,171
	2020	3,361	446	178	4,699	634	1,259
	2023	3,353	443	176	4,498	652	1,351
	2026	3,335	439	174	4,299	669	1,441
	2029	3,318	558	172	4,101	686	1,533
Water Systems and Other	2017	13,663	3,287	575	1,559	1,027	341
	2020	13,747	3,312	577	1,524	1,065	344
	2023	13,853	3,341	579	1,492	1,105	346
	2026	13,899	3,408	579	1,452	1,142	346
	2029	13,960	3,427	580	1,414	1,181	346
Grand Total	2017	236,849	139,344	81,674	61,542	50,174	52,810
	2020	237,084	139,249	81,238	74,594	52,001	53,801
	2023	234,501	144,471	79,770	71,791	53,697	53,182
	2026	231,837	142,802	78,291	68,803	55,395	52,552
	2029	229,175	141,216	76,804	65,841	57,116	51,921

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) MWh/yr. savings are not incremental. The pumping savings in 2029 are not in addition to the savings from the previous milestone years. Rather, they are the difference between the Reference Case space heating consumption in 2029 and the pumping consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 37 Continued: Total Economic Potential Electricity Savings by End Use, Sub-Sector and Milestone Year (MWh/yr.)

Sub-Sectors	Year	Annual Economic Potential Savings (MWh/yr.)					
		Process heating	Process cooling	Comfort HVAC	Conveyors	Other	Grand Total
Large Industry	2017	28,214	2,751	12,836	12,884	-	614,733
	2020	28,401	2,918	13,709	15,926	-	635,032
	2023	42,160	2,882	14,284	16,046	-	649,073
	2026	41,741	2,845	14,864	16,167	-	642,026
	2029	41,318	2,808	15,448	16,288	-	634,977
Manufacturing	2017	397	1,849	3,933	306	-	39,669
	2020	393	1,827	4,094	308	-	39,366
	2023	389	1,805	4,243	310	-	39,270
	2026	386	1,917	4,395	312	-	39,097
	2029	384	1,948	4,558	315	-	38,886
Fishing and Fish Processing	2017	842	20,105	1,681	563	-	33,899
	2020	833	19,894	1,644	559	-	33,507
	2023	824	19,683	1,603	573	-	33,155
	2026	815	19,471	1,569	577	-	32,790
	2029	806	19,258	1,536	581	-	32,549
Water Systems and Other	2017	408	-	290	4	-	21,154
	2020	413	-	292	4	-	21,278
	2023	426	-	293	4	-	21,438
	2026	430	-	293	4	-	21,552
	2029	434	-	293	4	-	21,638
Grand Total	2017	29,861	24,704	18,741	13,757	-	709,454
	2020	30,040	24,639	19,738	16,797	-	729,182
	2023	43,798	24,370	20,424	16,933	-	742,937
	2026	43,371	24,233	21,121	17,060	-	735,465
	2029	42,942	24,013	21,834	17,189	-	728,050

Notes:
1) Minimal consumption and no measures are targeted towards the 'Other' category for Industry.

Exhibit 38 Economic Potential Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Annual Savings, 2017, (MWh/yr.)	Annual Savings, 2020, (MWh/yr.)	Annual Savings, 2023, (MWh/yr.)	Annual Savings, 2026, (MWh/yr.)	Annual Savings, 2029, (MWh/yr.)
Premium Efficiency Pump Control with ASDs	90,015	90,075	88,829	87,555	86,272
Energy Management Information System (EMIS)	74,019	74,175	73,262	72,342	71,478
Premium Efficiency Fan Control with ASDs	66,665	66,393	65,736	65,072	64,404
Optimization of Pumping System	59,901	59,574	58,658	57,730	56,801
Organizational Energy Management (EM Team)	55,193	55,182	54,318	53,446	52,574
High Efficiency Lights (LEDs)	45,301	56,287	53,862	51,256	48,655
Correctly Sized Pumps: Impeller Trimming or Pump Selection	44,537	43,867	42,916	41,961	41,006
Sub-Metering	37,227	36,784	35,712	34,629	33,548
Operation and Maintenance (O&M) Program Supporting Efficiency	35,015	34,411	33,508	32,600	31,690
Correctly Sized Fans: Impeller Trimming or Fan Selection	28,492	27,946	27,301	26,653	26,018
Integrated Plant Control System	22,209	21,739	21,269	20,794	20,320
Process Optimization Efforts - Pulp and Paper	16,727	16,615	16,501	16,387	16,272
Premium Efficiency ASD Compressor	15,593	15,971	15,912	15,853	15,792
Air Leak Survey and Repair	13,594	13,876	13,715	13,553	13,389
Advanced ‘Predictive’ Process Control Systems	13,524	13,437	13,349	13,260	13,170
Optimized Distribution System (Incl. Pressure Losses)	9,915	9,993	16,119	15,366	14,681
Process Heat Recovery to Preheat Makeup Water	3,586	3,807	17,859	17,741	17,622
Optimized Motor Control	10,156	9,968	9,756	9,543	9,331
Optimized Distribution System (Incl. Pressure and Air End-Uses)	8,929	9,187	9,082	8,973	8,861
High-Efficiency Lighting Design	5,230	5,364	5,324	5,285	5,249
Insulation	5,010	4,983	4,948	4,912	4,876
Automated Lighting Controls	3,243	5,344	5,310	5,262	5,216
Process Optimization Efforts - Mining and Processing	4,785	4,851	4,730	4,608	4,485
Premium Efficiency Pump Motor	1,301	2,599	3,923	5,231	6,543
Premium Efficiency Refrigeration Control System and Compressor Sequencing	3,907	3,893	3,856	3,811	3,770
Correctly Sized Motors	1,280	2,559	3,839	5,121	6,406
Reduced Temperature Settings	3,946	3,906	3,811	3,716	3,622
Premium Efficiency Motors	1,145	2,299	3,458	4,624	5,797
Free Cooling	3,458	3,454	3,426	3,392	3,362
Optimized Conveyor Motor Control	1,373	4,019	3,953	3,886	3,819
Automated Temperature Control	3,429	3,464	3,373	3,283	3,193
High-Efficiency Packaged HVAC	1,043	2,110	3,158	4,218	5,283
Use Cooler Air from Outside for Make Up Air	2,938	2,955	2,915	2,875	2,835
Premium Efficiency Motors for Fans and Blowers	927	1,863	2,797	3,733	4,671
High Efficiency Chiller	1,833	1,832	1,830	1,981	2,035
Improve Insulation of Refrigeration System	1,725	1,746	1,717	1,687	1,658
Synchronous Belts	1,479	1,470	1,454	1,438	1,422
Optimized Sizes of Air Receiver Tanks	1,460	1,458	1,406	1,354	1,301

Exhibit 38 Continued: Economic Potential Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Annual Savings, 2017, (MWh/yr.)	Annual Savings, 2020, (MWh/yr.)	Annual Savings, 2023, (MWh/yr.)	Annual Savings, 2026, (MWh/yr.)	Annual Savings, 2029, (MWh/yr.)
Smart Defrost Controls	1,414	1,402	1,390	1,376	1,362
Optimized Distribution System	1,400	1,386	1,372	1,357	1,343
Chiller Economizer	1,284	1,278	1,265	1,253	1,240
Improved Ice Production System	1,231	1,220	1,210	1,200	1,189
Premium Efficiency Conveyor Motors	371	752	1,146	1,532	1,921
Heat Pumps	1,011	1,073	1,068	1,062	1,057
Air Compressor Heat Recovery	812	798	778	758	738
Ventilation Optimization	664	646	629	611	594
Sequencing Control	488	497	490	479	468
Floating Head Pressure Controls	339	337	332	327	322
Air Curtains	308	310	305	300	295
High Efficiency Oven/Dryer/Furnace/Kiln	15	17	48	65	82
Process Optimization Efforts - Fishing and Fish Processing	8	8	8	7	7
Ventilation Heat Recovery	4	4	4	4	4
Warehouse Loading Dock Seals	0	0	0	0	0
High Efficiency Water Heater	-	-	-	-	-
HVAC Air Curtains	-	-	-	-	-
Improved Building Insulation	-	-	-	-	-
Process Optimization Efforts - Oil Refining	-	-	-	-	-
Grand Total	709,454	729,182	742,937	735,465	728,050

Note: In the exhibit, a zero indicates a value that rounds off to zero (i.e., less than 0.5). A dash indicates a value that is actually zero.

Exhibit 39 Economic Potential Savings by Major End Use (2029)

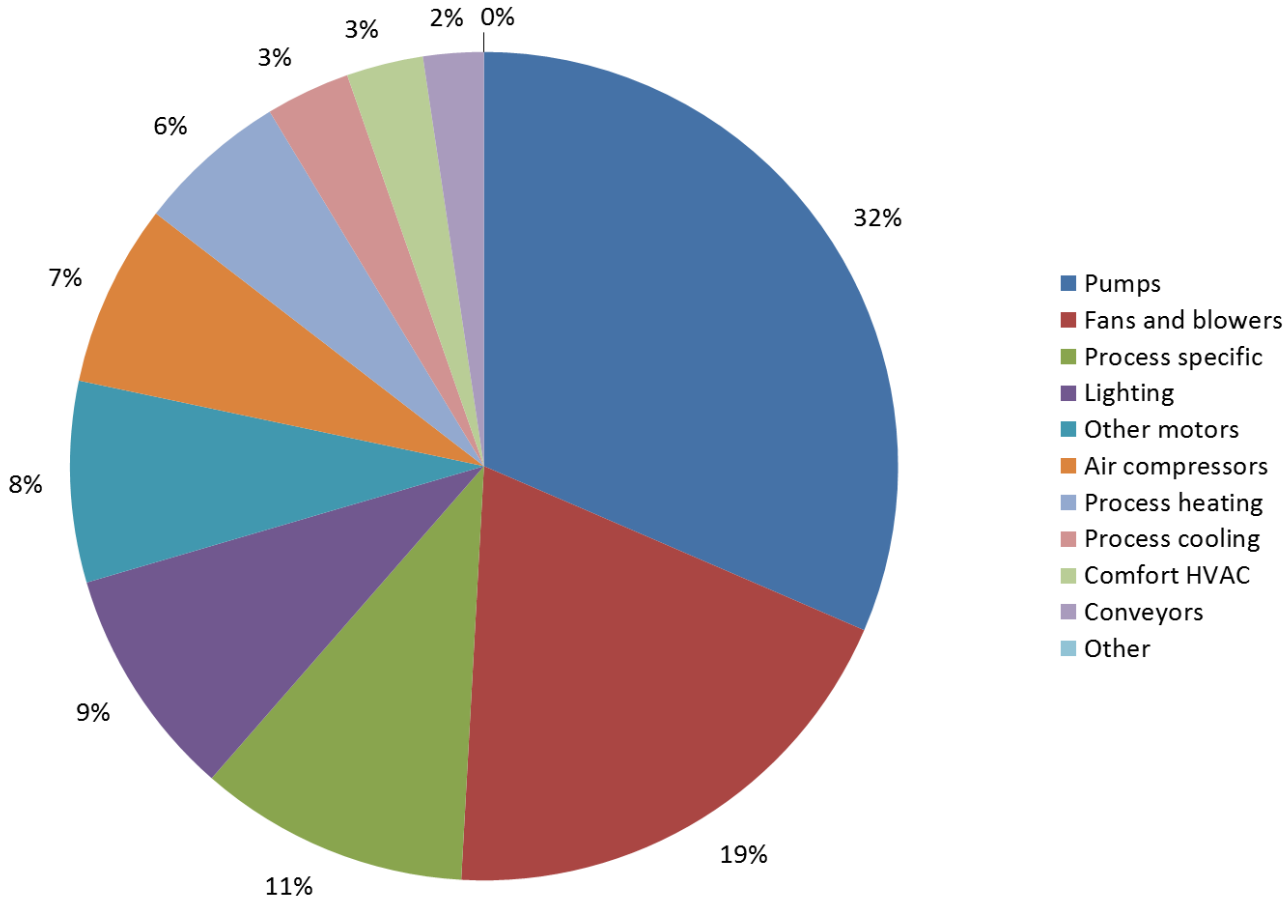


Exhibit 40 Economic Potential Savings by Major End Use and Sub-Sector, 2029 (MWh/yr.)

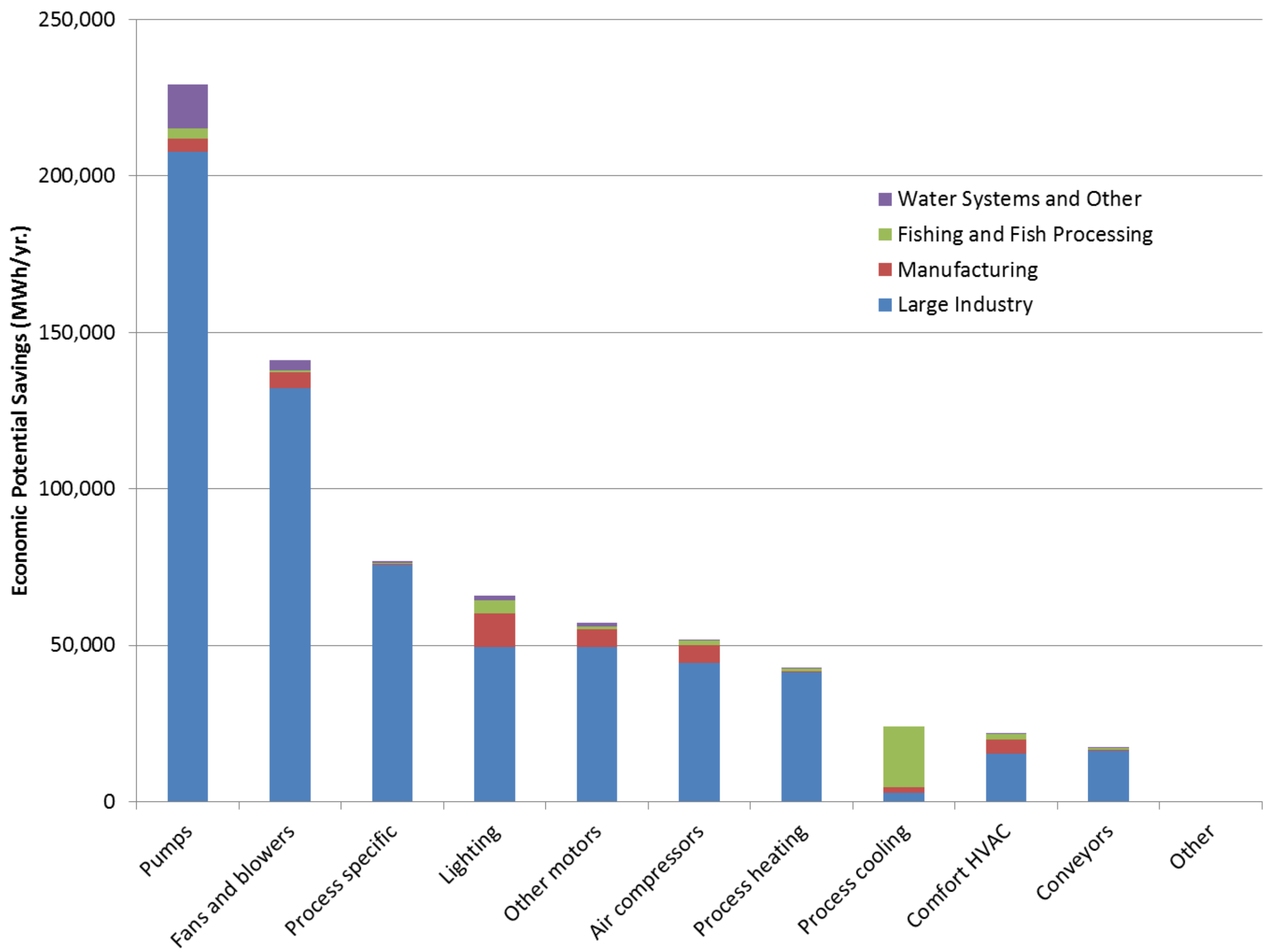
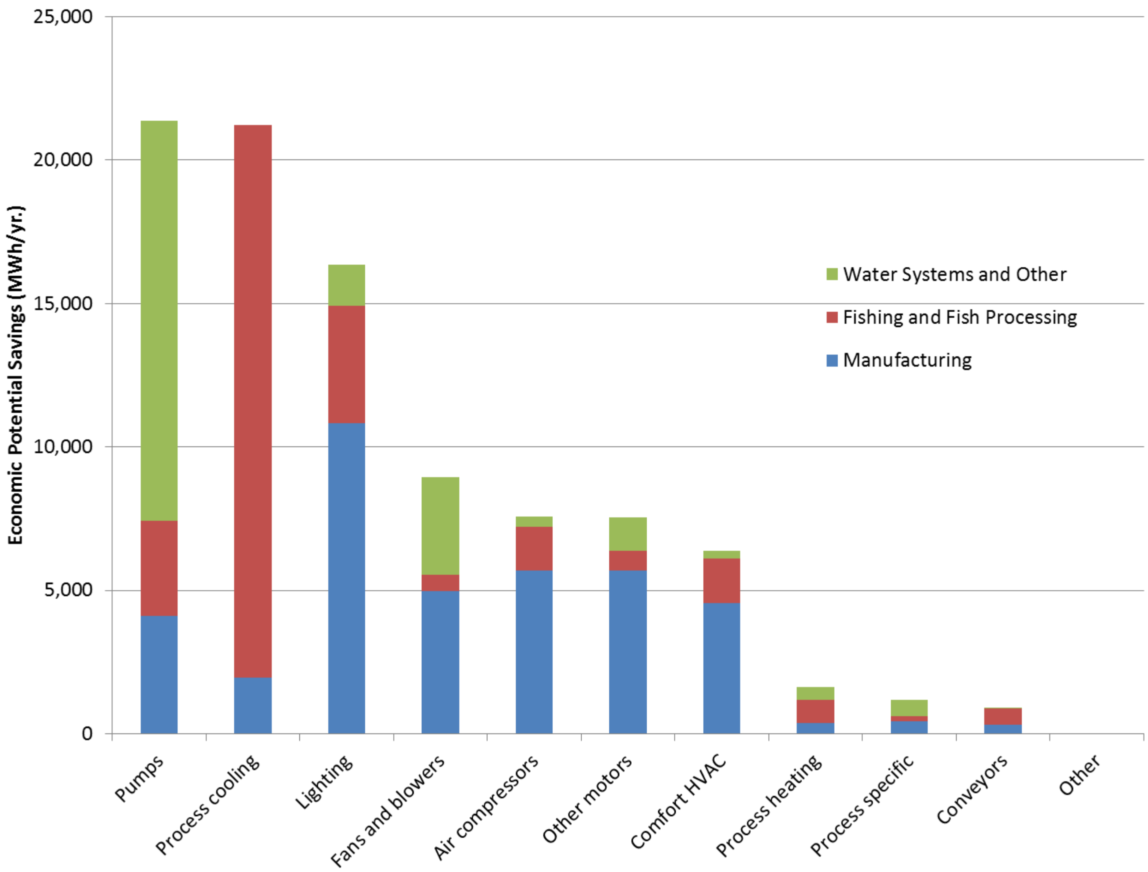


Exhibit 41 Economic Potential Savings by Major End Use and Sub-Sector for Small-Medium Industry, 2029, (MWh/yr)



8.5.2 Interpretation of Results

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

Electric Energy Savings by Milestone Year

The Economic Potential savings remains relatively level across the period of the study, increasing slightly from 3,177,000 MWh/yr. in 2017 to 3,228,000 MWh/yr. in 2029. Approximately 100% of the savings possible at the end of the study period are already economically viable within the first milestone period. There are main reasons for this high percentage of savings that occur at the beginning of the study period:

- Many of the measures pass the economic screen on the basis of their full cost, meaning that under the definition of economic potential they would be implemented in the first year. Of the 57 measures included in the analysis, 48 pass the economic screens on a full-cost basis, and can therefore be implemented immediately. These measures are also the largest savings opportunities, so almost all of the savings possible at the end of the study period are already economically viable within the first milestone period.
- While the explanation above accounts for why the bulk of the savings could be achieved by 2017, it does not explain the slight decrease in economic potential savings over the milestone years. This is as a result of natural adoption eroding savings within the economic potential scenario. While there are end uses where the opportunities for savings expand, there are other end uses where the opportunities contract, such as lighting. Lighting in the Reference Case includes the assumption that a significant portion of the market moves to LEDs by 2029. So while savings from LEDs are expected to keep growing throughout the study period, as time progresses more of these savings are credited to natural adoption and not shown in the economic potential savings. The effect ties back into the previous point, since most of the measures are considered to be adopted at the first milestone; the remaining measures that are adopted from 2017 to 2019 produce less savings than are eroded by natural changes.
- For industry, where CCE values are for the most part well below the Utilities' requirements, the changes in avoided costs throughout the milestone periods have less impact than the factors mentioned above. There are still some minor impacts from the avoided costs in the Island Interconnected region being expected to fall significantly after the interconnection is made with Labrador. Consequently, a few measures that pass in the first milestone period fail the economic screen later in the study, so that any further adoption of them is curtailed.

Once again, the shape of this curve is driven by many of the measures passing the economic screen on the basis of their full cost, meaning that under the definition of economic potential they would be implemented in the first year. During the next chapter of this report, the achievable potential will factor in more realistic adoption timelines, and will result in increasing savings over the milestones.

Electric Energy Savings by Sub-Sector

The Large Industrial plants account for over 87% of the potential savings; this reflects their use of the bulk of industrial consumption. Savings in manufacturing account for over 5% of the potential savings. Savings in fishing and fish processing facilities account for almost 5% of the potential savings, while savings in water systems and other facilities account for almost 3% of the potential savings.

By Region

Regional differences in electricity savings are driven largely by the types and sizes of facilities present in each region. Although such breakdowns are not shown here, in order to protect the confidentiality of certain facilities, the breakdown of savings by region closely follows the differences between the primary energy consuming industries in each region. Such breakdowns can be viewed in the Data Manager files.

Electric Energy Savings by End Use

Savings in the pumping end use account for approximately 31% of the total electricity savings in the Economic Potential Forecast. Of this, 38% is from upgrades to pump controls (ASDs), 25% is from pumping system optimization, 19% is from right-sizing of pumps, and 15% is from various system-level measures applied to this end use (Organization Energy Management, EMIS, sub-metering, O&M, etc).

The next largest end use for savings is fans and blowers, representing approximately 19% of the total electricity savings in the Economic Potential Forecast. Of this, approximately 50% is from upgrades to fan controls (ASDs), 18% is from right-sizing of fans, 10% is from optimizing distribution systems, and 18% is from various system-level measures applied to this end use.
The third largest end use for savings is process specific, representing approximately 11% of the total electricity savings in the Economic Potential Forecast. Savings in this end use are made up of process optimization efforts specific to different sub-sectors, advanced process controls, and system-level savings.

Lighting is the fourth largest end use for savings, representing 9% of the total electricity savings in the Economic Potential Forecast, with approximately 70% of these savings coming from upgrades to LED lights. Other motors and air compressors rank next in terms of savings, with approximately 8% and 7%, respectively.

Savings in the remaining end uses represent smaller portions electricity savings in the Economic Potential Forecast, and include process heating (6%), comfort HVAC (3%), process cooling (3%), process heating (3%), and conveyors (2%). While these savings may represent smaller amounts of the overall industrial economic potential, they can make up significant portions of the potential within individual sub-sectors. This is particularly true for end uses that are important to Small-Medium industrial sub-sectors, but not the Large industrial facilities that make up the bulk of the reference case consumption and economic potential savings.

8.5.3 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades 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, installing an adjustable speed drive will reduce the electricity use of a compressed air system, as will optimizing the compressed air distribution system. On its own, each measure will reduce overall air compressor 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 model system-level measures first (Organizational Energy Management, EMIS, etc.), followed by major retrofits to maximize their chances of inclusion in the model, and then finally lower-cost measures. This was done to get a sense of the maximum potential savings for industry. In our experience the total potential is maximized when the expensive measures are applied first. Having the low CCE measures at the beginning will reduce subsequent measure savings, and can make the high CCE measures fail, while low CCE measures at the end will still pass the economic screens.

- **There are interactive effects among end uses.** For example, the electricity savings from more efficient motors or lighting results in reduced waste heat. During the space heating season, motor and lighting waste heat contributes to a building's internal heat gains, which lowers the amount of heat that must be provided by the HVAC system. However, these interactive effects are minimal for the Industrial sector, where process loads typically dominate, and HVAC makes up a relatively small portion of consumption. As such, interactive effects are not modeled for the Industrial sector in this study.

8.6 Electric Peak Load Reductions from Energy Efficiency

Exhibit 42 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the Economic Potential Forecast. The reductions are shown by milestone year and sub-sector. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Sections 4 and 6.

Exhibit 43 shows the peak load reductions that would occur as a result of electric energy savings, by milestone year, end use, and sub-sector in the winter peak period. Exhibit 44 shows the same information for the small and medium industrial sub-sectors.

These exhibits only approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. This is not always correct.

Exhibit 45 shows the demand reductions associated with each electric energy savings measure contained in the Economic Potential Forecast for the milestone year 2029.

Electric peak load reductions related to capacity-only measures are presented separately in Section 8.7.

Exhibit 42 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year and Sub-Sector (MW)

Sub-Sector	2017	2020	2023	2026	2029
Large Industry	58.5	60.19	61.68	61.04	60.39
Manufacturing	2.9	2.92	2.93	2.92	2.92
Fishing and Fish Processing	2.7	2.67	2.63	2.59	2.56
Water Systems and Other	1.3	1.26	1.27	1.28	1.28
Grand Total	65.4	67.05	68.51	67.83	67.15

Exhibit 43 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year, End Use, and Sub-Sector, Winter Peak Period (MW)

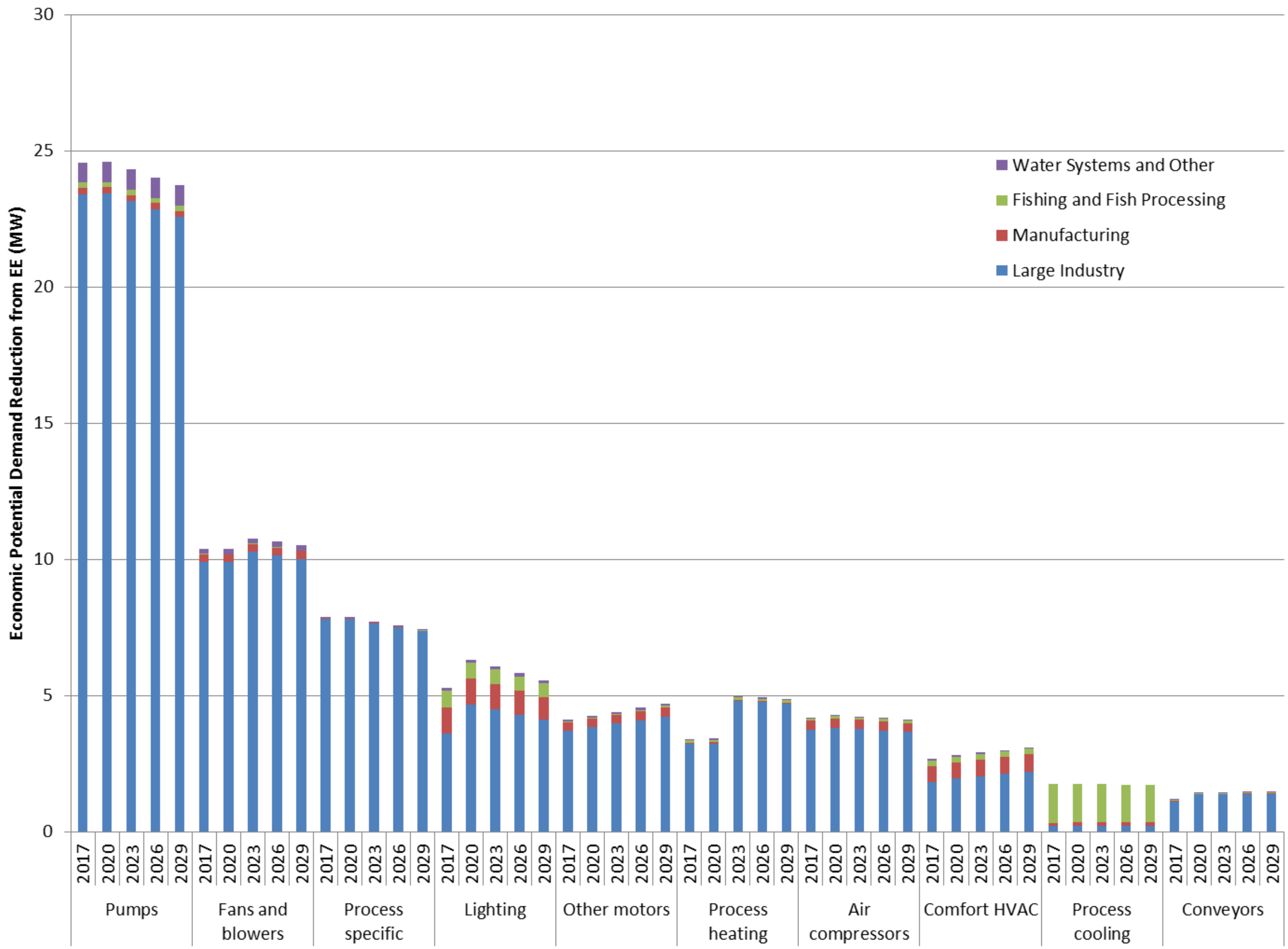


Exhibit 44 Electric Peak Load Reductions from Economic Energy Savings Measures for Small-Medium Industry, by Milestone Year, End Use, and Sub-Sector, Winter Peak Period (MW)

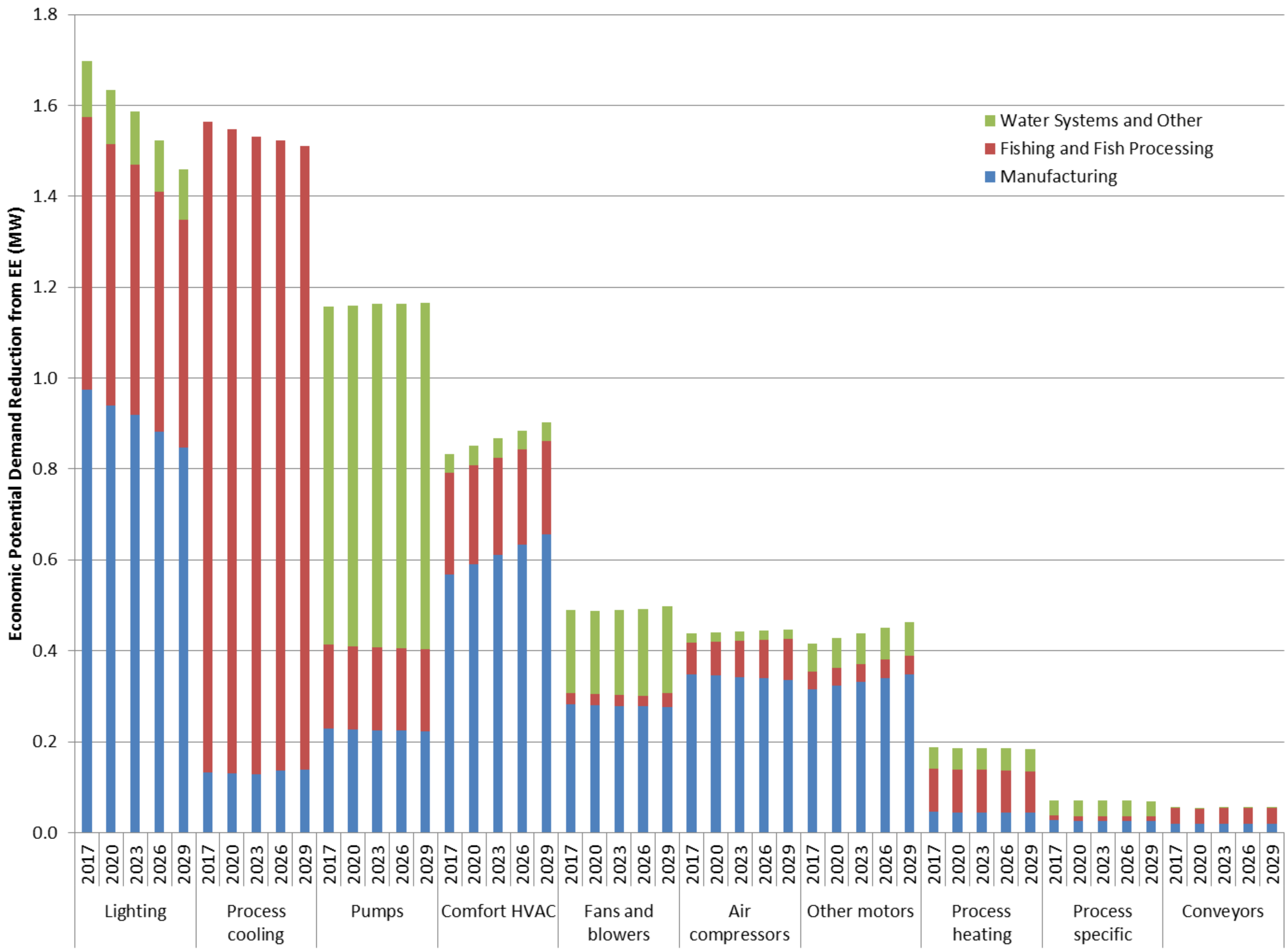


Exhibit 45 Electric Peak Load Reductions from Economic Energy Savings Measures, 2029 (MW)

Measure	All Regions
Premium Efficiency Pump Control with ASDs	9.0
Energy Management Information System (EMIS)	6.8
Optimization of Pumping System	5.9
Organizational Energy Management (EM Team)	4.9
Premium Efficiency Fan Control with ASDs	4.8
Correctly Sized Pumps: Impeller Trimming or Pump Selection	4.3
High Efficiency Lights (LEDs)	4.1
Sub-Metering	3.1
Operation and Maintenance (O&M) Program Supporting Efficiency	2.9
Process Heat Recovery to Preheat Makeup Water	2.0
Correctly Sized Fans: Impeller Trimming or Fan Selection	1.9
Integrated Plant Control System	1.8
Process Optimization Efforts - Pulp and Paper	1.3
Premium Efficiency ASD Compressor	1.2
Advanced 'Predictive' Process Control Systems	1.1
Air Leak Survey and Repair	1.1
Optimized Distribution System (Incl. Pressure Losses)	1.1
Optimized Motor Control	0.8
High-Efficiency Packaged HVAC	0.8
Optimized Distribution System (Incl. Pressure and Air End-Uses)	0.7
Premium Efficiency Pump Motor	0.7
Process Optimization Efforts - Mining and Processing	0.6
Insulation	0.6
Correctly Sized Motors	0.5
Reduced Temperature Settings	0.5
Premium Efficiency Motors	0.5
Automated Temperature Control	0.5
High-Efficiency Lighting Design	0.4
Automated Lighting Controls	0.4

Measure	All Regions
Premium Efficiency Motors for Fans and Blowers	0.3
Optimized Conveyor Motor Control	0.3
Premium Efficiency Refrigeration Control System and	0.3
Free Cooling	0.2
Use Cooler Air from Outside for Make Up Air	0.2
Premium Efficiency Conveyor Motors	0.2
High Efficiency Chiller	0.1
Heat Pumps	0.1
Improve Insulation of Refrigeration System	0.1
Synchronous Belts	0.1
Air Compressor Heat Recovery	0.1
Smart Defrost Controls	0.1
Optimized Sizes of Air Receiver Tanks	0.1
Optimized Distribution System	0.1
Chiller Economizer	0.1
Ventilation Optimization	0.1
Improved Ice Production System	0.1
Sequencing Control	0.0
Floating Head Pressure Controls	0.0
Air Curtains	0.0
High Efficiency Oven/Dryer/Furnace/Kiln	0.0
Ventilation Heat Recovery	0.0
Process Optimization Efforts - Fishing and Fish Proce	0.0
Warehouse Loading Dock Seals	0.0
Improved Building Insulation	-
HVAC Air Curtains	-
Process Optimization Efforts - Oil Refining	-
High Efficiency Water Heater	-
Grand Total	67

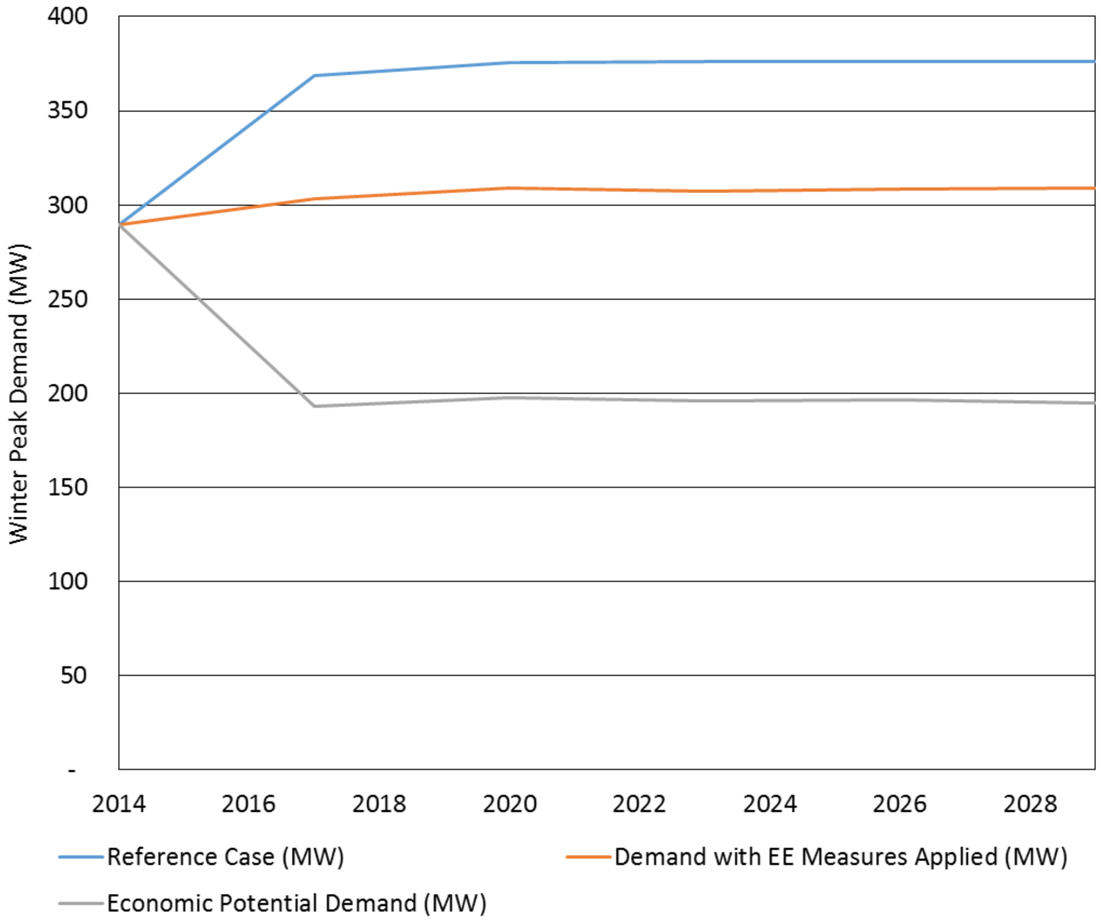
8.7 Summary of Peak Load Reduction

Exhibit 46 compares the Reference Case and Economic Potential Peak Demand Forecast levels of winter peak demand.[18] As illustrated, under the Reference Case industrial peak demand would grow from the Base Year level of 289 MW to approximately 376 MW by 2029. This contrasts with the Economic Potential Forecast in which peak demand would decrease to approximately 189 MW for the same period, a difference of approximately 187 MW or about 50%. The middle line on the chart shows the peak demand that would result if all the energy efficiency measures were applied but none of the demand reduction measures. As illustrated in the exhibit, approximately 36% of this reduction comes from the impact of energy efficiency measures.

As noted in Section 7.6, all of the demand reductions from Newfoundland Power's curtailment program will be captured in the Industrial report, including curtailment from some general service customers that would otherwise be classified as 'commercial' facilities in this study. These 'non-industrial' peak demand curtailments are included with reductions for the manufacturing sub-sector. As such, the results for this sub-sector will overestimate the potential curtailment specific to that sub-sector when these results are considered in isolation.

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

Exhibit 46 Reference Case Peak Demand versus Economic Potential Peak Demand in Industrial Sector (MW)



8.7.1 Peak Demand Reduction

Further detail on the total potential peak demand reduction provided by the Economic Potential Forecast is provided in the following exhibits:[19]

- Exhibit 47 presents the results by end use, sub-sector and milestone year
- Exhibit 48 provides a further disaggregation of the peak demand reduction by technology and milestone year
- Exhibit 49 presents peak demand reduction by major end use, milestone year and sub-sector
- Exhibit 50 presents peak demand reduction by major end use, milestone year and sub-sector, for small-medium industry

[19] MW reductions shown in the following exhibits are not incremental. For example, the process heating reductions in 2029 are not in addition to the process heating reductions from the previous milestone years. Rather, they are the difference between the Reference Case process heating peak demand in 2029 and the process heating peak demand if all the measures included in the Economic Potential scenario are implemented.

