Q. Please provide any studies or data that Newfoundland Power has regarding the feasibility, cost and load reductions from implementing residential demand response (such as direct load control) measures for electric resistance water heaters, heat pump water heaters, heat pump space heaters, and electric resistance heating.

A. Attachment A to this response provides Newfoundland Power's *2015 Hot Water Tank Direct Load Control Pilot* report. This report summarizes the hot water tank direct load control pilot completed by the Company during the 2014/2015 heating season.

Attachment B to this response provides the *Residential Sector Final Report* for the *Newfoundland and Labrador Conservation and Demand Management Potential Study: 2015* (the "CPS").[1] The demand reduction technologies included in the CPS and the impacts associated with them can be found in section *7.4 Demand Reduction Technology Assessment*.

Please see responses to Information Requests PUB-NP-029 and PUB-NP-078 for a copy of Newfoundland Power's study of time-of-use rates and the associated load data, respectively.

[1] The CPS provides a framework for Newfoundland Power and Newfoundland and Labrador Hydro to properly examine conservation and demand management opportunities. The primary outcomes of the study are: (i) identification of cost-effective energy saving and demand management measures; (ii) general parameters for program development; and (iii) quantification of achievable energy savings and demand management potential by sector and end-use. These outcomes form the basis for long-term planning, including energy savings targets, specific program design, implementation, evaluation and program delivery budgets.

2015 Hot Water Tank Direct Load Control Pilot

2015 Hot Water Tank
Direct Load Control Pilot

April 1, 2016

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1. Executive Summary

In the fall of 2014, Newfoundland Power launched a pilot program to reduce peak demand by controlling hot water tanks in approximately 500 customer homes in Paradise and Mount Pearl. This pilot was initiated in response to the constraints on electrical system capacity that became evident after the events in January of 2013 and 2014. The objective of the pilot was to assess the economic, market, and technical feasibility of direct load control to reduce overall peak demand.

Direct load control is a relatively common practice used across North America to reduce demand during peak times. Typically, utilities will install load control devices on customers' hot water tanks, air conditioners and pool pumps. Newfoundland Power focused on hot water tanks because approximately 90% of its customers use electricity for water heating and water heating is the second largest residential end use of electricity.

The Company marketed the pilot to designated subdivisions in Paradise and Mount Pearl. A total of 497 customers out of 5000, or 10%, completed equipment installations and participated in the pilot. The pilot program was operational during the 2014-2015 winter peak demand season, December 2014 through March of 2015.

The direct load control events took place on scheduled days or during periods when demand for electricity was very high. Throughout the pilot, 17 demand response events were conducted. These direct load control events occurred between 7:00 a.m. – 11:00 am and/or 4:00 p.m. – 8:00 pm on weekdays.

The overall demand reduction achieved by the direct load control events on average was 0.6 kW per participant. For events that included all participants, approximately 298 kW of demand reduction was achieved.

At the end of the pilot participants were asked to complete a survey evaluating their experience. Over 83% of participants reported being completely satisfied with the program, with less than 5% being unsatisfied. Over 94% of participants responded that they would participate in the program again.

Given the successful results of the pilot, Newfoundland Power assessed the potential costs and demand impacts for a broader hot water direct load control program. It was determined that based on the results of the pilot and the experience of other utilities, the Company could enroll approximately 24,000 participants in 5 years, thereby achieving approximately 14.4 MW of demand reduction by 2020.

Although the market and the technical feasibility of a larger program look positive, the economics of achieving this demand reduction are not. The program is estimated to cost approximately $22.6 million compared to the value of demand savings of $17.1 million over the life of the program. The Total Resource Cost Test result is calculated to be 0.8, failing to meet the requirement for implementing a conservation and demand management program.

2. Context

2.1 Existing Programs

The 2008 and 2012 Five Year Conservation and Demand Management Plans, delivered jointly by Newfoundland Power and Newfoundland and Labrador Hydro, have focused primarily on energy conservation. This reflected the relatively high marginal energy costs (predominately due to fuel costs at Hydro's Holyrood Thermal Station) which justified such a focus. The events of recent winters have since brought to light issues with the sufficiency of generation capacity on the Island Interconnected System. Although the current customer conservation programs focus on energy savings they also result in quantifiable demand savings.

Table 1 shows the estimated energy and demand savings achieved by the takeCHARGE customer energy conservation programs.

Table 1
takeCHARGE Rebate Program
Life to Date Energy and Demand Savings

	2009	2010	2011	2012	2013	2014	Life to Date
Annual Energy Savings (GWh)	2.6	7.7	19.8	28.2	36.3	50.0	144.7
Peak Demand Savings (MW)	0.8	1.6	3.8	2.6	2.5	3.6	15.0

Newfoundland Power's takeCHARGE customer energy conservation programs have achieved 15 MW in peak demand reduction. This demand reduction will occur annually for the life of the installed technologies.[1]

Current demand management activities at Newfoundland Power include the Curtailable Service Option available to large commercial customers and a Residential Seasonal Rate option.[2] The Company is also conducting a rate study to evaluate the effectiveness of time-of-day rates for reducing peak demand in the residential sector.

[1] For example, a customer who installs basement insulation in 2014 will achieve approximately 0.9 kW of annual peak demand reduction for the next 20 years.

[2] Sixteen general service customers participated in the Curtailable Service Option during the 2014-2015 winter season, providing a load reduction of approximately 10.4 MW.

2.2 North American Demand Management Practices

There are over 230 demand response programs offered by utilities across North America. Over 100 utilities in North America have implemented direct load control programs, and over 70 of those are directed to residential customers. Direct load control of residential hot water tanks to reduce peak demand is relatively common utility practice. Typically, utilities will install load control devices on customers' hot water tanks, air conditioners and pool pumps. The utilities then cycle these appliances off during times of peak demand and offer the customer a financial incentive in return.

Through hot water tank direct load control, utilities are able to reduce peak demand by approximately 0.5-0.6 kW per participant. Average participation rates of 13% are being achieved in direct load control programs, and typically 7-10% participation can be achieved within the first two to three years of program implementation.

A sample listing of utility direct load control program expenditures, participation, demand reduction and age of program is provided in Appendix A.[3]

2.3 Demand Management Potential

In 2014 and 2015, Newfoundland Power and Newfoundland and Labrador Hydro jointly completed an updated Conservation Potential Study ("CPS") for Newfoundland and Labrador. The primary outcomes of this CPS are identification of cost-effective energy and demand reduction measures, general parameters for program development, and quantification of achievable energy savings potential by sector and end-use.

Graphs 1 and 2 show the results of the CPS regarding achievable demand reduction from energy efficiency measures ("Energy Efficiency Measures") and demand reduction from demand response specific measures ("Demand Response") by sector by 2020.[4]

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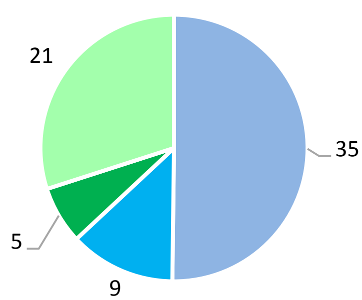
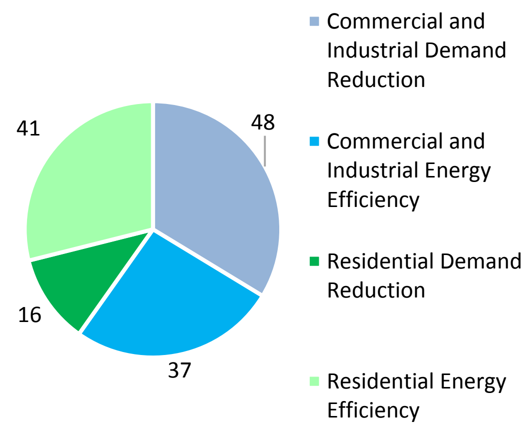
3 Appendix A is based on research conducted by E Source and published on August 16, 2012, "Hot or Not? DLC Program Benchmarking Results from the 2012 E Source Direct Load Control Program Study". E Source is a U.S. firm which provides research services for utilities and large energy users with critical problems involving energy efficiency, utility customer satisfaction, program design, marketing, customer management, and sustainability.