Exhibit 47 Total Economic Potential Peak Demand Reduction by End Use, Sub-Sector, and Milestone Year (MW)

Sub-Sectors	Year	Air comp-ressors	Comfort HVAC	Convey-ors	Fans and blowers	Lighting	Other motors	Process cooling	Process heating	Process specific	Pumps	Grand Total
Large Industry	2017	1	2	1	3	1	7	0	19	51	14	98
	2020	1	2	1	3	1	7	0	18	51	14	99
	2023	1	2	1	3	1	7	0	18	51	15	99
	2026	1	2	1	3	1	7	0	19	52	15	99
	2029	1	2	1	3	1	7	0	21	52	15	102
Manufacturing	2017	0	3	0	0	1	2	0	0	0	0	8
	2020	0	3	0	0	1	2	0	0	0	0	8
	2023	0	3	0	0	1	2	0	0	0	0	8
	2026	0	3	0	0	1	2	0	0	0	0	8
	2029	0	3	0	0	1	2	0	0	0	0	8
Fishing and Fish Processing	2017	0	0	0	0	0	0	1	0	0	0	1
	2020	0	0	0	0	0	0	1	0	0	0	1
	2023	0	0	0	0	0	0	1	0	0	0	1
	2026	0	0	0	0	0	0	1	0	0	0	1
	2029	0	0	0	0	0	0	1	0	0	0	1
Water Systems and Other	2017	0	0	0	0	0	0	0	0	0	2	3
	2020	0	0	0	0	0	0	0	0	0	2	3
	2023	0	0	0	0	0	0	0	0	0	2	4
	2026	0	0	0	0	0	0	0	0	0	2	4
	2029	0	0	0	0	0	0	0	0	0	2	4
Grand Total	**2017**	1	5	1	3	1	9	2	20	51	16	110
	2020	2	5	1	3	2	9	2	19	52	17	111
	2023	2	5	1	3	2	9	2	19	52	17	112
	2026	2	5	1	3	2	9	2	19	52	17	112
	2029	2	5	1	3	2	9	2	22	52	17	114

Notes:
1) The values in this exhibit do not include peak demand reductions from energy efficiency measures.
2) The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered ‘commercial’ facilities.
3) Results are measured at the customer’s point-of-use and do not include line losses.
4) Any differences in totals are due to rounding.
5) In the above exhibit a value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value.
6) MW reductions are not incremental. The process heating reductions in 2029 are not in addition to the reductions from the previous milestone years. Rather, they are the difference between the Reference Case process heating peak demand in 2029 and the process heating peak demand if all the measures included in the Economic Potential scenario are implemented.

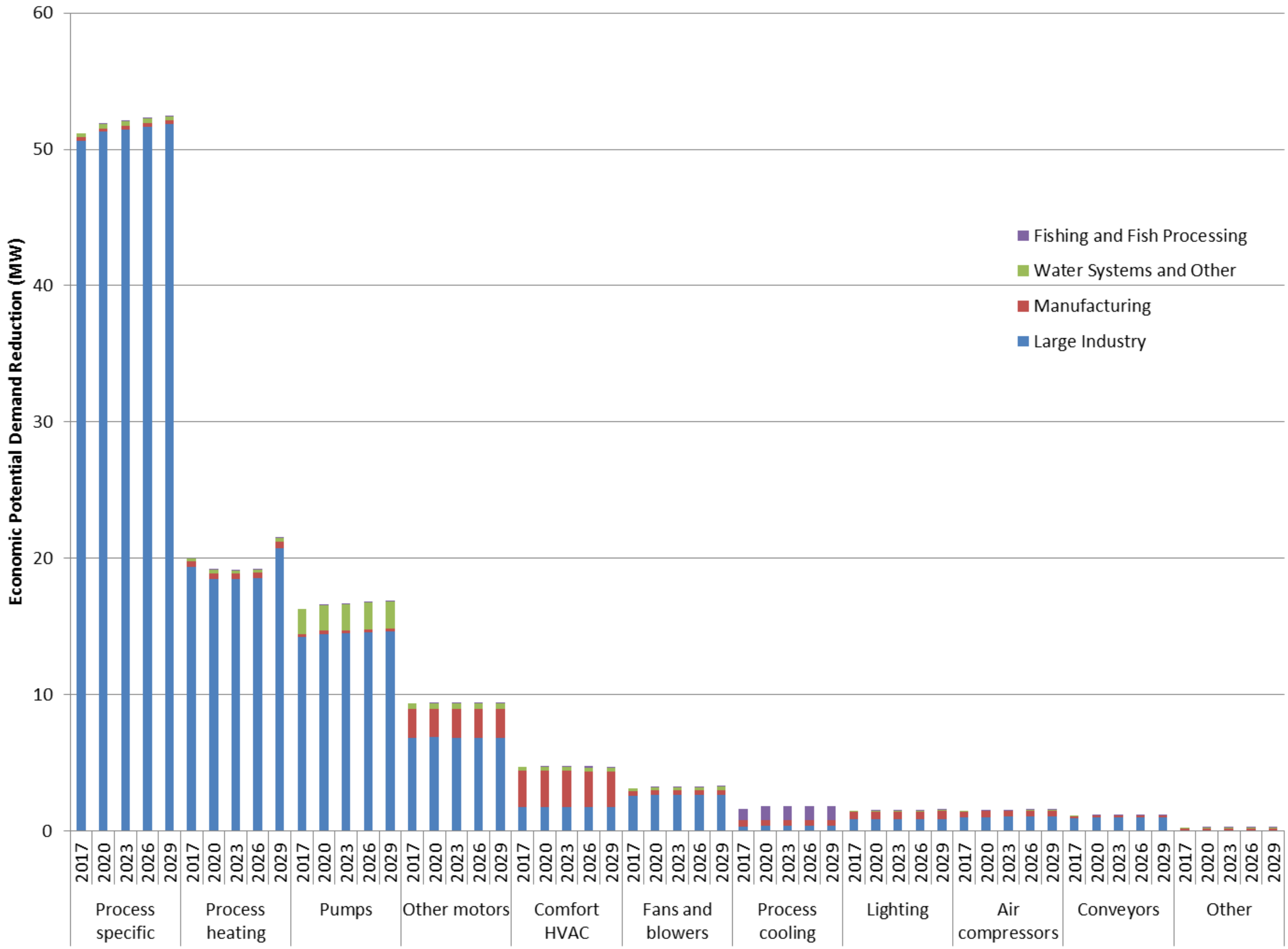
Exhibit 48 Economic Potential Peak Demand Reduction by Measure and Milestone Year (MW)

Measure	Peak Demand Reduction, 2017 (MW)	Peak Demand Reduction 2020 (MW)	Peak Demand Reduction 2023 (MW)	Peak Demand Reduction 2026 (MW)	Peak Demand Reduction 2029 (MW)
Operational changes for reduced peak load (DR Curtailments)	103	104	103	104	106
Power factor correction equipment	6	7	7	7	7
Peak Shifting through on-site storage	1	1	2	2	2
Grand Total	110	111	112	112	114

As with some previous conservation exhibits, Exhibit 48 provides results at a sufficient level of detail that some modeling issues require explanation:

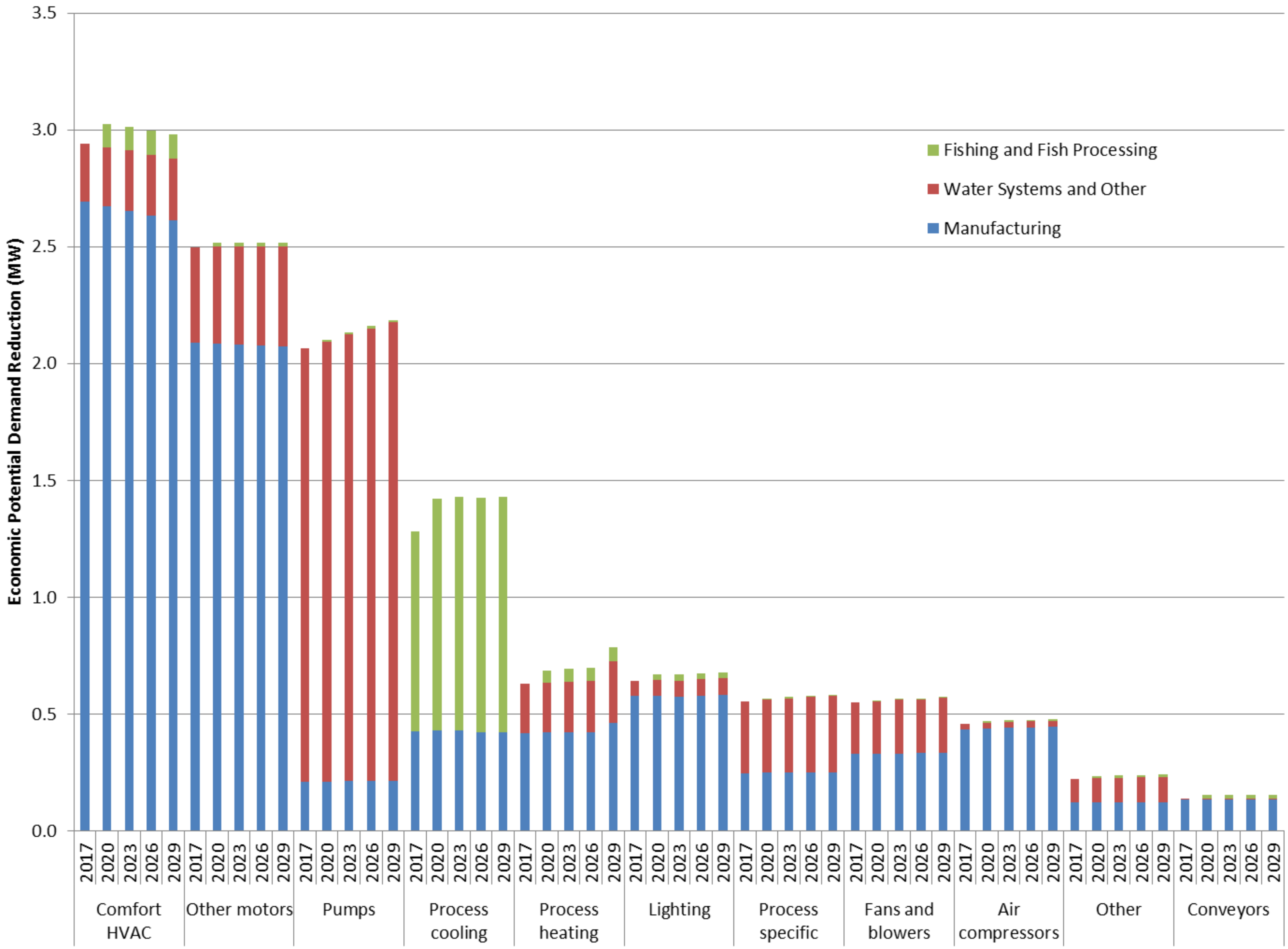
- Demand-specific measure savings are impacted by the demand savings from conservation measures. The demand reference case to which demand-specific measures are applied already factors in the corresponding Economic Potential demand savings from conservation measures. So the more peak demand reductions are generated through conservation measures, the less peak demand remains for demand-specific measures to reduce.
- This is particularly noteworthy for the curtailment demand measure, since cascading impacts could reduce the demand reduction levels shown here below what is expected based on current peak demand reduction arrangements. It is important to note that the model produce total demand reduction potentials in excessive of current curtailment arrangements, but that the model's cascade order will result in more of the total demand reduction potential being credited towards conservation measures and the demand-specific measures that precede curtailment in the cascade order.

Exhibit 49 Economic Potential Peak Demand Reduction by Major End Use, Year and Sub-Sector (MW)



Note: The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered 'commercial' facilities.

Exhibit 50 Economic Potential Peak Demand Reduction for Small-Medium Industry, by Major End Use, Year and Sub-Sector (MW)



Note: The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered 'commercial' facilities.

8.7.2 Interpretation of Results

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

Peak Demand Reduction by Measure

The largest portion of peak demand reductions is from a demand response curtailment program. This represents 93% of the peak reductions achieved by demand-specific measures. Power factor correction equipment accounts for about 6% of the remaining demand-specific measure reductions, with remainder coming from peak shifting / storage measures.

Peak Demand Reduction by Milestone Year

The Economic Potential peak load reductions increase very little, rising from 110 MW in 2017 to 114 MW in 2029. Approximately 96% of the peak reduction possible at the end of the study period is already economically viable within the first milestone period. Most of the measures pass the economic screen on the basis of their full cost, meaning that under the definition of economic potential they would be implemented in the first year.

Peak Demand Reduction by Sub-sector

Large industry account for 89% of the potential peak load reductions; this reflects their larger share of industrial energy consumption, and their suitability for demand measures. Peak load reductions in the manufacturing sub-sector account for 7% of the potential savings, however a significant portion of these savings can be attributed to general service customers participating in Newfoundland Power's curtailment program, which are captured here but otherwise considered 'commercial' facilities in this study. Peak load reductions in water systems & other industrial facilities account for 3% of the potential savings. Peak load reductions in fishing and fish processing facilities account for 1% of the potential savings.

Peak Demand Reduction by End Use

Process specific load reductions account for approximately 46% of the total load reductions in the Economic Potential Forecast, not including load reductions from energy efficiency measures. Other motors account for 8% of the total load reduction, pumps account for 15%, and process heating accounts for 18%. The remaining 13% of the total load reduction is from fans and blowers, conveyors, HVAC, air compressors, lighting, and process cooling. These divisions are largely driven by the breakdown of energy consumption in each sub-sector, as most of the demand measures are applied at the system level (to all end-uses).

8.8 Sensitivity of the Results to Changes in Avoided Cost

The avoided costs used in the Economic Potential model are varied by region and by milestone year. As with any forecast, the projected avoided costs are subject to uncertainty. Accordingly, the model has been re-run with avoided costs varied within a reasonable range. The lower end of this range is considered to be 10% below the current projection, for both energy cost and demand cost. The upper end of the range is considered to be 30% above the current projections for energy cost and 20% above the current projections for demand cost.

Exhibit 51 shows that the industrial results are not sensitive to this range of avoided costs, as results remain similar in each scenario. By 2029, the exhibit shows almost unchanged energy savings and demand reductions in both upper and lower ranges. The lack of change in energy savings potential with different avoided costs is mainly because the cost of conserved energy for most industrial measures is well below the avoided costs in all three scenarios. This was illustrated by the supply curves in Sections 7.5 and 7.6.

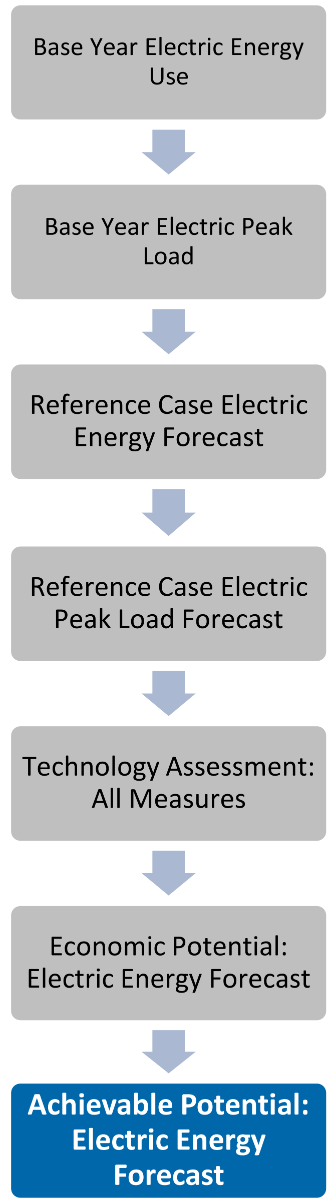
Exhibit 51 Sensitivity of the Energy Savings and Peak Demand Reduction to Avoided Cost

Region	Year	Lower Range of Reasonableness		Base Scenario		Upper Range of Reasonableness	
		Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)
All Regions	2017	703,176	175	709,454	176	750,447	180
	2020	712,998	177	729,182	178	752,776	181
	2023	725,967	178	742,937	180	745,329	180
	2026	732,749	179	735,465	180	737,832	180
	2029	725,334	181	728,050	182	730,325	182

The Data Manager file contains a sensitivity analysis by region, with similar findings that there are only small variations between scenarios in all regions. The results from the regional sensitivity analysis show the following changes in potential:

- The lower range of reasonableness produces energy savings that are 1% lower in the Island Interconnected region and almost unchanged in the Labrador and Isolated regions.
- The lower range of reasonableness produces peak demand savings that are almost unchanged in all regions.
- The upper range of reasonableness produces energy savings that are around 1% higher in the Island Interconnected region, around 2% higher in the Isolated region, and almost unchanged in the Labrador region.
- The upper and lower ranges of reasonableness produce peak demand reductions that are almost unchanged in all regions.
- The upper range of reasonableness produces peak demand savings that are around 2% higher in the Isolated region, and almost unchanged in the Island and Labrador regions.

9 Achievable Potential: Electric Energy Forecast



9.1 Introduction

This section presents the Industrial sector Achievable Potential for the study period (2014 to 2029). The Achievable Potential is defined as the proportion of the energy-efficiency opportunities 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
- Achievable Potential Workshop results
- Summary of potential electric energy savings
- Electric peak load reductions for energy efficiency measures
- Summary of peak load reductions
- Sensitivity of the results to changes in avoided cost
- Description of the application of net-to-gross ratios.

9.2 Description of Achievable Potential

Achievable Potential recognizes that, in many instances, it is difficult to induce all customers to purchase and install all the energy-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:

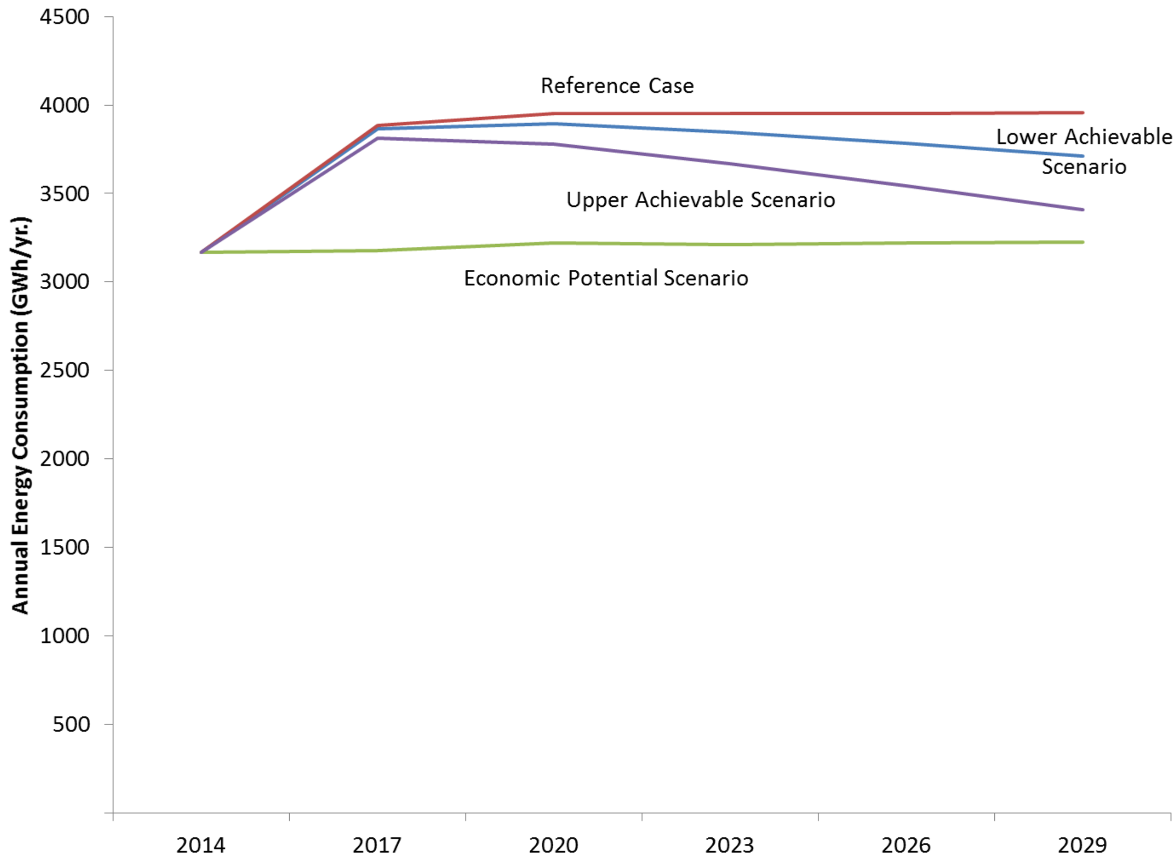
- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability.

The rate at which customers accept and purchase energy-efficiency products will be influenced by the level of financial incentives, information and other measures put in place by the Utilities and the Government of Newfoundland, other levels of government, and the private sector to remove barriers such as those noted above.

Exhibit 52 presents the levels of electricity consumption that are estimated in the Achievable Potential scenario. As illustrated, the Achievable Potential scenarios are banded by the two forecasts presented in previous sections: the Economic Potential Forecast and the Reference Case.

As illustrated in Exhibit 52 electric energy savings under the Achievable Potential scenario are less than in the Economic Potential Forecast. In this CDM study, the primary factor that contributes to the outcome shown in Exhibit 52 is the rate of market penetration. In the Economic Potential Forecast, efficient new technologies are assumed to fully penetrate the market as soon as it is economically 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 52 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Industrial Sector (GWh/yr.)



As also illustrated in Exhibit 52 the Achievable Potential results are presented as a band of possibilities, rather than a single line. This is because any estimate of Achievable Potential over a 20-year period is necessarily subject to uncertainty. Consequently, two Achievable Potential scenarios are presented: lower and upper.

The lower Achievable Potential assumes NL market conditions that are similar to those contained in the Reference Case. That is, the customers' awareness of energy-efficiency options and their motivation levels remain similar to those in the recent past, technology improvements continue at historical levels, and new energy performance standards continue as per current known schedules. It also assumes that the ability of the NL utilities to influence customers' decisions towards increased investments in energy-efficiency options remains roughly in line with previous CDM experience.

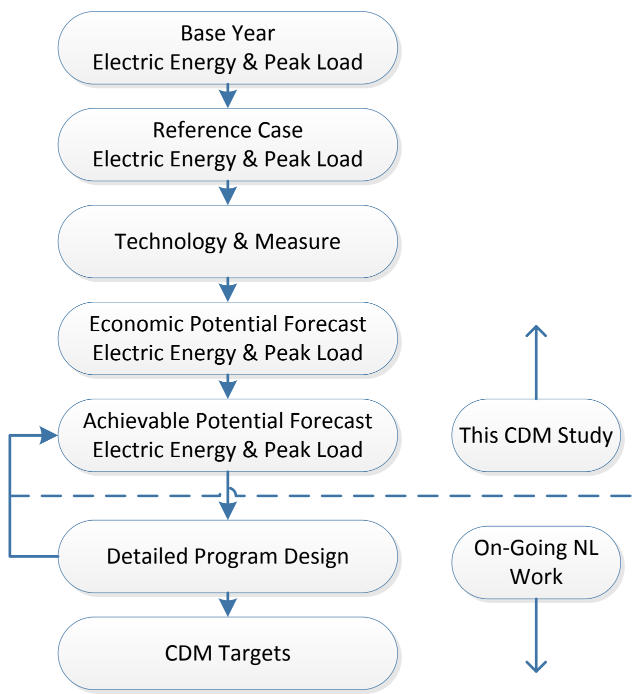
The upper Achievable Potential assumes NL market conditions that aggressively support investment in energy efficiency. For example, this scenario assumes that real electricity prices increase over the study period. It also assumes that federal and provincial government actions to mitigate climate change result in increased levels of complementary energy-efficiency initiatives. The upper Achievable Potential typically does not reach economic potential levels; this recognizes that some portion of the market is typically constrained by barriers that cannot realistically be affected by CDM programs within the study period.

9.2.1 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.

Exhibit 53 illustrates the relationship between Achievable Potential and the more detailed program design.

Exhibit 53 Achievable Potential versus Detailed Program Design



This study examined more than 50 technologies applicable to industrial electric end uses. Although considerable effort has been made to obtain up-to-date information on each technology and to tailor it to the local market in Newfoundland, this is not a substitute for the type of detailed groundwork needed to prepare a utility program. For each of the technologies selected for further investigation, it will be important to obtain further information on the technical viability and durability of the products in the Newfoundland climate, on the costs in the Newfoundland marketplace, and on real savings under local conditions. If the viability of the technology is confirmed, an assessment of the market barriers is required, leading to the development of program strategies to overcome these barriers.

9.3 Approach to the Estimation of Achievable Potential

Achievable Potential was estimated in a five-step approach.

- Priority opportunities were selected
- Opportunity profiles were created
- Opportunity worksheets were prepared
- A full-day workshop was held

- Workshop results were aggregated and applied along with information from additional sources to the remaining opportunities.

Further discussion is provided below.

Step 1 Select Priority Opportunities

The first step in developing the Achievable Potential estimates required selection of the energy-saving opportunities identified in the Economic Potential Forecasts to be discussed during the Achievable workshop. The workshop was targeted towards Utility customers that are not transmission-connected. The main focus was on the larger customers in the small-medium sub-sectors, as well as mining customers that are not transmission-connected. For these customers, several criteria determined selection, including:

- The priority measures should represent several different energy end uses
- The priority measures should assist in discussing and understanding the achievable potential for other measures in the same end use
- The priority measures should represent a significant portion of the overall economic potential
- The priority measures should have a variety of different likely patterns of market adoption, so the discussions will be widely varied.

A summary of the selected energy-efficiency actions, along with the approximate percentage that it represents in the Economic Potential Forecast for small-medium sub-sectors, is provided in Exhibit 54.

Exhibit 54 Industrial Sector Actions – Energy Efficiency

Measure #	Measure	End Use	Percentage of 2029 Economic Potential [20]	
			Consumption Savings	Demand Savings [21]
I-1	LED Lighting	Lighting	12.4%	0%
I-2	Optimization of Pumping Systems	Pumping	5%	0%
I-3	Roving Energy Managers	System (all)	7.3%	0%
I-4	Premium Efficiency Refrigeration Control Systems and Compressor Sequencing	Process Cooling / Refrigeration / Freezing	3.7%	0%
I-5*	Demand Response Curtailments	System (all) *	0%	93%
I-6	Optimization of Compressed Air Distribution Systems and End-uses	Compressed Air	0.9%	0%
I-7	Optimized Motor Control	Other Motors	1.6%	0%
I-8	Process Heat Recovery for HVAC	HVAC	0.6%	0%
Total			**31.5%**	**93%**

* Demand (kW) measures

Step 2 Create Opportunity Assessment Profiles

The next step involved the development of brief profiles for each of the opportunities noted above in Exhibit 54, in the form of PowerPoint slides. The slides are presented in Appendix G.

[20] Economic potential results for small-medium sub-sectors.
[21] Portion of savings from demand-specific measures only. Demand savings from EE measures not compared here.

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 (see Step 4 below). 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. As illustrated in Appendix G, each opportunity profile addresses the following areas:

- **Technology Description** – provides a summary statement of the broad goal and rationale for the action.
- **Target Sub-Sector Type and Typical Application —** highlights the sub-sectors and applications offering the most significant opportunities, and which provide a good starting point for discussion of the technology.
- **Financial and Economic Indicators —** provides estimates of average simple payback, cost of conserved electricity (CCE) and basis of assessment (full-cost versus incremental).
- **Eligible Participants —** provides the reference case 2029 energy consumption for this end use and an estimate of the technical applicability of the measure, which gives some context to the potential savings from the measure.
- **Economic Potential versus Time —** shows the pattern of the changing size of the opportunity over the study period. Most industrial opportunities are economic to capture immediately, so growth over time is limited to other measures that are implemented at equipment end of life. Also, opportunities decline with time as they are eroded by natural conservation activities.

Step 3 Prepare Opportunity Worksheets

A draft assessment worksheet was also prepared for each opportunity profile in advance of the Achievable workshop. The assessment worksheets complemented the information contained in the opportunity profiles by providing quantitative data on the potential electric 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.

The worksheets, including the results recorded during the workshop discussions, are provided in Appendix H. As illustrated in Appendix H, each opportunity assessment worksheet addresses the following areas:

- **Approximate Cost of Conserved Electricity —** shows the approximate levelized cost of saving each kWh of electricity saved by the measure. For the purposes of the workshop, this information provided participants with an indication of the scope for using financial incentives to influence customer participation rates.
- **Customer Payback —** shows the simple payback from the customer's perspective for the package of energy-efficiency measures included in the opportunity. This information provided an indication of the level of attractiveness that the opportunity would present to customers.
- **Economic Potential in Terms of Consumption (MWh) —** shows the total consumption that could theoretically be targeted by the opportunity, and provides the savings percentage being considered for this measure.

- **Participation Rates (%) —** these fields were filled in during the workshops (described below in the following step), based on input from the participants. They show the percentage of economic savings that workshop participants concluded could be achievable in the last milestone period.

- **Achievable Potential in Terms of Consumption Savings (MWh) —** these fields were calculated by the spreadsheet based on the participation rates provided by the participants.

- **Participation Rates Relative to the Discussion Scenario —** these fields were filled in during the workshops to provide guidance to the consulting team on how participation might differ in other regions or sub-sectors, or for related or similar technologies.

- **Other Parameters —** these fields were filled in during the workshop to capture highlights of the discussion.

Step 4 Conduct Achievable Workshop

The most critical step in developing the estimates of Achievable Potential was a one-day Achievable Potential workshop that was held on April 23, 2015. Workshop participants consisted of core members of the consultant team, CDM program and technical personnel from the Utilities, industry representatives, and representatives of other stakeholders. Together, the participating personnel brought many years of experience to the workshop related to the technologies and markets.

The purpose of this workshop was to:

- Promote discussion regarding the technical and market constraints confronting the identified energy-efficiency opportunities
- Identify potential strategies for addressing the identified constraints, including potential partners and delivery channels
- Compile participant views related to how much of the identified economic savings could realistically be achieved over the study period.

Following a brief consultant presentation that summarized the Industrial sector study results to date, the workshop provided a structured assessment of each of the selected opportunities. Opportunity assessment consisted of a facilitated discussion of the key elements affecting successful promotion and implementation of the CDM opportunity. More specifically:

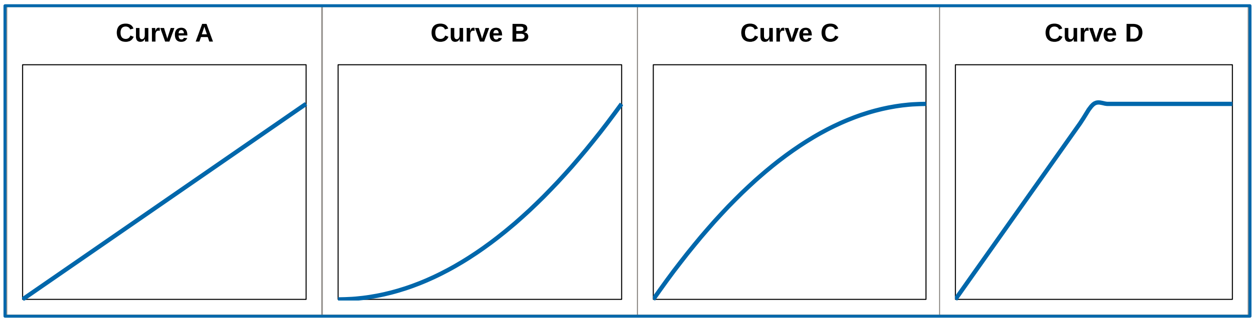
- What are the major constraints/challenges constraining customer adoption of the identified energy-efficiency opportunities?
  - How big is the “won’t” portion of the market for this opportunity?
- Preferred strategies and potential partners for addressing identified constraints (high level only)
  - Key criteria that determine customers’ willingness to proceed
  - Key potential channel partners
  - Optimum intervention strategies e.g., push, pull, combination
  - How sensitive is this opportunity to incentive levels?

Following discussion of market constraints and potential intervention strategies, the participants’ views on potential participation rates were recorded. The process involved the following steps:

- The participation rate for the upper Achievable scenario in 2029 was estimated.
- The shape of the adoption curve was selected for the upper Achievable scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate “ramp-up” rate for each opportunity (see Exhibit 55 below).

- The process was then repeated for the lower Achievable scenario.
- Once participation rates had been established for the specific technology, sub-sector and service region selected for the opportunity discussion, workshop participants provided the consultants with guidelines for extrapolating the discussion results to the other sub-sectors and service regions included in the opportunity, but not discussed in detail during the workshop. Where time permitted, participants also discussed how the adoption of similar, related technologies might differ from the technology being discussed.

Exhibit 55 Participation Rate "Ramp Up" Curves



Curve A represents a steady increase in the expected participation rate over the study period

Curve B represents a relatively slow participation rate during the first half of the study period followed by a rapid growth in participation during the second half of the 15-year study period

Curve C represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the study period

Curve D represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first half of the study period.

Step 5 Aggregate and Extend Opportunity Results

The final step involved aggregating and applying the results of the individual opportunities, along with information from additional sources, to the remaining opportunities to provide a view of the potential Achievable in the Industrial sector.

9.4 Achievable Workshop Results

The following sub-sections present a summary of the workshop discussions for each of the industrial opportunities listed in Exhibit 54 above. The adoption rates and curves selected by the participant are summarized in Section 9.4.10. Included for each opportunity are:

- Participation estimates (for 2029) made by workshop participants, with comments, where needed, about values assumed in the calculations (presented in Section 9.5)
- Where needed, additional participation estimates made after the workshop for the purposes of the calculations (presented in Section 9.5)
- Selected highlights that attempt to capture key discussion themes related to the opportunity.

Appendix H provides copies of the assessment worksheets used during the workshop.

9.4.1 Cross-Cutting Barriers and Strategies

This section presents barriers and strategies that apply broadly to industrial energy efficiency measures in Newfoundland and Labrador. Many of the barriers and challenges cited by workshop participants in the measure discussions applied to most other measures as well, and were often repeated. Many of the potential strategies and solutions discussed were also broadly applicable to industrial energy efficiency opportunities. So, this section presents some of the recurring themes from the workshop, while some opportunity specific barriers and challenges are noted in the ensuing sections.

Barriers and Challenges:

- **Capital costs** – energy efficiency investments compete with other production investments and low paybacks are required for action.
- **Competing priorities** – industry is often focused on production and not considering energy consumption. Many facilities do not have the technical staff to identify, quantify, and act on energy efficiency opportunities.
- **Awareness** – energy are bills often just accepted, without recognizing energy waste as an issue that can be improved. Even when people know of a particular technology, they do not often understand the potential savings.
- **Isolated communities** – significant travel distances and expenses to some isolated Labrador and Island communities make it harder to get the contractors, equipment, and personnel required to support energy efficiency.
- **Key decision makers** – plant employees understanding that there is an opportunity to improve energy consumption is not enough to drive adoption. Key upper management decision makers need to be informed about the opportunities and trust in the business cases presented to them.

Strategies and Solutions:

- **Improved programming options** – utilities can leverage new program strategies to overcome barriers, such as simplified application processes, direct install / “boots on the ground” programs, larger incentives, and roving energy managers.
- **Increased technical support** – utilities should facilitate increased external technical support for facilities. There is a need for support identifying the key opportunities for improvement specific to individual facilities. This could include energy audits, engineering studies, support justifying business case, and support installing equipment. This could include working through trade allies, contractors, and vendors.
- **Success stories** – utilities need to demonstrate projects, develop case studies, and recognize company achievements. Real life people telling real life success stories. This also gives an opportunity to promote non-energy benefits of many retrofits, such as O&M costs, reliability, safety, improved lighting quality, production, power quality.
- **Trusted broker** – utilities should try to become a “trusted broker” and a one-stop shop for industry to help overcome industry concerns with equipment standards, power quality, production, reliability, prequalification of products and contractors etc.

- **Build relationships and partnerships** – increased outreach to large customers and contact with the key decision makers to put energy management on their radar. Partnerships with industry associations can also help support industry in achieving energy efficiency goals.

- **Education and training** - opportunity for increased energy awareness through education and training for industry, operators, and channel partners.

9.4.2 LED Lighting

Achievable workshop participants provided 2029 participation rate estimates of 95% for the upper Achievable Potential scenario and 85% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be C, while in the lower Achievable Potential scenario it would most likely be A. These high expectations for LED lighting reflect the participants' views on the technology's strong momentum; backed by significant cost-effective savings, distributor support, and customer demand.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that there is generally an awareness of LED lighting opportunities, but the upfront costs remain prohibitive. It was indicated however that the trend is strongly towards LEDs and that distributors will be pushing these instead of fixtures like metal halides, which may not even be available anymore. The cost of an electrician to come out and put up the lights was another barrier cited, with strong preferences towards simplified incentive program applications and direct install programs.

The initial discussion focused on the Manufacturing sub-sector on the Island. Participants believed participation would be similar for Fishing and Fish Processing as well as Mining and Processing, and maybe slightly lower for Water Systems and Other. Participants expected that participation in Labrador would be similar to the Island, but lower for the Isolated regions where availability of electricians and costs of materials are more prohibitive. Participants also discussed some of the other lighting measures briefly. Automated lighting controls were thought to likely proceed slightly below LED levels, and high efficiency lighting design was expected to be adopted less frequently than LEDs.

9.4.3 Optimization of Pumping Systems

Achievable workshop participants provided 2029 participation rate estimates of 80% for the upper Achievable Potential scenario and 10% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in both the upper and lower Achievable Potential scenarios would be B. This wide gap between upper and lower Achievable Potential levels represents participant expectations that more aggressive CDM strategies, including significant technical support, could make significant inroads towards improving pumping efficiency, but that current CDM programs fail to overcome significant barriers such as lack of understanding or awareness of the opportunity.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that a lot of people do not understand their actual pumping requirements. Furthermore, there is a lot of overdesign in pumping systems, since no one complains about overdesign but under design risks process failure. Technical support to provide facilities with a better understanding of the pumping optimization opportunities specific to their facility was seen as an important area for improvement. Some pump suppliers will provide such information, but industry typically prefers unbiased opinions. It was also noted that VFDs are often used in pumping systems to cover up aspects of poor system design.

The initial discussion focused on the Water Systems and Other sub-sector on the Island. Participants believed participation would be similar for Fishing and Fish Processing as well as Manufacturing, and higher for Mining and Processing. Participants expected that participation in Labrador would be similar to the Island, but lower for the Isolated regions, where logistics are an issue. Participants also discussed some of the other pumping measures briefly. Pump control with ASDs was expected to achieve higher participation rates, premium efficiency pump motors were thought likely to proceed similarly to pumping optimization levels, and correctly sizing pumps was expected to be implemented less frequently.

9.4.4 Roving Energy Managers

Achievable workshop participants provided 2029 participation rate estimates of 70% for the upper Achievable Potential scenario and 0% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be B. This wide gap between upper and lower achievable potential levels represents participant expectations that a new program to provide industry energy management personnel support would be well received, but that this level of support does not exist in current CDM programs.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that only a handful of companies on the island would hire someone for energy management on their own. However, participants felt that many facilities would participate if they had access to shared energy managers through the Utilities. It was also noted that as plants interact with energy managers, their awareness of energy management will grow, and their adoption of energy efficiency practices will progress more naturally. One potential challenge cited by participants was the availability of qualified people to fill these roles, as many of the people in the province who would be a good fit might not be interested in leaving their current employment. Training opportunities could be offered to help develop a larger pool of potential energy managers.

The initial discussion focused on the Fishing and Fish Processing sub-sector on the Island. Participants believed participation would be similar for other sub-sectors. Participants expected that participation in Labrador might be lower than the Island, and much lower for the Isolated regions, given that these regions are more difficult to access. Participants also discussed some of the other system-level measures briefly. Operation and maintenance (O&M) programs for efficiency were thought likely to achieve lower levels than roving energy managers, while expectations for adoption of sub-metering, EMIS systems, and integrated plant control systems was much lower.

9.4.5 Premium Efficiency Refrigeration Control and Compressor Sequencing

Achievable workshop participants provided 2029 participation rate estimates of 60% for the upper Achievable Potential scenario and 15% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in both the upper and lower Achievable Potential scenarios would be B. These expectations for upgrades to refrigeration control systems reflect that a significant portion of industry will resist changing this technology, but also acknowledge that there is some department of fisheries money going into this already.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that the transition to newer refrigeration control systems requires significant efforts to make operators comfortable with the newer technology. Operators are comfortable with the old technology, which are relatively easy to understand, and find newer computer-based systems harder to use. People resist change, and are hesitant to change something critical to the facility that they know works and is reliable. It was also noted that a careful approach must be taken to convince people it works, but not insult their previous ways. To succeed here, participants recommended a good hands-on training program for operators.