4 The achievable potential is defined as the portion of the economic conservation potential that is achievable through utility interventions and programs given institutional, economic and market barriers. The upper achievable potential is considered to be the best case scenario with all market barriers removed, such as capital cost and product accessibility. The lower achievable potential is considered a business as usual scenario with the existing market barriers remaining in place.

Graph 1
Lower Achievable Demand Reduction Potential
Island Interconnected System
2020
(MW)



Graph 2
Upper Achievable Demand Reduction Potential
Island Interconnected System
2020
(MW)



Graphs 1 and 2 show 70 MW for the lower potential and 142 MW for the upper potential demand reduction on the Island Interconnected System.[5] Installation of energy efficiency measures that reduce consumption during times of peak demand account for approximately 43% and 55% of the lower and upper achievable demand reduction, respectively, that could be achieved by 2020.[6]

The majority of the demand reduction potential was identified in the Commercial and Industrial sector. Specifically, the Industrial sector represents about 87% and 74% of the overall lower and upper achievable demand reduction, respectively.[7]

Graph 3 shows the cumulative demand reduction potential achievable in the residential sector by 2020.

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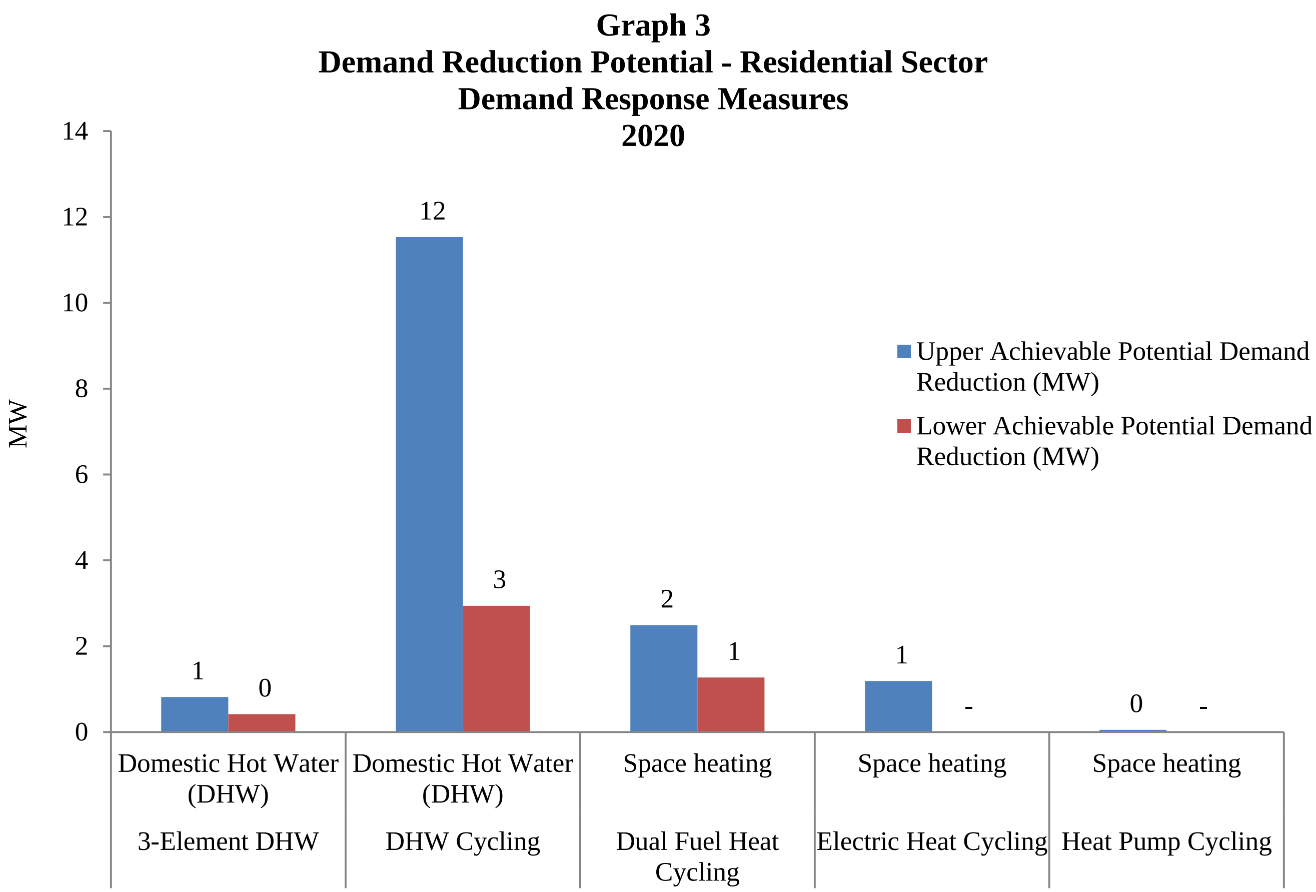
[5] 21+35+9+5=70 and 41+16+37+48= 142
[6] (21+9)/70=43% and (37+41)/142=55%.
[7] The Commercial and Industrial sector includes Hydro's large transmission level Industrial customers, as well as Newfoundland Power's and Hydro's General Service customers.



The highest residential demand reduction potential is in hot water tank load control, with potential for 3 MW in the lower achievable scenario, and 12 MW in the upper achievable scenario. This reflects the use of electricity for water heating in over 90% of Newfoundland Power's residential customers.

3. Pilot Assessment

3.1 Pilot Overview

Newfoundland Power contracted Util-Assist to develop and implement a direct load control pilot program for residential electric water heaters in the Northeast Avalon service area.[8] The objective of this pilot program was to assess the economic, market, and technical feasibility of demand load control to reduce overall peak demand. The pilot aimed to achieve the benefits of demand response by cycling off residential electric hot water tanks.

[8] Util-Assist, located in Ontario, is a leader in smart grid portfolio services and delivers direct load control programs for over 40 utilities in Canada.

3.2 Pilot Administration

The pilot was marketed to 5,000 residential customers in the following neighborhoods of Paradise and Mount Pearl:

- Pearl View/Mt Carson Terrace
- Newer sections of Elizabeth Park
- Trails End
- Karwood
- Adams Pond
- Grand Meadows
- Valley Ridge
- Fairview Estates

Table 1 shows the number of customers that registered to participate in the SmartPeak pilot by month.