The initial discussion focused on the Fishing and Fish Processing sub-sector on the Island. Participants believed participation would be similar for other sub-sectors. Participants expected that participation in Labrador might be lower than the Island, and significantly lower for the Isolated regions, given that these regions are more remote. Participants also discussed some of the other refrigeration measures briefly. High efficiency VFD chillers were thought likely to achieve higher levels of adoption; floating head pressure controls and smart defrost controls were expected to reach similar levels of adoption; and improved ice production systems were expected to be adopted less.

9.4.6 Demand Response Curtailments

Achievable workshop participants provided 2029 participation rate estimates of 15% for the upper Achievable Potential scenario and 5% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be B, while the lower Achievable Potential scenario adoption curve was selected as D, to reflect that some facilities are already participating in a demand curtailment program.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that back-up power does not usually cover 100% of a facility’s requirements, and that dated transfer switches not intended for frequent use can also reduce a facility’s ability to participate. It was noted that higher incentives could make participation more valuable and increase uptake. Another approach could be to help assess ways through which specific facilities could participate.

The initial discussion focused on the Manufacturing sub-sector on the Island. Participants believed participation for Water Systems based on facility size (larger facilities in St. Johns already participating), would be much lower for Mining and Processing, and not applicable to Fishing and Fish Processing. Participants also discussed some of the other demand reduction measures briefly. Peak shifting through on-site storage was thought likely to proceed similarly to DR curtailments, while power factor correction equipment was expected to have higher potential for adoption.

9.4.7 Optimization of Compressed Air Distribution Systems and End-uses

Achievable workshop participants provided 2029 participation rate estimates of 90% for the upper Achievable Potential scenario and 20% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in both the upper and lower Achievable Potential scenarios would be A. This wide gap between upper and lower achievable potential levels again represents participant expectations that more aggressive CDM strategies could achieve significantly more adoption.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that there is often a perception in industry that compressed air is free. Additionally, even facilities that understand there are likely opportunities to improve their compressed air system often lack the details required to prioritize and justify retrofit decisions. Participants felt that a direct approach to technical support is required, such as a compressed air audit program.

The initial discussion focused on the Mining and Processing sub-sector on the Island. Participants believed participation would be similar for all other sub-sectors. Participants expected that participation in Labrador would be similar to the Island, but lower for the Isolated regions where travel would be a barrier to compressed air auditors. Participants also discussed some of the other compressed air measures briefly. Participants felt that low capital cost measures like air leak surveys and repair, and using cooler air from outside for makeup air, would achieve similar levels of adoption. While higher capital cost measures like ASD compressors, optimized air receiver tanks, and sequencing controls would achieve low levels of adoption.

9.4.8 Optimized Motor Control

Achievable workshop participants provided 2029 participation rate estimates of 80% for the upper Achievable Potential scenario and 15% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be A, while in the lower Achievable Potential scenario it would most likely be B. This wide gap between upper and lower achievable potential levels represents participant views that there is fairly low uptake as of now, and significant capital costs to overcome, but that the technology is mature and customers are interested in adopting it.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that supply channels and awareness of VFDs are well developed, but that some issues persist. For example, VFDs are sometimes incorrectly assumed to be the solution to a facility's problems, and the vendor is unlikely to turn down a customer asking for a VFD. Participants felt that Utility support at the commissioning stage would help support more effective implementation of the technology, and that lists of qualified suppliers would also be useful.

The initial discussion focused on the Manufacturing sub-sector on the Island. Participants believed participation would be similar for all other sub-sectors. Participants expected that participation in Labrador would be similar to the Island, but lower for the Isolated. Participants also discussed some of the other motor measures briefly. Correctly sized motors through a maintenance program, conveyor motor controls, and fan ASDs were all expected to achieve similar levels of adoption to optimized motor control. Premium efficiency motors were expected to achieve higher levels of adoption than optimized motor control.

9.4.9 Process Heat Recovery for HVAC

Achievable workshop participants provided 2029 participation rate estimates of 50% for the upper Achievable Potential scenario and 10% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in both the upper and lower Achievable Potential scenarios would be A. These expectations reflect that there is fairly low uptake as of now for this relatively mature opportunity, but that it might be possible to overcome some of the awareness hurdles through new program elements. The adoption levels here also factor in that the applicability for this measure is relatively low, meaning that many facilities where this would not be technically feasible have already been filtered out separately.

In addition to the cross-cutting barriers and strategies noted above in Section 9.4.1, workshop participants noted that the potential for recovering heat from air compressors largely depends on the existing layout of compressors within the facility, and as such is more common in new builds. The source and consistency of waste heat supply through seasonal temperature changes was also identified as an important consideration. A barrier highlighted by participants for HVAC measures in general was the lack of understanding of the concept of wasted energy, and that they can take steps to reduce their energy bill. Strategies suggested by participants included HVAC opportunity assessments, as well as more generally getting customers to re-consider their HVAC systems and not simply accept the status quo.

The initial discussion focused on the Manufacturing sub-sector on the Island. Participants believed participation would be similar for all other sub-sectors. Participants expected that participation in Labrador would be the similar to the Island, but lower for the Isolated. Participants also discussed some of the other HVAC measures briefly. Automated temperature controls and reduced temperature settings were expected to achieve higher levels of adoption than process heat recovery, while high-efficiency HVAC systems were expected to have similar adoption levels to process heat recovery. Ventilation optimization, ventilation heat recovery, warehouse loading seals, improved building insulation, and HVAC air curtains were all expected to have lower participation rates.

9.4.10 Aggregate Results

Exhibit 56 summarizes the participant rate and “ramp up” curve assumptions discussed above.

Exhibit 56 Summary of Achievable Potential Participation Rates and Curves

Technology	Lower Achievable Potential		Upper Achievable Potential	
	2029 Participation Factor	Adoption Curve	2029 Participation Factor	Adoption Curve
I-1: LED Lighting	85%	Curve A	95%	Curve C
I-2: Optimization of Pumping Systems	10%	Curve B	80%	Curve B
I-3: Roving Energy Managers	0%	N/A	70%	Curve B
I-4: Premium Efficiency Refrigeration Control Systems and Compressor Sequencing	15%	Curve B	60%	Curve B
I-5: Demand Response Curtailments	5%	Curve D	15%	Curve B
I-6: Optimization of Compressed Air Distribution Systems and End-uses	20%	Curve A	90%	Curve A

Exhibit 56 Continued: Summary of Achievable Potential Participation Rates and Curves

Technology	Lower Achievable Potential		Upper Achievable Potential	
	2029 Participation Factor	Adoption Curve	2029 Participation Factor	Adoption Curve
I-7: Optimized Motor Control	15%	Curve B	80%	Curve A
I-8: Process Heat Recovery for HVAC	10%	Curve A	50%	Curve A

As noted earlier, it was not possible to fully address all opportunities in the one-day workshop. Consequently, the workshop focused on opportunities for small-medium sub-sectors selected based on the criteria described in Step 1. Estimated participation rates for the remaining opportunities were extrapolated from the workshop results shown above, and an aggregate set of results was prepared for small-medium sub-sectors, which included all of the eligible technologies.

For large industrial sub-sectors (transmission-connected facilities), which were not the focus of the workshops, estimated participation rates were developed with several additional information sources. Different forms of information were available for various facilities, but the key sources included the following:

- Facility energy audit reports
- Surveys completed by the facilities
- takeCHARGE Industrial Energy Efficiency Program reports and project tracking
- Conversations with a mining expert experienced in the province
- ICF experience in similar jurisdictions.

The results shown in the attached appendices and in the following summary section incorporate the results of all these inputs.

9.5 Summary of Potential Electric Energy Savings

This section presents a summary of the electric energy savings for the upper and lower achievable potential scenarios. The summary is organized and presented in the following sub-sections:

- Overview and selected highlights
- Electric energy savings – Upper Achievable scenario
- Electric energy savings – Lower Achievable scenario.

9.5.1 Overview and Selected Highlights

Exhibit 57 presents an overview of the results for the total Newfoundland service territory by milestone year, for three scenarios: Economic Potential, upper Achievable Potential and lower Achievable Potential.

Exhibit 57 Electricity Savings by Milestone Year for Three Scenarios (GWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case	Potential Savings (GWh/yr.)	% Savings Relative to Reference Case
2017	709	18%	73	1.9%	19	0.5%
2020	729	19%	171	4.4%	57	1.5%
2023	743	19%	285	7.3%	108	2.8%
2026	735	19%	409	10.5%	170	4.4%
2029	728	19%	545	14.0%	244	6.3%

Selected Highlights – Potential Electric Energy Savings

Selected highlights of the potential electric energy savings for the upper and lower achievable potential scenarios shown in Exhibit 57 are summarized below. Further detail is provided in the following sub-sections and in the accompanying appendices.

One key highlight is that there is a large gap between the upper and lower Achievable Potential scenarios (14% vs. 6.3%). This is a factor of what each scenario represents. For many measures, that are not new technologies, the lower Achievable Potential represents that existing CDM programming has made limited progress towards the full potential for conservation. Conversely, the upper Achievable Potential represents that there is significant potential for further adoption of measures if expanded CDM programs can help overcome key barriers.

Savings by Milestone Year

Savings in both Achievable scenarios are reached somewhat more steadily throughout the period than in the Economic Potential scenario. In the upper Achievable Potential scenario, 31% of the 2029 savings would be achieved by 2020, rising to 52% in 2023 and 75% by 2026. In the lower Achievable Potential scenario, 23% of the 2029 savings would be achieved by 2020, rising to 44% in 2023 and 70% by 2026. Although there are some measures in both scenarios that can be implemented early in the study period, the majority are expected to follow an adoption curve that starts slowly and builds up towards 2029.

Savings by Sub-Sector

Large industry account for approximately 90% of each of the upper and lower Achievable Potential savings; this reflects their larger market share and their generally higher level of energy intensity per facility. Manufacturing, Fishing and Fish Processing, and Water Systems and Other sub-sectors make up 5%, 3%, and 2%, respectively of the 2029 upper and lower Achievable Potential savings.

Savings by End Use

Pump system savings account for 32% of the upper Achievable Potential savings in 2029 and 26% of the lower Achievable Potential savings. The most significant measures that save pump system electricity include premium efficiency pump control with ASDs, optimization of pumping systems, correctly sized pumps (impeller trimming or pump selection), and premium efficiency pump motors.

Fans and blowers account for 19% of 2029 upper Achievable Potential savings and 17% of lower Achievable Potential savings. The measure that saves the most fan and blower electricity is premium efficiency fan control with ASDs.

Lighting and process specific end uses each account for an average of 11% of 2029 upper Achievable Potential savings and 15% and 13% respectively of lower Achievable Potential. The reduction in lighting electricity comes principally from installing high efficiency lighting (LEDs), as well as a small portion is attributed to automated lighting controls and high-efficiency lighting design. Process specific savings are also expected to be significant, representing 11% of 2029 upper Achievable Potential savings and 13% of 2029 lower Achievable Potential savings.

The 6 remaining end uses are all under 10% in both scenarios. Together they account for 27% of upper Achievable Potential savings in 2029 and 29% of lower Achievable Potential savings in 2029.

Savings by Measure

The most significant savings in the Achievable Potential come from the following measures:

- Premium efficiency pump control with ASDs, which account for 14% of the upper Achievable Potential savings in 2029 and 12% of the lower Achievable Potential savings in 2029
- Premium efficiency fan control with ASDs, which accounts for 11% of the upper Achievable Potential savings in 2029 and 9% of the lower Achievable Potential savings in 2029
- Energy Management Information System (EMIS), which accounts for 10% of the upper Achievable Potential savings in 2029 and 12% of the lower Achievable Potential savings in 2029
- Optimization of pumping system, which accounts for 9% of the upper Achievable Potential savings in 2029 and 7% of the lower Achievable Potential savings in 2029
- High efficiency Lights (LED), which accounts for 8% of the upper Achievable Potential savings in 2029 and 12% of the lower Achievable Potential savings in 2029
- Organizational Energy Management (EM Team), which accounts for 8% of the upper Achievable Potential savings in 2029 and 4.6% of the lower Achievable Potential savings in 2029.

There are numerous other smaller measures that contribute to the overall Achievable Potential results.

9.5.2 Electric Energy Savings – Upper Achievable Scenario

The following exhibits present the potential electricity savings[22] under the upper Achievable Potential scenario. The results shown are relative to the Reference Case. The results for the total Newfoundland service territory[23] are broken down as follows:

- Exhibit 58 presents the results by milestone year
- Exhibit 59 presents the results by sub-sector and milestone year
- Exhibit 60 presents the results by end use and milestone year
- Exhibit 61 presents the results by measure and milestone year.

[22] Note: A value of “0” in the following exhibits means a relatively small number, not an absolute value of zero.
[23] To maintain customer confidentiality this section does not present a regional breakdown of results, but this is available in the Data Manager file.

Exhibit 58 Upper Achievable Electricity Savings, All Regions (MWh/yr.)

Region	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case
All Regions	72,541	170,535	284,877	409,407	545,014	14%

Exhibit 59 Upper Achievable Electricity Savings by Sub-Sector and Milestone Year (MWh/yr.)

Sub-Sector	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Large Industry	64,358	152,386	254,885	366,033	486,892	13%	89%
Manufacturing	5,532	10,785	15,970	21,000	25,902	19%	5%
Fishing and Fish Processing	1,721	4,568	8,459	13,234	18,801	15%	3%
Water Systems and Other	930	2,796	5,561	9,139	13,420	17%	2%
Grand Total	72,541	170,535	284,877	409,407	545,014	14%	100%

Note: Any difference in totals is due to rounding.

Exhibit 60 Upper Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Pumps	18,726	47,288	83,999	127,448	176,115	24%	32%
Fans and blowers	9,082	24,211	46,480	72,467	102,921	19%	19%
Lighting	13,628	30,943	42,146	50,786	57,284	48%	11%
Process specific	7,733	18,092	30,604	45,049	61,148	6%	11%
Air compressors	8,239	16,644	24,494	32,004	39,165	22%	7%
Other motors	6,705	14,050	21,969	30,427	39,364	6%	7%
Process heating	4,152	8,509	17,103	24,703	33,147	10%	6%
Conveyors	1,854	4,657	7,148	9,719	12,362	6%	2%
Comfort HVAC	1,834	3,943	6,205	8,639	11,224	8%	2%
Process cooling	588	2,198	4,729	8,164	12,283	12%	2%
Other	-	-	-	-	-	0%	0%
Grand Total	72,541	170,535	284,877	409,407	545,014	14%	100%

Note: Any difference in totals is due to rounding.

Exhibit 61 Upper Achievable Electricity Savings by Measure and Milestone Year (MWh/yr.)

End Use	Measure	Year					Adoption Curve[24]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Other motors	Correctly Sized Motors	220	670	1,350	2,257	3,377	A	-3.9 [25]	-3.4 [25]	13.5
Comfort HVAC	Reduced Temperature Settings	463	910	1,319	1,697	2,045	A	0	0	N/A
Pumps	Correctly Sized Pumps: Impeller Trimming or Pump Selection	4,782	9,623	14,451	19,214	23,857	B	0.1	0.1	0.1
Process heating	Insulation	945	1,862	2,749	3,608	4,439	B	0.2	0.2	0.3
Fans and blowers	Correctly Sized Fans: Impeller Trimming or Fan Selection	1,722	3,608	5,634	7,774	10,009	B	0.3	0.2	0.3
Process cooling	Smart Defrost Controls	43	167	364	621	923	B	0.3	0.8	0.3
Process specific	Advanced 'Predictive' Process Control Systems	407	1,597	3,517	6,113	9,326	N/A	0.6	N/A	N/A
System	Sub-Metering	2,071	5,293	9,465	14,439	20,060	B	0.7	0.3	2.6
Other motors	Optimized Motor Control	1,624	3,172	4,625	5,980	7,235	A	0.7	0.6	0.9
Air compressors	Use Cooler Air from Outside for Make Up Air	506	995	1,439	1,849	2,226	A	0.8	0.6	2.1
Process cooling	Floating Head Pressure Controls	9	37	80	138	207	B	0.8	1.5	0.7
Pumps	Premium Efficiency Pump Control with ASDs	3,611	13,991	29,958	50,424	74,234	B	1.0	1.0	1.5
Process cooling	Free Cooling	56	222	490	848	1,287	B	1.1	2.1	1.0
System	Operation and Maintenance (O&M) Program Supporting Efficiency	2,973	6,554	10,618	15,071	19,809	B	1.2	1.9	2.1

[24] Note that curves A, B, and C in this exhibit are as presented in Exhibit 55. While some measures follow different adoption curves for different sub-sectors, the most common curve is presented here.
[25] This CCE value is negative since the opportunity involves the selection of a smaller replacement motor at the equipment's end of life, which is actually less expensive than the default of purchasing a new oversized motor.

Exhibit 61 Continued: Upper Achievable Electricity Savings by Measure and Milestone Year (MWh/yr)

End Use	Measure	Year					Adoption Curve[24]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Process specific	Process Optimization Efforts - Pulp and Paper	3,439	6,784	10,020	13,136	16,123	N/A	1.3	N/A	N/A
Fans and blowers	Synchronous Belts	196	395	594	793	990	B	1.4	1.0	1.6
Fans and blowers	Premium Efficiency Fan Control with ASDs	2,661	10,450	22,948	39,774	60,528	B	1.7	1.5	2.0
Fans and blowers	Premium Efficiency Motors for Fans and Blowers	126	401	840	1,458	2,262	B	1.8	1.5	19.7
Conveyors	Premium Efficiency Conveyor Motors	64	197	406	676	1,010	A	2.0	1.5	24.1
Pumps	Premium Efficiency Pump Motor	168	537	1,141	1,988	3,099	B	2.1	2.0	14.7
Pumps	Optimization of Pumping System	6,222	14,344	24,097	35,260	47,588	B	2.2	2.1	3.3
System	Organizational Energy Management (EM Team)	7,786	16,042	24,382	32,873	41,470	B	2.2	3.4	4.3
Air compressors	Optimized Sizes of Air Receiver Tanks	220	427	599	745	865	A	2.4	2.9	3.6
Other motors	Premium Efficiency Motors	200	611	1,233	2,062	3,087	A	2.4	2.0	11.2
Process specific	Process Optimization Efforts - Mining and Processing	181	727	1,581	2,714	4,090	B	2.5	2.5	N/A
System	Integrated Plant Control System	2,684	5,533	8,517	11,601	14,750	B	2.8	1.9	10.3
System	Energy Management Information System (EMIS)	7,470	16,671	27,410	39,618	53,206	B	2.9	3.3	7.0
Air compressors	Air Leak Survey and Repair	2,715	5,341	7,625	9,666	11,475	A	3.0	2.4	8.2
Process cooling	Improved Ice Production System	21	83	183	318	486	B	3.5	N/A	3.5
Conveyors	Optimized Conveyor Motor Control	256	1,290	1,889	2,455	2,988	A	3.8	3.9	2.7
Comfort HVAC	Automated Temperature Control	454	914	1,330	1,716	2,070	A	4.0	3.5	7.0
Comfort HVAC	High-Efficiency Packaged HVAC	82	256	513	858	1,285	A	4.1	3.9	21.7
Air compressors	Optimized Distribution System (Incl. Pressure and Air End-Uses)	1,539	3,077	4,438	5,679	6,804	A	4.1	3.7	7.2

Exhibit 61 Continued: Upper Achievable Electricity Savings by Measure and Milestone Year (MWh/yr)

End Use	Measure	Year					Adoption Curve[24]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Air compressors	Premium Efficiency ASD Compressor	2,281	4,609	6,800	8,908	10,925	A	4.1	2.9	8.7
Lighting	Automated Lighting Controls	1,129	3,019	3,898	4,488	4,887	A	4.4	4.3	5.5
Lighting	High Efficiency Lights (LEDs)	10,691	24,383	33,141	39,688	44,304	A	4.4	4.3	5.4
Process heating	Process Heat Recovery to Preheat Makeup Water	550	1,165	5,916	9,594	14,047	B	5.0	4.9	4.9
Fans and blowers	Optimized Distribution System (Incl. Pressure Losses)	208	825	3,439	5,036	6,803	B	5.3	4.7	6.4
Process heating	High Efficiency Oven/Dryer/Furnace/Kiln	2	2	16	26	38	B	5.4	5.6	4.8
Air compressors	Sequencing Control	81	158	222	275	319	A	5.6	N/A	24.0
Process cooling	Premium Efficiency Refrigeration Control System and Compressor Sequencing	119	468	1,019	1,738	2,586	B	5.6	N/A	4.8
Process cooling	Optimized Distribution System	18	70	155	269	410	B	5.7	N/A	5.1
Process heating	Heat Pumps	14	59	128	219	330	B	5.8	N/A	9.7
Process cooling	Air Curtains	3	13	29	49	75	B	6.8	N/A	6.3
Process cooling	High Efficiency Chiller	59	230	507	959	1,470	B	7.0	6.2	7.2
Process cooling	Chiller Economizer	17	66	145	250	379	B	7.5	N/A	7.2
Process cooling	Improve Insulation of Refrigeration System	35	140	307	530	801	B	9.1	N/A	8.1
Comfort HVAC	Air Compressor Heat Recovery	92	181	264	341	411	A	9.4	N/A	14.1
Lighting	High-Efficiency Lighting Design	1,279	2,276	2,957	3,447	3,818	A	10.0	N/A	12.7
Comfort HVAC	Ventilation Optimization	45	87	127	163	195	A	11.7	N/A	20.2
Comfort HVAC	Ventilation Heat Recovery	0	0	1	1	1	A	N/A	N/A	21.6

Exhibit 61 Continued: Upper Achievable Electricity Savings by Measure and Milestone Year (MWh/yr)

End Use	Measure	Year					Adoption Curve[24]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Comfort HVAC	Warehouse Loading Dock Seals	0	0	0	0	0	A	N/A	N/A	21.4
Comfort HVAC	Improved Building Insulation	-	-	-	-	-	N/A	N/A	N/A	N/A
Comfort HVAC	HVAC Air Curtains	-	-	-	-	-	N/A	N/A	N/A	N/A
Process heating	High Efficiency Water Heater	-	-	-	-	-	N/A	N/A	N/A	N/A
Process specific	Process Optimization Efforts - Fishing and Fish Processing	1	3	4	5	6	B	N/A	N/A	21.1
Process specific	Process Optimization Efforts - Oil Refining	-	-	-	-	-	N/A	N/A	N/A	N/A

Note: In the exhibit, a zero indicates a value that rounds off to zero (i.e., less than 0.5). A dash indicates a value that is actually zero.

Exhibit 61 provides results at a sufficient level of detail that some modeling issues require explanation:

- In some cases, the potential shown in this exhibit is lower than for the same measure in Exhibit 65. This occurs for measures that are late in the “cascade” of measures that apply to a specific end use. It is caused when other measures earlier in the sequence of measures applied by the model have much higher savings in the Upper Achievable than in the Lower Achievable scenarios, leaving less energy to be saved by later measures in the sequence.
- The CCE values in Exhibit 61 do not always match those presented elsewhere in the report. The CCE values presented in these exhibits are calculated weighted averages, based on the particular mixture of sub-sectors and regions in which the measure is applied in this scenario. For most measures, the CCE varies by sub-sector and region, because of varying savings and costs. If the mixture of sub-sectors in the Upper Achievable scenario is different from the mixture in the Lower Achievable scenario, the weighted average CCE will be somewhat different. In general, the CCE values in this chapter will be lower than those presented in Chapter 7, because the economic screening removes the most expensive applications of most measures.

9.5.3 Electric Energy Savings – Lower Achievable Scenario

- The following exhibits present the potential electricity savings[26] under the lower Achievable Potential scenario. The results shown are relative to the Reference Case. The results for the total Newfoundland service territory[27] are broken down as follows:

- Exhibit 62 presents the results by milestone year
- Exhibit 63 presents the results by sub-sector and milestone year
- Exhibit 64 presents the results by end use and milestone year
- Exhibit 65 presents the results by measure and milestone year.

Exhibit 62 Lower Achievable Electricity Savings, All Regions (MWh/yr.)

Region	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case
All Regions	19,188	57,009	108,002	170,436	244,363	6%

Exhibit 63 Lower Achievable Electricity Savings by Sub-Sector and Milestone Year (MWh/yr.)

Sub-Sector	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Large Industry	15,759	49,569	95,880	153,151	221,429	6%	91%
Manufacturing	2,239	4,540	6,997	9,457	11,929	9%	5%
Fishing and Fish Processing	845	1,980	3,396	5,067	6,990	5%	3%
Water Systems and Other	345	920	1,729	2,761	4,015	5%	2%
Grand Total	19,188	57,009	108,002	170,436	244,363	6%	100%

Note: Any difference in totals is due to rounding.

[26] A value of "0" in the following exhibits means a relatively small number, not an absolute value of zero.
[27] To maintain customer confidentiality this section does not present a regional breakdown of results, but this is available in the Data Manager file.

Exhibit 64 Lower Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Pumps	2,748	10,910	24,009	41,618	63,230	9%	26%
Lighting	7,055	17,560	25,154	31,814	37,631	32%	15%
Fans and blowers	1,697	6,736	15,690	27,305	41,693	8%	17%
Process specific	1,350	5,359	11,835	20,627	31,558	3%	13%
Air compressors	4,303	8,830	13,224	17,578	21,875	12%	9%
Other motors	734	2,940	6,634	11,828	18,523	3%	8%
Process heating	426	1,695	5,362	9,388	14,429	4%	6%
Comfort HVAC	506	1,343	2,451	3,829	5,459	4%	2%
Conveyors	205	984	2,203	3,892	6,041	3%	2%
Process cooling	164	652	1,441	2,558	3,924	4%	2%
Other	-	-	-	-	-	0%	0%
Grand Total	19,188	57,009	108,002	170,436	244,363	6%	100%

Note: Any difference in totals is due to rounding.

Exhibit 65 Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	Year					Adoption Curve[28]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Other motors	Correctly Sized Motors	18	91	257	556	1,024	B	-3.8 [29]	-3.4 [29]	13.5
Comfort HVAC	Reduced Temperature Settings	139	368	670	1,041	1,476	A	0	0	N/A
Pumps	Correctly Sized Pumps: Impeller Trimming or Pump Selection	202	795	1,726	2,954	4,431	B	0.1	0.1	0.1
Process heating	Insulation	95	376	835	1,461	2,245	B	0.2	0.2	N/A
Fans and blowers	Correctly Sized Fans: Impeller Trimming or Fan Selection	141	552	1,207	2,080	3,147	B	0.3	0.2	0.3
Process cooling	Smart Defrost Controls	10	41	90	157	240	B	0.3	0.8	N/A
System	Sub-Metering	326	1,298	2,859	4,972	7,595	B	0.5	0.3	N/A
Process specific	Advanced 'Predictive' Process Control Systems	117	463	1,025	1,789	2,736	N/A	0.6	N/A	N/A
Other motors	Optimized Motor Control	140	549	1,206	2,087	3,168	B	0.7	0.6	0.9
Air compressors	Use Cooler Air from Outside for Make Up Air	298	592	866	1,125	1,367	A	0.8	0.6	2.1
Process cooling	Floating Head Pressure Controls	2	9	21	36	56	B	0.9	1.5	N/A
System	Operation and Maintenance (O&M) Program Supporting Efficiency	613	2,398	5,239	9,028	13,645	B	1.0	1.9	2.1
Pumps	Premium Efficiency Pump Control with ASDs	1,286	5,108	11,181	19,248	28,994	B	1.0	1.0	1.4

[28] Note that curves A, B, and C in this exhibit are as presented in Exhibit 55. While some measures follow different adoption curves for different sub-sectors, the most common curve is presented here.
[29] This CCE value is negative since the opportunity involves the selection of a smaller replacement motor at the equipment's end of life, which is actually less expensive than the default of purchasing a new oversized motor.

Exhibit 65 Continued: Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	Year					Adoption Curve[28]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Process cooling	Free Cooling	28	111	245	430	661	B	1.1	2.1	1.0
Fans and blowers	Synchronous Belts	19	76	168	293	448	B	1.2	1.0	1.6
Process specific	Process Optimization Efforts - Pulp and Paper	563	2,231	4,964	8,718	13,443	N/A	1.3	N/A	N/A
Fans and blowers	Premium Efficiency Fan Control with ASDs	974	3,865	8,551	14,910	22,793	B	1.6	1.5	1.9
Fans and blowers	Premium Efficiency Motors for Fans and Blowers	15	78	221	476	874	B	1.7	1.5	19.7
Conveyors	Premium Efficiency Conveyor Motors	8	40	116	249	458	B	1.9	1.5	24.1
System	Energy Management Information System (EMIS)	1,190	4,737	10,517	18,443	28,417	B	2.0	3.3	N/A
Pumps	Premium Efficiency Pump Motor	21	105	298	640	1,175	B	2.0	2.0	14.7
Pumps	Optimization of Pumping System	735	2,906	6,407	11,132	16,959	B	2.1	2.1	3.4
System	Organizational Energy Management (EM Team)	478	1,908	4,209	7,327	11,200	B	2.2	3.4	4.3
Air compressors	Optimized Sizes of Air Receiver Tanks	157	311	443	561	664	A	2.3	2.9	3.6
Other motors	Premium Efficiency Motors	24	121	342	740	1,363	B	2.3	2.0	12.1
Process specific	Process Optimization Efforts - Mining and Processing	121	489	1,068	1,840	2,779	B	2.5	2.5	N/A
Air compressors	Air Leak Survey and Repair	1,847	3,666	5,319	6,852	8,267	A	3.1	2.4	8.2
Process cooling	Improved Ice Production System	5	20	45	79	122	N/A	3.5	N/A	N/A
System	Integrated Plant Control System	282	1,103	2,425	4,208	6,408	B	3.6	1.9	11.6
Air compressors	Premium Efficiency ASD Compressor	1,022	2,066	3,058	4,018	4,945	A	3.8	2.9	8.7
Conveyors	Optimized Conveyor Motor Control	19	232	513	891	1,358	B	3.9	3.9	2.7

Exhibit 65 Continued: Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	Year					Adoption Curve[28]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Air compressors	Optimized Distribution System (Incl. Pressure and Air End-Uses)	816	1,646	2,404	3,117	3,785	A	4.0	3.7	7.2
Comfort HVAC	High-Efficiency Packaged HVAC	15	50	108	196	317	A	4.1	3.9	21.7
Comfort HVAC	Automated Temperature Control	242	527	824	1,136	1,461	A	4.1	3.5	7.1
Lighting	High Efficiency Lights (LEDs)	5,605	13,865	19,861	25,083	29,597	A	4.5	4.3	5.4
Lighting	Automated Lighting Controls	742	2,182	2,960	3,560	4,013	A	4.5	4.3	5.4
Process heating	Process Heat Recovery to Preheat Makeup Water	23	96	1,814	3,180	4,891	B	5.0	4.9	N/A
Process heating	High Efficiency Oven/Dryer/Furnace/Kiln	0	0	2	4	7	B	5.3	5.6	N/A
Air compressors	Sequencing Control	49	97	139	176	207	A	5.3	N/A	24.0
Fans and blowers	Optimized Distribution System (Incl. Pressure Losses)	61	240	1,287	2,117	3,047	B	5.3	4.7	6.4
Process cooling	Optimized Distribution System	6	23	51	90	139	B	5.7	N/A	N/A
Process cooling	Premium Efficiency Refrigeration Control System and Compressor Sequencing	31	121	267	464	707	B	5.7	N/A	N/A
Process heating	Heat Pumps	2	10	22	39	61	B	5.8	N/A	N/A
Process cooling	Air Curtains	1	3	8	13	20	B	6.2	N/A	N/A
Process cooling	High Efficiency Chiller	31	121	268	512	794	B	7.0	6.2	7.2
Process cooling	Chiller Economizer	5	22	48	84	129	B	7.5	N/A	N/A
Comfort HVAC	Air Compressor Heat Recovery	21	41	60	79	96	A	9.7	N/A	14.1

Exhibit 65 Continued: Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	Year					Adoption Curve[28]	Weighted Average CCE (¢/kWh)		
		2017	2020	2023	2026	2029		Island	Labrador	Isolated
Process cooling	Improve Insulation of Refrigeration System	7	29	64	111	170	B	9.7	N/A	N/A
Lighting	High-Efficiency Lighting Design	636	1,229	1,718	2,127	2,462	A	9.9	N/A	12.7
Comfort HVAC	Ventilation Heat Recovery	-	-	-	-	-	N/A	N/A	N/A	N/A
Comfort HVAC	Ventilation Optimization	-	-	-	-	-	N/A	N/A	N/A	N/A
Comfort HVAC	Warehouse Loading Dock Seals	0	0	0	0	0	A	N/A	N/A	21.4
Comfort HVAC	Improved Building Insulation	-	-	-	-	-	N/A	N/A	N/A	N/A
Comfort HVAC	HVAC Air Curtains	-	-	-	-	-	N/A	N/A	N/A	N/A
Process heating	High Efficiency Water Heater	-	-	-	-	-	N/A	N/A	N/A	N/A
Process specific	Process Optimization Efforts - Fishing and Fish Processing	0	1	2	3	4	B	N/A	N/A	21.1
Process specific	Process Optimization Efforts - Oil Refining	-	-	-	-	-	N/A	N/A	N/A	N/A

Note: In the exhibit, a zero indicates a value that rounds off to zero (i.e., less than 0.5). A dash indicates a value that is actually zero.

As with Exhibit 61, Exhibit 65 provides results at a sufficient level of detail that some modeling issues require explanation:

- As explained following Exhibit 61, in some cases, the potential shown in this exhibit is higher than for the same measure in Exhibit 61. This occurs for measures that are late in the "cascade" of measures that apply to a specific end use. It is caused when other measures earlier in the sequence of measures applied by the model have much lower savings in the Lower Achievable than in the Upper Achievable scenarios, leaving more energy to be saved by later measures in the sequence.
- The CCE values in Exhibit 65 do not always match those presented earlier in the report. As discussed earlier that is because the CCE values presented in these exhibits are calculated weighted averages, based on the particular mixture of sub-sectors and regions in which the measure is applied in this scenario.

9.6 Electric Peak Load Reductions from Energy Efficiency

Exhibit 66 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the Achievable Potential Forecast. The reductions are shown by milestone year and sub-sector for both lower and upper achievable potential savings. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Sections 4 and 6.

Exhibit 67, Exhibit 68, Exhibit 69, and Exhibit 70 show the lower and upper Achievable Potential savings by sub-sector and principal end use for each milestone year.

Electric peak load reductions related to capacity-only measures are presented separately in Section 9.7.

Exhibit 66 Electric Peak Load Reductions from Lower and Upper Achievable Potential Energy Savings Measures, by Milestone Year and Sub-Sector, Winter Peak Period (MW)

Sub-Sector	Milestone Years	Lower	Upper
Large Industry	2017	1.4	6.1
	2020	4.5	14.3
	2023	8.9	24.1
	2026	14.3	34.7
	2029	20.8	46.2
Manufacturing	2017	0.2	0.4
	2020	0.3	0.8
	2023	0.5	1.2
	2026	0.7	1.5
	2029	0.9	1.9
Fishing and Fish Processing	2017	0.1	0.2
	2020	0.2	0.4
	2023	0.3	0.7
	2026	0.5	1.1
	2029	0.6	1.5
Water Systems and Other	2017	0.0	0.1
	2020	0.1	0.2
	2023	0.1	0.3
	2026	0.2	0.5
	2029	0.2	0.8

Exhibit 67 Electric Peak Load Reductions from Upper Achievable Potential Energy Savings Measures, by Milestone Year, End Use and Sub-Sector, Winter Peak Period (MW)

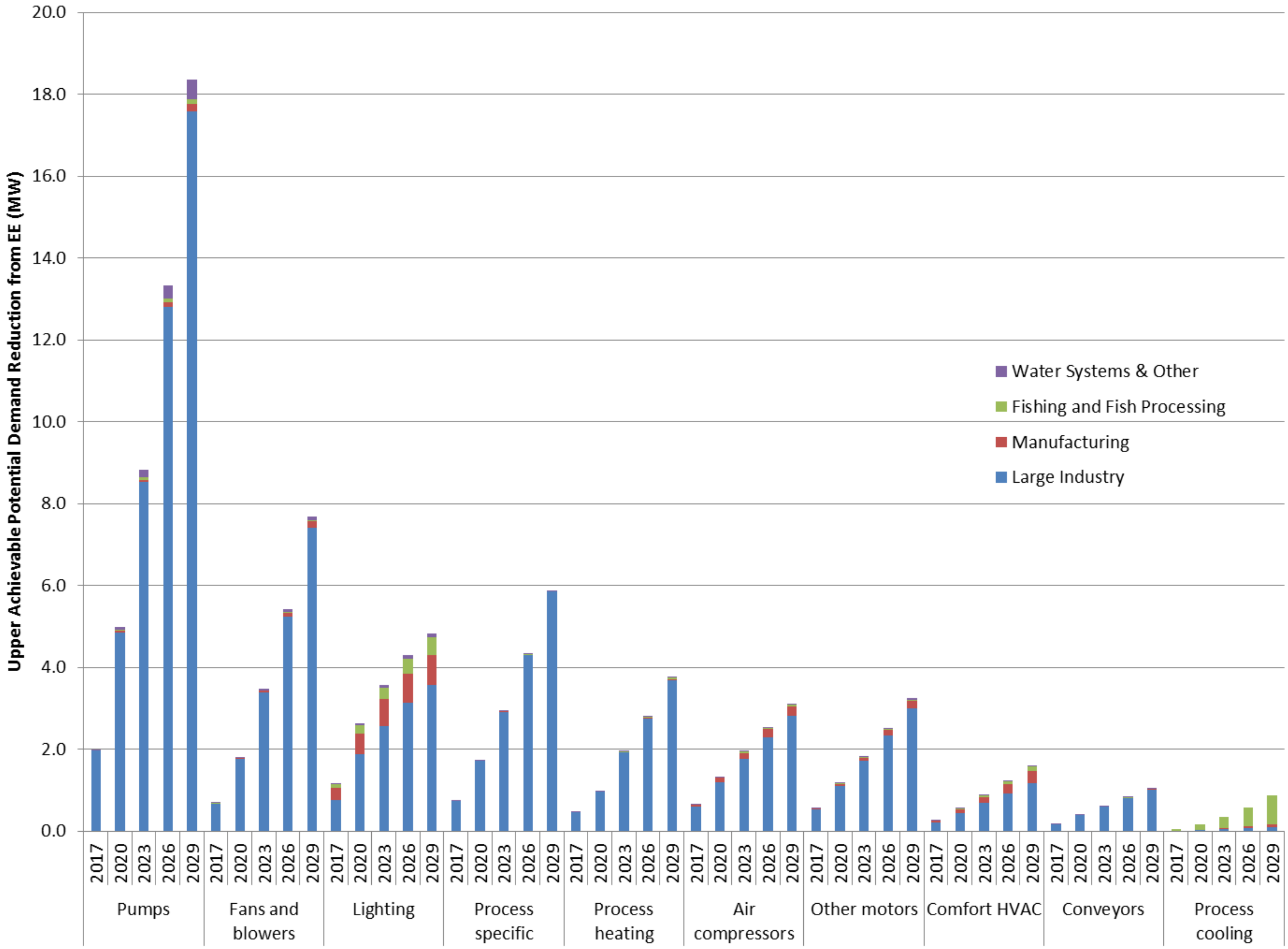


Exhibit 68 Electric Peak Load Reduction from Upper Achievable Potential Energy Saving Measures for Small-Medium Industry, by Milestone Year, End Use, and Sub-Sector, Winter Peak Period (MW)