Table 1
SmartPeak Registrations by Month

Month	Marketing Activities	Number of Registrations per Month	Cumulative Total Registrations
November 2014	E-mail, Direct Mail	569	569
December 2014	E-mail, Phone Campaign	186	755
January 2015	E-mail, Phone Campaign	58	813
February 2015	Phone Campaign	1	814

Of the 5,000 customers who received marketing materials to participate in the pilot a total of 814 customers, approximately 16%, actually registered for the pilot. Not all customers who registered for the pilot fulfilled the requirements to participate. For example, only customers with electric hot water tanks were considered eligible, as well, customers had to be available for an installation appointment. A total of 497, approximately 10%, of customers completed the equipment installation. The success of the marketing and participation that the SmartPeak pilot was able to achieve in approximately 3 months demonstrates the receptiveness to this type of program offering amongst residential customers.

Table 1 also shows the effect of diminishing returns in regards to participant enrollments. A 10% adoption rate for this type of direct load control program is consistent with the Company's research of other utilities offering similar programs. Most utilities are able to achieve 7-10% within the first few years of implementing the program. After those initial customer enrollments within the first 2 to 3 years it becomes increasingly difficult to obtain new customer enrollments.

All pilot participants received a $50 credit on their electricity bill and were entered into a draw to win an iPad. The first half of the incentive was credited on their electricity bill upon installation of the equipment, and the remaining $25 was paid following the end of the pilot when the participant completed an online survey. Participants were also offered a report on the hot water usage and tips on saving energy that they would receive at the end of the pilot.

An Advanced Meter Infrastructure ("AMI") meter with a control switch was installed near the hot water tank in each participant's home. This device allowed for communication in both directions between the hot water tank and the utility. This device was also able to provide 5 minute interval data on the energy use of the tank enabling the Company to quantify the demand reduction achieved through load control events.

AMI meters were also used to replace existing revenue meters on the participating homes. AMI meters were selected for the pilot for their ability to increase the communication strength between the meter on the hot water tank and the Util-Assist data center. These meters also had the ability to provide whole home usage data. With the data provided by the AMI meters, the Company was able to verify the overall demand reduction achieved by switching off hot water tanks during peak times on the entire home.

More information about the whole home data collected through this pilot is provided in Appendix B.

The pilot program was operational during the 2014-2015 winter peak demand season, December 2014 through March of 2015.

3.3 Direct Load Control Events and Results

The direct load control events took place on scheduled days or during periods when demand for electricity was very high, but not on weekends or holidays. The maximum number of demand response events performed on any participant's hot water tank was 15. Throughout the pilot, 17 demand response events were conducted: 10 on the entire pilot participant group and 7 on a smaller subset of participants either for testing purposes or prior to full meter deployment. These direct load control events occurred between 7:00 a.m. – 11:00 am and/or 4:00 p.m. – 8:00 pm on weekdays.[9] Participants were notified via email or text in advance of when a control event took place. For events that included all participants, approximately 298 kW of demand reduction was achieved.

Demand reduction impacts of events were calculated by comparing the event day consumption profiles ("Event Day") to non-event day consumption profiles ("Non-Event Days"). The difference between the typical consumption on the Non-Event Days compared to the Event Day was used to estimate the demand reduction achieved by the event.

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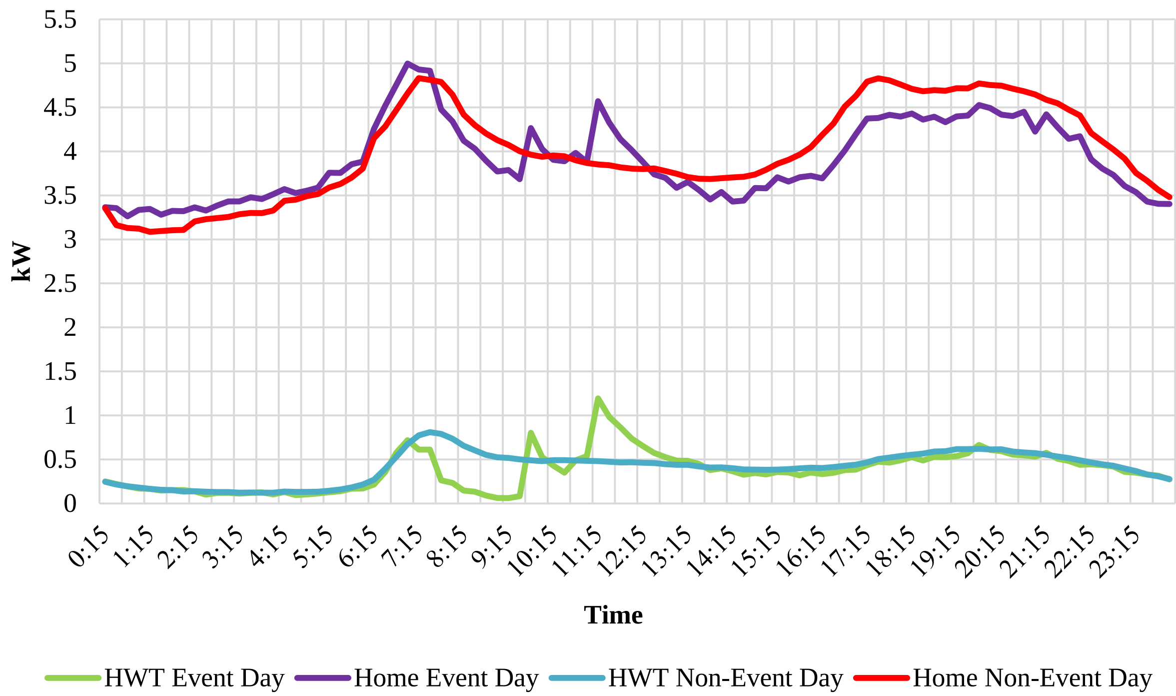
9 Actual event times varied during the 7:00 to 11:00am and 4:00 – 8:00pm timeframe. This was done to investigate the post event demand impacts and durations as discussed in Section 4.3: Post Event Demand Impacts.

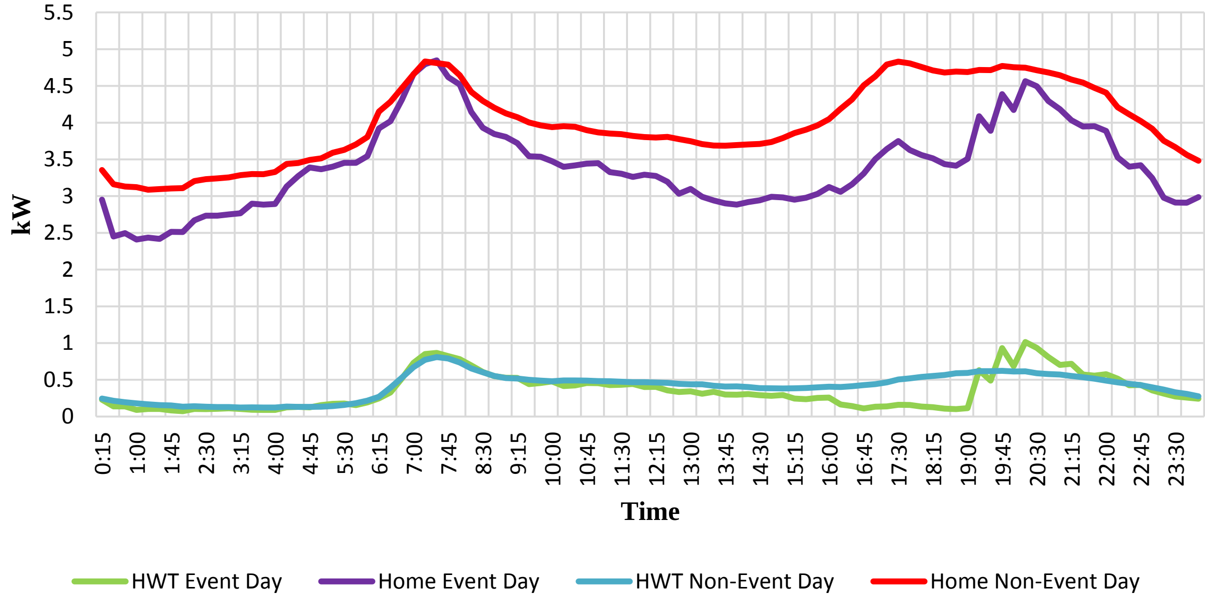
Graph 4 shows the average demand load profiles for the participating homes and their hot water tanks. It includes (i) the average weekday load profile during the pilot period for participating homes, (ii) the average load profile during days with control events in the morning for these homes (iii) the average weekday load profiles during the pilot period for the participant's hot water tanks, and (iv) the average load profile during days with morning control events for these hot water tanks.