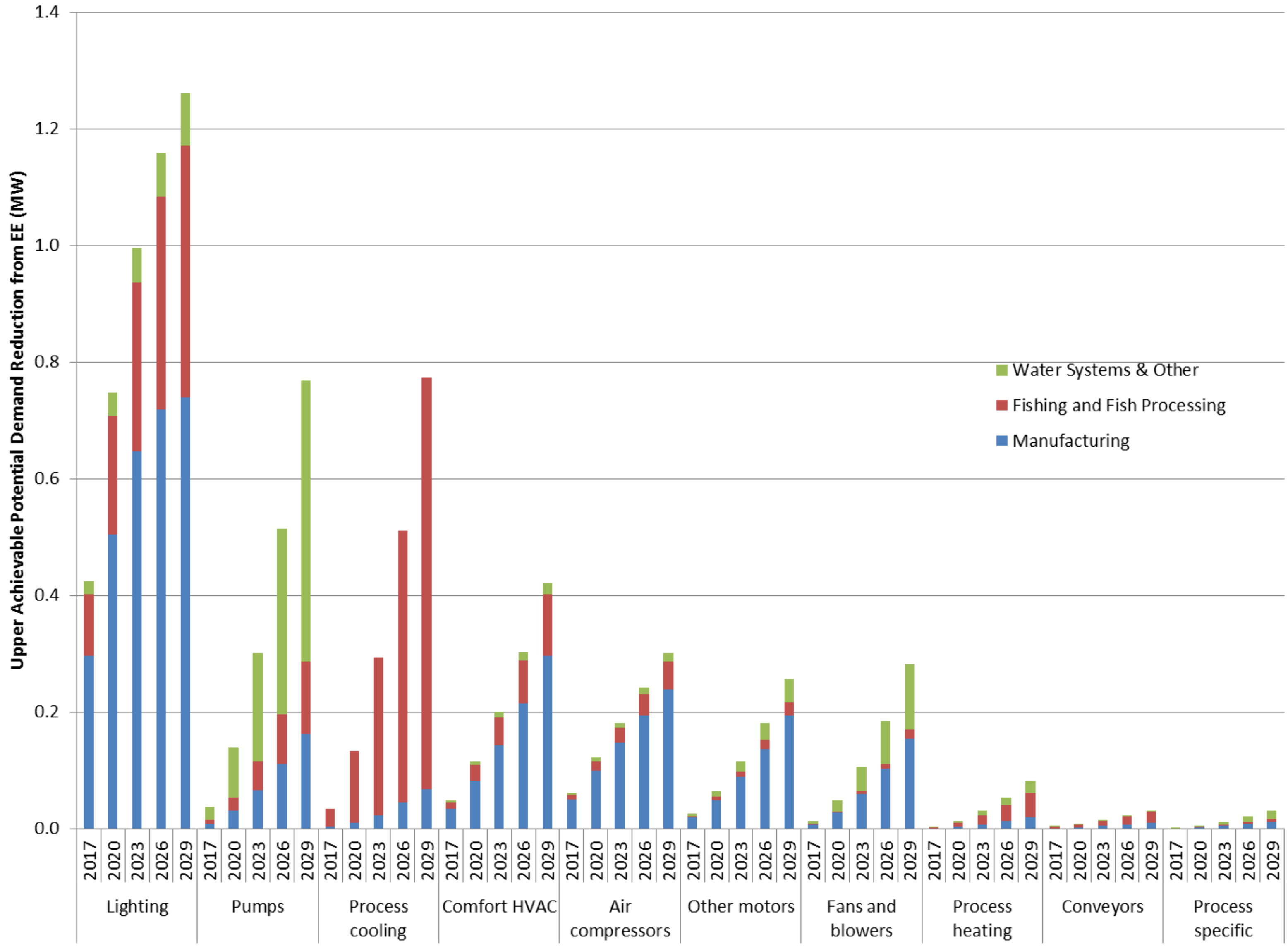


Exhibit 69 Electric Peak Load Reduction from Lower Achievable Potential Energy Saving Measures, by Milestone Year, End-Use, and Sub-Sector, Winter Peak Period (MW)

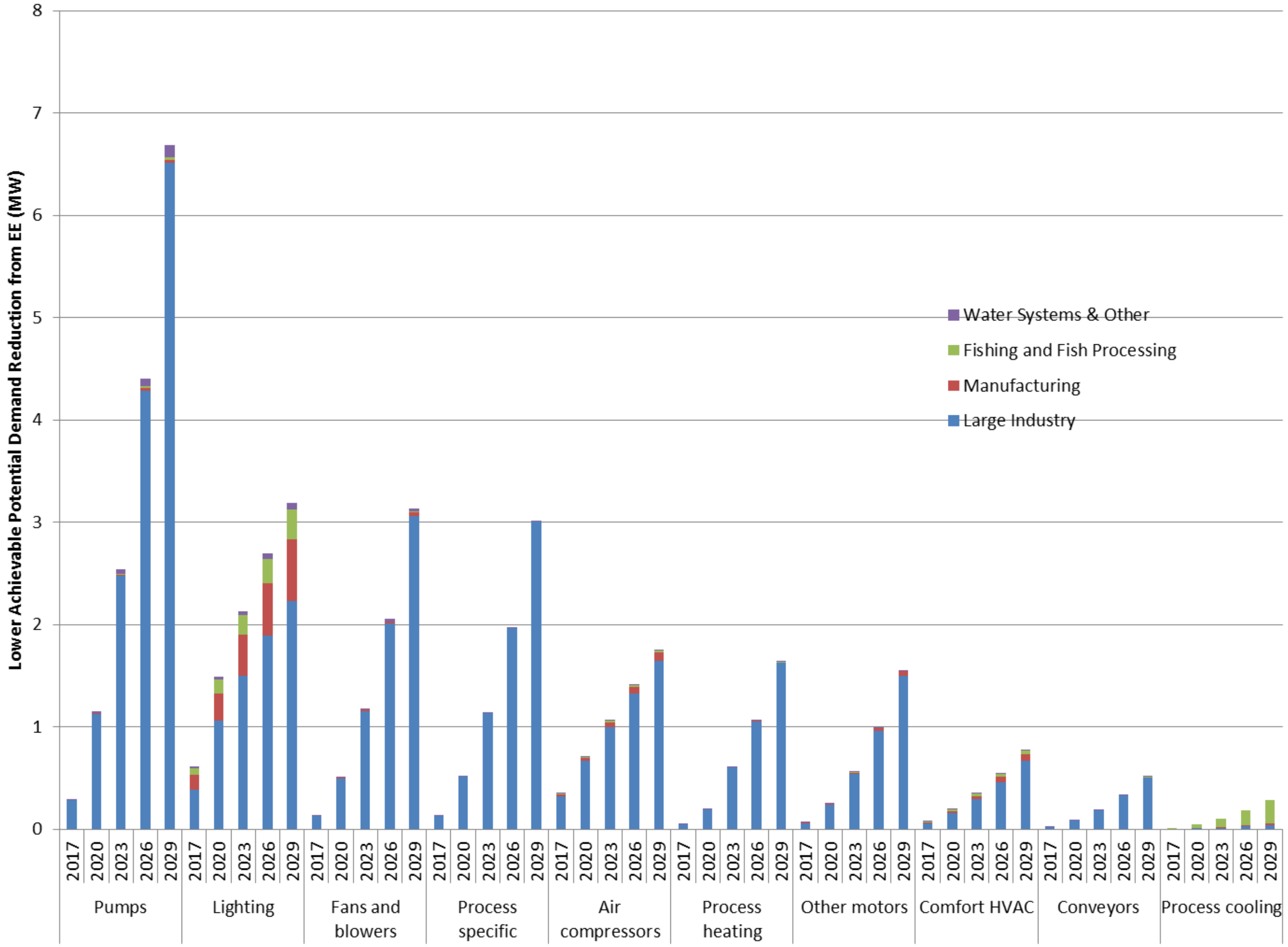


Exhibit 70 Electric Peak Load Reductions from Lower Achievable Potential Energy Savings Measures for Small-Medium Industry, by Milestone Year End Use and Sub-Sector, Winter Peak Period (MW)

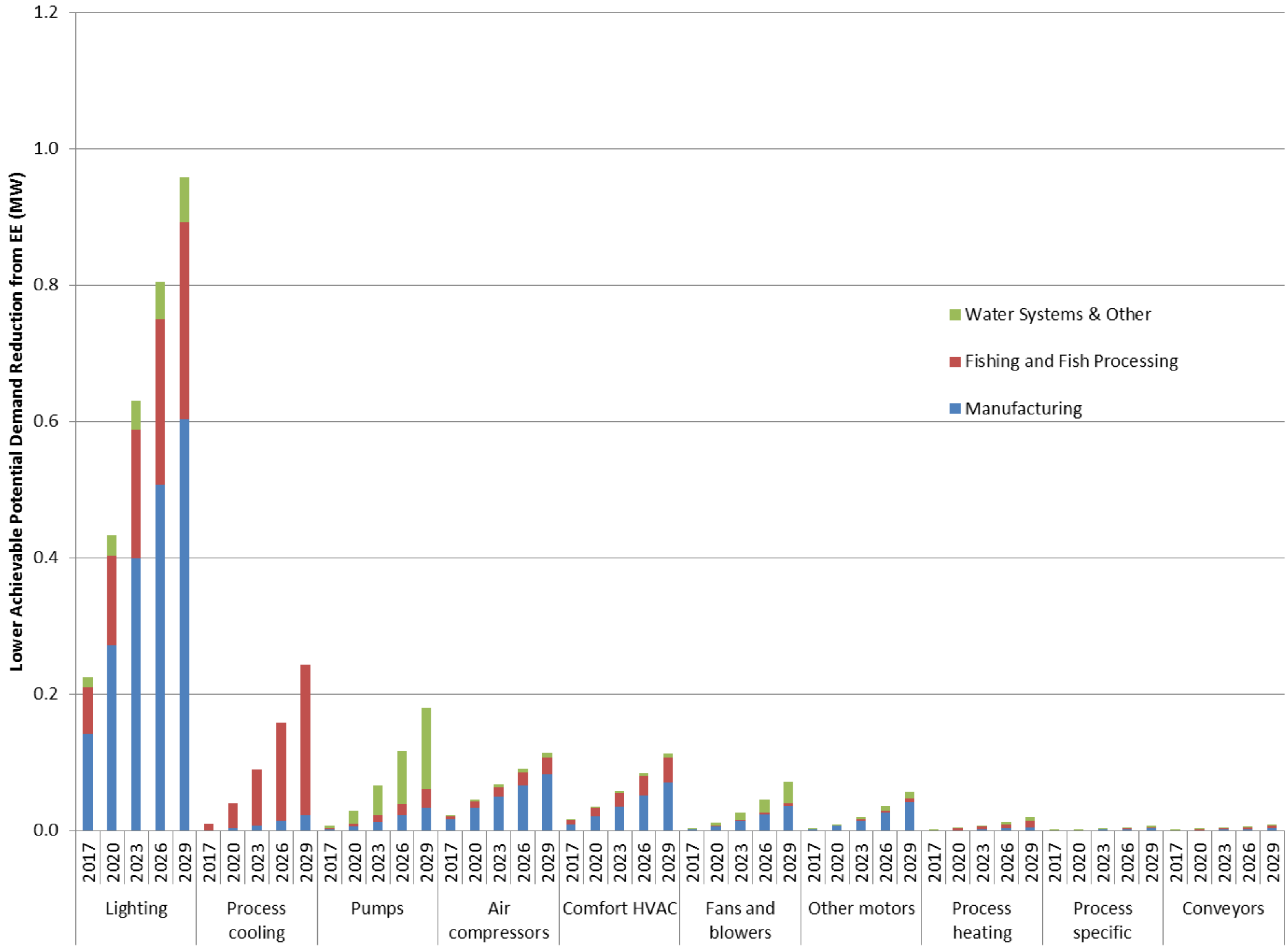


Exhibit 71 only approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. This is not always correct.

Exhibit 71 Electric Peak Load Reductions from Achievable Potential Energy Savings Measures, 2029 (MW)

Measure	Large Industry		S/M Industry		Total	
	Lower Achiev.	Upper Achiev.	Lower Achiev.	Upper Achiev.	Lower Achiev.	Upper Achiev.
Premium Efficiency Pump Control with ASDs	3.0	7.5	0.1	0.3	3.1	7.8
Energy Management Information System (EMIS)	2.7	4.9	0.0	0.2	2.7	5.1
High Efficiency Lights (LEDs)	1.7	2.7	0.8	1.0	2.5	3.7
Optimization of Pumping System	1.8	4.7	0.0	0.2	1.8	5.0
Premium Efficiency Fan Control with ASDs	1.7	4.4	0.0	0.1	1.7	4.5
Operation and Maintenance (O&M) Program Supporting Efficiency	1.2	1.7	0.1	0.1	1.3	1.9
Process Optimization Efforts - Pulp and Paper	1.1	1.3	-	-	1.1	1.3
Organizational Energy Management (EM Team)	1.0	3.5	0.1	0.4	1.1	3.9
Sub-Metering	0.7	1.6	0.0	0.3	0.7	1.9
Air Leak Survey and Repair	0.6	0.9	0.0	0.1	0.7	0.9
Integrated Plant Control System	0.6	1.3	0.0	0.1	0.6	1.4
Process Heat Recovery to Preheat Makeup Water	0.6	1.6	0.0	0.0	0.6	1.6
Correctly Sized Pumps: Impeller Trimming or Pump Selection	0.4	2.4	0.0	0.1	0.5	2.5
Premium Efficiency ASD Compressor	0.4	0.7	0.0	0.1	0.4	0.8
Process Optimization Efforts - Mining and Processing	0.4	0.6	-	-	0.4	0.6
Automated Lighting Controls	0.3	0.3	0.1	0.1	0.3	0.4
Optimized Distribution System (Incl. Pressure and Air End-Uses)	0.3	0.5	0.0	0.0	0.3	0.5
Optimized Motor Control	0.2	0.5	0.0	0.1	0.3	0.6
Insulation	0.3	0.5	0.0	0.0	0.3	0.5
Correctly Sized Fans: Impeller Trimming or Fan Selection	0.2	0.7	0.0	0.0	0.2	0.7
Advanced 'Predictive' Process Control Systems	0.2	0.8	-	-	0.2	0.8
Optimized Distribution System (Incl. Pressure Losses)	0.2	0.4	0.0	0.1	0.2	0.5
Reduced Temperature Settings	0.2	0.3	-	-	0.2	0.3
Automated Temperature Control	0.2	0.2	0.0	0.1	0.2	0.3
High-Efficiency Lighting Design	0.2	0.3	0.0	0.1	0.2	0.3
Premium Efficiency Pump Motor	0.1	0.3	0.0	0.0	0.1	0.3
Optimized Conveyor Motor Control	0.1	0.2	0.0	0.0	0.1	0.3

Exhibit 71 Continued: Electric Peak Load Reductions from Achievable Potential Energy Savings Measures, 2029 (MW)

Measure	Large Industry		S/M Industry		Total	
	Lower Achiev.	Upper Achiev.	Lower Achiev.	Upper Achiev.	Lower Achiev.	Upper Achiev.
Premium Efficiency Motors	0.1	0.2	0.0	0.0	0.1	0.3
Use Cooler Air from Outside for Make Up Air	0.1	0.2	0.0	0.0	0.1	0.2
Correctly Sized Motors	0.1	0.3	0.0	0.0	0.1	0.3
Premium Efficiency Motors for Fans and Blowers	0.1	0.2	0.0	0.0	0.1	0.2
High Efficiency Chiller	0.0	0.0	0.1	0.1	0.1	0.1
Premium Efficiency Refrigeration Control System and Compressor Sequencing	0.0	0.0	0.0	0.2	0.1	0.2
Optimized Sizes of Air Receiver Tanks	0.0	0.0	0.0	0.0	0.1	0.1
Free Cooling	0.0	0.0	0.0	0.1	0.0	0.1
High-Efficiency Packaged HVAC	0.0	0.1	0.0	0.1	0.0	0.2
Premium Efficiency Conveyor Motors	0.0	0.1	0.0	0.0	0.0	0.1
Synchronous Belts	0.0	0.1	0.0	0.0	0.0	0.1
Smart Defrost Controls	-	-	0.0	0.1	0.0	0.1
Sequencing Control	0.0	0.0	0.0	0.0	0.0	0.0
Air Compressor Heat Recovery	0.0	0.0	0.0	0.0	0.0	0.1
Improve Insulation of Refrigeration System	0.0	0.0	0.0	0.0	0.0	0.1
Optimized Distribution System	-	-	0.0	0.0	0.0	0.0
Chiller Economizer	0.0	0.0	0.0	0.0	0.0	0.0
Improved Ice Production System	-	-	0.0	0.0	0.0	0.0
Heat Pumps	0.0	0.0	0.0	0.0	0.0	0.0
Floating Head Pressure Controls	0.0	0.0	0.0	0.0	0.0	0.0
Air Curtains	-	0.0	0.0	0.0	0.0	0.0
High Efficiency Oven/Dryer/Furnace/Kiln	0.0	0.0	0.0	0.0	0.0	0.0
Process Optimization Efforts - Fishing and Fish Processing	-	-	0.0	0.0	0.0	0.0
Warehouse Loading Dock Seals	-	-	0.0	0.0	0.0	0.0
Ventilation Heat Recovery	-	-	-	0.0	-	0.0
High Efficiency Water Heater	-	-	-	-	-	-
Ventilation Optimization	-	-	-	0.0	-	0.0
Process Optimization Efforts - Oil Refining	-	-	-	-	-	-
Improved Building Insulation	-	-	-	-	-	-
HVAC Air Curtains	-	-	-	-	-	-
Grand Total	20.8	46.2	1.8	4.2	22.5	50.4

As with Exhibit 65, Exhibit 71 only approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. This is not always correct.

Exhibit 71 provides results at a sufficient level of detail that some modeling issues require explanation:

- In some cases, the potential shown for Lower Achievable is higher than for the same measure in Upper Achievable. This occurs for measures that are late in the "cascade" of measures that apply to a specific end use. It is caused when other measures earlier in the sequence of measures applied by the model have much lower savings in the Lower Achievable than in the Upper Achievable scenarios, leaving more energy to be saved by later measures in the sequence.

9.7 Summary of Peak Load Reductions

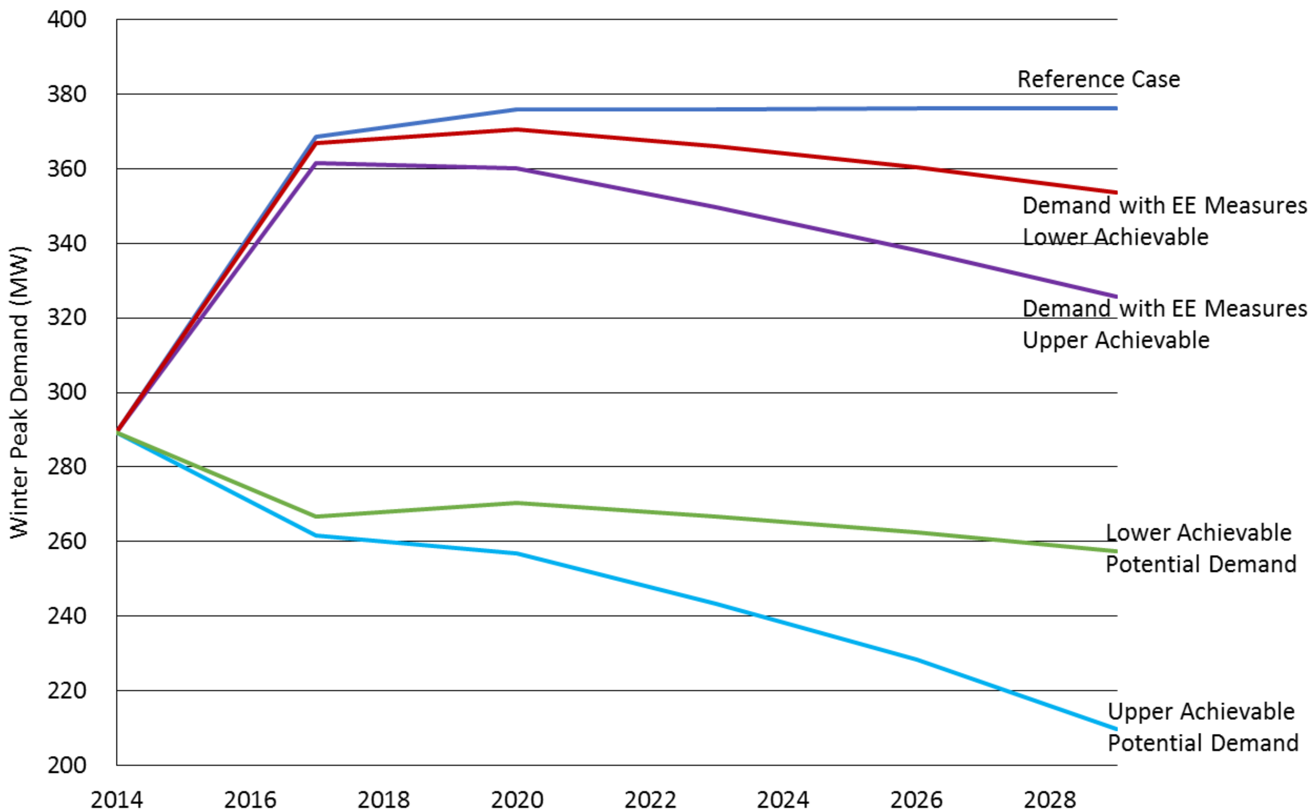
This section presents a summary of the electric peak load reductions that would result from the application of peak demand efficient measures. Exhibit 72 compares the Reference Case, Lower Achievable Potential and Upper Achievable Potential Peak Demand Forecast levels of winter peak demand.[30]

As illustrated, under the Reference Case industrial peak demand would grow from the Base Year level of 289 MW to approximately 376 MW by 2029. This contrasts with the Lower Achievable Potential Forecast in which peak demand would decrease to approximately 288 MW for the same period, a difference of approximately 88 MW or about 23%. The Upper Achievable Potential forecasts peak demand at 220 MW, a difference of approximately 156 MW or 41%. The other two lines on the chart show the peak demand that would result if all the energy efficiency measures were applied but none of the demand reduction measures in each of the Lower and Upper Achievable Potential scenarios. As illustrated in the exhibit, 13% of the upper Achievable Potential scenario reduction, and 6% of the lower Achievable Potential scenario reduction comes from the impact of energy efficiency measures.

As noted in Section 7.6, all of the demand reductions from Newfoundland Power's curtailment program will be captured in the Industrial report, including curtailment from some general service customers that would otherwise be classified as 'commercial' facilities in this study. These 'non-industrial' peak demand curtailments are included with reductions for the manufacturing sub-sector. As such, the results for this sub-sector will overestimate the potential curtailment specific to that sub-sector when these results are considered in isolation.

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

Exhibit 72 Peak Demand of Reference Case, Lower Achievable Potential and Upper Achievable Potential in Industrial Sector (MW)



9.7.1 Peak Demand Reduction

Further detail on the total potential peak demand reduction provided by the Upper and Lower Achievable Potential Forecast is provided in the following exhibits:[31]

- Exhibit 73 presents the results by sub-sector, measure and milestone year
- Exhibit 74 and Exhibit 76 present peak demand reduction by major end use, milestone year and sub-sector
- Exhibit 75 and Exhibit 77 present peak demand reduction by major end use, milestone year and sub-sector for small-medium industry

[31] MW reductions shown in the following exhibits are not incremental. For example, the space heating reductions in 2029 are not in addition to the space heating reductions from the previous milestone years. Rather, they are the difference between the Reference Case space heating peak demand in 2029 and the space heating peak demand if all the measures included in the Lower or Upper Achievable Potential scenario are implemented.

Exhibit 73 Total Lower Achievable Potential Peak Demand Reduction by Sub-Sector, Measure and Milestone Year (MW)

Sub-sectors	Milestone Years	Operational changes for reduced peak load (DR Curtailments)		Peak shifting through on-site storage		Power factor correction equipment		Grand Total	
		Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.
Large Industry	2017	88.83	87.97	0.01	0.02	0.67	1.33	89.51	89.32
	2020	88.28	89.01	0.01	0.04	1.37	2.65	89.66	91.70
	2023	86.68	90.19	0.02	0.06	2.03	3.85	88.72	94.10
	2026	84.75	92.16	0.02	0.07	2.66	4.95	87.43	97.18
	2029	82.52	96.81	0.03	0.09	3.26	6.00	85.80	102.90
Manufacturing	2017	6.70	6.50	0.00	0.00	0.03	0.09	6.73	6.59
	2020	6.55	7.01	0.00	0.00	0.05	0.17	6.60	7.18
	2023	6.38	7.28	0.03	0.23	0.08	0.24	6.49	7.75
	2026	6.22	7.59	0.05	0.29	0.10	0.31	6.38	8.19
	2029	6.06	7.86	0.08	0.35	0.13	0.37	6.26	8.59
Fishing and Fish Processing	2017	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.09
	2020	0.00	0.00	0.01	0.18	0.05	0.17	0.06	0.35
	2023	0.00	0.00	0.02	0.26	0.08	0.25	0.10	0.51
	2026	0.00	0.00	0.04	0.33	0.10	0.32	0.14	0.65
	2029	0.00	0.00	0.05	0.39	0.13	0.38	0.18	0.77
Water Systems and Other	2017	3.94	3.85	0.00	0.00	0.01	0.04	3.95	3.90
	2020	3.94	3.80	0.00	0.01	0.02	0.08	3.97	3.89
	2023	3.94	3.74	0.00	0.01	0.04	0.11	3.99	3.87
	2026	3.92	3.66	0.01	0.02	0.05	0.14	3.97	3.82
	2029	3.89	3.59	0.01	0.02	0.06	0.17	3.96	3.78
Grand Total	2017	99.47	98.33	0.01	0.12	0.71	1.45	100.20	99.89
	2020	98.77	99.82	0.02	0.23	1.50	3.06	100.30	103.11
	2023	97.01	101.22	0.07	0.56	2.22	4.45	99.30	106.22
	2026	94.89	103.41	0.12	0.72	2.91	5.72	97.92	109.84
	2029	92.46	108.27	0.17	0.86	3.57	6.92	96.21	116.04

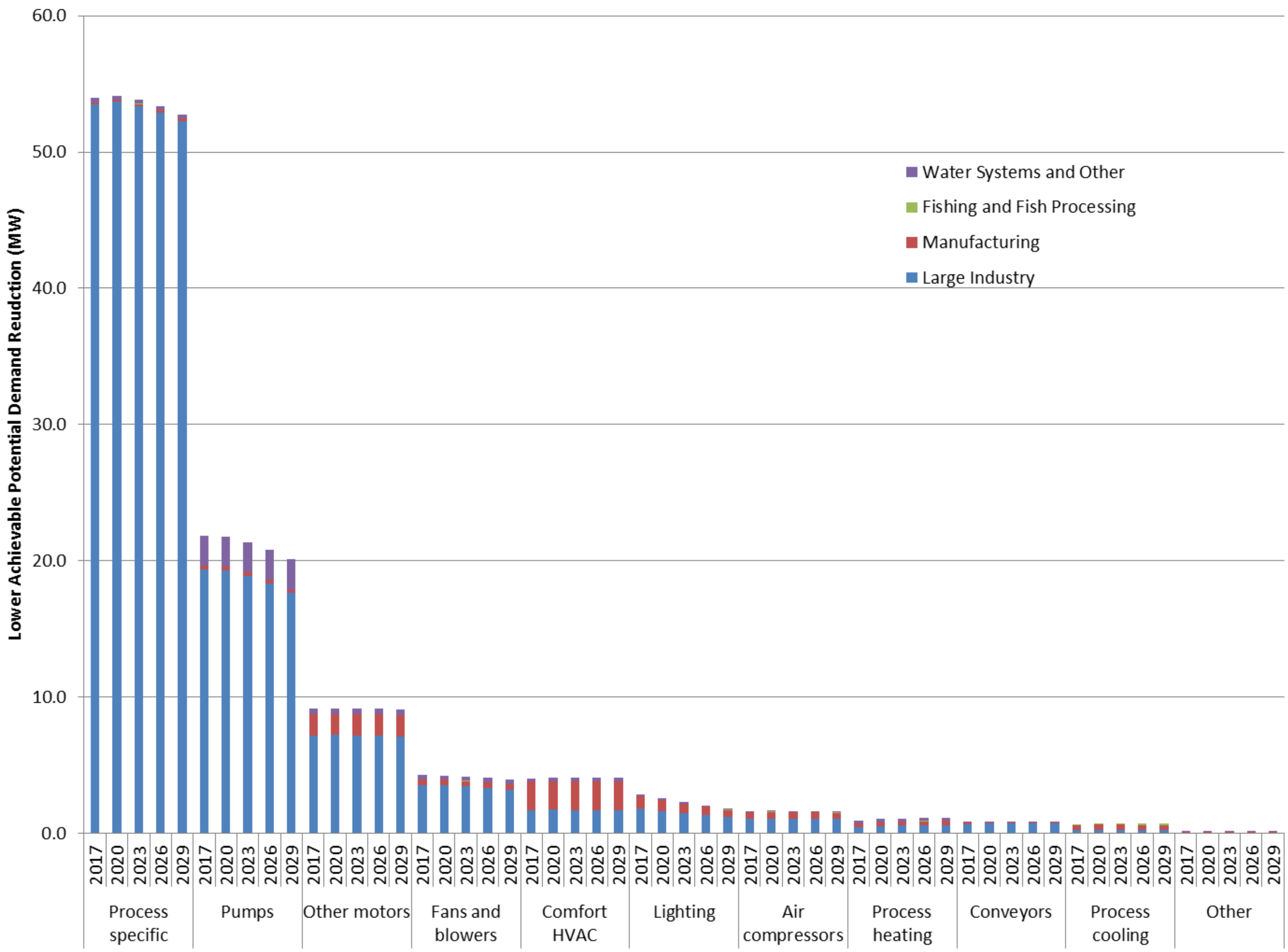
Notes:
1) The values in this exhibit do not include peak demand reductions from energy efficiency measures.
2) The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered ‘commercial’ facilities.

3) Results are measured at the customer's point-of-use and do not include line losses.
4) Any differences in totals are due to rounding.
5) Totals are calculated using the actual numerical value.
6) MW reductions are not incremental. The peak shifting reductions in 2029 are not in addition to the reductions from the previous milestone years. Rather, they are the difference between the Reference Case peak shifting peak demand in 2029 and the peak shifting peak demand if all the measures included in the Economic Potential scenario are implemented.

As with some previous conservation exhibits, Exhibit 73 provides results at a sufficient level of detail that some modeling issues require explanation:

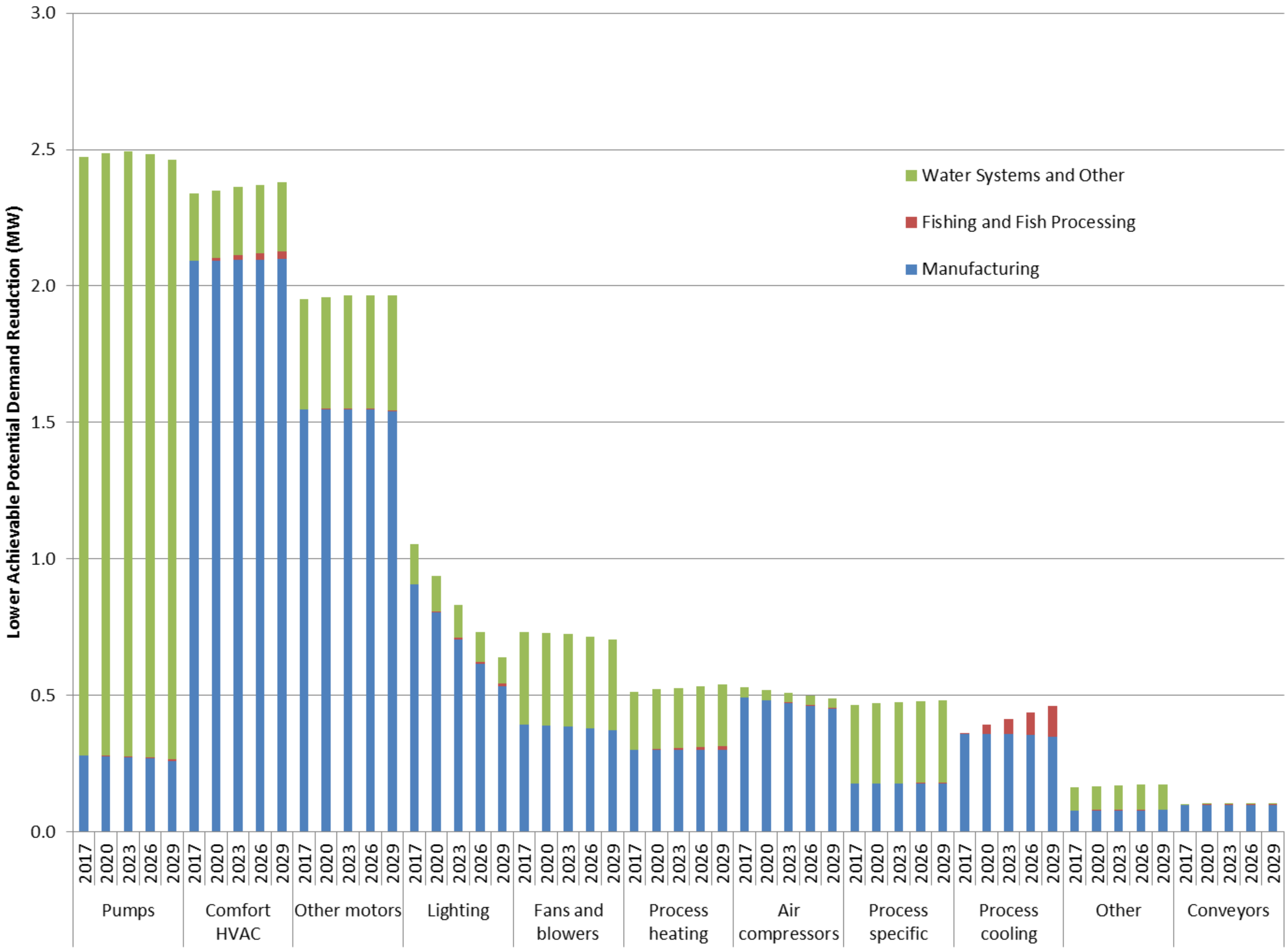
- As explained for previous Achievable Potential exhibits, in some cases, the potential shown for Lower Achievable is higher than for Upper Achievable. This occurs for measures that are late in the "cascade" of measures that apply to a specific end use. It is caused when other measures earlier in the sequence of measures applied by the model have much lower savings in the Lower Achievable than in the Upper Achievable scenarios, leaving more energy to be saved by later measures in the sequence. This is compounded if the later measures have strong adoption potential in the Lower Achievable scenario.
- Additionally, demand-specific measure savings will fluctuate based on the demand savings from conservation measures. The demand reference case to which demand-specific measures are applied already factors in the corresponding Upper or Lower Achievable demand savings from conservation measures. So the more peak demand reductions are generated through conservation measures, the less peak demand remains for demand-specific measures to reduce.
- This is particularly noteworthy for the curtailment demand measure, since cascading impacts could reduce the demand reduction levels shown here below what is expected based on current peak demand reduction arrangements. It is important to note that the model produce total demand reduction potentials in excessive of current curtailment arrangements, but that the model's cascade order will result in more of the total demand reduction potential being credited towards conservation measures and the demand-specific measures that precede curtailment in the cascade order.

Exhibit 74 Lower Achievable Potential Peak Demand Reduction by Major End Use, Year and Sub-sector (MW)



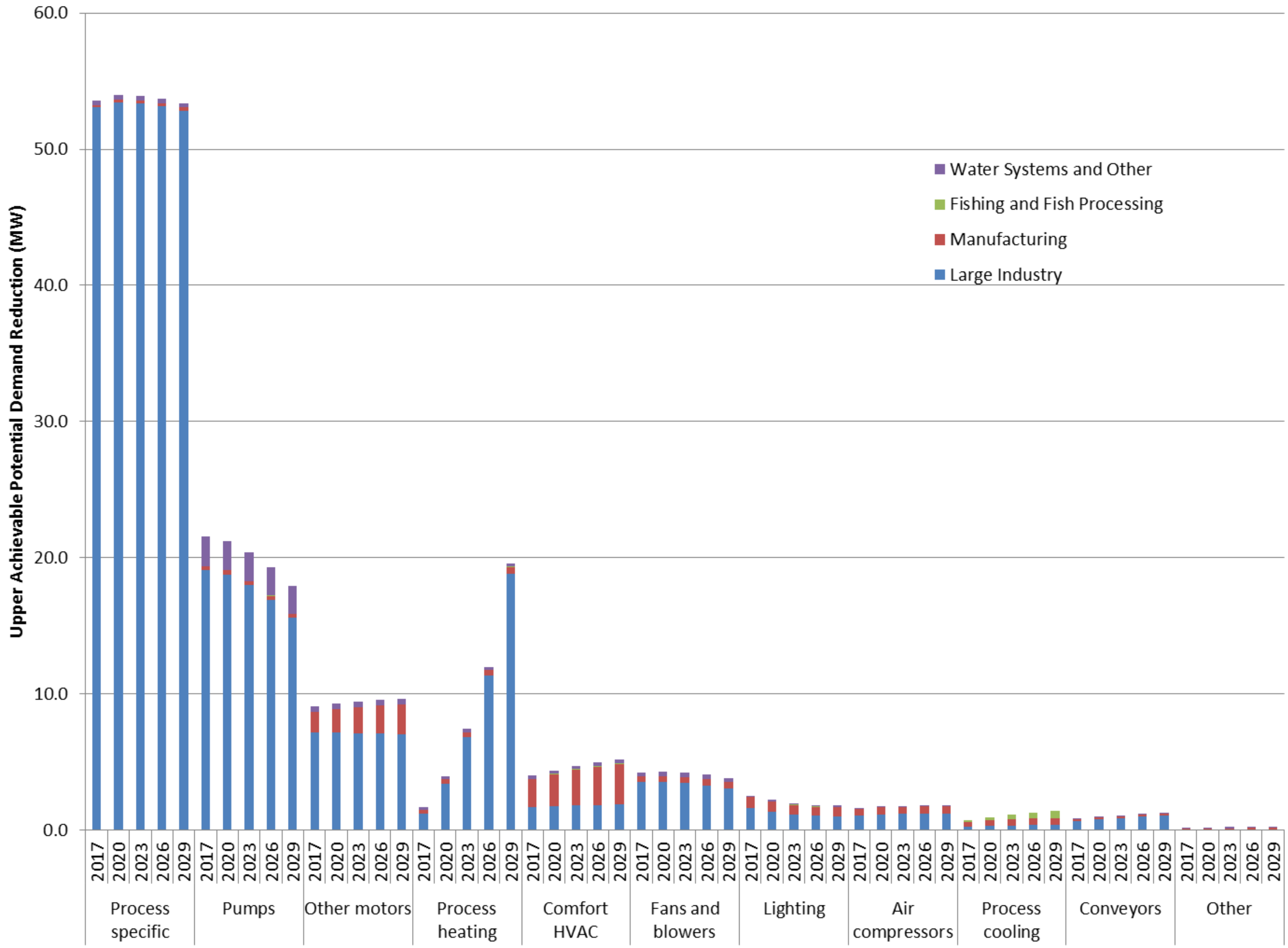
Note: The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered 'commercial' facilities.

Exhibit 75 Lower Achievable Potential Peak Demand Reduction by Major End Use for Small-Medium Industry, Year and Sub-sector (MW)



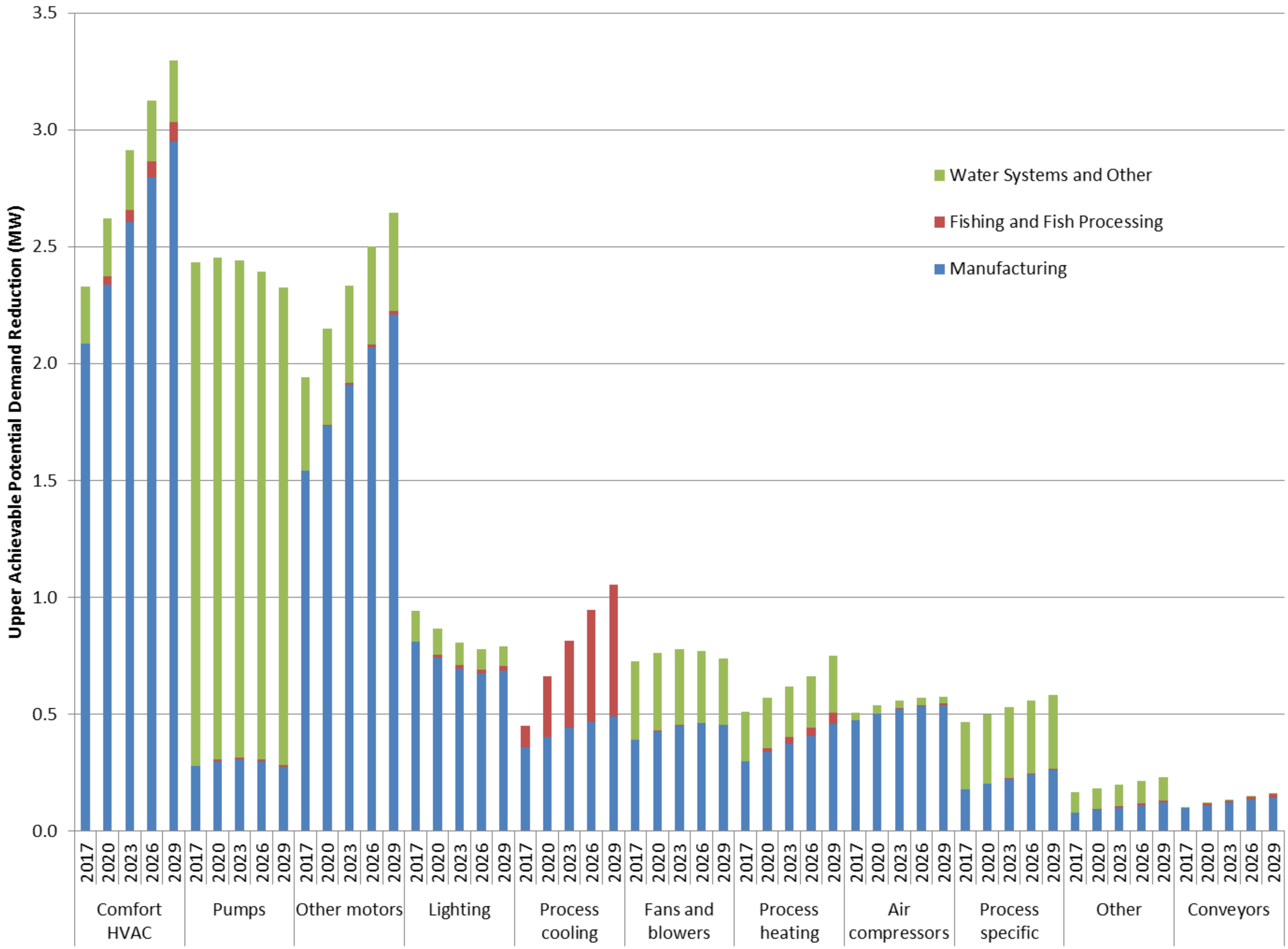
Note: The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered 'commercial' facilities.