Graph 4
Non-Event and Morning Event Day Load Profiles



Graph 5 shows the average demand load profiles for the participating homes and their hot water tanks. It includes (i) the average weekday load profile during the pilot period for participating homes, (ii) the average load profile during days with control events in the evenings for these homes (iii) the average weekday load profiles during the pilot period for the participant's hot water tanks, and, (iv) the average load profile during days with evening control events for these hot water tanks.

Graph 5
Non-Event and Evening Event Day Load Profiles



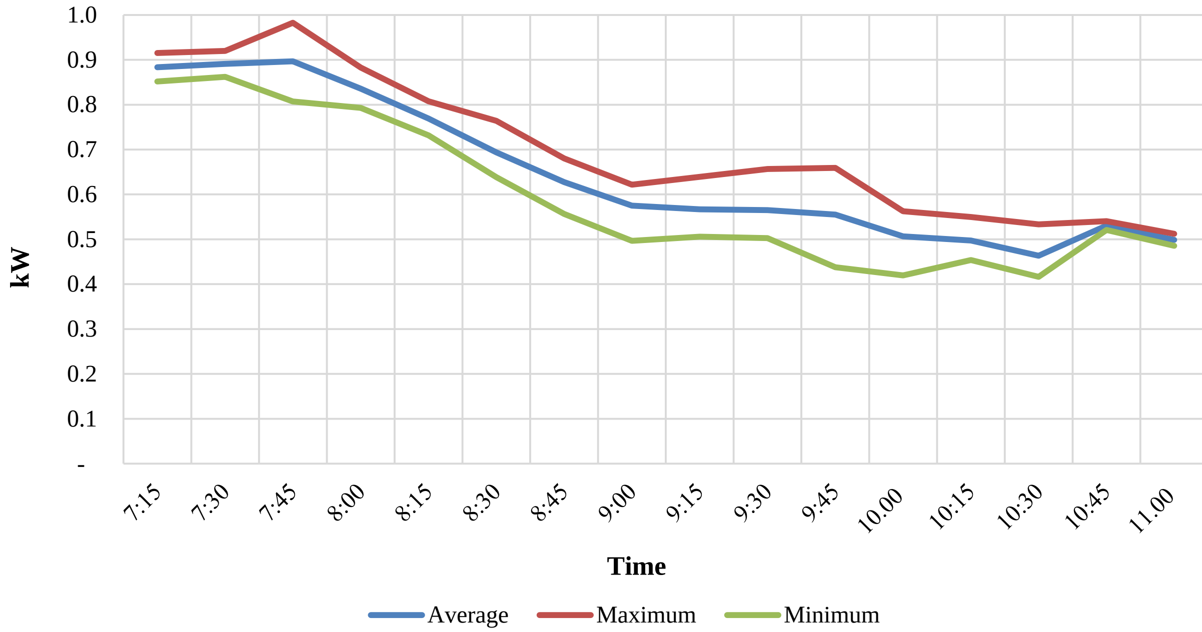
Graph 4 and 5 show that peak consumption typically occurs in the participant's homes between approximately 7:00 – 8:00 a.m. and 5:00– 6:30 p.m. The non-event day data was averaged out for the entire pilot period (4 months) while the event day data is the average of only the event days (12 days). This is the reason for the variance in the whole home load profiles.[10] The hot water tank load profile results are very consistent except during events. This illustrates that hot water tanks typically have predictable and uniform consumption patterns.

During events the whole home load profile parallels the control event impacts on the hot water tank.

[10] For example, the weather on the event day on average was likely different than the non-event day resulting in lower aggregate curves. More information can be found on the whole home data collected during the pilot in Appendix B.

Graph 6 shows the average, the maximum, and the minimum demand reduction achieved through morning direct load control events on the hot water tank.

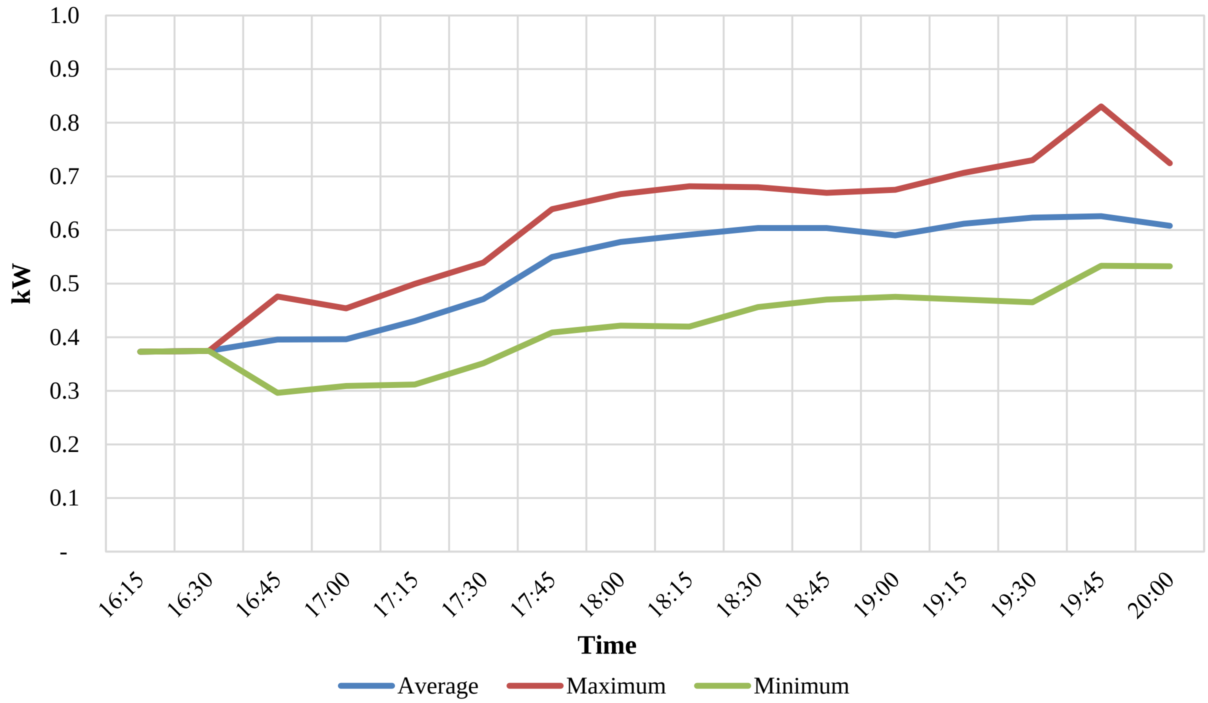
Graph 6
Morning Event Demand Reduction Results
Average, Minimum and Maximum
Hot Water Tank



The average demand reduction achieved on the hot water tanks during the morning peak was approximately 0.6 kw/tank. The maximum demand reduction achieved on average throughout the event timeframe was approximately 0.7 kW/tank and the minimum was 0.6 kW/tank.