Exhibit 76 Upper Achievable Potential Peak Demand Reduction by Major End Use, Year and Sub-sector (MW)



Note: As discussed previously, the manufacturing sub-sector also includes curtailment demand reductions from general service customer participants from the commercial sector

Exhibit 77 Upper Achievable Potential Peak Demand Reduction by Major End Use for Small-Medium Industry, Year and Sub-sector (MW)



Note: The manufacturing sub-sector also includes curtailment program reductions from Newfoundland Power general service participants otherwise considered 'commercial' facilities.

9.7.2 Interpretation of Results

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

Peak Demand Reduction by Milestone Year

The Lower Achievable Potential peak load reductions decrease from 100 MW in 2017 to 96 MW in 2029. The Upper Achievable Potential peak load reductions increase from 100 MW in 2017 to 116 MW in 2029. All three measures have potential savings beginning with the first milestone year.

Peak Demand Reduction by Sub-Sector

Large industry accounts for approximately 95% of the potential peak load reductions in 2029; this reflects their larger market share and their generally higher level of electrical intensity per facility. Peak load reductions in Water Systems and Other account for 3% of the potential savings; Manufacturing account for 7% of the lower Achievable Potential savings, however a significant portion of these savings can be attributed to general service customers participating in Newfoundland Power's curtailment program, which are captured here but otherwise considered 'commercial' facilities in this study; and Fishing and Fish Processing account for 1% of the lower Achievable Potential savings.

Peak Demand Reduction by End Use

The measure with the most significant impact on peak demand reduction is Operational changes for reduced peak load (DR Curtailments). This measure, as well as Peak shifting through on-site storage and Power factor correction equipment, are applicable to all end uses.

Process specific load reductions initially account for approximately 54% of the total load reductions in the upper Achievable Potential Forecast, not including load reductions from energy efficiency measures, in 2017; this declines to 46% of the total by 2029.

Demand reduction in pump systems account for approximately 22% of the total load reductions in the upper Achievable Potential Forecast in 2017, not including load reductions from energy efficiency measures; this decreases to 15% of the total by 2029.

Demand reduction in process heating account for approximately 2% of the demand reductions in the upper Achievable Potential Forecast in 2017, not including reductions from energy efficiency measures; this increases to 17% of the total by 2029.

9.8 Sensitivity of the Results to Changes in Avoided Cost

The avoided costs used in the Achievable Potential model are varied by region and by milestone year. As with any forecast, the projected avoided costs are subject to uncertainty. Accordingly, the model has been re-run with avoided costs varied within a reasonable range. The lower end of this range is considered to be 10% below the current projection, for both energy cost and demand cost. The upper end of the range is considered to be 30% above the current projections for energy cost and 20% above the current projections for demand cost.

Exhibit 78 shows that the industrial lower Achievable Potential results are not sensitive to this range of avoided costs, as results remain similar in each scenario. By 2029, the exhibit shows almost unchanged energy savings and demand reductions in both upper and lower ranges. The lack of change in energy savings potential with different avoided costs is mainly because the cost of conserved energy for most industrial measures is well below the avoided costs in all three scenarios. This was illustrated by the supply curves in Sections 7.5 and 7.6.

Exhibit 78 Sensitivity of the Lower Achievable Potential Energy Savings and Peak Demand Reduction to Avoided Cost

Region	Year	Lower Range of Reasonableness		Base Scenario		Upper Range of Reasonableness	
		Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)
All Regions	2017	18,856	102	19,188	102	21,537	102
	2020	53,198	105	57,009	105	58,185	106
	2023	106,121	109	108,002	109	108,017	109
	2026	170,137	114	170,436	114	170,431	114
	2029	244,008	119	244,363	119	244,350	119

Exhibit 79 shows that the 2029 industrial upper Achievable Potential results are also not sensitive to this range of avoided costs, as results remain similar in each scenario. In both exhibits, the primary change is in the upper range of reasonableness growing more quickly, as some measures that would not normally pass economic screens until later milestone years are included starting in 2017.[32]

Exhibit 79 Sensitivity of the Upper Achievable Potential Energy Savings and Peak Demand Reduction to Avoided Cost

Region	Year	Lower Range of Reasonableness		Base Scenario		Upper Range of Reasonableness	
		Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)	Energy Savings (MWh/yr.)	Peak Demand Reduction (MW)
All Regions	2017	71,663	107	72,541	107	77,160	107
	2020	164,371	118	170,535	119	170,543	119
	2023	279,767	132	284,877	133	284,897	133
	2026	408,343	148	409,407	148	409,442	148
	2029	543,663	166	545,014	166	545,044	166

The Data Manager file contains sensitivity analyses for both upper and lower Achievable Potential by region, which shows similar findings in that results in all regions are almost unchanged between scenarios in 2029.

[32] This change in the rate of measure adoption has a very minor impact on the overall final savings between scenarios. However, this change produces some counter intuitive results, whereby certain base scenario years are higher than the upper range scenario, because the latter scenario adopted certain measures sooner. This is simply a function of the model's architecture and the nature of the cascading measures so that they reduce the savings potential of subsequent measures. The result is a very minor difference, only apparent because of a lack of other differences between scenarios.

9.9 Net-to-Gross

Net-to-gross ratios are used to estimate the free-ridership occurring in CDM programs. Free riders are program participants who would have undertaken an efficiency or demand management measure naturally, even without the influence of the utility's program. A net-to-gross ratio is a factor that represents the net program impact divided by the gross program impact. The net impact can be found by multiplying the gross impact by the net-to-gross ratio.

Net-to-gross ratios have been estimated for many of the utility programs conducted in NL over the past several years. Though net-to-gross ratios are dependent on many factors, the estimates from previous programs were assumed to provide a reasonable approximation for the ratios in the near future. The majority of industrial measures in the present study were not explicitly included in past programs, so net-to-gross ratios were not available. This analysis uses net-to-gross ratios for similar measures from other sectors where possible, as well as an assumed to rate of 93% for many industrial measures. This value is based on programs in other jurisdictions and the assumption that free ridership tends to be low for capital intensive industrial projects reliant on utility support.

Sources:

The following sources were used to estimate the measure net-to-gross ratios shown in Exhibit 80:

- Net-to-gross ratios provided by Newfoundland Power, from evaluations of the CDM programs that have been run in the province.
- Ontario Energy Board TRC Guide recommendations.[33]
- Ontario Power Authority 2013 Conservation Results.[34]

Caviat:

The estimates produced by the models in this study are not purely gross achievable potential estimates, because the reference case includes some naturally occurring savings. In order to calibrate the model's reference case to the Utilities' load forecast, it was essential to make reasonable assumptions about what efficiency improvements customers would make during the study period, in the absence of new utility programs. The economic, upper achievable, and lower achievable potentials were all calculated from this reference baseline that includes some naturally occurring savings. If the results are then adjusted for net-to-gross ratios, the following adjustments are both being made in the model:

- Naturally occurring savings, from customers who would adopt the efficiency measures in the absence of new utility programs, are being accounted for in the reference case.
- Free-ridership, from customers who participate in a program but would have adopted the efficiency measures without its influence, are being accounted for in the net-to-gross ratio.

It appears likely that there is some double-counting between naturally occurring savings and free-ridership: some of the customers who would have adopted the measures naturally and some of the customers who would be free-riders in a program are actually the same people. Therefore, the exhibits shown below with net upper and lower achievable potential, are likely underestimates of the true net potential.

Results:

The net and gross achievable potential results are presented in the following four exhibits:

[33] Ontario Energy Board, *Total Resource Cost Guide.* October, 2006.
[34] Ontario Power Authority, *2013 Conservation Results*. December, 2014.

- Exhibit 80 shows the gross and net upper and lower achievable potential for energy efficiency, by measure for the year 2029, along with the net-to-gross ratios used
- Exhibit 81 shows the gross and net upper and lower achievable potential for demand reduction, by measure for the year 2029, along with the net-to-gross ratios used

At this time, net-to-gross ratios were not available for demand reduction programs in NL. Because these measures offer no financial advantages to the customer where time of use rates are not in use, free-ridership is assumed to be zero for these measures. The net-to-gross ratios are therefore assumed to be 1.0, and the net potential is equal to the gross potential.

Exhibit 80 Gross Versus Net Upper and Lower Achievable EE Potential by Measure, 2029

		Upper		Lower	
Measure	Assumed Net-to-Gross Ratio	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
Premium Efficiency Pump Control with ASDs	0.93	74,234	69,038	28,994	26,964
Premium Efficiency Fan Control with ASDs	0.93	60,528	56,291	22,793	21,197
Energy Management Information System (EMIS)	0.93	53,206	49,482	28,417	26,428
Optimization of Pumping System	0.93	47,588	44,257	16,959	15,772
High Efficiency Lights (LEDs)	0.70	44,304	31,013	29,597	20,718
Organizational Energy Management (EM Team)	0.93	41,470	38,567	11,200	10,416
Correctly Sized Pumps: Impeller Trimming or Pump Selection	0.93	23,857	22,187	4,431	4,121
Sub-Metering	0.93	20,060	18,656	7,595	7,063
Operation and Maintenance (O&M) Program Supporting Efficiency	0.93	19,809	18,423	13,645	12,690
Process Optimization Efforts - Pulp and Paper	0.00	16,123	0	13,443	0
Integrated Plant Control System	0.93	14,750	13,718	6,408	5,959
Process Heat Recovery to Preheat Makeup Water	0.93	14,047	13,063	4,891	4,548
Air Leak Survey and Repair	0.90	11,475	10,328	8,267	7,440
Premium Efficiency ASD Compressor	0.90	10,925	9,832	4,945	4,451
Correctly Sized Fans: Impeller Trimming or Fan Selection	0.93	10,009	9,308	3,147	2,926
Advanced 'Predictive' Process Control Systems	0.00	9,326	0	2,736	0
Optimized Motor Control	0.93	7,235	6,729	3,168	2,946
Optimized Distribution System (Incl. Pressure and Air End-Uses)	0.93	6,804	6,328	3,785	3,520
Optimized Distribution System (Incl. Pressure Losses)	0.93	6,803	6,327	3,047	2,834

Exhibit 80 Continued: Gross Versus Net Upper and Lower Achievable EE Potential by Measure, 2029

		Upper		Lower	
Measure	Assumed Net-to-Gross Ratio	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
Automated Lighting Controls	0.80	4,887	3,909	4,013	3,211
Insulation	0.75	4,439	3,329	2,245	1,684
Process Optimization Efforts - Mining and Processing	0.93	4,090	3,804	2,779	2,584
High-Efficiency Lighting Design	0.80	3,818	3,054	2,462	1,969
Correctly Sized Motors	0.93	3,377	3,141	1,024	952
Premium Efficiency Pump Motor	0.75	3,099	2,324	1,175	881
Premium Efficiency Motors	0.75	3,087	2,315	1,363	1,022
Optimized Conveyor Motor Control	0.93	2,988	2,779	1,358	1,263
Premium Efficiency Refrigeration Control System and Compressor Sequencing	0.93	2,586	2,405	707	658
Premium Efficiency Motors for Fans and Blowers	0.75	2,262	1,697	874	655
Use Cooler Air from Outside for Make Up Air	0.93	2,226	2,070	1,367	1,271
Automated Temperature Control	0.93	2,070	1,925	1,461	1,359
Reduced Temperature Settings	0.93	2,045	1,901	1,476	1,373
High Efficiency Chiller	0.90	1,470	1,323	794	714
Free Cooling	0.93	1,287	1,197	661	615
High-Efficiency Packaged HVAC	0.93	1,285	1,195	317	295
Premium Efficiency Conveyor Motors	0.75	1,010	758	458	343
Synchronous Belts	0.93	990	920	448	417
Smart Defrost Controls	0.93	923	858	240	223
Optimized Sizes of Air Receiver Tanks	0.93	865	805	664	617
Improve Insulation of Refrigeration System	0.93	801	745	170	158
Improved Ice Production System	0.93	486	452	122	113
Air Compressor Heat Recovery	0.93	411	382	96	90
Optimized Distribution System	0.93	410	381	139	129
Chiller Economizer	0.93	379	353	129	120
Heat Pumps	0.93	330	307	61	56
Sequencing Control	0.93	319	297	207	193
Floating Head Pressure Controls	0.93	207	193	56	52
Ventilation Optimization	0.93	195	181	0	0
Air Curtains	0.93	75	70	20	19
High Efficiency Oven/Dryer/Furnace/Kiln	0.93	38	35	7	6
Process Optimization Efforts - Fishing and Fish Processing	0.93	6	6	4	4
Ventilation Heat Recovery	0.85	1	1	0	0
Warehouse Loading Dock Seals	0.75	0	0	0	0

Exhibit 80 Continued: Gross Versus Net Upper and Lower Achievable EE Potential by Measure, 2029

		Upper		Lower	
Measure	**Assumed Net-to-Gross Ratio**	**Gross Upper Achievable Potential (MWh/yr.)**	**Net Upper Achievable Potential (MWh/yr.)**	**Gross Lower Achievable Potential (MWh/yr.)**	**Net Lower Achievable Potential (MWh/yr.)**
Improved Building Insulation	0.00	0	0	0	0
HVAC Air Curtains	0.00	0	0	0	0
Process Optimization Efforts - Oil Refining	0.00	0	0	0	0
Grand Total	0.86	545,014	468,657	244,363	203,042

Exhibit 81 Gross Versus Net Upper and Lower Achievable Demand Reduction Potential by Measure, 2029

		Upper		Lower	
Measure	**Assumed Net-to-Gross Ratio**	**Gross Upper Achievable Potential (MWh/yr.)**	**Net Upper Achievable Potential (MWh/yr.)**	**Gross Lower Achievable Potential (MWh/yr.)**	**Net Lower Achievable Potential (MWh/yr.)**
Operational changes for reduced peak load (DR Curtailments)	1.00	108	108	92	92
Peak Shifting through on-site storage	1.00	1	1	0	0
Power factor correction equipment	1.00	7	7	4	4
Grand Total	1.00	116	116	96	96

10 References

The sources listed below include references used in preparation of this report and additional resources likely to be helpful for research on energy consumption patterns and efficient technologies. Additional references on specific technologies can be found in the TRM Analysis workbooks, supplied as accompanying deliverables with this report.

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11 Glossary

Achievable Potential:

The portion of the economic conservation potential that is achievable through utility interventions and programs given institutional, economic and market barriers.

Avoided Cost:

By reducing electricity consumption and capacity requirements through the implementation of conservation and demand management programs, the NL utilities avoid the cost of having to buy electricity on the open market, contract for long term supply, and/or build and run new generation facilities. This avoided cost is used to develop a benchmark against which the cost of energy efficiency measures can be compared.

Base Year:

The base year for the 2015 CDM potential assessment is the 2014 sales for the two utilities. This number is derived from 2014 sales and forecast 2014 electric energy and capacity requirements as is explained in each report.

Benchmark for Economic Analysis:

The study established benchmarks for the economic cut-off for new avoided electrical supply on each of the different supply systems in NL. These values were selected to provide the CDM potential assessment with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost-effective over time. The following values were used:

Year	Avoided Cost per kWh		
	Island Interconnected	Labrador Interconnected	Isolated
2014	$0.11	$0.04	$0.21
2017	$0.13	$0.04	$0.23
2020	$0.05	$0.05	$0.26
2023	$0.06	$0.05	$0.29
2026	$0.07	$0.06	$0.34
2029	$0.08	$0.07	$0.37

Cost of Conserved Energy (CCE):

The CCE is calculated for each energy-efficiency measure. The CCE is the annualized incremental capital and operating and maintenance (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.

Cost of Electric Peak Reduction (CEPR):

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

Conservation and Demand Management (CDM):

CDM is the influencing of customers' electricity use to obtain desirable and quantifiable changes in that use. For example, CDM comprises such cooperative joint customer and utility initiatives as peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, flexible load shape, customer on-site generation and other similar activities.

Economic Potential:
The Economic Potential is the savings in electricity consumption due to energy efficient measures whose Cost of Conserved Energy (CCE) is less than or equal to the Benchmark for Economic Analysis.

Effective Measure Life (EML):
The estimated median number of years that the measures installed under a program are still in place and operable. EML incorporates: field conditions, obsolescence, building remodelling, renovation, demolition, and occupancy changes.

Electricity Audit:
An on-site inspection and cataloguing of electricity-using equipment/buildings, electricity consumption and the related end uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for CDM program design, and identifying specific energy savings projects.

Electric Capacity:
The maximum electric power that a device or network is capable of producing or transferring.

Electricity Conservation:
Activities by utilities or electricity users that result in a reduction of electric energy use without adversely affecting the level or quality of energy service provided. Electricity conservation measures include substitution of high-efficiency motors for standard efficiency ones, occupancy sensors in office buildings, insulation in residences, etc.

Electricity Efficiency:
The ratio of the useful energy delivered by a dynamic system to the amount of electric energy supplied to it.

Electric Energy:
Energy in the form of electricity. Energy is the ability to perform work. Electric energy is different from electric power. Electric energy is measured in kilowatt-hours, megawatt-hours or gigawatt-hours.

Electricity Intensity:
Electric energy use measured per application or end use. Examples would include kilowatt-hours per square meter of lit office space per day, kilowatt-hours per tonne of pulp produced, and kilowatt-hours per year per residential refrigerator. Electricity intensity increases as electricity efficiency decreases.

Electric Power:
The rate at which electric energy is produced or transferred, usually measured in watts, kilowatts and megawatts.

End use:
The services of economic value to the users of energy. For example, office lighting is an end use, whereas electricity sold to the office tenant is of no value without the equipment (light fixtures, wiring, etc.) necessary to convert the electricity into visible light. End use is often used interchangeably with energy service.

Energy Service:
An amenity or service supplied jointly by energy and other components such as buildings, motors and lights. Examples of energy services include residential space heating, commercial refrigeration, paper production, and lighting. The same energy service can frequently be supplied with different mixes of equipment and energy.

Financial Incentive:
Certain financial features in the utility's conservation and demand management programs designed to motivate customer participation. These may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate in a specific conservation and demand management measure or technology.

Flexible Load Shape:
This is utility action to present customers with variations in service quality in exchange for incentives. Programs involved may be variations of interruptible or curtailable load, concepts of pooled, integrated energy management systems, or individual customer load control devices offering service constraints.

Gigawatt-hour (GWh):
One gigawatt-hour is one million kilowatt-hours.

Integrated Planning or Integrated Resource Planning (IRP):
See Supply Planning.

Integrated Electricity Planning (IEP):
See Supply Planning.

Kilowatt (kW):
One thousand watts; the basic unit of measurement of electric energy. One kilowatt-hour represents the power of one thousand watts (one kilowatt) for a period of one hour. A typical non-electrically heated detached home in NL uses about 10,700 kWh per year. A four foot fluorescent lamp in an office might use about 100-200 kWh per year and a large coal-fired plant might produce about three billion kWh per year.

Levelized Cost of Conservation (LCC):
The LCC is calculated for each energy efficiency measure. The LCC is the annualized incremental capital and O&M cost of the measure divided by the annual energy conserved, excluding any administrative or program costs. The LCC represents the cost of generating or conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity. In the context of industrial energy efficiency measures, it is essentially the same as the cost of conserved energy (CCE), which is the term used in this report.

Load Forecast:
This is a forecast of electricity demand over a specified time period. Long-term load forecasts usually pertain to a 10 to 20-year period. In the case of NL, the load forecast assumes a specific set of rates or prices for electricity and competing energy forms, as well as many other economic variables. In addition, forecasts of electricity conserved through CDM programs are incorporated into the Supply Planning process.

Load Research:
Research to disaggregate and analyze patterns of electricity consumption by various sub-sectors and end uses is defined as load research. Load research supports the development of the load forecast and the design of conservation and demand management programs.

Load Shape:
The time pattern and magnitude of a utility's electrical demand.

Load Shifting:
Utility program activity to shift demand from peak to off-peak periods is defined as load shifting.

Measure Total Resource Cost (TRC):
The measure TRC calculates the net present value of energy savings that result from an investment in an energy-efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and O&M costs. This calculation includes, among others, the following inputs: the avoided electricity supply costs, the life of the technology, and the selected discount rate, which in this analysis has been set at 7%.

A measure with a positive measure TRC value is included in subsequent stages of the analysis, which consists of the Economic and Achievable Potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

Megawatt (MW):
One thousand kilowatts.

Natural Change in Electricity Intensity:
The future change in electricity intensity in a given end use that is expected to occur in the absence of conservation and demand management programs. In developing an estimate of natural change in electricity intensity it is necessary to make an explicit assumption about the future prices of electricity and competing fuels.

Peak Clipping:
Utility program activity to reduce peak demand without reducing demand at other times of the day or year.

Peak Demand:
Peak demand is the maximum electric power required by a customer or electric system during a short time period, typically one hour. The peak is the time (usually of day or year) at which peak demand occurs. The peak period of interest in NL is from 7 a.m. to noon and 4 p.m. to 8 p.m. on the four coldest days of the winter, for a total of 36 hours.

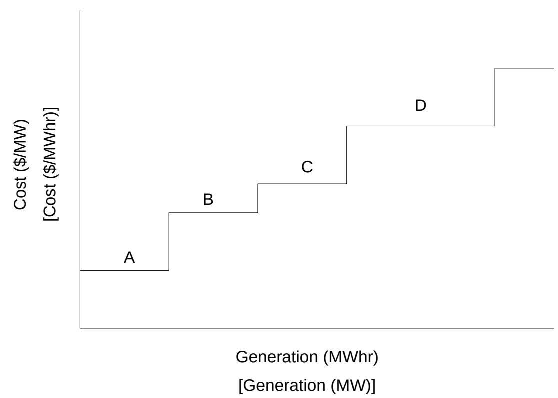
Rate Structure:
The formulas used to calculate charges for the use of electricity. For example, the present rate structures for both NL utilities for most industrial customers consists of a fixed monthly charge and charges for both electric energy usage and monthly peak demand usage.

Reference Case:
Provides a forecast of electricity sales that includes natural conservation (that which would occur in the absence of CDM programs) but no impacts of utility CDM programs. The reference case for the study is based on the 2014 base year and the Utilities' Load Forecast.

Sector:
A group of customers having a common type of economic activity. This CDM potential assessment includes the Residential, Commercial, and Industrial sectors.

Sub-sectors:
A classification of customers within a sector by common features. Industrial sub-sectors are generally grouped by size (electrical intensity) and type of processes. Commercial sub-sectors are generally by type of commercial service (retail and wholesale trade). Residential sub-sectors are by type of home (single-family dwelling or apartment). Commercial sub-sectors are generally by type of commercial service (retail and wholesale trade).

Supply Curves:
A graph that depicts the volume of energy at the appropriate screened price in ascending order of cost. Steps A through D below represent programs options, or technologies arranged as a supply curve.



Supply Planning:
The process of long-term planning of electricity generation and associated transmission facilities, in combination with supply reductions made possible through conservation and demand management, in order to meet forecast demands. Supply Planning in NL is done in a framework that recognizes economic, financial, environmental and social costs, risks, and impacts.

Technical Efficiency:
Efficiency of a system, process, or device in achieving a certain purpose, measured in terms of the physical inputs required to produce a given output. In the context of electricity conservation the relevant input is electric energy.

Technology-Based Potential:
Energy and or capacity/demand savings realized through the implementation of energy-efficiency technologies.

Watt:
The basic unit of measurement of electric power.

Appendix A Background-Section 3: Base Year Electricity Use

Introduction

Appendix A provides additional detailed information related to each of the major steps employed to generate the profile of Industrial sector Base Year electricity use. The major steps involved are:

- **Step 1:** Determine total base year consumption
- **Step 2:** Develop electricity end-use profiles by sub-sector and region
- **Step 3:** Estimate breakdown of electricity consumption for the study Base Year of 2014

A.1 Step 1: Determine Total Base Year Consumption

Utility sales data for 2014 was used to establish the base year consumption by sub-sector and region. The segmentation of data received from the Utilities is discussed below.

The Large industrial category is modeled as three separate sub-sectors, but the results are presented together to maintain customer confidentiality. The sales data used to build up the base case for each sub-sector was received from the Utilities as follows:

- **Pulp and Paper** - This sub-sector includes consumption for the following facility:
  - Corner Brook Pulp & Paper

- **Oil Refining** - This sub-sector includes consumption for the following facility:
  - North Atlantic Refining

- **Mining and Processing** - This sub-sector includes consumption for the following facilities:
  - Iron Ore Company of Canada
  - Vale - Long Harbour
  - Praxair - Long Harbour
  - All small-medium Mining metered accounts (by rate class for each region)

The small-medium sub-sectors used in the modeling are indicated below. Along with each of these sub-sectors are the categories for which the Utilities provided sales data (which also guided the sub-sector selection):

- **Fishing and Fish Processing** - This sub-sector includes consumption for the following facilities:
  - All small-medium Fishing and Fish Processing accounts (by rate class for each region)

- **Manufacturing** - This sub-sector includes consumption for the following facilities:
  - All small-medium Manufacturing accounts (by rate class for each region)

- **Water Systems and Others** - This sub-sector includes consumption for the following facilities:
  - All small-medium 'Comm & Util - Water Systems' accounts (by rate class for each region)
  - All small-medium Sawmill accounts (by rate class for each region)

The 2014 consumption data provided for each of these categories was summed to get sub-sector totals in each region. Rate class divisions were also captured with the Data Manager tool, to enable additional analysis of this data.

Once again, each of these sub-sectors is modeled separately for each region. However, the base year consumption presented below in Exhibit A 1 combines all regions and all Large Industrial sub-sectors.

Exhibit A 1 Base Year Industrial Utility Data from 2014, by Sub-Sector

Sub-Sectors	2014 Consumption (MWh)	Number of Metered Accounts	Portion of Consumption
Large Industry	2,828,377	132	89%
Fishing and Fish Processing	128,368	599	4%
Manufacturing	136,074	1,027	4%
Water Systems and Other	76,585	1,425	2%
Grand Total	**3,169,404**	**3,183**	100%

Note that the number of metered accounts included in the diagram above is not reflective of the number of facilities. These account numbers include separate accounts for different meters, and a lot of these industrial facilities have multiple meters. Also note that the metered account numbers presented for Large Industry also contain the small-medium component of the Mining sub-sector, which accounts for all but five of these accounts.

A.2 Step 2: Develop Electricity End Use Profiles

The next major task involved the development of electricity end use profiles for each of the six sub-sectors covered in this study. These profiles indicate what portion of a facility's total electricity consumption is consumed by each of the different types of equipment (end uses) at the facility.

Separate end use breakdowns were developed for each Large Industrial facility and for each of the small-medium sub-sectors. These breakdowns were then combined through weighted averages to produce a single representative breakdown for each sub-sector in each region, based on the relative consumption associated with each breakdown in the base year.

Exhibit A 3 summarizes the sources used to develop the end use profiles for each of the sub-sectors.

Exhibit A 2 Data Sources for End Use Breakdown Development

Sub-Sector	Sources for End Use Breakdowns
Pulp and Paper	Based on a survey completed by Corner Brook Pulp & Paper in January 2015. Note that refiners and agitators are included in the 'other motors' category.
Oil Refining	Based on a survey completed by North Atlantic Refining in January 2015.
Mining and Processing	Based on a consumption-weighted average of breakdowns from the following sources: ▪ A survey completed by the Iron Ore Company of Canada in January 2015. ▪ A survey completed by Vale - Long Harbour in January 2015. ▪ An estimate of cryogenic air separation unit electricity consumption. ▪ A breakdown developed with local industry experts as part of the 2008 NL study, and mining breakdowns from past ICF studies.
Fishing and Fish Processing	Based on four Commercial End Use Survey audits of relevant NL facilities, the Fish and Fish Processing breakdown developed with local industry experts as part of the 2008 NL study, and on relevant breakdowns from past ICF studies in similar regions.
Manufacturing	Based on three Commercial End Use Survey audits of relevant NL facilities, the manufacturing breakdown developed with local industry experts as part of the 2008 NL study, and on relevant breakdowns from past ICF studies in similar regions.
Water Systems and Other	Based on a Commercial End Use Survey audit of one relevant NL facility, a breakdown developed by ICF based on past energy audits and regional water system studies, as well as ICF's understanding of energy consumption in sawmills. Note that more than 95% of consumption in this sub-sector is made up by Water Systems.

Once again, these profiles map proportionally how much electricity is used by each of the end uses for each sub-sector. Exhibit A 3 summarizes the end use profiles for each of the sub-sectors. While this exhibit presents an average breakdown representing all regions of this study, the modeling does use separate breakdowns for different regions, where the differences between each region are clearly understood (Large industry).

Exhibit A 3 Sub-Sector Electricity End Use Profiles

Level 1	Level 2	Level 3	Large Industry	Fishing and Fish Processing	Manufacturing	Water Systems and Other
Process	Process heating		10%	8%	3%	3%
	Process cooling		0%	53%	6%	0%
	Motors and motor driven equipment	Air compressors	4%	3%	10%	1%
		Pumps	18%	5%	6%	62%
		Fans and blowers	16%	1%	8%	9%
		Conveyors	5%	4%	2%	0%
		Other motors	18%	4%	29%	10%
	Process Specific		24%	2%	3%	8%
Comfort	Lighting		2%	7%	15%	3%
	HVAC		2%	12%	17%	3%
Other			0%	1%	1%	1%

A.3 Step 3: Estimation of Base Year Electricity Consumption

The next step was to calculate how the base year electricity is consumed, based on the previously established total base year consumption and the base year electricity end use profiles. Electricity consumption in each sub-sector in each region is multiplied by the appropriate end use breakdown.

For example, the end use electricity consumption for each sub-sector is calculated by the following equation:

$$EndUse_{1\text{-}2} = Sub\text{-}Sector_{2} * Breakdown_{1\text{-}2}$$

Where: $EndUse_{1\text{-}2}$ *= Electricity consumption for end use type #1 in sub-sector #2*
$Sub\text{-}Sector_{2}$ *= Total annual consumption (kWh) for sub-sector #2*
$Breakdown_{1\text{-}2}$*= End use profile breakdown (%) for end use type #1 in sub-sector #2*

The Industrial sector consumption is assessed based on total electricity consumption by sub-sector, not by unit-energy consumption per plant or piece of equipment. For this reason, the Industrial sector only considers electricity consumption, unlike the Residential and Commercial sectors, and does not track natural gas or other fuel used in these facilities. The profiles or sub-sector archetypes that were used in the model to calculate the consumption by end use, sub-sector, and region, were based on plant electricity consumption, not plant energy consumption. As such, some modeling parameters, such as saturations of electrical equipment and fuel share, are kept at 100% for the Industrial sector.

This approach is preferred in the Industrial sector where there is larger variability between facilities and production metrics, even within a given sub-sector. Basing the analysis off actual base year data also eliminates the need for iterative calibration of base year model inputs, required in the other sectors to have them match sales data.

Exhibit A 4 summarizes the base year electricity consumption by end use and sub-sector. Once again, this is a summary of the results for all regions, where the model uses separate end use profiles to calculate these breakdowns independently for each region. So while this table matches Exhibit 7 (which appears in Section 3 of the main body of the report), equivalent base year electricity consumption exhibits are available in Data Manager for the Island Interconnected, Labrador Interconnected, and Isolated regions. This section also does not replicate the pie charts presented in Section 3. Those graphs, along with other regional data are available in, or can be created using, the Data Manager.

Exhibit A 4 Electricity Consumption by End Use and Sub-Sector in the Base Year (2014), All Regions (MWh/yr.)

Sub-Sector	Reference Case Consumption (MWh/yr.)					
	Air compressors	Comfort HVAC	Conveyors	Fans and blowers	Lighting	Other
Large Industry	114,864	63,253	139,539	451,374	66,231	1,816
Fishing and Fish Processing	3,662	15,927	5,100	1,266	8,878	1,663
Manufacturing	13,359	22,895	2,544	11,100	20,518	1,061
Water Systems and Other	742	2,013	39	7,221	2,437	883
Grand Total	132,627	104,087	147,222	470,962	98,064	5,424

Sub-Sector	Reference Case Consumption (MWh/yr.)					
	Other motors	Process cooling	Process heating	Process specific	Pumps	Grand Total
Large Industry	516,357	3,880	271,244	681,186	518,634	2,828,377
Fishing and Fish Processing	5,339	68,032	9,830	2,014	6,656	128,368
Manufacturing	39,644	7,951	4,121	4,759	8,121	136,074
Water Systems and Other	7,692	-	2,228	5,814	47,516	76,585
Grand Total	569,033	79,863	287,423	693,774	580,927	3,169,404

Appendix B Background-Section 4: Base Year Peak Load

Introduction

Appendix B provides additional detailed information related to each of the major steps employed in the generation of the Industrial sector Base Year peak loads. The discussion is organized as follows:

- Overview of peak load methodology
- Segmentation of industrial sub-sectors
- Hours-Use factors
- Detailed results.

B.1 Overview of Peak Load Profile Methodology

As noted in the main text, development of the electric peak load estimates employs four specific factors as outlined below:

- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. 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 relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.

- **Peak Day Factor:** This factor reflects 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.

- **Per Unit Hourly Factor:** The relationship of load among different hours of the day for each day type (weekday, weekend day, peak day) and for each month reflects the operating hours of the electric equipment or end use within residences by sub-sector. For example, for lighting, this would be affected by time of day, season (affected by daylight), and room type, where applicable. For the Base Year, lighting is treated on an aggregate basis by total facility.

The four factors (sets of ratios) defined above provide the basis for converting annual energy to any hourly demand specified including the grouping of hours used in the four peak periods defined in this study. Exhibit B 1, below, illustrates how each of the above four factors is applied sequentially to a known annual energy value to produce a peak load value, defined as a specific peak period. In the example, the Annual Peak Hour is used.

Exhibit B 1 Illustrative Application of Annual Energy to Peak Period Value Factors

The Annual Peak Hour demand is computed based on the December peak day at 6 pm. The NL peak is assumed to occur in December, although the model allows for a January peak, as well. The following steps are required:

- **Step 1:** The monthly usage allocation factor for December is applied to the annual energy use to calculate December energy use.
- **Step 2:** The average weekday in December is calculated based on the formula shown below, which adjusts the average day type use to reflect any difference in typical weekend use versus typical weekday use.

  1 / [Days in Month * (5/7 + 2/7 * Weekend Ratio)]

- **Step 3:** The peak day factor is then applied to the average weekday electric energy use to determine the peak day use (as defined by the NL utilities).
- **Step 4:** The peak hour is then calculated based on allocating the peak day use according to the per unit hourly load factor for a peak winter (December) day, using the percentage of use in that hour versus the daily usage for the December peak day.

It should be noted that the methodology shown in Exhibit B 1 produces aggregate diversified average loads for all customers or end uses in the defined sub-sector.

Exhibit B 2 provides a specific numeric example for the calculation of Annual Peak Hour demand (kW). The example presented in Exhibit B 2 is for electric water heating in a manufacturing plant. The example shows how the annual consumption of 33,000 kWh can be converted to a peak demand value for the Annual Peak Hour by the calculation of a corresponding hours-use value.[35]

Exhibit B 2 Sample Hours-Use Calculation for Electric Water Heating

Annual Peak Hour (7 pm Winter Peak) =

$$\frac{Annual\ kWh\ \times Mo.Allocation}{Days\ in\ Month \times \left[\frac{5}{7} + \left(\frac{2}{7} \times Weekend\ Ratio\right)\right]} \times Peak\ Day\ Factor \times Peak\ Hour\ \%\ Daily\ kWh$$

Annual Peak Hour (7 pm Winter Peak) =

$$\frac{33{,}000\ [\text{Ann. kWh}] \times\ 8.72\%\ [\text{Mo. Alloc.}]}{31 \times \left[\frac{5}{7} + \left(\frac{2}{7} \times 1.0\ [\text{Dec. Wkend Ratio}]\right)\right]} \times 1.0\ [\text{Dec. Peak Day Fact.}] \times 0.035022\ [\text{Peak Hr \% Day kWh}]$$

= 3.25 kW

$$\frac{33{,}000\ [\text{annual kWh}]}{3.25\ [\text{7 pm Winter Peak}]} = 10{,}151\ [\text{Annual Peak Hour Hours Use}]$$

This means that any applicable manufacturing plant annual water heating kWh can be converted to demand at winter peak hour (7 pm) by dividing by 10,151.

[35] This is a sample calculation that does not use numbers or a peak period relevant to this study.

For other peak periods, such as the morning and evening periods of the four coldest winter days used in this study, different sets of hours are used, with calculations corresponding to the above steps. The resulting relationship between annual use and peak can be defined in terms of an hours-use factor, the ratio of the annual energy to the peak, for the defined peak period.

B.2 Segmentation of Industrial Sub-Sectors

The Industrial sector segmentation used to generate the electric peak load profiles is the same as that used for electric energy use. That is, there is a load profile that corresponds to each combination of sub-sector and end use.

Exhibit B 3 shows the industrial sub-sectors and end uses that were addressed.

Exhibit B 3 Industrial Sub-Sectors Used for Electric Peak Load Calculations

Sub-Sector (Mining and Processing, Pulp and Paper, Oil Refining, Fishing and Fish Processing, Manufacturing, and Water Systems and Other)
End Use (Process heating, Process cooling, Air compressors, Pumps, Fans and blowers, Conveyors, Other motors, Process specific, Lighting, Comfort HVAC, and Other)

B.3 Hours-Use Factors

Exhibit B 4 describes the assumptions and data sources for the load profile factors that were used to develop the corresponding hours-use factors. To produce a demand for a combination of sub-sector and end use, the corresponding annual energy is divided by the hours-use factor for the peak period for the applicable load shape. For certain end uses that are assumed to have no usage during the winter months (e.g., space cooling) the hours-use values are considered infinite (noted by 1E+15), resulting in virtually zero demand when divided into annual energy.

Most of the studies referenced in the exhibit are the same as those used to develop hours-use factors for the CDM Potential Study completed for NL in 2008 and are also the same as those used for studies in other provinces. For most end uses, hours-use factors remain very stable from year to year and across jurisdictions, as long as the peak period of interest is the same. The amount of energy consumed varies from year to year and from place to place, but the shape of the load – when the energy is used – remains very similar.

In this analysis, therefore, the initial estimate of industrial peak demand used the hours-use factors from a similar study for another Canadian utility that ICF completed, since this approach had not been used in the industrial portion of the 2008 CDM Potential study for NL. The results were within a few percent of utility measured values. The team then calibrated the model by adjusting the hours-use factors for the weather-sensitive end uses (such as space heating) for all three sectors simultaneously, until the model peak demand output agreed closely with the Utilities' measured peak demand.

Exhibit B 4 Industrial End Use Load Shape Parameters

Load Shape #	End Use	Sub-Sector	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
3001	Process heating	All sub-sectors	Calculated in a past CDM study for 'All Industrials'	1.0 (24/7, based on Fleming Hours Use study)	1.0 Assumed	Flat – Past CDM study, Hours of Use Study by A. Fleming[36] 24

[36] Rochester Gas & Electric Company; 1991 DSM Evaluation Report Load Shape workpapers.