Graph 7 shows the average, the maximum, and the minimum demand reduction achieved through evening direct load control events on the hot water tank.

Graph 7
Evening Event Demand Reduction Results
Average, Minimum and Maximum
Hot Water Tank



The average demand reduction achieved on the hot water tanks during the evening peak was approximately 0.5 kw/tank. The maximum demand reduction achieved on average throughout the event timeframe was approximately 0.6 kW/tank and the minimum was 0.4 kW/tank.

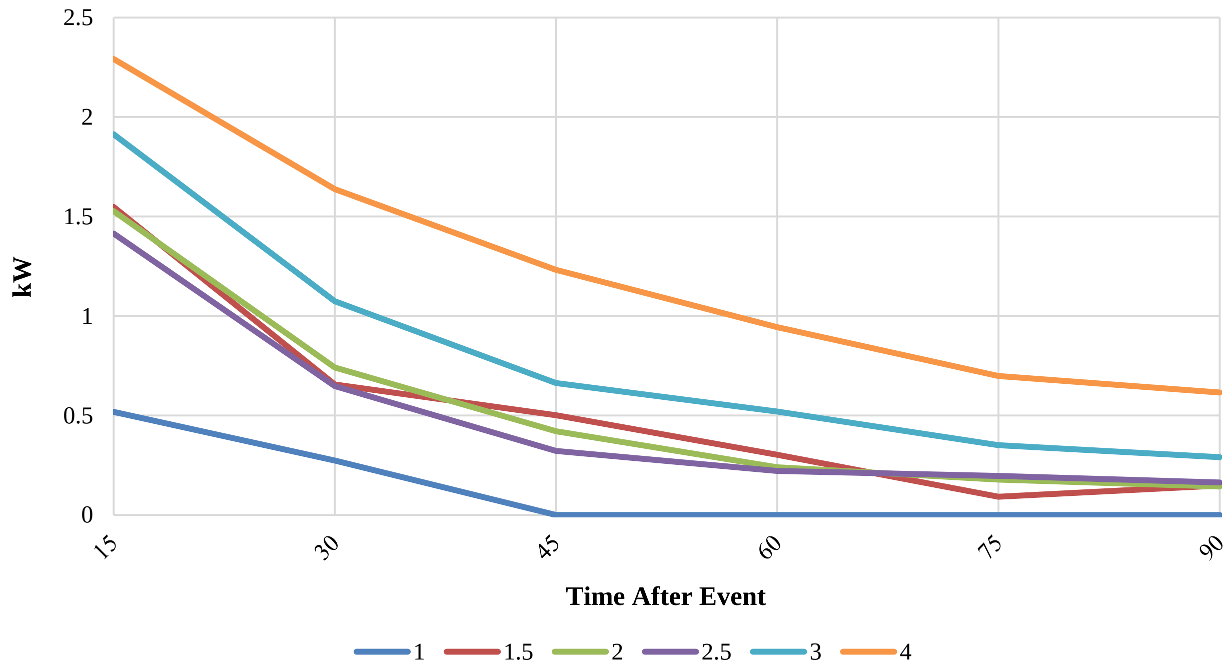
A representative sample of the estimated hot water tank demand reduction resulting from SmartPeak load control event is provided in Appendix C. The average weekly and weekday hot water tank load profiles by month for the duration of the pilot are provided in Appendix D.

Post Event Demand Impacts

At the end of a control event, participant hot water tanks are returned to normal service. Due to temperature drop within a tank during the control event, the heating element will typically come on immediately to reheat the water in the tank. The longer an event duration, the longer it will take each affected tank to reach its temperature set point. In this way, by directly controlling a group of hot water tanks, the utility removes the normal diversity in this load type among participant homes. This can cause a peak in demand following the end of a control event. This is referred to as cold load pick up. The pilot also examined this effect.

Graph 8 shows the demand impact after control events of various durations.

Graph 8
Post Event Demand Impact
Average kW Per Hot Water Tank



Graph 8 shows that a one hour event results in an approximately 0.5 kW post event demand increase and the tank remains on for approximately 30-45 minutes, while a four hour event results in an approximately 2.3 kW peak and the tank remains on for approximately 90-120 minutes. The cold load pick-up demand spike appears to occur almost immediately, within 15 minutes after the event. By 30 minutes after an event, the demand impact drops by approximately 55-75%.

Cold load pick-up was observed after every event regardless of duration. The results indicate that offsetting event end times (hot water tank restoration times) by a minimum of 15 minutes for groups of participants would reduce the post event demand impact.

3.4 Participant Survey

A survey was conducted at the end of the pilot to understand customers' experiences and satisfaction with the pilot. Of the 422 post pilot survey respondents, 86% were either satisfied or very satisfied with SmartPeak events. Approximately 11% of respondents reported running out of hot water during an event.[11] A total of 70% responded that they did not make any adjustments

[11] This may be a result of a communication failure that occurred after an event on January 9th that resulted in some hot water tanks remaining off for a prolonged period of time.

to their hot water usage and of those who did make adjustments, 16% rescheduled a shower, 20% rescheduled laundry and 22% rescheduled their dishwasher.

Participants were asked if the following statement was true, "The SmartPeak pilot program delivery occurred exactly as it was explained to me". 84% of participants said that they agreed or strongly agreed with the statement. Nearly 84% of participants reported being completely satisfied with the program, with less than 5% being unsatisfied. Over 94% of participants responded that they would participate in the program again.

3.5 Pilot Delivery Observations

Pilot Coordination
Through delivery of the SmartPeak pilot, Newfoundland Power gained experience regarding the significant administrative effort and coordination required to implement a direct load control program. If this pilot was implemented as a provincial program it would require significant administrative effort and cost to coordinate the installation of the equipment in participant's homes, as well as installation of the communication and control system. There are many parties involved in developing and installing the infrastructure required for such a program. This includes the customer, the customer contact center, the electrician, the inspector, and the equipment manufacturer.

All participants enrolled were contacted to schedule an installation appointment. The day before the installation, a customer service agent would contact the customer to provide a reminder of the appointment. The electrician would follow the appointment schedule while maintaining sufficient inventory of control switches and other hardware required to complete the installations. When the installation appointment was complete, the electrician would notify the inspector. The Provincial or municipal inspection authority would schedule a time with the customer to review the installation. Once installations and inspections were complete, the equipment manufacturer would conduct system acceptance testing to ensure the communication network for the devices was stable before the control events could be initiated by the utility.

Pilot Infrastructure
The pilot infrastructure was delivered and implemented in a condensed timeframe. This resulted in running smaller and fewer events during the initial weeks of the pilot because the pilot infrastructure was not fully installed or tested. Sufficient time to install and commission the communications network infrastructure would be required when implementing a larger program.

Infrastructure Flexibility
Reliable execution of demand response events in a relatively short period of time is critical to the success of any demand response pilot in order to be responsive to real time system requirements. Load control events for the pilot were primarily prescheduled events. In order for this type of program to be considered effective, the Company needs to be able to call for a direct load control event within 2 hours of when it is required on the system.

3.6 Pilot Outcomes

The SmartPeak pilot determined that peak demand reduction could technically be achieved through direct load control of residential hot water tanks. The ability to reduce demand during peak times by approximately 0.6 kW per participant was achieved on the Island Interconnected System. For events that included all participants, approximately 298 kW of demand reduction was achieved.

The pilot also demonstrated this type of program is feasible in Newfoundland Power's residential market. Customers are accepting of direct load control programs. The majority of customers reported that they were not negatively impacted by the events. Survey results also indicate that the majority of pilot participants would be willing to enroll in a future direct load control program.

4. Potential Program Assessment

Given the results of the pilot, Newfoundland Power has assessed the potential costs and demand impacts for a hot water tank direct load control program. The pilot also allowed Newfoundland Power to assess the customer experience, the administrative effort and the technological requirements that would be necessary for a full program implementation.

4.1 Program Concept

Program Description
The objective of a SmartPeak program would be to reduce electricity use during peak times and when there is a potential for a supply shortage. This would be achieved by controlling the hot water tanks and turning them off during peak times, since water heating is the second largest consumer of electricity in Newfoundland homes.

Delivery Strategy
The SmartPeak program would be delivered through a turnkey service provider to streamline resources and reduce the amount of administrative effort and coordination required from the Company. There typically would be cost efficiencies for this type of program delivery. Many of the turn key service providers offer hot water direct load control programs across North America. They have access to trade allies, training materials, call centers, and support expertise that is not available at Newfoundland Power.[12]

Marketing initiatives would include email campaigns, promotion on social media and the takeCHARGE and Newfoundland Power website as well as some direct mail.

Market Considerations
The SmartPeak program would initially be available to urban residential customers on the Northeast Avalon Peninsula with electrical hot water tanks.[13] This program would extend to

[12] Over time, as expertise develops within the Company consideration would be given to managing the program internally if it were considered to be cost effective.
[13] An initial focus on the Northeast Avalon Peninsula reflects the relative population density in this area. It also reflects the electrical system's largest load center.

other areas on the island throughout the enrollment timeframe of the program (2015-2020). It is expected that the program will be available only to areas were the program can be considered cost effective.[14] Although approximately 90% of Newfoundland homes use electricity for heating their hot water, the communications infrastructure will limit the geographic areas where a direct load control program could be implemented.

There are multiple technology options available for communicating and controlling residential hot water tanks. Newfoundland Power will be limited to technology options that can function in a non-AMI environment and can provide strong communication signals through Newfoundland's terrain and low population density. There are a number of advantages and disadvantages to each technology option. There is little difference in cost among the various technology options.

Detail on typical technology options used by utilities for residential direct load control of hot water tanks is provided in Appendix E.

Incentive Strategy
Customers would receive a financial incentive for participating. They may also receive energy efficient giveaways such as low flow shower heads or pipe insulation.

Program Monitoring and Evaluation
The program would be monitored for demand reduction achieved through the use of a two-way switch technology. A two-way switch allows for communication in both directions, to the customer's hot water tank and back to the utility. This will allow Newfoundland Power the ability to determine the number of tanks that are controllable and the demand reduction that can be achieved.

4.2 Participation, Demand Reduction and Costs

Results from research of other utilities offering similar residential direct load control programs as well as the results of the SmartPeak pilot show that utilities on average will achieve a 13% participation rate. The research also indicates that in the first three years participation rates can reach approximately 7-10%.

[14] It would be cost prohibitive to install the required communications infrastructure in some geographic areas, where program participation would not be expected to achieve sufficient demand reduction benefits.

Table 2 shows the participation rate Newfoundland Power would expect for a full rollout of a residential hot water tank direct load control program.

Table 2
Participation Rate for SmartPeak Program

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Total Number of Participants Expected	1,000	10,000	16,000	20,000	22,000	24,000
Participation Rate	0%	4%	7%	9%	10%	11%
Demand Reduction Achieved (MW)	0.60	6.00	9.60	12.00	13.20	14.40

Newfoundland Power would expect to achieve an 11% participation rate by the year 2020. This would result in a demand reduction of approximately 14.4 MW.

Estimated Costs
Table 3 shows the estimated costs for program delivery for 2015 through 2020.[15]

Table 3
Estimated Program Delivery Costs
2015 through 2020

($000s)

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
In Home Equipment	411	3,844	2,688	1,889	1,020	1,061
Network Equipment	140	232	226	330	290	380
Program Delivery	233	397	634	661	798	772
Total	**784**	**4,473**	**3,548**	**2,880**	**2,108**	**2,213**

The estimated costs for program delivery for 2015 through 2025 are provided in Appendix F.

15 Costs in Table 3 represent the expenditures associated with implementing the program and installing the program infrastructure over the first five years. After 2020, costs become relatively stable. Ongoing program operation costs for 2020-2025 can be found in Appendix F.

4.3 Cost Benefit Analysis

Economic viability of the Company's conservation and demand management programs is assessed in terms of program benefits and costs, primarily using the Total Resource Cost test ("TRC").[16] A TRC ratio result of greater than 1.0 indicates the program has positive economic effect.

Table 4 shows the total program costs, the demand reduction achieved and the TRC for the SmartPeak program.

Table 4
Program Costs, Demand Reduction and TRC

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Total Estimated Costs ($000s)	784	4,473	3,548	2,880	2,108	2,213
Demand Reduction Achieved (MW)	0.60	6.00	9.60	12.00	13.20	14.40
Total Resource Cost (TRC)						**0.8**[17]

Table 4 shows the SmartPeak program is considered marginally cost effective for the duration of the program with a TRC result of 0.8.[18] Typically, a program must achieve 1.0 TRC or higher in the planning stages in order to move forward with program development. Due to the current demand constraints on the system, there may be reasons to proceed with program development in spite of this TRC result.

The economic analysis used to assess a SmartPeak program is based on the current marginal cost forecast as projected by Hydro in February 2015.

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16 Use of TRC for economic screening of programs is consistent with the 2008 and 2015 Potential Study, the 2008 Five Year Plan, the 2012 Five Year Plan and current Canadian utility practice. The TRC is used to determine if a program minimizes the overall cost of supplying energy by evaluating the costs and benefits from the perspective of the participant and the utility.

17 The TRC calculation is based on total costs and total demand reduction for the full program delivery timeframe, including 5 year program implementation period with a technology life of 10 years. Details on the proposed costs and savings for 2015-2025 are provided in Appendix F.

18 For this type of program, the total TRC for the program duration, 5 year program implementation with a technology life of 10 years, should be the primary consideration because it takes a number of years to develop the infrastructure required to obtain the demand reduction that will make the program cost effective. TRC results would typically be negative during this development time period.

Table 5 shows this cost projection for 2015 through 2025.

Table 5
Marginal Cost Projection for the
Island Interconnected System
2015 through 2025

	Capacity ($/kW / Yr)
2015	51
2016	70
2017	74
2018	98
2019	99
2020	108
2021	112
2022	115
2023	119
2024	123
2025	126

Table 5 shows that the marginal capacity costs for the Island Interconnected System range from $51 per kW in 2015 to $126 per kW in 2025. Current costs for a SmartPeak program are estimated to be $184 per kW. In order for this program to be cost effective for Newfoundland Power customers, the cost per kW to deliver this program should be less than $115.