Exhibit B 4 Continued: Industrial End Use Load Shape Parameters

Load Shape #	End Use	Sub-Sector	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
						hours/day, 7 days/wk. 51 wks/yr.
3003	Process cooling	All sub-sectors	Calculated in a past CDM study for 'All Industrials'	RG&E retail refrigeration reflects 6-7days/wk operation from Fleming Study	RG&E retail refrigeration (summer >1)	RG&E retail refrigeration[37] modified to reflect 16 hrs/6-7days/50-51 weeks operation from Fleming Study
3005	Pumps	Large Industry	Calculated in a past CDM study for 'Non-agriculture Industrials'	1.0 assumed, reflects 7-day operation from Fleming Study	1.0 Assumed	Nearly flat, reflects 23/7/52 operation from Fleming Study
3006	Pumps	Small-Medium sub-sectors	Calculated in a past CDM study for 'Agriculture and Other industrials'	0.25 assumed, reflects 5-day operation from Fleming Study	1.0 Assumed	Nearly flat weekday, reflects 23/5/50 operation from Fleming Study
3008	Fans and Blowers	Large Industry	Calculated in a past CDM study for 'Non-agriculture Industrials'	0.6 assumed, reflects 5-7-day operation from Fleming Study	1.0 Assumed	Nearly flat, reflects 22/5-7/51 operation from Fleming Study
3009	Fans and Blowers	Small-Medium sub-sectors	Calculated in a past CDM study for 'Agriculture and Other industrials'	0.25 assumed, reflects 5-day operation from Fleming Study	1.0 Assumed	Nearly flat, reflects 22/5/51 operation from Fleming Study
3011	Conveyors and Other motors	Large Industry	Calculated in a past CDM study for 'Non-agriculture Industrials'	0.6 assumed, reflects 5-7-day operation from Fleming Study	1.0 Assumed	Somewhat flat, reflects 17/5-7/50-51 operation from Fleming Study
3012	Conveyors and Other motors	Small-Medium sub-sectors	Calculated in a past CDM study for 'Agriculture and Other industrials'	0.25 assumed, reflects 5-day operation from Fleming Study	1.0 Assumed	Somewhat flat, reflects 17/5/50 operation from Fleming Study
3014	Compressed air	Large Industry	Calculated in a past CDM study for 'Non-agriculture Industrials'	0.6 assumed, reflects 5-7-day operation from Fleming Study	1.0 Assumed	Mostly flat, reflects 19/5-7/50-52 operation from Fleming Study
3015	Compressed air	Small-Medium	Calculated in a past CDM study for 'Agriculture	0.25 assumed, reflects 5-day	1.0 Assumed	Mostly flat, reflects 19/5/50 operation from Fleming Study

37 Ibid.

Exhibit B 4 Continued: Industrial End Use Load Shape Parameters

Load Shape #	End Use	Sub-Sector	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
		sub-sectors	and Other industrials'	operation from Fleming Study		
3017	Process specific	Small-Medium sub-sectors	Calculated in a past CDM study for 'Agriculture and Other industrials'	0.25 assumed, reflects 5-day operation from Fleming Study	1.0 Assumed	Somewhat flat, reflects 16/5/51 operation from Fleming Study
3018	Process specific	Mining and Processing	Calculated in a past CDM study for 'Metal & Non-Metal Mining'	1.0 assumed, reflects 7-day operation from Fleming Study	1.0 Assumed	Somewhat flat, reflects 16/7/50 operation from Fleming Study
3019	Process specific	Pulp and Paper, Oil Refining	Calculated in a past CDM study for 'Petroleum, Paper, Other Heavy Industry'	0.85 assumed, reflects 6-7-day operation from Fleming Study	1.0 Assumed	Flat, reflects 24/6-7/50-51 operation from Fleming Study
3020	HVAC	Fishing and Fish Processing	RG&E health ventilation	0.76 – 0.86 from RG&E health ventilation	RG&E health ventilation	RG&E health ventilation - reflects 19/6/45 operation from Fleming Study
3021	HVAC	Pulp and Paper	RG&E office ventilation	App. 0.68 - 0.85 from RG&E office ventilation	RG&E office ventilation	RG&E office ventilation - reflects 12/7/52 operation from Fleming Study
3022	HVAC	All other sub-sectors	RG&E comm. Ventilation	1.0 assumed, reflects 7-day operation from Fleming Study	RG&E comm. Ventilation	RG&E comm. Ventilation - reflects 12-16/7/52 operation from Fleming Study
3024	Lighting	Fishing and Fish Processing	RG&E commercial lighting	0.85 assumed, reflects 6-day operation from Fleming Study	RG&E commercial lighting	RG&E commercial lighting, reflects 21/6/50 operation from Fleming Study
3025	Lighting	Oil Refining	RG&E health lighting	RG&E health lighting, reflects 6-7-day operation from Fleming Study	RG&E health lighting	RG&E health segment lighting, reflects 21/6-7/52 operation from Fleming Study
3026	Lighting	All other sub-sectors	RG&E office lighting	RG&E office. lighting, reflects 5-7-day operation from Fleming Study	RG&E office lighting	RG&E office lighting, reflects 16-22/5-7/52 operation from Fleming Study
3027	Other end uses	All sub-sectors	Calculated in a past CDM study for 'All Industrials'	RG&E Commercial Total	Approx. 1.1 - RG&E Comm. Total	RG&E Commercial Total, reflects 14-20/5-7/48-50 operation from Fleming Study

Exhibit B 4 Continued: Industrial End Use Load Shape Parameters

Load Shape #	End Use	Sub-Sector	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
3029	HVAC	Fishing and Fish Processing	RG&E health ventilation	0.76 – 0.86 from RG&E health ventilation	RG&E health ventilation	RG&E health ventilation - reflects 19/6/45 operation from Fleming Study
3030	HVAC	Pulp and Paper	RG&E office ventilation	App. 0.68 - 0.85 from RG&E office ventilation	RG&E office ventilation	RG&E office ventilation - reflects 12/7/52 operation from Fleming Study
3031	HVAC	All other sub-sectors	RG&E comm. Ventilation	1.0 assumed, reflects 7-day operation from Fleming Study	RG&E comm. Ventilation	RG&E comm. Ventilation - reflects 12-16/7/52 operation from Fleming Study
3033	HVAC	Fishing and Fish Processing	RG&E health ventilation	0.76 – 0.86 from RG&E health ventilation	RG&E health ventilation	RG&E health ventilation - reflects 19/6/45 operation from Fleming Study
3034	HVAC	Pulp and Paper	RG&E office ventilation	App. 0.68 - 0.85 from RG&E office ventilation	RG&E office ventilation	RG&E office ventilation - reflects 12/7/52 operation from Fleming Study
3035	HVAC	All other sub-sectors	RG&E comm. Ventilation	1.0 assumed, reflects 7-day operation from Fleming Study	RG&E comm. Ventilation	RG&E comm. Ventilation - reflects 12-16/7/52 operation from Fleming Study

Exhibit B5 shows the distinct hour-use values developed for each combination of peak period, sector, sub-sector, and end use employed in this study, as generated from the applicable load shape.

The hours-use value represents the divisor to convert annual energy (e.g., MWh) to that peak period demand. For example, dividing the annual electricity consumed for pumping in large industry by the hours-use value for the Annual Peak Hour (i.e., 9,210) will convert annual MWh to demand at the annual system peak hour (6 pm).

Exhibit B 5 Industrial Sector Load Shape Hours-Use Values

Code	Sector Type	Sub-Sector	Region	End Use	End Use Sub	Measure	Hours-Use Factor
3001	Ind	All	All	Process heating	All	Base	8,794
3003	Ind	All	All	Process cooling	All	Base	14,040
3005	Ind	Large Industry	All	Pumps	All	Base	9,210
3006	Ind	Small-Medium sub-sectors	All	Pumps	All	Base	18,340
3008	Ind	Large Industry	All	Fans and Blow ers	All	Base	13,200
3009	Ind	Small-Medium sub-sectors	All	Fans and Blow ers	All	Base	18,004
3011	Ind	Large Industry	All	Conveyors and Other motors	All	Base	11,744
3012	Ind	Small-Medium sub-sectors	All	Conveyors and Other motors	All	Base	16,317
3014	Ind	Large Industry	All	Compressed air	All	Base	12,150
3015	Ind	Small-Medium sub-sectors	All	Compressed air	All	Base	16,882
3017	Ind	Small-Medium sub-sectors	All	Process specific	All	Base	17,158
3018	Ind	Mining and Processing	All	Process specific	All	Base	7,194
3019	Ind	Pulp and Paper, Oil Refining	All	Process specific	All	Base	12,071
3020	Ind	Fishing and Fish Processing	Island	HVAC	All	Base	7,508
3021	Ind	Pulp and Paper	Island	HVAC	All	Base	7,834
3022	Ind	All other sub-sectors	Island	HVAC	All	Base	6,940
3024	Ind	Fishing and Fish Processing	All	Lighting	All	Base	8,173
3025	Ind	Oil Refining	All	Lighting	All	Base	8,894
3026	Ind	All other sub-sectors	All	Lighting	All	Base	12,766
3027	Ind	All sub-sectors	All	Other end uses	All	Base	8,677
3029	Ind	Fishing and Fish Processing	Labrador	HVAC	All	Base	8,943
3030	Ind	Pulp and Paper	Labrador	HVAC	All	Base	9,332
3031	Ind	All other sub-sectors	Labrador	HVAC	All	Base	8,267
3033	Ind	Fishing and Fish Processing	Isolated	HVAC	All	Base	7,508
3034	Ind	Pulp and Paper	Isolated	HVAC	All	Base	7,834
3035	Ind	All other sub-sectors	Isolated	HVAC	All	Base	6,940

Since the Utilities do not conduct regular class or end-use load analysis studies, there is no actual total (or sub-sector) end-use load profile upon which to calibrate the load profile models developed for this study. The best option for calibrating NL-specific load profile parameters is the weather-sensitive loads, since that is the most area specific.

Since separately metered space heating end-use load data was not available from the Utilities, normal weather for the past 10 years was used to determine monthly allocations, and weekend/weekday ratios were developed from similar studies for another Canadian utility.

For peak day factors, analysis of the past 30 years' average vs. peak weather conditions (in heating degree days) for St. John's was analyzed to determine typical peak day factors for normal weather, which ranged from about 1.4 to 1.5 for winter months. For non weather-sensitive end uses, a factor of 1.0 was assumed, absent specific load study data.

Hours-use factors for weather sensitive end uses (codes 3020, 3021, 3022, and 3029 through 3035 above, along with similar end uses in the residential and commercial sectors) were adjusted to calibrate the model's estimate of peak load to the utility's recorded averages during the peak period, for each of the three regions.

B.4 Detailed Results

The following exhibit shows peak demand by sub-sector and end use for the peak period identified for this study.

Each of these sub-sectors is modeled separately for each region. However, the base year consumption presented below in Exhibit B6 combines all regions and all Large Industrial sub-sectors.

Exhibit B 6 Industrial Sector Base Year (2014) Peak Hour Demand, by Sub-Sector and End Use (MW)*

Sub-Sectors	Process specific	Pumps	Other motors	Fans and blowers	Process heating	Comfort HVAC	Conveyors	Air compressors	Lighting	Process cooling	Other
Large Industry	61	56	44	34	31	8	12	9	6	0	0
Fishing and Fish Processing	0	0	0	0	1	2	0	0	1	5	0
Manufacturing	0	0	2	1	0	3	0	1	2	1	0
Water Systems and Other	0	3	1	0	0	0	0	0	0	-	0
Grand Total	62	60	47	35	33	14	12	11	8	6	1

*Results are measured at the customer's point-of-use and do not include line losses. Any differences in totals are due to rounding.

Appendix C Background-Section 5: Reference Case Electricity Use

Introduction

Appendix C provides additional detailed information related to each of the major steps employed to generate the profile of Industrial Sector Reference Case electricity use. The major steps involved are:

- **Step 1:** Estimate consumption growth by sub-sector from Utility load forecasts
- **Step 2:** Estimate naturally-occurring changes to efficiency for each end use
- **Step 3:** Adjust end use breakdowns at each milestone to account for changes from relative levels of growth between certain facilities and from naturally-occurring changes.

C.1 Step 1: Estimation of Growth from Utility load forecasts

The Utilities provided the following load forecast data:

- Individual 2017 and 2019 consumption forecasts for each of the 5 large industrial facilities
- Forecasts by milestone year for each region covering combined commercial and small-medium industrial rate classes

For the five large industrial facilities the reference case consumption growth expectations are based on the required increase from base year levels to meet the 2017 load forecast, for 2017 growth, and based on meeting the 2019 load forecast for 2020 growth. After 2020 the reference case consumption is considered to remain unchanged for these facilities. This assumes that none of the large industries will close, and that no new large industrial facilities will be constructed. The Utilities agreed with this approach being the best option to dealing with uncertainty.

Of the small-medium sub-sectors, Water Systems is the only one where growth was definitely expected by the Utilities. Outside of this sub-sector it is more difficult to predict with accuracy whether there will be growth or plant closures. In general, expectations from the Utilities are for more commercial sector growth than small-medium industrial growth. This is important because the load forecast provided by the Utilities did not separate growth expectations for the small-medium industrial sub-sectors from growth in commercial sub-sectors. The approach agreed upon with the Utilities was to consider that Water Systems would grow at the same pace as the Commercial Sector, with minimal growth expectations for Manufacturing and Fish Processing throughout the study.

To achieve this, the load forecast consumption growth was split up by rate class. A portion of the incremental commercial-industrial consumption was assigned to Water Systems in every rate class where it was included in the base year, based on the relative size of base year Water System consumption to the total. In performing this exercise the Commercial Sector noted some rate classes with expectations for growth (or shrinkage) which were entirely industrial consumption in the base year. These findings were backed up by comments in the load forecast document (references to fish plants, mining activities, etc) so a small level of growth was included in certain small-medium mining and fishing rates classes, to ensure that the load forecast level could be properly met. The balance of the load forecast's consumption growth was attributed to the Commercial Sector, such that the total load forecast levels should equal the model reference case.

Exhibit C1 provides the resulting electricity consumption forecast for the milestone years of this study. The most significant changes are seen in the Large Industry sub-sector, which experiences significant growth towards the beginning of the study period.

Exhibit C 1 Combined Industrial Load Growth by Sub-Sector, (MWh/yr.)

Sub-Sectors	2014	2017	2020	2023	2026	2029
Large Industry	2,828,377	3,545,751	3,610,520	3,611,310	3,612,167	3,613,020
Fishing and Fish Processing	128,368	128,129	128,005	127,889	127,777	127,669
Manufacturing	136,074	135,714	135,714	135,024	134,693	134,371
Water Systems and Other	76,585	76,818	76,818	78,920	79,717	80,613
Grand Total	**3,169,404**	**3,886,412**	**3,886,412**	**3,953,143**	**3,954,354**	**3,955,674**

C.2 Step 2: Estimation of Naturally-Occurring Changes

For the purposes of this study, “natural” changes to electricity consumption are defined as those changes to electricity usage patterns that occur without incentive or other intervention.

The main factor being assessed in the Industrial Sector are expectations for natural stock penetration by more efficient equipment, but natural-occurring improvements in equipment efficiency are also indirectly considered.

The industrial analysis differs from the commercial and residential sectors in that a reference case of measure adoption is estimated, after the TRM workbooks are finalized and base year measure penetration is established. This reference case considers what level of adoption, beyond the base year penetration, measures considered in this study might be adopted without intervention. From this reference case penetration an amount of natural savings (%) will be estimated for each end use. While this approach focuses on measure adoption levels, factors such as recent improvements in LED lighting efficacy and their rapidly declining costs will influence these reference case adoption expectations.

Since the total reference case electricity consumption is calibrated to the Utilities’ forecasts, the impacts of natural conservation did not reduce the overall consumption level. Instead, their impact changes the relative importance of different end uses over the course of the study period.

The naturally occurring changes will alter the end use breakdowns used for different milestones of the study, to make some end uses represent a larger or smaller portion of a facility’s electricity consumption over the study’s time frame. For example, if technology that was 5% more efficient than previous equipment was expected to be installed in all end uses, each end use would maintain its same portion of total electricity consumption. However, if lighting consumption is expected to decrease by 2% per year, while the rest of end uses do not see their efficiencies improve, then lighting will over time represent a smaller portion of a facility’s electricity consumption.

Exhibit C 2 illustrates how the natural savings end use factors were developed. The level of natural savings was estimated by multiplying the natural adoption expectations used in the economic potential scenario by the percentage of end use savings in the economic potential scenario. Then, end use factors were calculated such that applying each factor to its respective reference case consumption will leave the reference case total unchanged. The improvements will be assumed to phase in evenly over the study period, so a fraction of this factor is applied to end use breakdowns at each of the study’s five milestone periods.

Exhibit C 2 Development of Natural Conservation End Use Factors

End Use	Reference Case Consumption 2029 (MWh)	Natural Savings, 2029 (%)	Remaining Portion of Reference Case (MWh)	End-Use Factor
Pumps	731,491	2%	717,474	0.994
Process specific	961,594	0%	956,837	1.008
Process heating	345,232	0%	344,065	1.010
Process cooling	106,481	1%	105,254	1.001
Other motors	615,489	0%	612,468	1.008
Other	5,683	0%	5,683	1.013
Lighting	118,789	12%	105,028	0.896
Fans and blowers	540,384	1%	532,718	0.999
Conveyors	217,317	0%	216,438	1.009
Comfort HVAC	137,695	1%	136,258	1.002
Air compressors	175,517	2%	172,618	0.996
Grand Total	3,955,674		3,904,840	

C.3 Step 3: Adjustment of End Use Breakdowns to Changes

The end use breakdowns used in each milestone period of this study need to be adjusted to account for uneven growth levels and for natural conservation.

As growth across different facilities and sub-sectors is uneven, certain sub-sector end use profiles needed to be adjusted to match these differences. More specifically, for the Mining and Processing sub-sector, which contains a blend of distinct large and small-medium facilities, that each has their own end use profile, the relative growth of these different elements needed to be accounted for in the weighted average sub-sector end use profile. This ensures that if a single segment is growing significantly faster than the rest of the facilities in its sub-sector, the end use profile used in the reference case for all of the sub-sector's facilities would reflect the increased portion of consumption at the growing facility.

The natural conservation factors discussed in the previous section will then be applied to the end use breakdowns. After these adjustments are made, the end use breakdowns can be applied to the load forecast consumption levels to develop the reference case.

This section does not replicate the reference case pie charts and other graphs presented in Section 5. If those graphs are needed for each supply system, they can be created using the Data Manager.

Appendix D Background-Section 6: Reference Case Peak Load

Introduction

The methodology for estimating forecast peak loads is identical to the methodology described in Appendix B, employing the same hours-use factors. The following exhibit shows the Reference Case peak load profile for all regions.

Exhibit D 1 Electric Peak Loads, by Milestone Year, Peak Period and Sub-Sector (MW)

Sub-Sectors	Year	Reference Case Peak Demand (MW)											
		Air compressors	Comfort HVAC	Conveyors	Fans and blowers	Lighting	Other	Other motors	Process cooling	Process heating	Process specific	Pumps	Grand Total
Large Industry	2014	9	8	12	37	6	0	47	0	31	53	56	258
	2017	13	12	17	42	8	0	50	2	37	85	71	337
	2020	13	13	18	42	8	0	50	2	37	88	73	344
	2023	13	13	18	42	8	0	50	2	37	88	73	344
	2026	13	13	18	42	8	0	50	2	37	88	73	344
	2029	13	13	18	42	8	0	50	2	37	89	73	344
Fishing and Fish Processing	2014	0	2	0	0	1	0	0	5	1	0	0	11
	2017	0	2	0	0	1	0	0	5	1	0	0	11
	2020	0	2	0	0	1	0	0	5	1	0	0	11
	2023	0	2	0	0	1	0	0	5	1	0	0	11
	2026	0	2	0	0	1	0	0	5	1	0	0	11
	2029	0	2	0	0	1	0	0	5	1	0	0	11
Manufacturing	2014	1	3	0	1	2	0	2	1	0	0	0	11
	2017	1	3	0	1	2	0	2	1	0	0	0	11
	2020	1	3	0	1	2	0	2	1	0	0	0	11
	2023	1	3	0	1	2	0	2	1	0	0	0	11
	2026	1	3	0	1	1	0	2	1	0	0	0	11
	2029	1	3	0	1	1	0	2	1	0	0	0	11
Water Systems and Other	2014	0	0	0	0	0	0	0	-	0	0	3	5
	2017	0	0	0	0	0	0	0	-	0	0	3	5
	2020	0	0	0	0	0	0	0	-	0	0	3	5
	2023	0	0	0	0	0	0	1	-	0	0	3	5
	2026	0	0	0	0	0	0	1	-	0	0	3	5
	2029	0	0	0	0	0	0	1	-	0	0	3	5

Appendix E Background-Section 7: Technology Assessment: Energy-efficiency Measures

Introduction

Exhibit E1 provides an example of part of the worksheet that calculates the CCE for premium efficiency motors, one of the analyzed measures. For more detail on this and all the other measures, refer to the TRM Workbook submitted with this deliverable.

Exhibit E 1 Sample Measure CCE Calculation Worksheet

NP + NLH: Industrial, Island - Electric efficiency

Premium Efficiency Motors

Return to Index

Measure Description

Description: Electric motors convert approximately 85% of industrial plant electricity use to torque to drive industrial end uses such as fans, pumps, material handling, and a large portion of process loads. These motors range in size from 75 Watts to more than 25,000 kW, with corresponding efficiencies of 40%-98%. While inherently efficient in converting electricity to shaft or motive power, on average 5%-8% of this power is lost in motor inefficiencies that occur before the driven equipment losses.

Baseline: Standard motor
Upgrade: Install premium efficiency motors for other machine drives
Baseline: Annual consumption, equipment
Heating Fuel Type: Electricity
Main End Use: Other Motors
Resource Costs: Baseload

Fuel	Customer Cost		Avoided Costs (NPV) Pulp and Paper	Mining and Processing	Refining	Fishing and Fish Processing	Manufacturing	Water Systems and Other	Weighted Average	Reference + Notes
Electricity	$0.082	$/kWh	$0.755	$0.755	$0.755	$0.755	$0.755	$0.755		Please see "Avoided Costs" and "Customer Costs" tabs
Electric Demand	$6.960	$/kW	$0.946	$0.946	$0.946	$0.946	$0.946	$0.946		Please see "Avoided Costs" and "Customer Costs" tabs

Measure Cost Definitions & Calculations

		Pulp and Paper	Mining and Processing	Refining	Fishing and Fish Processing	Manufacturing	Water Systems and Other	Weighted Average	Reference + Notes
Baseline Consumption	Electricity kWh/yr	2,192,285	2,280,221	1,755,858	503,313	1,034,587	2,280,221	**2,107,973**	
Upgrade Consumption	Electricity kWh/yr	2,148,440	2,234,617	1,720,740	493,246	1,013,895	2,234,617	**2,065,814**	
	Winter Peak Hours-Use Factor	11,744	11,744	11,744	16,317	16,317	16,317	**15,603**	
Resource Savings	Electricity (kWh/yr.)	43,846	45,604	35,117	10,066	20,692	45,604	**42,159**	
	Electricity (kW peak)	3.734	3.883	2.990	0.617	1.268	2.795	**2.73**	
Cost Parameters	Upgrade, Material ($)	$55,858.00	$55,858.00	$55,858.00	$38,930.00	$32,680.00	$55,858.00	**$53,596**	
	Upgrade, Installation ($)	$6,671.00	$6,671.00	$6,671.00	$4,785.00	$4,285.00	$6,671.00	**$6,438**	
	Baseline, Material ($)	$45,177.00	$45,177.00	$45,177.00	$31,430.00	$26,502.50	$45,177.00	**$43,354**	
	Baseline, Installation ($)	$9,035.40	$9,035.40	$9,035.40	$6,286.00	$5,300.50	$9,035.40	**$8,671**	
	Total Measure Cost [A]	$8,317	$8,317	$8,317	$5,999	$5,162	$8,317	**$8,009**	
	Basis (Full/Incremental)	Incr.	Incr.	Incr.	Incr.	Incr.	Incr.	**Incr.**	
	Incremental O&M ($/yr.)							**-**	
Lifetimes	Upgrade (yrs.)	15	15	15	15	15	15	**15**	
	Baseline (yrs.)	15	15	15	15	15	15	**15**	
	Cost Savings ($/yr.)	$3,617	$3,762	$2,897	$829	$1,703	$3,754	**$3,472**	
	Simple Payback (yrs.)	2.3	2.2	2.9	7.2	3.0	2.2	**2.4**	
	NPV of O&M Costs ($) [B]	-	-	-	-	-	-	**-**	
Total Avoided Supply Costs	Electric Energy	$33,097	$34,424	$26,508	$7,598	$15,619	$34,424	**$31,824**	
(NPV, $) [C]	Electric Demand	$4	$4	$3	$1	$1	$3	**$3**	
Total Customer Bill Reduction	Electric Energy	$34,075	$35,442	$27,292	$7,823	$16,081	$35,442	**$32,765**	
(NPV, $) [D]	Electric Demand	$247	$256	$197	$41	$84	$185	**$180**	

Economic Tests

		Pulp and Paper	Mining and Processing	Refining	Fishing and Fish Processing	Manufacturing	Water Systems and Other	Weighted Average	Reference + Notes
Incentive	Target Payback (yrs.)	10	10	10	30	10	10	**10**	
	Percent of Measure Costs	-	-	-	-	-	-	**-**	
	Incentive ($) [E]	-	-	-	-	-	-	**-**	
Administration Costs	% of Incentive [F]	30%	30%	30%	30%	30%	30%	**30%**	
	% of Savings Value to Utility [G]	50%	50%	50%	50%	50%	50%	**50%**	
	Admin. Costs per Unit ($) [H]	$16,550	$17,214	$13,255	$3,800	$7,810	$17,213	**$15,913**	
	Net-to-Gross Ratio [I]	90%	90%	90%	90%	90%	90%	**90%**	
Total Resource Cost Test	TRC Benefits ($)	$29,790	$30,985	$23,860	$6,839	$14,058	$30,984	**$28,644**	
	TRC Costs ($)	$24,035	$24,699	$20,740	$9,199	$12,456	$24,698	**$23,121**	
	Measure TRC ($)	$5,755	$6,286	$3,119	-$2,359	$1,602	$6,286	**$5,523**	
	TRC Benefit/Cost Ratio	1.24	1.25	1.15	0.74	1.13	1.25	**1.23**	
	Cost of Conserved Electricity (CCE) (¢/kWh)	**2.15**	**2.07**	**2.68**	**6.75**	**2.83**	**2.07**	**2.20**	
Participant Cost Test	PCT Benefits ($)	$34,322	$35,698	$27,489	$7,864	$16,165	$35,627	**$32,945**	
	PCT Costs ($)	$8,317	$8,317	$8,317	$5,999	$5,162	$8,317	**$8,009**	
	Measure PCT ($)	$26,005	$27,382	$19,173	$1,865	$11,003	$27,310	**$24,936**	
	PCT Benefit/Cost Ratio	4.13	4.29	3.31	1.31	3.13	4.28	**4.08**	
Ratepayer Impact Measure Test	RIM Benefits ($)	$29,790	$30,985	$23,860	$6,839	$14,058	$30,984	**$28,644**	
	RIM Costs ($)	$47,440	$49,343	$37,996	$10,877	$22,358	$49,277	**$45,564**	
	Measure RIM ($)	$33,100	$34,428	$26,511	$7,599	$15,620	$34,427	**$31,826**	
	RIM Benefit/Cost Ratio	1.64	1.64	1.64	1.64	1.64	1.64	**1.64**	
Program Administrator Costs Test	PAC Benefits ($)	$29,790	$31,216	$24,037	$6,876	$14,134	$31,150	**$28,790**	
	PAC Costs ($)	$16,550	$17,214	$13,255	$3,800	$7,810	$17,213	**$15,913**	
	Measure PAC ($)	$13,240	$14,002	$10,782	$3,076	$6,323	$13,937	**$12,877**	
	PAC Benefit/Cost Ratio	1.80	1.81	1.81	1.81	1.81	1.81	**1.81**	

Resource Savings Assumptions (Percent relative to baseline, not including heating penalties/cooling benefits)

Fuel	End Use	Sub End Use	Applies? (Yes = 1, 0 = No) Baseline	Upgrade	Measure Resource Savings (%)						Weighted Average	Reference + Notes
Electricity	Other Motors	General	1	1	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	**2.0%**	

Resource Savings Wrap-Up (Percent relative to baseline, main end uses, including heating penalties/cooling benefits)

Fuel	End Use	Applies? (Yes = 1, 0 = No) Baseline	Upgrade	Measure Resource Savings (%)						Weighted Average	Reference + Notes
Electricity	Other Motors	1	1	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	**2.0%**	

Exhibit E2 provides a list of all the industrial measures initially considered for this study. It indicates which measures were included for further study. For those measures excluded from the study, the exhibit provides the reason for that decision.

Exhibit E 2 Industrial Measures Considered

End Use	Measure		Reasons for Exclusion
Air Compressors	Premium Efficiency ASD Compressor	Included	
	Use Cooler Air from Outside for Make Up Air	Included	
	Optimized Distribution System (Incl. Pressure and Air End Uses)	Included	
	Optimized Sizes of Air Receiver Tanks	Included	
	Sequencing Control	Included	
	Air Leak Survey and Repair	Included	
	Replace Compressed Air Use	Excluded	This opportunity has been captured within the above optimized compressed air distribution system measure, since these are inter-related improvements and would both flow from a compressed air audit.
Conveyors	Optimized Conveyor Motor Control	Included	
	Premium Efficiency Conveyor Motors	Included	
Fans and Blowers	Premium Efficiency Fan Control with ASDs	Included	
	Synchronous Belts	Included	
	Premium Efficiency Motors for Fans and Blowers	Included	
	Correctly Sized Fans: Impeller Trimming or Fan Selection	Included	
	Optimized Distribution System (Inc. Pressure Losses)	Included	
	Magnetic Clutch Fan Control	Excluded	Targets the same potential savings as the above ASD measure, with lower cost equipment. The above ASD measure has been expanded to also cover this form of speed control.
HVAC	Automated Temperature Control	Included	
	Air Compressor Heat Recovery	Included	
	Ventilation Heat Recovery	Included	
	Ventilation Optimization	Included	
	Reduced Temperature Settings	Included	
	High-efficiency Packaged HVAC	Included	
	Warehouse Loading Dock Seals	Included	
	Improved Building Insulation	Included	
	HVAC Air Curtains	Included	

Exhibit E 2 Continued: Industrial Measures Considered

End Use	Measure		Reasons for Exclusion
Lighting	High Efficiency Lights (LEDs)	Included	
	Automated Lighting Controls	Included	
	High Efficiency Lighting Design	Included	
Other Motors	Correctly Sized Motors	Included	
	Optimized Motor Control	Included	
	Premium Efficiency Motors	Included	
Process Cooling/ Refrigeration/ Freezing	Chiller Economizer	Included	
	Free Cooling	Included	
	Floating Head Pressure Controls	Included	
	High Efficiency Chiller	Included	
	Optimized Distribution System	Included	
	Premium Efficiency Refrigeration Control System and Compressor Sequencing	Included	
	Improve Insulation of Refrigeration System	Included	
	Smart Defrost Controls	Included	
	Improved Ice Production System	Included	
	Air Curtains	Included	
Process Heating	Heat Pumps	Included	
	Insulation	Included	
	Process Heat Recovery to Preheat Makeup Water	Included	
	High Efficiency Oven/Dryer/Furnace/Kiln	Included	
	High Efficiency Water Heater	Included	
Process Specific	Process Optimization Efforts – Fishing and Fish Processing	Included	
	Process Optimization Efforts – Pulp and Paper	Included	
	Process Optimization Efforts – Mining and Processing	Included	
	Process Optimization Efforts – Oil Refining	Included	
	Advanced 'Predictive' Process Control Systems	Included	
Pumps	Optimization of Pumping System	Included	
	Premium Efficiency Pump Motor	Included	
	Premium Efficiency Pump Control with ASDs	Included	
	Correctly Sized Pumps: Impeller Trimming or Pump Selection	Included	
System (Energy)	Sub-Metering	Included	
	Energy Management Information System (EMIS)	Included	
	Organizational Energy Management (EM Team)	Included	

Exhibit E 2 Continued: Industrial Measures Considered

End Use	Measure		Reasons for Exclusion
	Operation and Maintenance (O&M) Program Supporting Efficiency	Included	
	Integrated Plant Control System	Included	
System (Demand)	Power Factor Correction Equipment	Included	
	Operating Changes for Reduced Peak Load	Included	
	Peak Shifting Through On-Site Storage	Included	
	More Specific Demand Reduction Technologies	Excluded	The Peak Shifting measure above considers technologies that can be used in each sub-sector to reduce demand.[38] The electric energy technologies include numerous measures that will also reduce demand.

[38] The demand reduction benefits quantified in this model only capture the benefits from reductions coincident with the annual provincial peak periods.

Appendix F Background-Section 8: Economic Potential: Electric Energy Forecast

Introduction

Exhibit F 1 provides the industrial economic potential consumption by measure and milestone. For further details on the economic potential scenario, including regional breakdowns, please refer to the Data Manager file submitted with this report.

Exhibit F 1 Economic Potential Electricity Savings by Measure and Milestone Year (GWh/yr.)

End Use	Measure	Cost Basis	Annual Savings (GWh/yr.)				
			2017	2020	2023	2026	2029
System	Sub-Metering	Full	57.7	56.2	54.6	53.1	51.5
	Energy Management Information System (EMIS)	Full	56.5	55.8	55.1	54.4	53.7
	Organizational Energy Management (EM Team)	Full	49.5	48.8	48.1	47.4	46.7
	Operation and Maintenance (O&M) Program Supporting Efficiency	Full	29.6	28.9	28.2	27.5	26.8
	Integrated Plant Control System	Full	18.8	18.4	18.0	17.5	17.1
Pumps	Optimization of Pumping System	Full	58.7	57.7	56.8	59.6	59.9
	Premium Efficiency Pump Motor	Incr	3.9	5.2	6.5	2.6	1.3
	Premium Efficiency Pump Control with ASDs	Full	88.8	87.6	86.3	90.1	90.0
	Correctly Sized Pumps: Impeller Trimming or Pump Selection	Full	42.9	42.0	41.0	43.9	44.5
Fans and Blowers	Premium Efficiency Fan Control with ASDs	Full	65.7	65.1	64.4	66.4	66.7
	Synchronous Belts	Full	1.5	1.4	1.4	1.5	1.5
	Premium Efficiency Motors for Fans and Blowers	Incr	2.8	3.7	4.7	1.9	0.9
	Correctly Sized Fans: Impeller Trimming or Fan Selection	Full	27.3	26.7	26.0	27.9	28.5
	Optimized Distribution System (Incl. Pressure Losses)	Full	16.1	15.4	14.7	10.0	9.9
Lighting	High Efficiency Lights (LEDs)	Full	53.9	51.3	48.7	56.3	45.3
	Automated Lighting Controls	Full	5.3	5.3	5.2	5.3	3.2
	High-Efficiency Lighting Design	Full	5.3	5.3	5.2	5.4	5.2
Process Specific	Process Optimization Efforts - Fishing and Fish Processing	Full	0.0	0.0	0.0	0.0	0.0
	Process Optimization Efforts - Pulp and Paper	Full	16.5	16.4	16.3	16.6	16.7
	Process Optimization Efforts - Mining and Processing	Full	4.7	4.6	4.5	4.9	4.8
	Advanced ‘Predictive’ Process Control Systems	Full	13.3	13.3	13.2	13.4	13.5
	Process Optimization Efforts - Oil Refining	Full	-	-	-	-	-
Air Compressors	Premium Efficiency ASD Compressor	Incr	15.9	15.9	15.8	16.0	15.6
	Use Cooler Air from Outside for Make Up Air	Full	2.9	2.9	2.8	3.0	2.9

Exhibit F 1 Continued: Economic Potential Electricity Savings by Measure and Milestone Year (GWh/yr.)

End Use	Measure	Cost Basis	Annual Savings (GWh/yr.)				
			2017	2020	2023	2026	2029
	Optimized Distribution System (Incl. Pressure and Air End-Uses)	Full	9.1	9.0	8.9	9.2	8.9
	Optimized Sizes of Air Receiver Tanks	Full	1.4	1.4	1.3	1.5	1.5
	Sequencing Control	Full	0.5	0.5	0.5	0.5	0.5
	Air Leak Survey and Repair	Full	13.7	13.6	13.4	13.9	13.6
Process Cooling / Refrigeration / Freezing	Chiller Economizer	Full	1.3	1.3	1.2	1.3	1.3
	Free Cooling	Full	3.4	3.4	3.4	3.5	3.5
	Floating Head Pressure Controls	Full	0.3	0.3	0.3	0.3	0.3
	High Efficiency Chiller	Incr	1.8	2.0	2.0	1.8	1.8
	Optimized Distribution System	Full	1.4	1.4	1.3	1.4	1.4
	Premium Efficiency Refrigeration Control System and Compressor Sequencing	Full	3.9	3.8	3.8	3.9	3.9
	Improve Insulation of Refrigeration System	Full	1.7	1.7	1.7	1.7	1.7
	Smart Defrost Controls	Full	1.4	1.4	1.4	1.4	1.4
	Improved Ice Production System	Full	1.2	1.2	1.2	1.2	1.2
	Air Curtains	Full	0.3	0.3	0.3	0.3	0.3
Other Motors	Correctly Sized Motors	Full	3.8	5.1	6.4	2.6	1.3
	Optimized Motor Control	Full	9.8	9.5	9.3	10.0	10.2
	Premium Efficiency Motors	Incr	3.5	4.6	5.8	2.3	1.1
HVAC	Automated Temperature Control	Full	3.4	3.3	3.2	3.5	3.4
	Air Compressor Heat Recovery	Full	0.8	0.8	0.7	0.8	0.8
	Ventilation Heat Recovery	Full	0.0	0.0	0.0	0.0	0.0
	Ventilation Optimization	Full	0.6	0.6	0.6	0.6	0.7
	Reduced Temperature Settings	Full	3.8	3.7	3.6	3.9	3.9
	High-Efficiency Packaged HVAC	Incr	3.2	4.2	5.3	2.1	1.0
	Warehouse Loading Dock Seals	Full	0.0	0.0	0.0	0.0	0.0
	Improved Building Insulation	Full	-	-	-	-	-
	HVAC Air Curtains	Full	-	-	-	-	-
Conveyors	Optimized Conveyor Motor Control	Full	4.0	3.9	3.8	4.0	1.4
	Premium Efficiency Conveyor Motors	Incr	1.1	1.5	1.9	0.8	0.4
Process Heating	Heat Pumps	Full	1.1	1.1	1.1	1.1	1.0
	Insulation	Full	4.9	4.9	4.9	5.0	5.0
	Process Heat Recovery to Preheat Makeup Water	Full	17.9	17.7	17.6	3.8	3.6
	High Efficiency Oven/Dryer/Furnace/Kiln	Incr	0.0	0.1	0.1	0.0	0.0
	High Efficiency Water Heater	Incr	-	-	-	-	-

Appendix G Background-Section 9: Achievable Workshop Action Profile Slides

CDM Potential Study

Newfoundland and Labrador

Agenda

1. Overview of the CPR Approach, Tools, Outputs
2. Overview of the Industrial technology results to date
3. Discussion of Industrial Opportunities
4. Wrap Up & Next Steps

9:00 am – 9:15 am	Welcome & Introductions
9:15 am – 9:45 am	Overview Of CDM Potential Study Approach, Outputs & Tools
9:45 am – 10:15 am	Overview of Industrial Sector Technology Results to Date and Workshop Discussion Format
10:15 am– 10:30 am	Break
10:30 am – 11:30 am	Discussion of Industrial Opportunity #1 LED Lighting
11:30 am – 12:00 pm	Discussion of Industrial Opportunity #2 Optimization of Pumping Systems
12:00 pm – 12:30 pm	Lunch
12:30 pm – 1:00 pm	Discussion of Industrial Opportunity #3 Roving Energy Managers
1:00 pm – 1:30 pm	Discussion of Industrial Opportunity #4 Premium Efficiency Refrigeration Control Systems
1:30 pm – 2:00 pm	Discussion of Industrial Opportunity #5 Demand Response Curtailments
2:00 pm – 2:30 pm	Discussion of Industrial Opportunity #6 Optimization of Compressed Air Distribution Systems and End-uses
2:30 pm – 2:45 pm	Break
2:45 pm – 3:15 pm	Discussion of Industrial Opportunity #7 Optimized Motor Control
3:15 pm – 3:45 pm	Discussion of Industrial Opportunity #8 Process Heat Recovery for HVAC
3:45 pm – 4:30 pm	Wrap up and Next Steps

1

Overview of the CPR Approach, Tools, Outputs

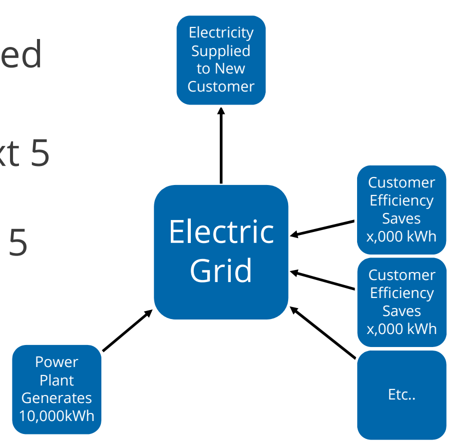
Study Background & Objectives

"The purpose of this Project is to develop a Conservation and Demand Management ("CDM") Potential Study to identify the remaining achievable, cost-effective **electric energy efficiency and demand management potential** in Newfoundland and Labrador."