Table 6 shows the value of demand savings estimated for a SmartPeak program from a utility perspective based on overall cost reductions on the Island Interconnected System from 2015 through 2029.

Table 6
Value of Demand Savings
2015 through 2029
($000's)

2015	33
2016	457
2017	769
2018	1,273
2019	1,420
2020	1,686
2021	1,739
2022	1,794
2023	1,851
2024	1,910
2025	1,888
2026	1,145
2027	652
2028	325
2029	162
Total	**17,104**

Table 6 shows the value of demand savings estimated from a utility perspective based on overall cost reductions on the Island Interconnected System over the duration of the program is $17.1 million. This is compared to $22.6 million to deliver the program.

5. Summary and Conclusion

The SmartPeak direct load control pilot was implemented for the 2014 and 2015 winter heating season. Through this pilot Newfoundland Power was able to quantify the demand reduction potential of 0.6 kW on average per participant when residential hot water tanks are cycled off during times of system peak demand. The pilot also achieved high levels of customer satisfaction from those who participated, with 94% stating that they would participate again in the future. The pilot allowed the Company to create a program brand and delivery model that could be used if this pilot was rolled into a full program.

The pilot also gathered load shape data on hot water usage and whole home usage that Newfoundland Power did not have access to before. This data will be used for planning and program development of future conservation initiatives. It will also be used to provide a better understanding of residential demand and customer electricity usage patterns.

The pilot confirmed that a residential hot water tank direct load control program made available to a larger participation base could be used to reduce peak demand on the Island Interconnected System. This type of program could achieve up to 14.4 kW in annual peak demand savings by 2020. The estimated cost of delivery for this program is $22.6 million. Economic analysis indicates a total resource cost test result of 0.8 for the life of the program. A TRC of 1.0 is the threshold for determining whether or not a program is economically viable. A larger direct load control program is feasible from a technical and market perspective but it is marginally feasible from an economic perspective.

Although the economics of the program indicate risk, there may be other reasons to implement a program to control demand during system peaks on the Island Interconnected system. Current conservation efforts focus on energy efficiency but system constraints may warrant consideration of additional demand response initiatives. At this time there is uncertainty with respect to the marginal cost of energy and capacity on the Island Interconnected System beyond 2017.

Appendix A

North American Utility Program Metrics

Table A-1 shows the direct load control program expenditure and participation results for 17 utilities as reported in 2012.[19]

Table A-1
Average Direct Load Control Program Expenditure[20]

Utility	Annual Program Expenditure ($000s)	Total Participants	Total Demand Reduction Achievable (MW)	Age of Program
Roseville*	130	3,800	4	5
Vectren Energy	890	27,600	25	20
Southern Maryland Electric Cooperative	1,750	32,000	37	4
Idaho Power*	2,900	37,000	47	8
Alliant Energy*	3,000	48,000	36	20
Commonwealth Edison*	3,300	73,000	112	16
MidAmerican Energy*	3,780	63,129	67	23
Rocky Mountain Power	4,840	104,921	110	9
Dominion*	4,900	35,146	35	2
PNM	4,950	32,177	39	4
LG&E and KU Energy	6,600	138,700	152	11
Progress Energy Carolinas*	11,000	71,000	90	3
Xcel energy (CO) *	12,400	149,000	150	11
Pacific Gas and Electric	17,000	164,950	138	5
Xcel energy (MN)	25,200	375,000	395	22
Baltimore Gas and Electric *	51,000	300,000	526	23
Florida Power and Light	52,000	819,500	999	26

[19] This data is based on research conducted by E Source and published on August 16, 2012, "Hot or Not? DLC Program Benchmarking Results from the 2012 E Source Direct Load Control Program Study". E Source is a U.S. firm which provides research services for utilities and large energy users with critical problems involving energy efficiency, utility customer satisfaction, program design, marketing, customer management, and sustainability.

[20] For some utilities this data includes small business customers in total participation numbers. These are indicated by an asterisk.

Appendix B

Whole Home Data

As part of the SmartPeak pilot, AMI meters were used to replace the participants' existing revenue meters. This was done to increase the network communications between the meter installed on the hot water tank and the Util-Assist data center. These meters also had the ability to collect data on household electricity use.

Demand reduction impacts of events on the overall household were calculated by comparing the event day consumption profiles to non-event day consumption profiles. The difference between the typical consumption on the non-event days compared to the event day was used to estimate the demand reduction achieved by the event. The load shape of the home was compared to the load shape of the hot water meters to confirm the overall demand reduction to the home.

At the end of the pilot the load shapes were assessed and it was determined that the whole home data could not be used as a direct comparison to the hot water tank data because of the effect that weather has on electricity use in homes with electric space heating. The weather on the event days was different than the nonevent days and therefore caused variances between the hot water tank load curves and the whole home load curve because of the impact of electric heat.

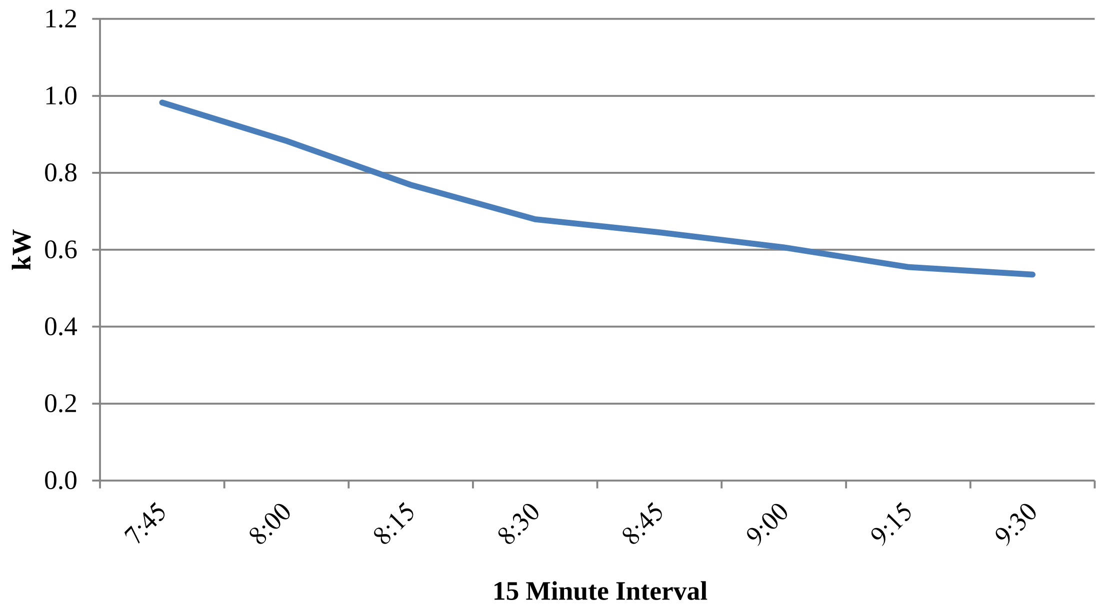
Another issue that occurred in the pilot that resulted in the whole home data not being comparable to the hot water tank data was that participants modified their behavior when notified of a direct load control event. The results of the survey show that approximately 30% of respondents made adjustments to their hot water usage when an event occurred. This could result in the overall home demand decreasing more than the decrease that occurred on the hot water tank as a result of an event.