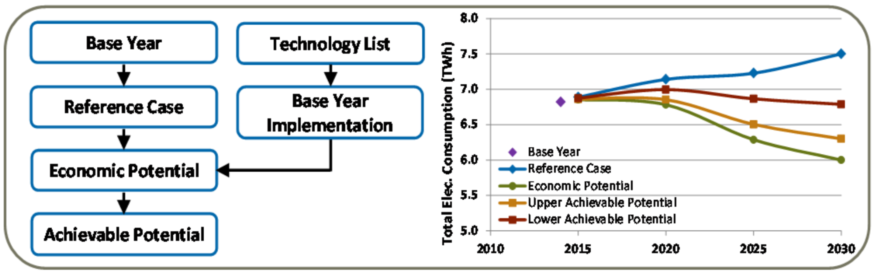
- Characterize available equipment and behaviours: EE and DR
- Estimate achievable potential EE (GWh) and DR (MW) load reduction

Study Objectives

- Last Study: 2008
- Factors in expected system changes
- Will feed into next 5 year plan – to be completed in 2015



Study Methodology and Outputs



Level of Study Detail

- Sectors: **Residential, Commercial,** and **Industrial**
- Regions: **Newfoundland, Labrador,** and **Isolated Diesel**
- Base Year: calendar year **2014**
- Milestone Years: **2017, 2020, 2023, 2026** and **2029.**
- Subsectors
- End Uses
- Technologies

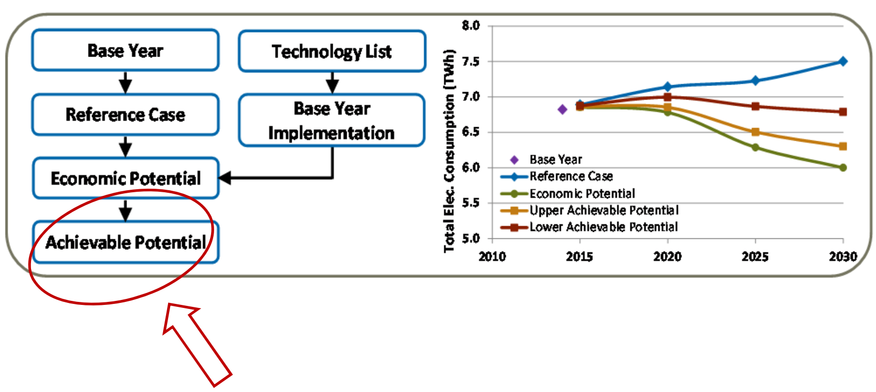
More on these later

What this Study is NOT

- It is not program design
- It is not setting DSM targets
- It is not an IRP

- It is designed to provide input to all those processes.

Today



Achievable Potential

Achievable Potential: *The achievable potential is the portion of the economic conservation potential that is achievable through utility interventions and programs given institutional, economic, and market barriers.*

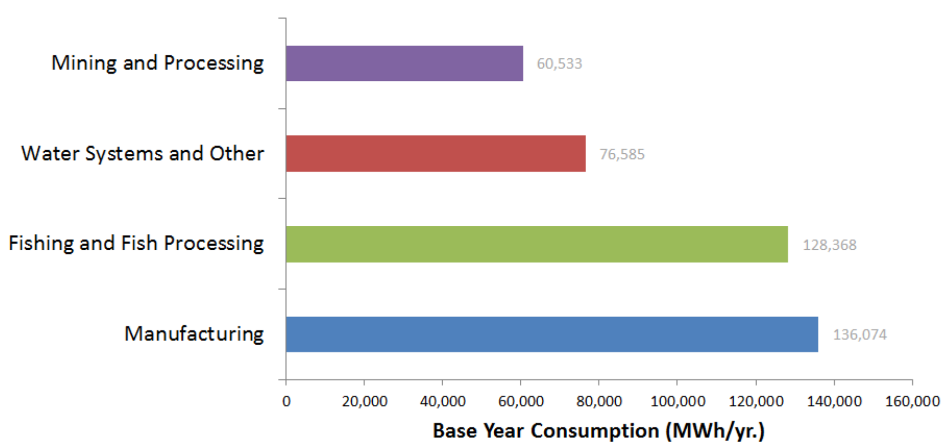
- **"**Upper" = Very Best Possible Case
- "Lower" = Business as Usual

2

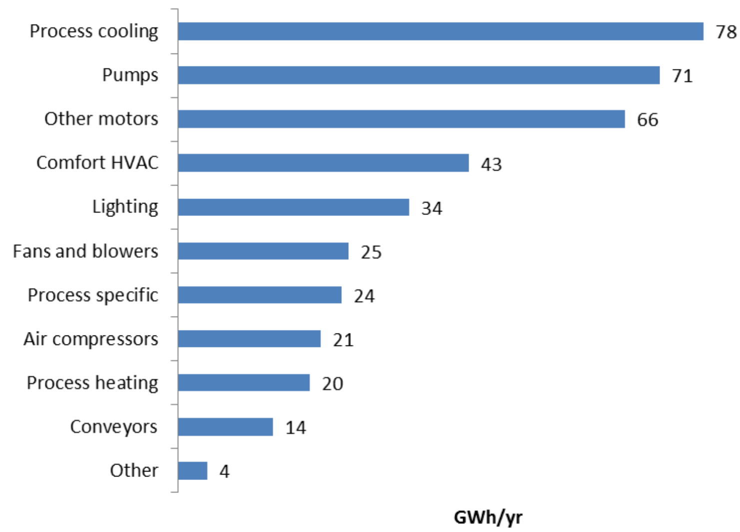
Overview of the Industrial technology results to date

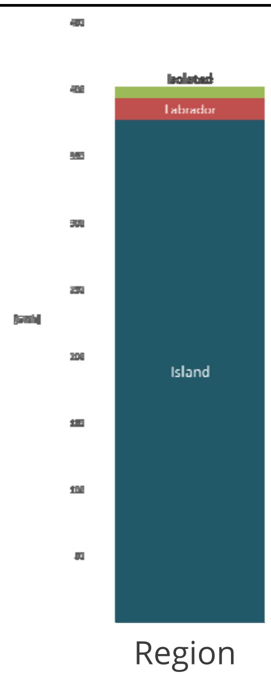
Segmentation
Region
(Without large transmission-connected Industry)

Segmentation
Sub-Sector
(Without large transmission-connected Industry)



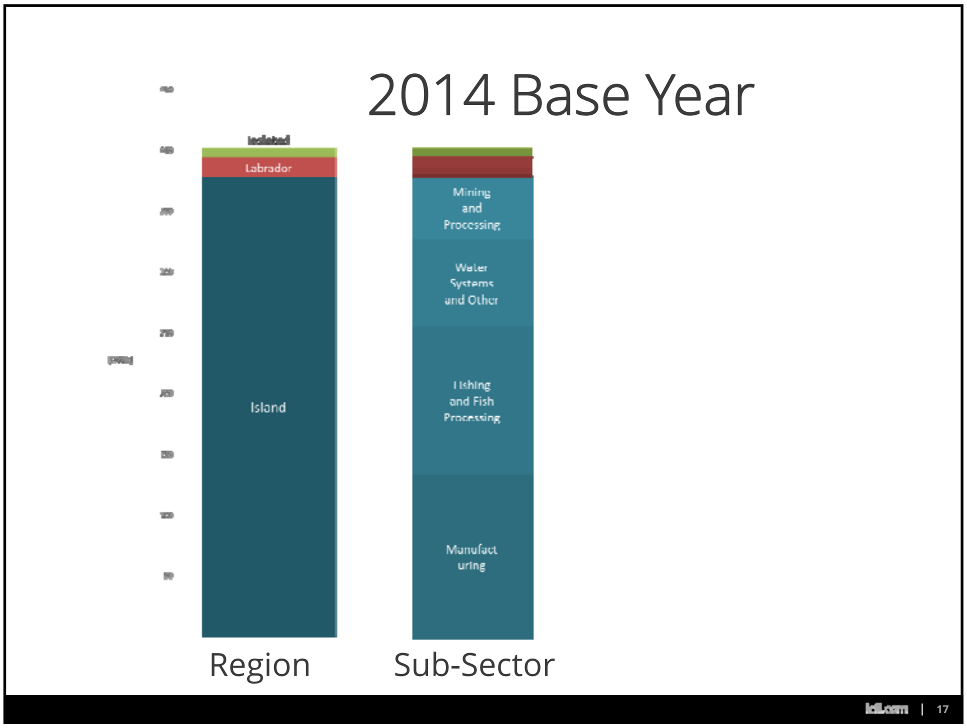
End Uses

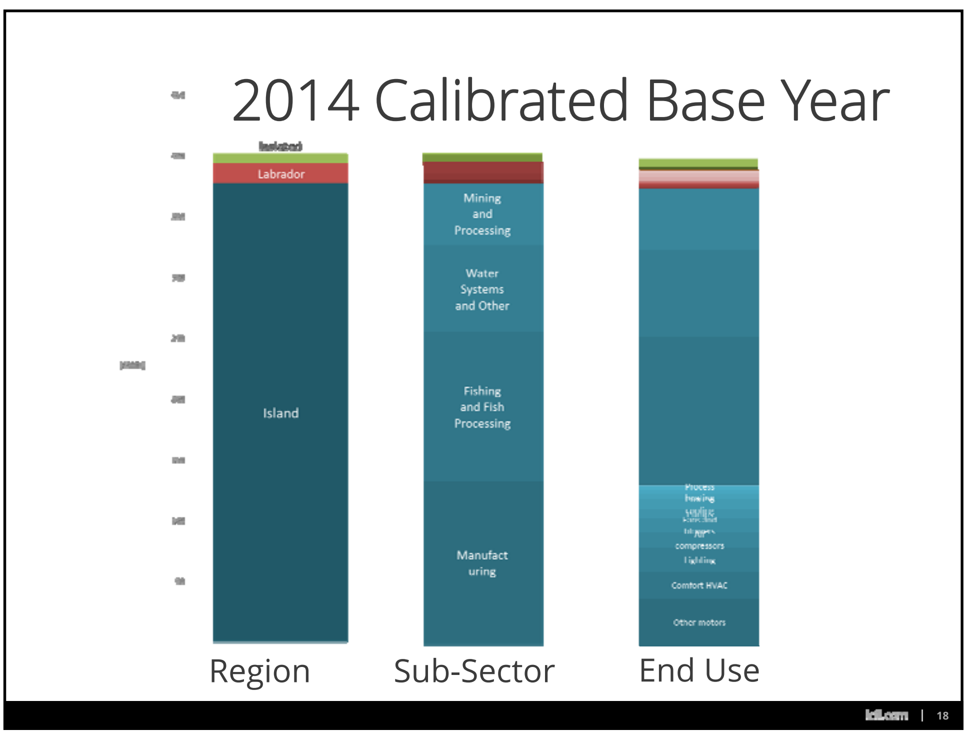




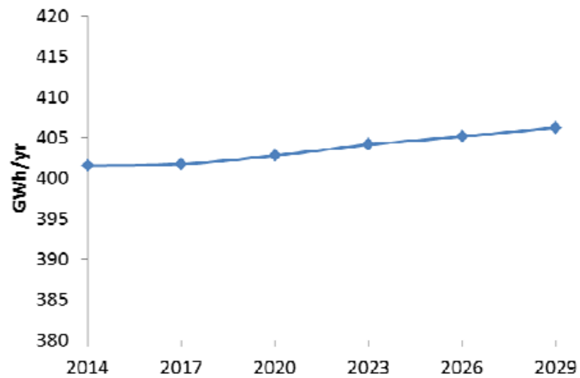
2014 Base Year

Total electricity
sold to small-medium
industrial customers,
by region
for 2014


2014 Base Year
Isolated
Labrador
Island
Mining and Processing
Water Systems and Other
Fishing and Fish Processing
Manufacturing
Region
Sub-Sector
17


2014 Calibrated Base Year
Isolated
Labrador
Island
Mining and Processing
Water Systems and Other
Fishing and Fish Processing
Manufacturing
Comfort HVAC
Other motors
Region
Sub-Sector
End Use
18

Reference Case – The Foundation



- Utility load forecast is used to create growth forecasts applied out to the year 2029. This becomes the reference case.
- Efficiency measures can then be applied.

Screening the Technologies

- Compare cost of conserved electricity for over the energy efficiency technologies to economic thresholds of:

Year	Avoided Cost per kWh		
	Island Interconnected	Labrador Interconnected	Isolated
2014	$0.108	$0.037	$0.21
2017	$0.125	$0.039	$0.23
2020	$0.050	$0.045	$0.26
2023	$0.059	$0.053	$0.29
2026	$0.068	$0.061	$0.34
2029	$0.076	$0.068	$0.37

Screening the Technologies

- Compare cost of electric peak reduction for the demand reduction technologies to economic thresholds of:

Year	Avoided Cost per kW		
	Island Interconnected	Labrador Interconnected	Isolated
2014	$50.911	$72.059	
2017	$65.116	$82.527	
2020	$101.821	$91.601	
2023	$115.126	$103.571	
2026	$124.930	$112.390	
2029	$124.907	$112.370	

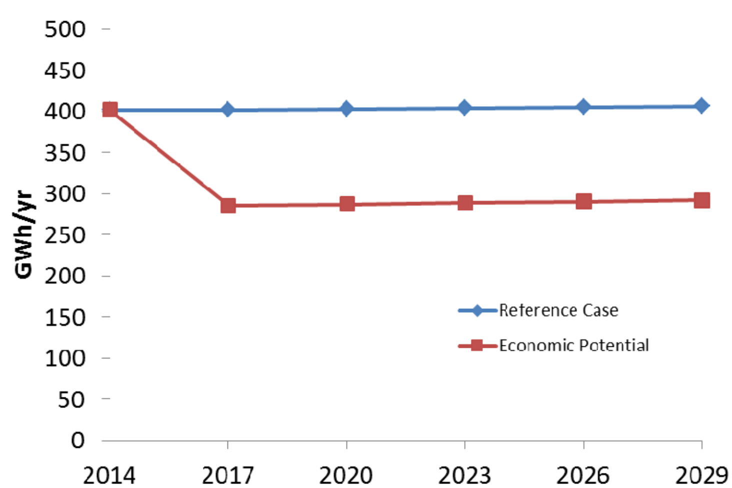
The Results – the Big Picture

- Overall economic potential is around 28% of projected 2029 consumption
- Around 52 out of 57 measures passed the screen in at least some sub-sectors and regions
  - Most measures pass the economic screens on a full-cost basis, and can therefore are implemented immediately in the economic potential scenario.
  - During the next section of the study, with the help of this workshop, the achievable potential will factor in more realistic adoption timelines, and will result in increasing savings over the milestones.

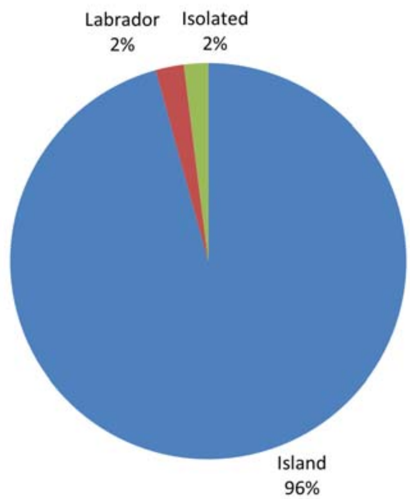
The Results – the Big Picture

- Almost all of savings for sub-sectors considered today are in the Island region.
- Pumps, Lighting, Process Cooling, and Fans/Blowers are the four largest end uses for savings, and together account for around 75% of the economic potential.
- HVAC represents a larger portion of potential demand savings (although pumps are still the largest end use).

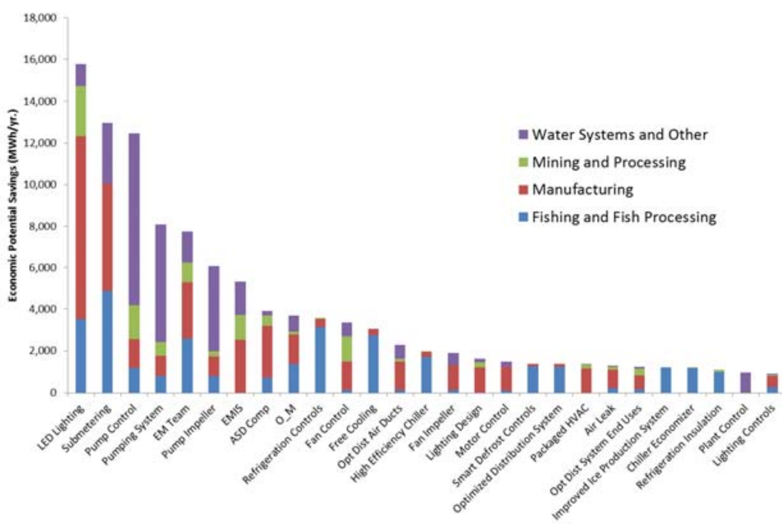
Overall results – 2 scenarios



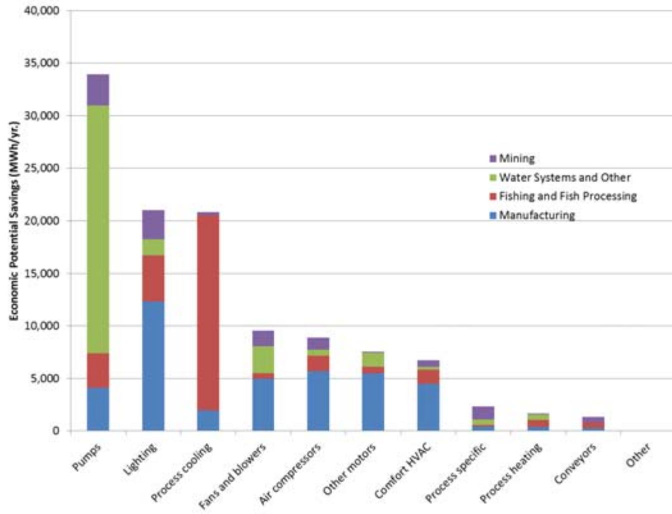
Overall Results-Distribution of Savings



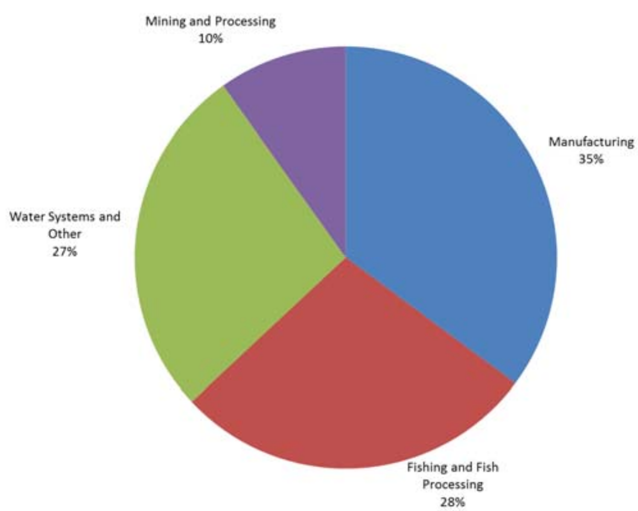
Top Measures in 2029 – Economic Potential



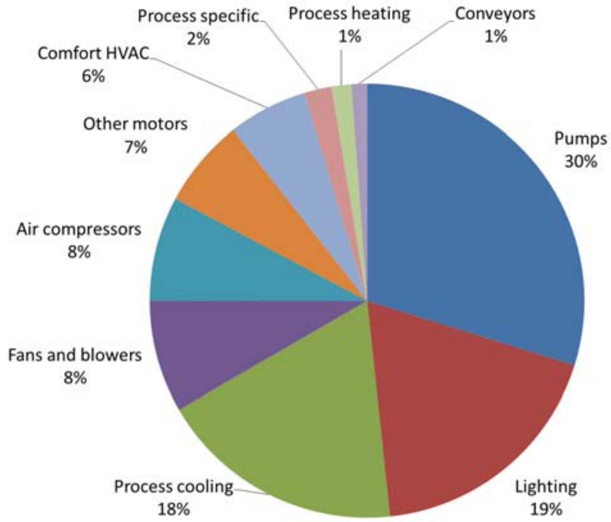
Economic Potential by End Use and Sub-Sector



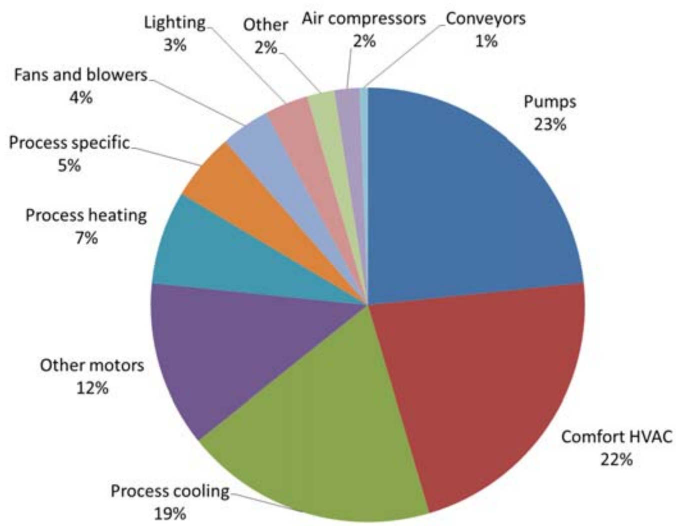
Economic Potential by Sub-Sector - 2029



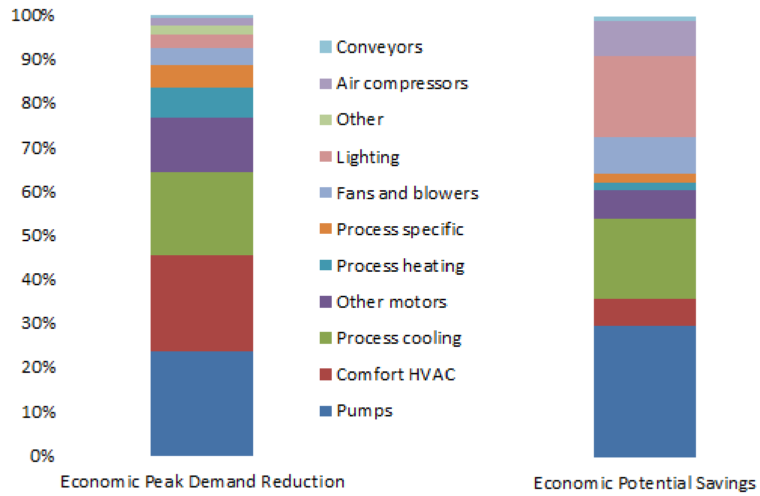
Economic Potential by End Use - 2029



Peak Demand Reduction by End Use – 2029



Comparison of Electric Energy & Peak Demand Savings



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Discussion of Industrial Opportunities

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High Level Market Characterization

Today's Discussion

- Barriers – Price, Availability, Awareness, Risk, etc
- Baseline – Affirmation of where we are starting from
- Market Structure – supply channels
- Main Actors – potential partners

High Level Strategy/ Program Design

- How do we make this opportunity happen?
- What would ideal strategy/program look like?
- Participation at the "upper" and "lower" levels?
- Applicability to other markets? Related technologies?

Today's Discussion

- Exchange of ideas and views
  - There are no wrong answers
  - Discussion is key!! Numbers will follow from it
- Today's Focus - selected opportunities
  - Subset of the opportunities identified in the study
  - Selected to cover a variety of different technologies and markets
  - Will extrapolate results to remaining sub-sectors and/or technologies

Choice of Measures to Discuss

- Represent a substantial portion of the economic potential
- Cover many different end uses
- Can be used as a basis to discuss other measures in the same end use
- Some new program options
- **A set of conversations that are as different from each other as possible!**

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Discussion Approach

- Proposed approach to each opportunity discussion
  - Introduction by ICF
  - Constraints, barriers & challenges
  - High level strategy
  - "Best Case" participation rates, 2029
  - "Lower Case" participation rates, 2029
  - Shape of adoption curve
  - Guidelines to consultants

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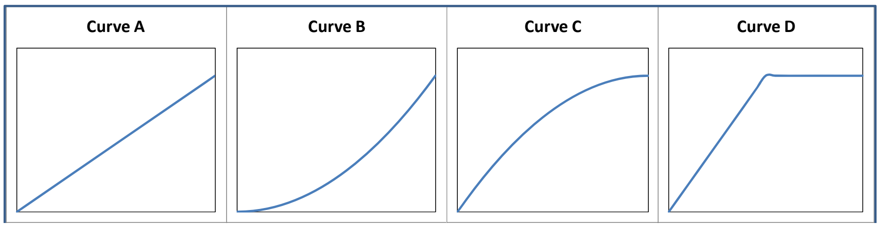
Achievable Potential - Definition

- The proportion of Economic Potential that can be realistically achieved
  - Includes consideration of customer perspective & market barriers
  - Recognizes that CDM programs can address some, but not all, market barriers
- Expressed as a range
  - Reflects the uncertainties of any forecast
  - Acknowledges that there are different levels of potential CDM program intervention
  - Recognizes that there are external factors that influence customer decisions

Achievable Potential – 2 Scenarios

- **"**Upper" = Very Best Possible Case
  - Theoretically = Economic potential minus "can't" or "won't" portion of market
  - Aggressive CDM program approach implied
  - Highly supportive context e.g. healthy economy, high level of public emphasis on climate change mitigation etc.
- "Lower" = Business as Usual
  - CDM program support is similar to, or modest increase over past years
  - Market interest/commitment to energy efficiency and environment remains approximately as current
  - Federal and provincial gov't EE and GHG efforts as current

Adoption Curves



Opportunities for Today's Workshop

Opportunity	Primary End Use	Percent of 2029 Economic Potential Savings
LED Lighting	Lighting	13.9%
Optimization of Pumping Systems	Pumping	7.1%
Roving Energy Managers	System (all)	6.8%
Premium Efficiency Refrigeration Control Systems	Process Cooling / Refrigeration / Freezing	3.1%
Demand Response Curtailments	System - Demand	51%
Optimization of Compressed Air Distribution Systems and End-uses	Compressed Air	1.1%
Optimized Motor Control	Other Motors	1.3%
Process Heat Recovery for HVAC	HVAC	0.5%

Industrial Opportunity 1:

LED Lighting

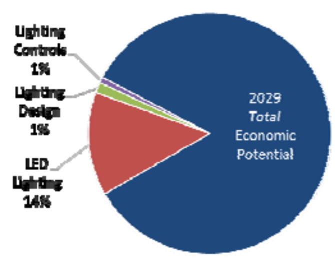
Installing LED lighting to replace inefficient existing lighting fixtures (MH, HPS, T12).

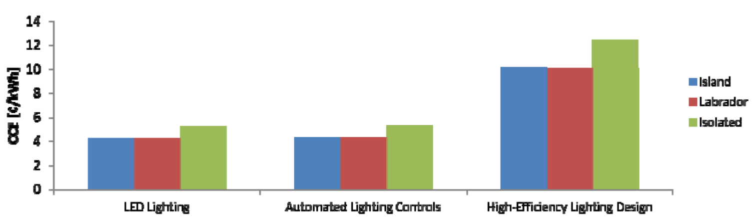
Industrial Opportunity 1:

LED Lighting

Comparison with Other Lighting Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
LED Lighting	15,773	All
Automated Lighting Controls	889	All
High-Efficiency Lighting Design	1,608	Island (in 2017) & Isolated





Industrial Opportunity 1:

LED Lighting

Assumptions

Focus Building Type	Manufacturing
Focus Region	Island
Typical Application:	
Cost	$230
Useful Life	12 years
Savings:	
Lighting	52%

Industrial Opportunity 1:

LED Lighting

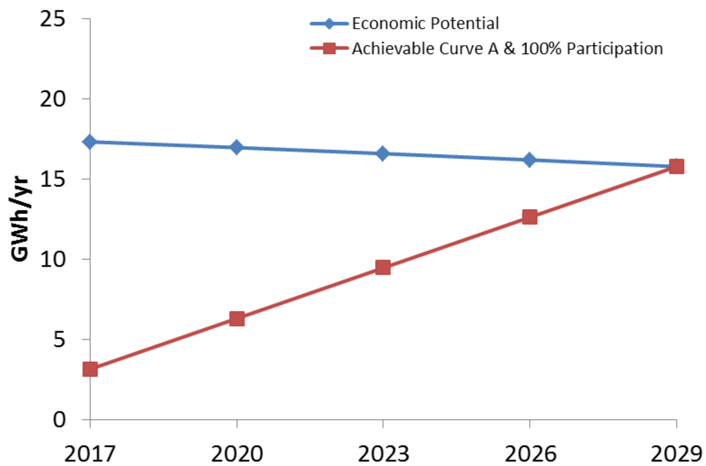
Economic Indicators

Simple Payback (Manufact. - Island)	4.8 years
Average CCE (¢/kWh):	
Island	4.30
Labrador	4.27
Isolated	5.27
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	66,812 MWh
Applicability (Manufacturing)	100%

Industrial Opportunity 1:

LED Lighting

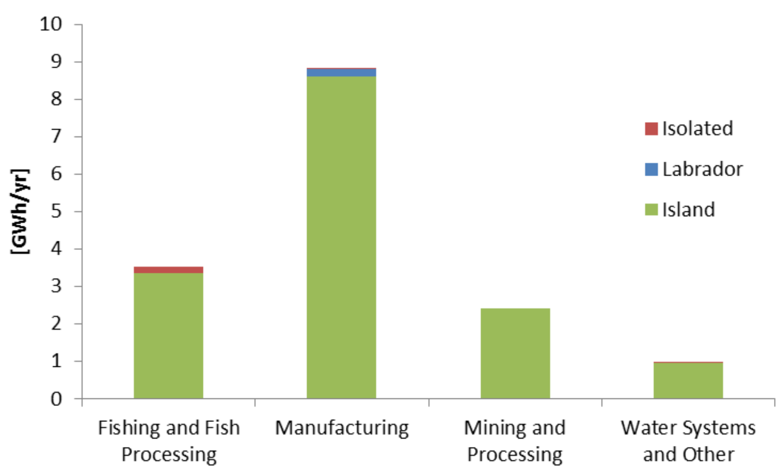
Progression of Economic Potential



Industrial Opportunity 1:

LED Lighting

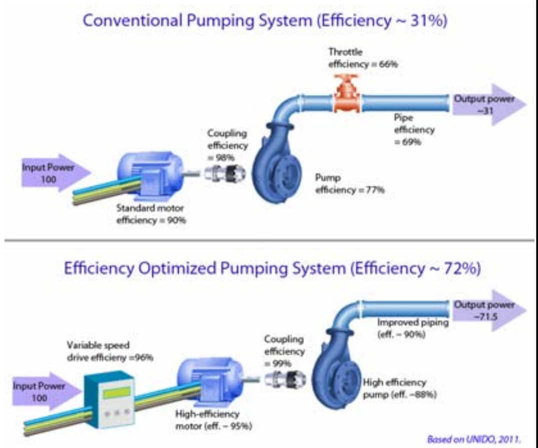
2029 Economic Potential Breakdown



Industrial Opportunity 2:

Optimization of Pumping Systems

- Better **matching pump size** and type with operation and system demands (pump replacement, replacing valves)
- **Operational changes**
- Reduce friction in pumping system by piping redesign and retrofit; **removing dead end pipes** and isolating flow paths to nonessential or non-operating equipment.
- Use pressure switches to **shut down unnecessary pumps**

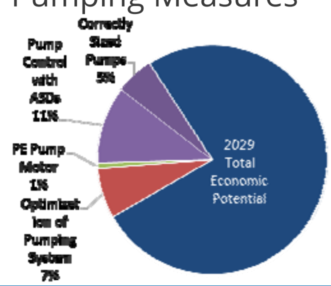


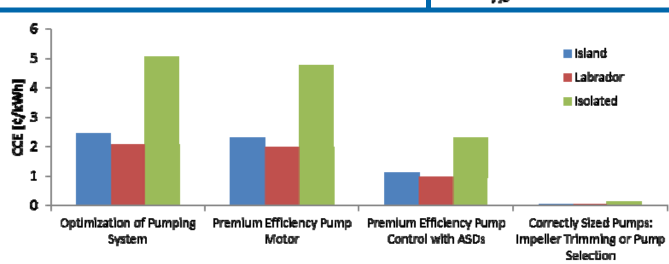
Industrial Opportunity 2:

Optimization of Pumping Systems

Comparison with Other Pumping Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
Optimization of Pumping System	8,085	All
Premium Efficiency Pump Motor	856	All
Premium Efficiency Pump Control with ASDs	12,476	All
Correctly Sized Pumps: Impeller Trimming or Pump Selection	6,065	All





Industrial Opportunity 2:

Optimization of Pumping Systems

Assumptions

Focus Sub-Sector Type	Water Systems and Other
Focus Region	Island
Typical Application:	
Cost	$62,150
Useful Life	15 years
Savings:	
Pumping	20%

Industrial Opportunity 2:

Optimization of Pumping Systems

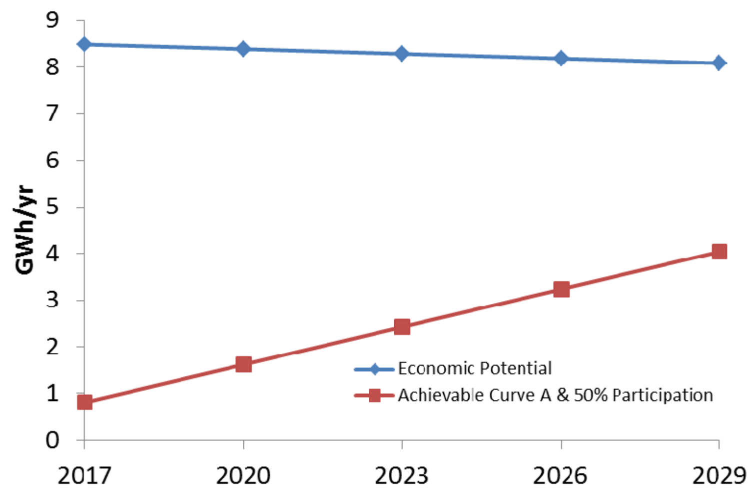
Economic Indicators

Simple Payback (Water Systems - Island)	2.3 years
Average CCE (¢/kWh):	
Island	2.46
Labrador	2.09
Isolated	5.06
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	198,800 MWh
Applicability (Water Systems)	80%

Industrial Opportunity 2:

Optimization of Pumping Systems

Progression of Economic Potential



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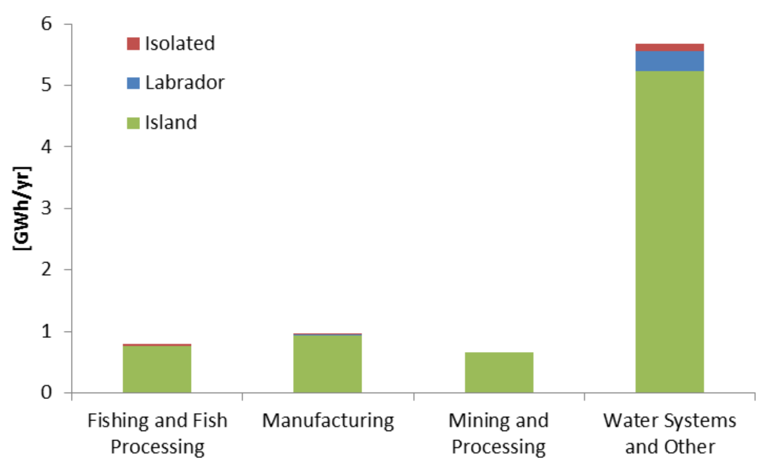
Industrial Opportunity 2:

Optimization of Pumping Systems

2029 Economic Potential Breakdown



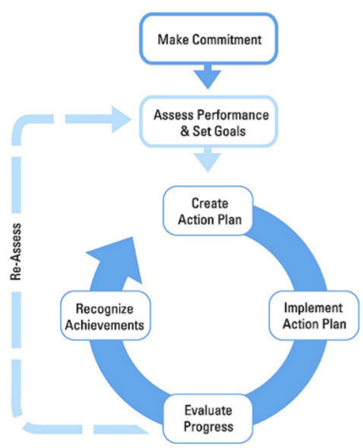
52

Industrial Opportunity 3:

Roving Energy Managers

- Formal establishment of energy management responsibilities
- Internal plant EM team or a Roving Energy Manager that splits their time between multiple facilities.
- Ensure someone is focused on improving facility energy performance and championing energy efficiency projects.
- 'Enabling' measure

Structure of a Strategic Energy Management System



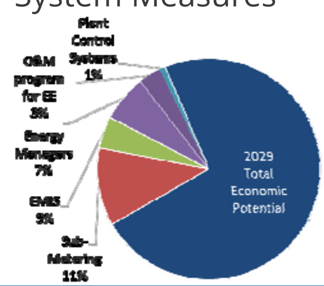
Source: US EPA, 2010.

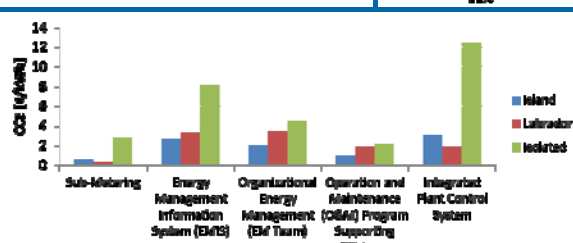
Industrial Opportunity 3:

Roving Energy Managers

Comparison with Other System Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
Sub-Metering	12,969	All
Energy Management Information System (EMIS)	5,315	All
Organizational Energy Management (EM Team)	7,742	All
Operation and Maintenance (O&M) Program for Efficiency	3,696	All
Integrated Plant Control System	963	Isolated





Industrial Opportunity 3:

Roving Energy Managers

Assumptions

Focus Sub-Sector Type	Fishing and Fish Processing
Focus Region	Island
Typical Application:	
Cost	$5,000
Useful Life	1 years
Savings:	
System (all end-uses)	2.5%

Industrial Opportunity 3:

Roving Energy Managers

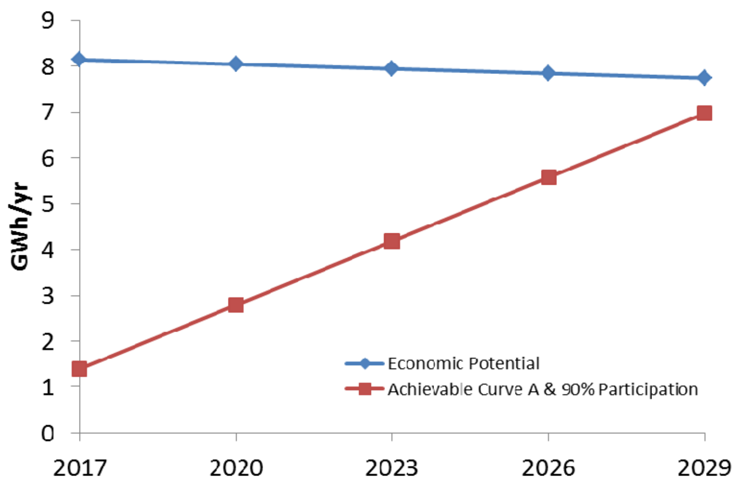
Economic Indicators

Simple Payback (Fishing - Island)	1.7 years
Average CCE (¢/kWh):	
Island	1.97
Labrador	3.42
Isolated	4.52
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	1,058,314 MWh
Applicability (Fishing)	100%

Industrial Opportunity 3:

Roving Energy Managers

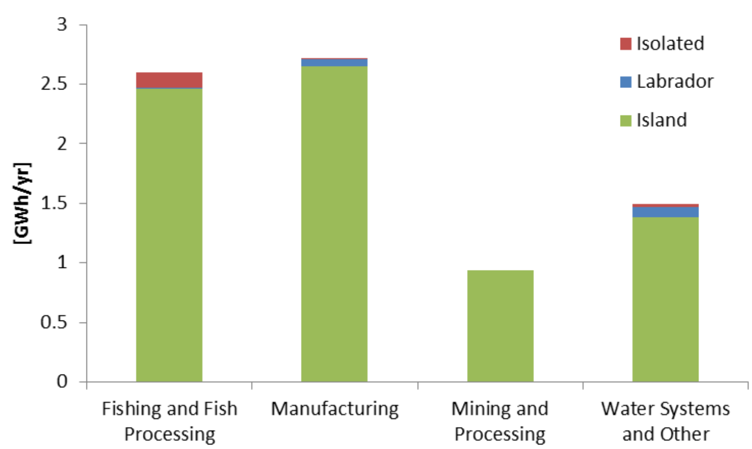
Progression of Economic Potential



Industrial Opportunity 3:

Roving Energy Managers

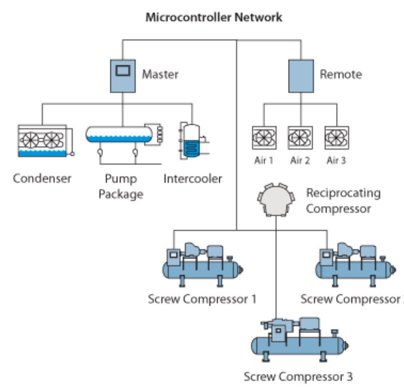
2029 Technical Potential Breakdown



Industrial Opportunity 4:

PE Refrigeration Control Systems

- Centralized control system interfacing to existing controllers for optimally controlling the operation of each of the compressors, condensers, and evaporators
- Ensure smooth control during load fluctuations or setpoint changes
- Optimize the sequencing when multiple compressors are included in a system, to most efficiently match variable load requirements

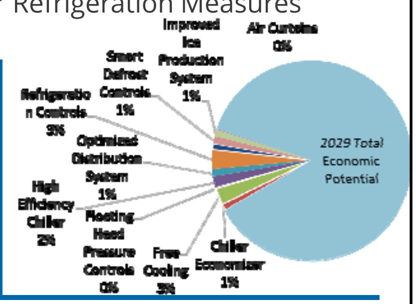


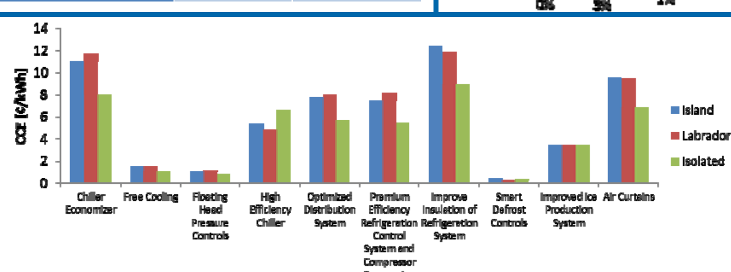
Industrial Opportunity 4:

PE Refrigeration Control Systems

Comparison with Other Refrigeration Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
Chiller Economizer	1,183	Isolated
Free Cooling	3,068	All
Floating Head Pressure Controls	302	All
High Efficiency Chiller	1,959	Island, Isolated
Optimized Distribution System	1,360	Island, Isolated
PE Refrigeration Control and Sequenc	3,567	Island, Isolated
Improve Insulation of Refrigeration Sy	1,078	Isolated
Smart Defrost Controls	1,376	All
Improved Ice Production System	1,203	All
Air Curtains	215	Isolated





Industrial Opportunity 4:

PE Refrigeration Control Systems

Assumptions

Focus Sub-Sector Type	Fishing and Fish Processing
Focus Region	Island
Typical Application:	
Cost	$88,992
Useful Life	15 years
Savings:	
Refrigeration	9%

Industrial Opportunity 4:

PE Refrigeration Control Systems

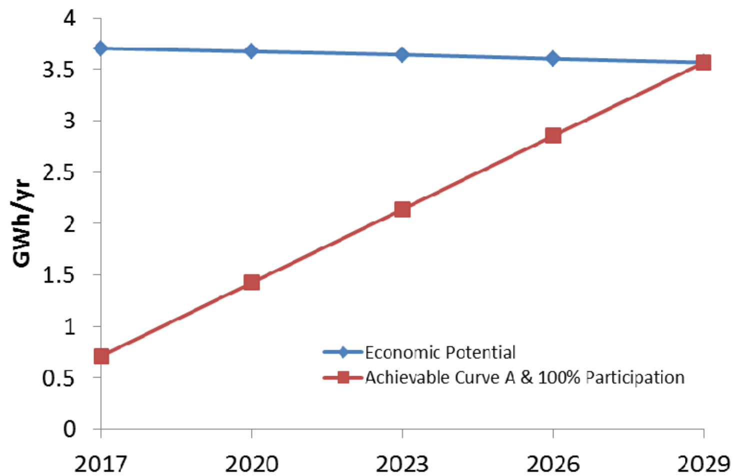
Economic Indicators

Simple Payback (Fishing - Island)	5.0 years
Average CCE (¢/kWh):	
Island	7.47
Labrador	8.18
Isolated	5.42
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	106,294 MWh
Applicability (Fishing)	80%

Industrial Opportunity 4:

PE Refrigeration Control Systems

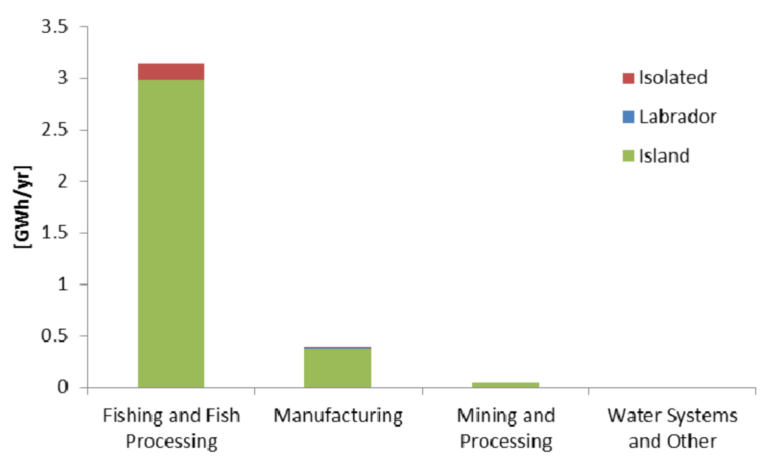
Progression of Economic Potential Savings



Industrial Opportunity 4:

PE Refrigeration Control Systems

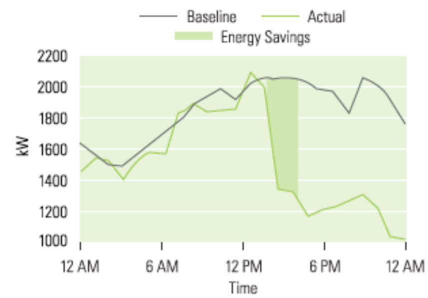
2029 Economic Potential Breakdown



Industrial Opportunity 5:

Demand Response Curtailments

- Participating facilities are incented to reduce their demand during critical provincial peak periods
- Utilities inform program participants when there will be a ‘peak period event’
- Operational changes, rescheduling of production, and use of back-up power equipment



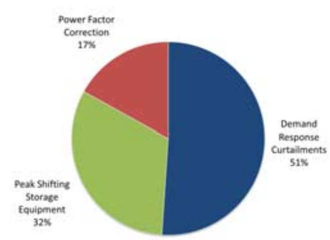
Courtesy: RLW Analytics

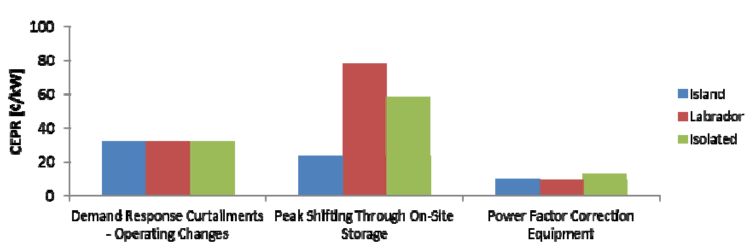
Industrial Opportunity 5:

Demand Response Curtailments

Comparison with Other Demand Measures

	2029 Economic Potential Peak Demand Reduction (MW)	Passes Economic Test in Regions
Demand Response Curtailments - Operating Changes	3 *	All
Peak Shifting Through On-Site Storage	2	Island, Isolated, partial Labrador
Power Factor Correction	1	All





Industrial Opportunity 5:

Demand Response Curtailments

Assumptions

Focus Sub-Sector Type	Manufacturing
Focus Region	Island
Typical Application:	
Cost	$29 / peak kVA
Useful Life	1 years
Savings:	
System (all end uses)	10%

Industrial Opportunity 5:

Demand Response Curtailments

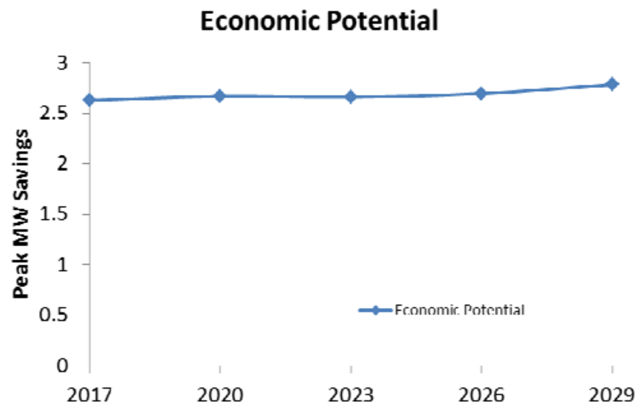
Economic Indicators

Simple Payback (Manufact - Island)	0.5 years *
Average CEPR (¢/kW):	
Island	32.3
Labrador	32.0
Isolated	32.4
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
Demand by 2029 (ref. case)	375 MW
Applicability (Manufacturing)	100%

Industrial Opportunity 5:

Demand Response Curtailments

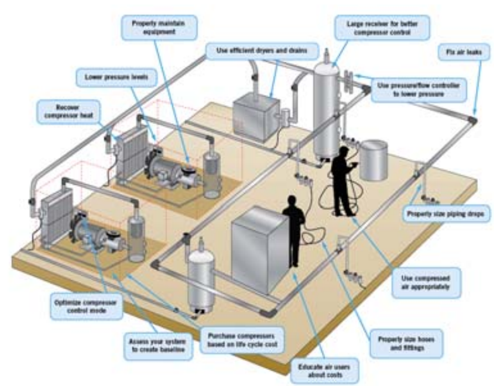
Progression of Economic Potential Savings



Industrial Opportunity 6:

Optimization of Compressed Air Systems

- Minimization of system pressure drops between the compressor and the end uses
- Elimination of inappropriate uses of compressed air

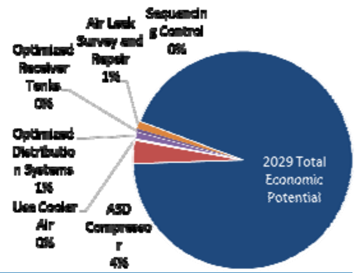


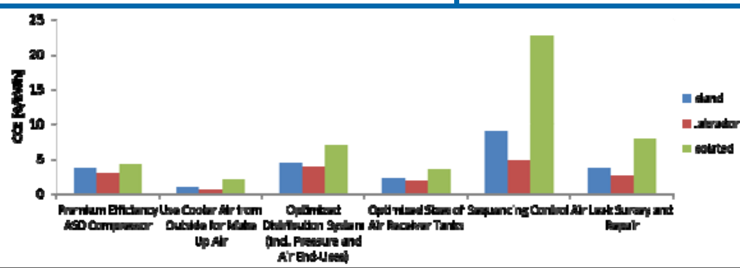
Industrial Opportunity 6:

Optimization of Compressed Air Systems

Comparison Between Compressed Air Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
PE ASD Compressor	3,927	All
Cooler Air from Outside for MUA	243	All
Optimized Distribution System (Incl. F	1,214	All
Optimized Sizes of Air Receiver Tank	502	All
Sequencing Control	22	Island (2017), Labrador
Air Leak Survey and Repair	1,290	All





Industrial Opportunity 6:

Optimization of Compressed Air Systems

Assumptions

Focus Sub-Sector Type	Mining
Focus Region	Island
Typical Application:	
Cost	$50,200
Useful Life	10 years
Savings:	
Air Compressors	10%

Industrial Opportunity 6:

Optimization of Compressed Air Systems

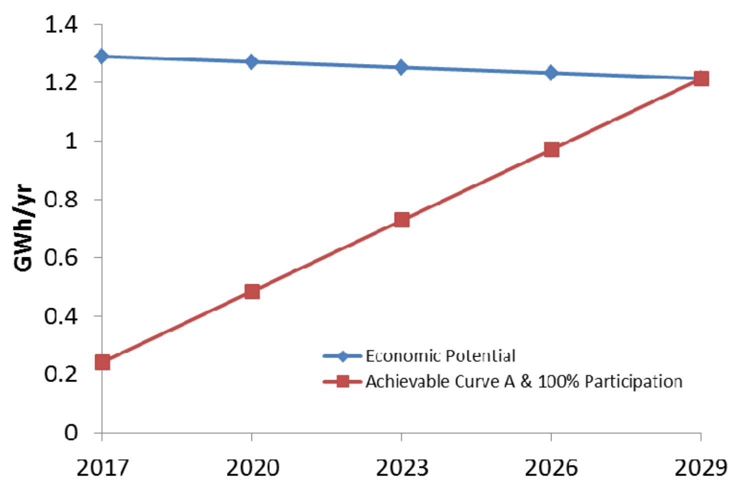
Economic Indicators

Simple Payback (Mining - Island)	3.5 years
Average CCE (¢/kWh):	
Island	4.35
Labrador	3.75
Isolated	6.97
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	56,396 MWh
Applicability (Mining)	90%
Principal Sub-Sectors	Mining

Industrial Opportunity 6:

Optimization of Compressed Air Systems

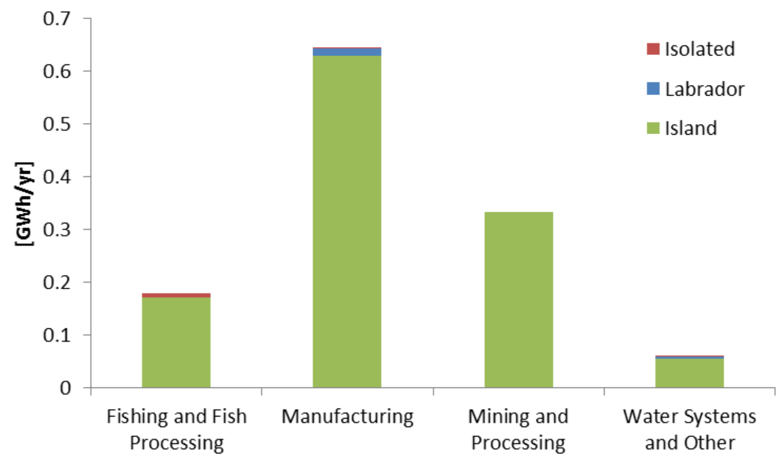
Progression of Economic Potential Savings



Industrial Opportunity 6:

Optimization of Compressed Air Systems

2029 Economic Potential Savings Breakdown



Industrial Opportunity 7:

Optimized Motor Control

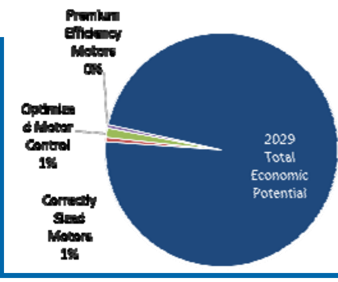
- For many applications, optimized sensor-based controls offering on/off settings for motors will be the ideal control solution, shutting themselves off when the process is not in session.
- For applications with significant variations in load, adjustable speed drives that match the motor speed to load requirements can result in significant energy savings.

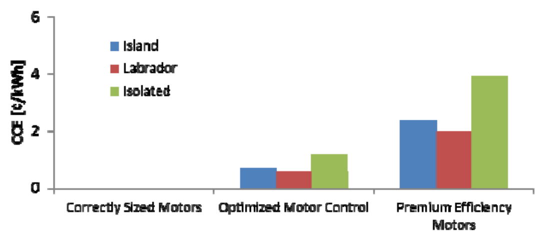
Industrial Opportunity 7:

Optimized Motor Control

Comparison Between Other Motor Measures

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
Correctly Sized Motors	677	All
Optimized Motor Control	1,471	All
Premium Efficiency Motors	557	All





Industrial Opportunity 7:

Optimized Motor Control

Assumptions

Focus Sub-Sector Type	Manufacturing
Focus Region	Island
Typical Application:	
Cost	$3,781
Useful Life	15 year
Savings:	
Other Motors	5%

Industrial Opportunity 7:

Optimized Motor Control

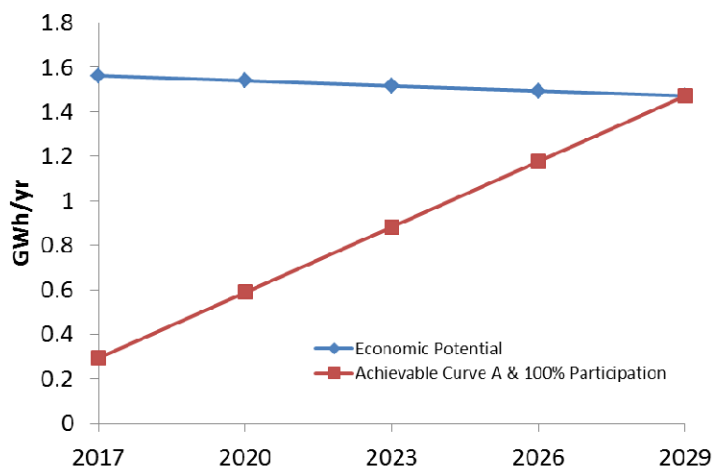
Economic Indicators

Simple Payback (Manufacturing - Is	0.9
Average CCE (¢/kWh):	
Island	0.71
Labrador	0.61
Isolated	1.17
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	77,010 MWh
Applicability (Manufacturing)	70%

Industrial Opportunity 7:

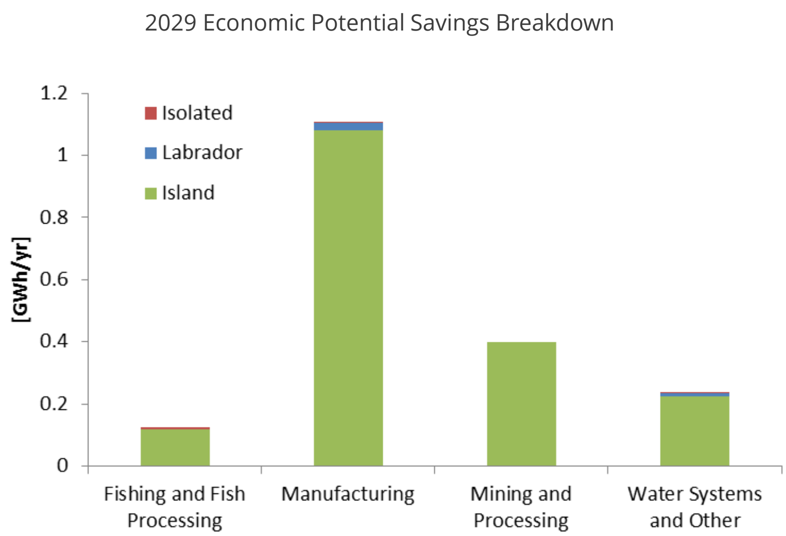
Optimized Motor Control

Progression of Economic Potential Savings



Industrial Opportunity 7:

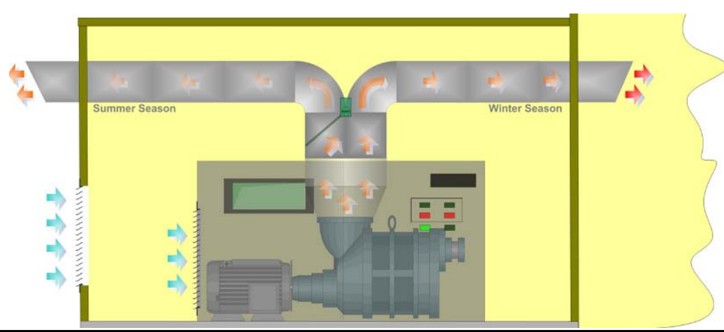
Optimized Motor Control



Industrial Opportunity 8:

Process Heat Recovery for HVAC

- Air cooled compressors exhaust heated air. In most cases a simple duct system can direct the heated air to inside the building during winter and to outside the building during summer.
- Many other processes also produce waste heat that can be harnessed with varying degrees of difficulty.

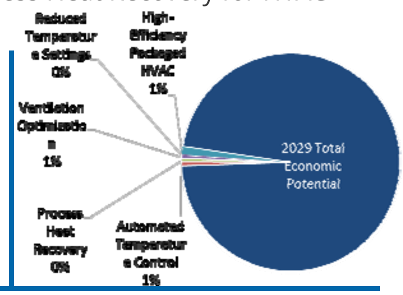


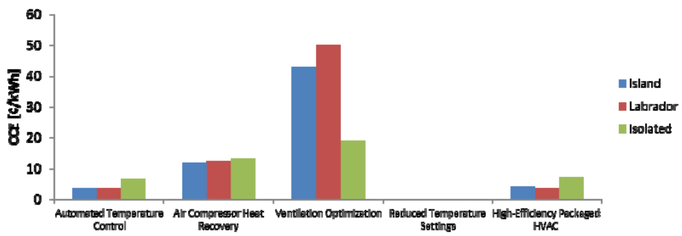
Industrial Opportunity 8:

Process Heat Recovery for HVAC

Comparison Between Process Heat Recovery for HVAC

	2029 Economic Potential Savings (MWh)	Passes Economic Test in Regions
Automated Temperature Control	724	All
Process Heat Recovery	541	Island (2017), Isolated
Ventilation Optimization	586	Isolated
Reduced Temperature Settings	94	All
High-Efficiency Packaged HVAC	1,341	All





Industrial Opportunity 8:

Process Heat Recovery for HVAC

Assumptions

Focus Sub-Sector Type	Manufacturing
Focus Region	Island
Typical Application:	
Cost	$5,425
Useful Life	20 years
Savings:	
Comfort HVAC	15%

Industrial Opportunity 8:

Process Heat Recovery for HVAC

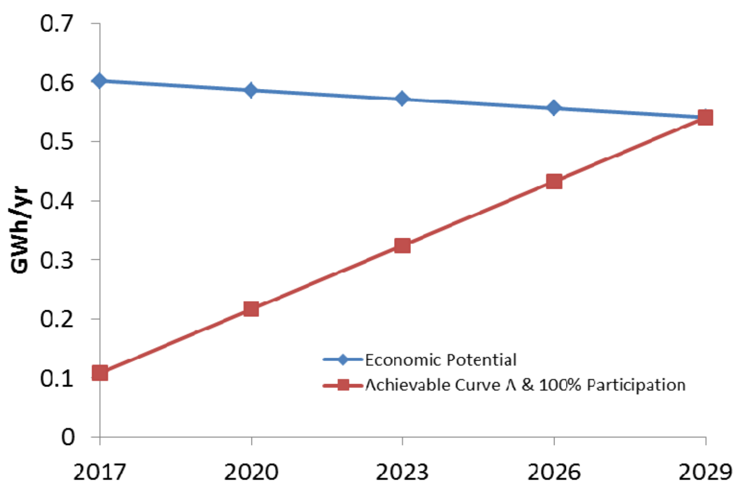
Economic Indicators

Simple Payback (Manufacturing - Is	9.9 years
Average CCE (¢/kWh):	
Island	12.01
Labrador	12.38
Isolated	13.24
Basis	Full
Eligibility Timeline	Immediate
Eligible participants:	
End Use size by 2029 (ref. case)	73,431 MWh
Applicability (Manufacturing)	30%

Industrial Opportunity 8:

Process Heat Recovery for HVAC

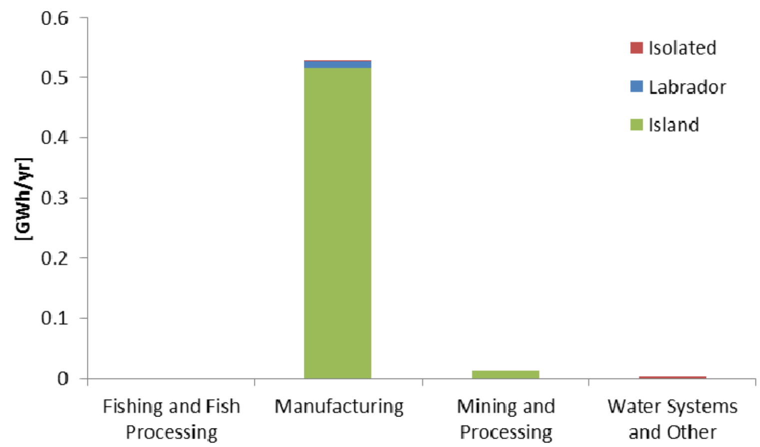
Progression of Economic Potential Savings



Industrial Opportunity 8:

Process Heat Recovery for HVAC

2029 Economic Potential Savings Breakdown



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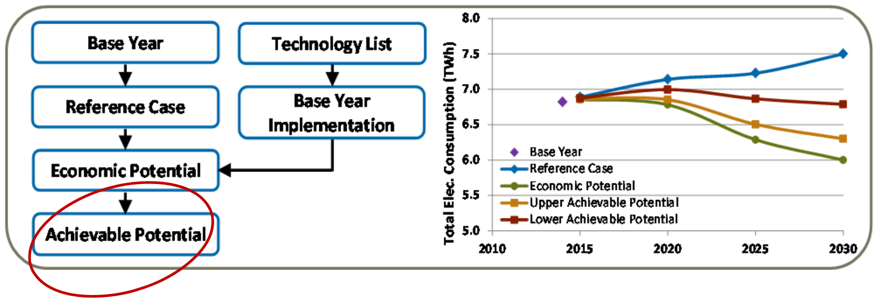
Wrap Up & Next Steps

Next Steps



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INTERNATIONAL

Appendix H Background-Section 10: Achievable Workshop Measure Worksheets

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

1: LED Lighting

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Manufacturing		
MEASURE INFORMATION			
CCE (¢/kWh)	4.9		
Simple Payback (years)	4.8		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	20,518		
Econ Potential Savings (MWh)	8,808		
Econ Potential Savings (%)	43%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	85%	Curve A	Lot of momentum for the technology, distributor support, and customer demand (maintenance/reliability drivers as
Aggressive Marketing (HIGH)	95%	Curve C	
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	17,440		Lower 2029 Savings
Aggressive Marketing (MWh)	19,492		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Automated Lighting Controls	Slightly lower (since LEDs so high)	Pretty easy sell, particularly if retrofitting lighting already, but is an extra step and not everyone will bother.	
High-Efficiency Lighting Design	A lot lower	Distributors wont mention unless you ask.	Note that lighting design is often free, and done by the lighting distributors/vendors if asked for
Other Sub-Sectors:			
Fishing and Fish Processing	Same.		
Mining and Processing	Same.		
Water Systems and Other	Similar, maybe slightly lower; Municipalities, town councils, could be constrained in		
Other Regions:			
Labrador	Same	Isolated	Lower - Availability of electricians and cost of LEDs higher
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High - and needs simple incentive
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Need more external technical support, plant focused on

GENERAL NOTES:
- Down the road, trend is strongly towards LEDs, and distributors will be pushing these instead of fixtures like MH - which may not even be available.
- Work through lighting distributors or contractors working on standing offers at the facility

BARRIERS/CHALLENGES:
- Upfront costs: Awareness is there
- While people know of technology, not always fully aware of savings, simplicity
- Worries about reliability
- Competing priorities: focused on keeping production going and not worried about energy/lighting
- Savings too low in some cases to justify efforts (if lighting small portion at facility)
- Cost of getting an electrician to come out and put up lights
- Isolated communities (Lab & Island) have even harder time getting contractors to come on site.
-Food & Bev / Fishing: Fixtures need to be aproved

STRATEGIES/SOLUTIONS:
- External technical support
- Low hanging fruit assessments
- Significant and simple incentives
- Direct install program options - again, simpler the better
- Demo projects /case studies / share success stories amongst industry
- CME strategy where they are the application process: Utility direct install where they have a team of people to get it done, incl. electricians on board and everything taken care of

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

2: Optimization of Pumping Systems

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Water Systems and Other		
MEASURE INFORMATION			
CCE (¢/kWh)	2.0		
Simple Payback (years)	2.3		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	50,274		
Econ Potential Savings (MWh)	5,672		
Econ Potential Savings (%)	11%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	10%	B	Opportunity has to present itself.
Aggressive Marketing (HIGH)	80%	B	In St. Johns.... Likely higher outside St. johns. Customer base is quite small, so should be able to build relationships. (However one person thought smaller players outside St. Johns might be harder to reach).
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	5,027		Lower 2029 Savings
Aggressive Marketing (MWh)	40,219		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Premium Efficiency Pump Control with ASDs	Higher	More straightforward opportunity. But need awareness of variability. Similar cost/technical barriers.	
Correctly Sized Pumps: Impeller Trimming or Pump Selection	Lower	Need of team/engineer to actually implement this.	
Premium Efficiency Pump Motor	Same	Need more awareness on HE motors of re-winding, cost of motor 2% of lifetime costs.	
Other Sub-Sectors:			
Mining and Processing	Higher - Controls/VFDs for systems. More in house expertise for larger mines. Mill has some shutdown opportunities for maintenance, not underground in the mine. Similar barriers.		
Fishing and Fish Processing	Same - Limited awareness and technical expertise. Need to help ID opps and with technical aspects. More time in off-season for retrofits, but during season focus is all on production. Lots off opps in general in Fish plants and historically little focus on EE.		
Manufacturing	Same - Similar barriers		
Other Regions:			
Labrador	Same	Isolated	Lower - Logistics are an issue
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Opp ID, technical support, case studies, audit program.

GENERAL NOTES:
- VFD can cover up some aspects of poor design
- Municipality: as building and expanding systems, putting in VFDs (2 of 5)

BARRIERS/CHALLENGES:
- Awareness is a major issue. A lot of people do not understand pumping and the opportunity
- A lot of over design in pumping systems (no one complains about overdesign, but under design risks the process failing). If you tell someone to trim impellers, needs an engineer and team of people to get it done. Not easy.
-Generally poor design of systems. Often too many pumps.
- VFD studies get done, business case presented, often not implemented.
-Disruption to service is barrier for municipality. Dont take a day off, harder to switch out.
- Fish plant seasonality (low hours of use limits savings, bumps up payback)
- cost
-20 year rated pumps going for 40 years+
- Risk of other impacts from changing pumps on system.

STRATEGIES/SOLUTIONS:
- Identifying custom solutions by facility
- Technical challenges / Education / Expertise: awareness of opportunity, spread awareness of incentives
-Engineering consulting, some pump suppliers - suppliers convenient, but want unbiased opinions
-Incorporate with production schedules - production is king, fish plants needs to happen off-season, and cant impact reliability.
- Educational campaigns / awareness / case studies

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

3: Roving Energy Managers

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Fishing and Fish Processing		
MEASURE INFORMATION			
CCE (¢/kWh)	5.2		Lower for other Sub-sectors
Simple Payback (years)	1.7		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	128,250		
Econ Potential Savings (MWh)	2,596		
Econ Potential Savings (%)	2%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	0%		
Aggressive Marketing (HIGH)	70%	Curve B	If all costs are removed, seafood specific this would be fast (95%), but unlikely to be fully paid by the utilities.
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	0		Lower 2029 Savings
Aggressive Marketing (MWh)	89,775		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Sub-Metering	Much lower	Subscriptions services also available. 10-20k offering, meter, technician time, etc… relatively extensive service and little interest in doing on their own. Tough to prove opps without this…. Might follow after awareness.	
Energy Management Information System (EMIS)	Much lower		
Integrated Plant Control System	Much lower	Capital costs high.	
Operation and Maintenance (O&M) Program for Efficiency	Lower	Some maintenance slips from schedule. Ie, look for 3 year but then slips to 5 year cycle. If minor problems only then don't waste money on maintenance, shift budget to production.	
Other Sub-Sectors:			
Mining and Processing	Same		
Water Systems and Other	same		
Manufacturing	same		
Other Regions:			
Labrador	Lower - harder to access	Isolated	Much Lower - services cost less i
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Technical Support

GENERAL NOTES:
- Only a hanful of companies on the island that would hire someone for EM on their own. Lots would participate if had access to shared resource through utilities.
-

BARRIERS/CHALLENGES:
- Awareness. Comes back to simply not recognizing energy waste as an issue.
- Risk on utility side in terms of results from roving energy manager actually being implemented.
- Availability of people for this - there are qualified people, but they are not necessarily available (wont quit job for this).

STRATEGIES/SOLUTIONS:
- Screen ideal candidates
- Have sites have some skin in the game; possibly increasing over time.
- Training opportunities offered to generate EMs
- As plants interact with EM their awareness of EM grows, and it progresses more naturally.

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

4: Premium Efficiency Refrigeration Control Systems and Compressor Sequencing

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Fishing and Fish Processing		
MEASURE INFORMATION			
CCE (¢/kWh)	4.8		
Simple Payback (years)	5.0		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	67,969		
Econ Potential Savings (MWh)	3,141		
Econ Potential Savings (%)	5%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	15%	Curve B	Some dept. of fisheries money going into this.
Aggressive Marketing (HIGH)	60%	Curve B	Shift to younger generation to encourage and require newer systems
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	10,195		Lower 2029 Savings
Aggressive Marketing (MWh)	40,782		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Floating Head Pressure Controls	Same	Improve Insulation of Refrigeration System	
Smart Defrost Controls	Same	Air Curtains	
Free Cooling	Lower	Chiller Economizer	
High Efficiency Chiller	Higher for VFD on screw compressor	Optimized Distribution System	
Improved Ice Production System	Lower	Heat Recovery for Water Heating	Mainly savings from oil, so lower on its own.
Other Sub-Sectors:			
Mining and Processing			
Water Systems and Other			
Manufacturing	Same		
Other Regions:			
Labrador	Lower - Remote	Isolated	Lower - Remote
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High
Sensitivity to Education and Direct Program Support (High, Med, Low)			Awareness / Education
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			

GENERAL NOTES:
- Awareness/Comfort - Content with old systems that are easy to understand. Harder to troubleshoot PLCs, and focused on reliability.
- CCE for $1/kwh for current refrig costs in isolated, but consultants cost is huge

BARRIERS/CHALLENGES:
- Internet acces in isolated prevents access online for online optimization services.
- Lack of consultants to go to all the remote areas - Need to pay them more to go farther, and need to ensure costs remain at acceptable level for Utility.
- Capital cost
- People resist change, and not going to let go easily of something critical to the facility that they know works/is reliable.
- Intimidated / change of routine required to go from looking at a dial to going on a computer system.
-Need to have operators there by law, so hesitancy to invest in control systems, if still need operator there anyways. Some provinces have legislation that requires less operators with controls.

STRATEGIES/SOLUTIONS:
- Try to convince people it works / fine line vs. not insulting people
- Lot of training / education / good training program for operators
- Not enough to just have case studies - need training /help
-Maybe down the road with younger more tech savvy operators adoption will better accepted.

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

5: Demand Response Curtailments

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Manufacturing		
MEASURE INFORMATION			
CCE (¢/kWh)	32.3		
Simple Payback (years)	0.5*		
ECONOMIC POTENTIAL (2029)			
Peak Demand (MW)	11		
Peak Demand Reduction (MW)	1		
Econ Potential Savings (%)	5%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	5%	D	Few have opted out, fuel costs were too much after events went up in last 2 year period.
Aggressive Marketing (HIGH)	15%	B	More back-up generation being installed in the future.
ACHIEVABLE POTENTIAL			
BAU Marketing (MW)	1		Lower 2029 Savings
Aggressive Marketing (MW)	2		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Peak Shifting Through On-Site Storage	Similar	See commercial discussion. Not all Building automation systems used as prescribed (overuled).	High demand times for water similar to Electricity. So harder.
Power Factor Correction Equipment	Higher	Lack of awareness. Know of one mine that is around 0.8 PF so is an opp, but some facilities do have PF correction.	
Other Sub-Sectors:			
Fishing and Fish Processing	N/A		
Mining and Processing	Would not disrupt process. Full back-up, but the cost to do this would be prohibitive. Also have some smaller generation, but limited.		
Water Systems and Other	Most of big systems in St. Johns already on curtailment program. Smaller systems outside harder. Shutting down system by system difficult, and coming back online in stages poses challenges.		
Other Regions:			
Labrador		Isolated	N/A
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High
Sensitivity to Education and Direct Program Support (High, Med, Low)			Medium
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Medium

GENERAL NOTES:
- Awareness of program is high
- Around 9-10 larger customers participating

BARRIERS/CHALLENGES:
- Back-up power doesnt usually cover 100%, so can maybe partially cover
-Transfer switches also an issue as dated switches not meant to be used in such frequency.

STRATEGIES/SOLUTIONS:
- Higher incentives could make participation more valuable and grow.
- Some promotion of programs / explanation of options.

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

6: Optimization of Compressed Air Distribution Systems and End-uses

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Mining and Processing		
MEASURE INFORMATION			
CCE (¢/kWh)	3.7		
Simple Payback (years)	3.5		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	18,435		
Econ Potential Savings (MWh)	997		
Econ Potential Savings (%)	5%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	20%	A	
Aggressive Marketing (HIGH)	90%	A	Lots of potential and interest.
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	3,687		Lower 2029 Savings
Aggressive Marketing (MWh)	16,592		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Air Leak Survey and Repair	Same	low-cost opp	
PE ASD Compressor	Lower	Higher capital costs	
Optimized Sizes of Air Receiver Tanks	Lower	low-cost opp	
Cooler Air from Outside for MUA	Same	Higher capital costs	
Sequencing Control	Lower	Higher capital costs	
Other Sub-Sectors:			
Manufacturing	Same		
Fishing and Fish Processing	Same		
Water Systems and Other	Same		
Other Regions:			
Labrador	same	Isolated	lower - travel barrier for auditor
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			Med
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Compressed Air Audit

GENERAL NOTES:
-
-

BARRIERS/CHALLENGES:
- Perception that compressed air is free in industry
- Costs
- Awareness/education: know its an opp but dont have solid facts to base decision on.

STRATEGIES/SOLUTIONS:
- Support proving business case / focusing on which compressed air opps to pursue
- Raise awareness - lot of low cost measures but people have other priorities and need utility help to sitdown and create a plan/quantify what they know is there.
-Need boots on the ground to ID opps at plant.
-Compressed air audit program

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

7: Optimized Motor Control

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Manufacturing		
MEASURE INFORMATION			
CCE (¢/kWh)	0.8		
Simple Payback (years)	0.9		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	39,644		
Econ Potential Savings (MWh)	1,106		
Econ Potential Savings (%)	3%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	15%	B	Fairly low uptake as of now.
Aggressive Marketing (HIGH)	80%	A	Capital cost involved, but mature enough technology and there is interest.
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	5,947		Lower 2029 Savings
Aggressive Marketing (MWh)	31,716		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Correctly Sized Motors	Same	Most customers just want it to work again as fast as possible. Don't even consider that it might not be sized correctly.	Through a motor maintenance program include assessment of sizing.
Premium Efficiency Motors	Higher		
Conveyor Motor Control	Same		
Fan ASD	Same		
Other Sub-Sectors:			
Fishing and Fish Processing	Same		
Mining and Processing	Same		
Water Systems and Other	Same		
Other Regions:			
Labrador	Same	Isolated	Lower - accessability
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			Med
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			ID and proper implementation of motor control

GENERAL NOTES:
- On/off controls only for smaller motors
- Supply channels exist

BARRIERS/CHALLENGES:
- Percieved reliability risk
- VFDs installed by personel that are not knowledgeable
- VFDs being installed where not the correct solution to the problem... covering up the issues with a VFD.
- When customer goes to supplier for VFD, not going to be turned down and told to do a study.

STRATEGIES/SOLUTIONS:
- Need education on what VFDs have acceptable harmonics performance. Avoid PF issues as well. Low additional cost for these better performance VFD.
- Developing lists of qualified or reputable suppliers
- Utility support at comissioning stage to support more effective implementation
- Qualified product list

NL ACHIEVABLE POTENTIAL WORKSHOP - INDUSTRIAL SECTOR

Process Heat Recovery for HVAC

			COMMENTS
Focus Region	Island Interconnected		
Focus Sub-Sector	Manufacturing		
MEASURE INFORMATION			
CCE (¢/kWh)	8.1		
Simple Payback (years)	9.9		
ECONOMIC POTENTIAL (2029)			
End Use Consumption (MWh)	22,895		
Econ Potential Savings (MWh)	528		
Econ Potential Savings (%)	2%		
PARTICIPATION RATES	**% by 2029**	**Curve**	
BAU Marketing (LOW)	10%	A	Mature opp already, with low adoption.
Aggressive Marketing (HIGH)	50%	A	Applicability, already removed 70%...
ACHIEVABLE POTENTIAL			
BAU Marketing (MWh)	2,289		Lower 2029 Savings
Aggressive Marketing (MWh)	11,447		Upper 2029 Savings
RELATIVE PARTICIPATION RATES (H=Higher; L=Lower; S=Same; N/A=Not Applicable)			
Related Measures:			
Automated Temperature Control	Higher	Warehouse Loading Dock Seals	lower
High-Efficiency Packaged HVAC	same*	Improved Building Insulation	lower
Reduced Temperature Settings	Higher	HVAC Air Curtains	lower
Ventilation Optimization	lower		
Ventilation Heat Recovery	lower		
Other Sub-Sectors:			
Fishing and Fish Processing	same		
Mining and Processing	same		
Water Systems and Other	same		
Other Regions:			
Labrador	same	Isolated	lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Med, Low)			High
Sensitivity to Education and Direct Program Support (High, Med, Low)			High
Most Critical Program Support Type(s) (e.g. Opportunity Identification, Trade Ally Training, Technical Workshops, etc.)			Opp identification

GENERAL NOTES:
- Really depends on existing setup of compressors. More common in new builds.
- General Heat Recovery in breweries etc, in larger facilities.

BARRIERS/CHALLENGES:
- Configurations for retrofit.
- Consistency of waste heat supply (changes between seasons)
- Source of heat
- Quality requirements / regulations for Fishing & Food/Bev
- Price
- Lack of understanding the concept of wasted energy. Think they are focused on energy costs but don't challenge.

STRATEGIES/SOLUTIONS:
- Get customers to re-consider their HVAC systems and not just accept the status quo
- Benchmarking vs. similar facilities to show they should be able to improve
- HR integrated with other HVAC opp assessment

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