Appendix C

Hot Water Tank Load Profiles for DLC Events

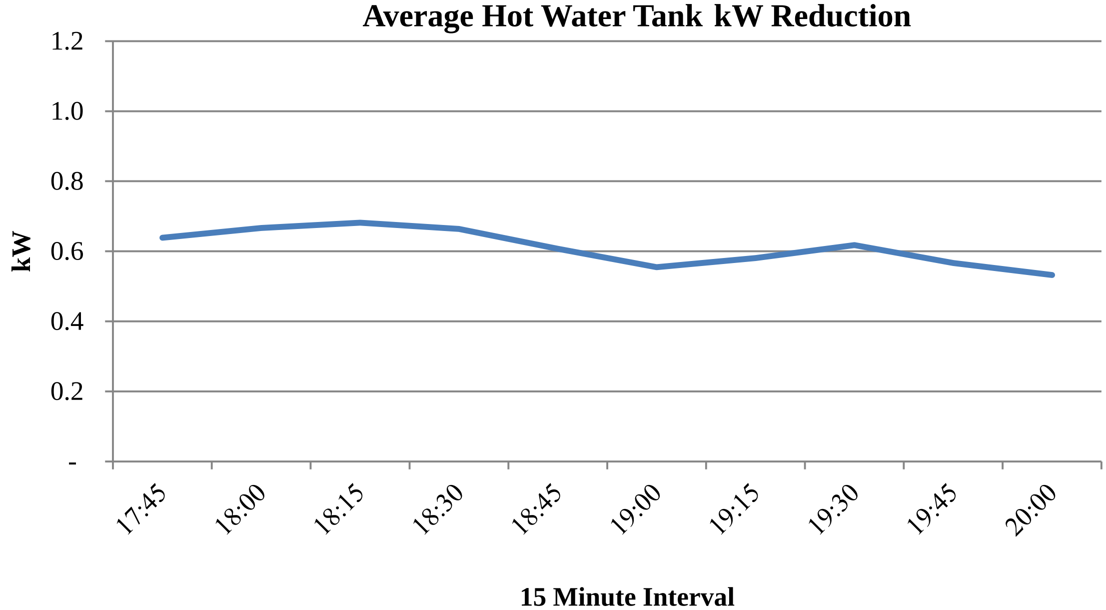
A representative sample of the estimated demand reduction achieved through the SmartPeak load control events is provided in the tables below.

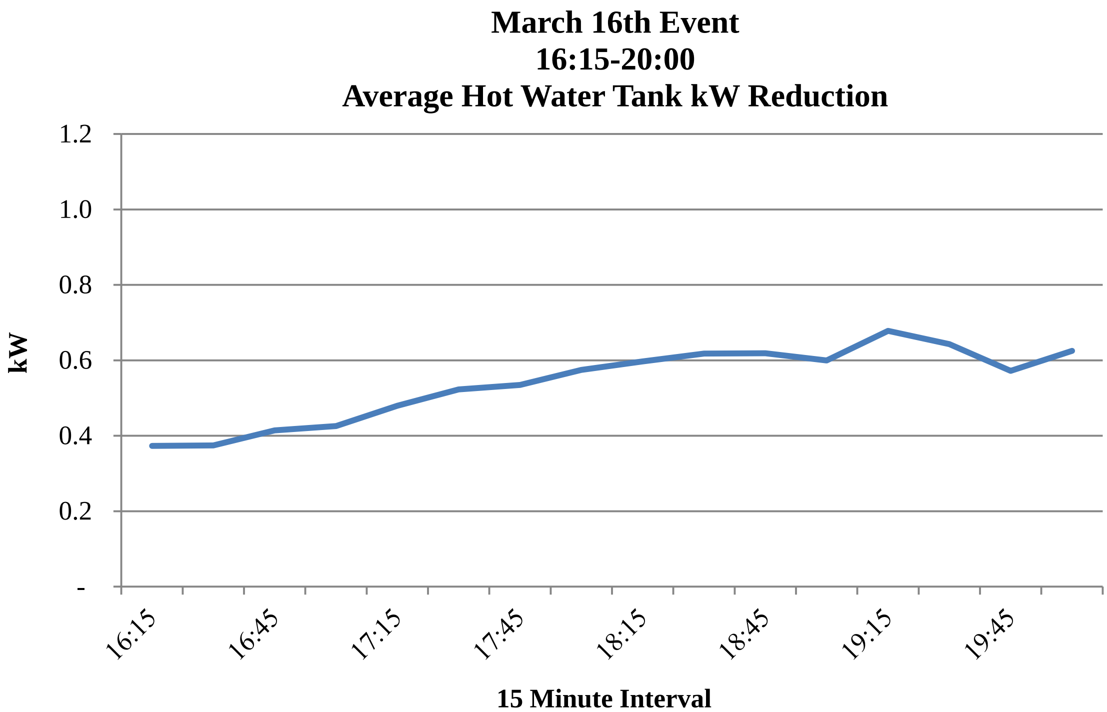
February 25th Event
7:45-9:30
Average Hot Water Tank kW Reduction

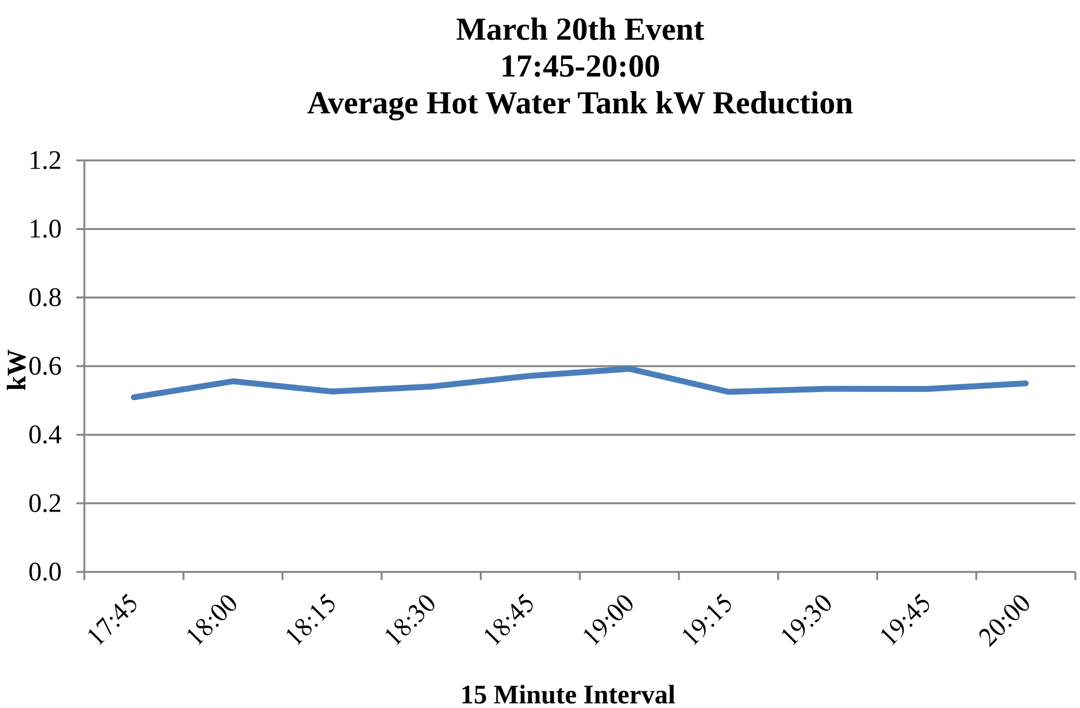


March 14th Event
17:45-20:00

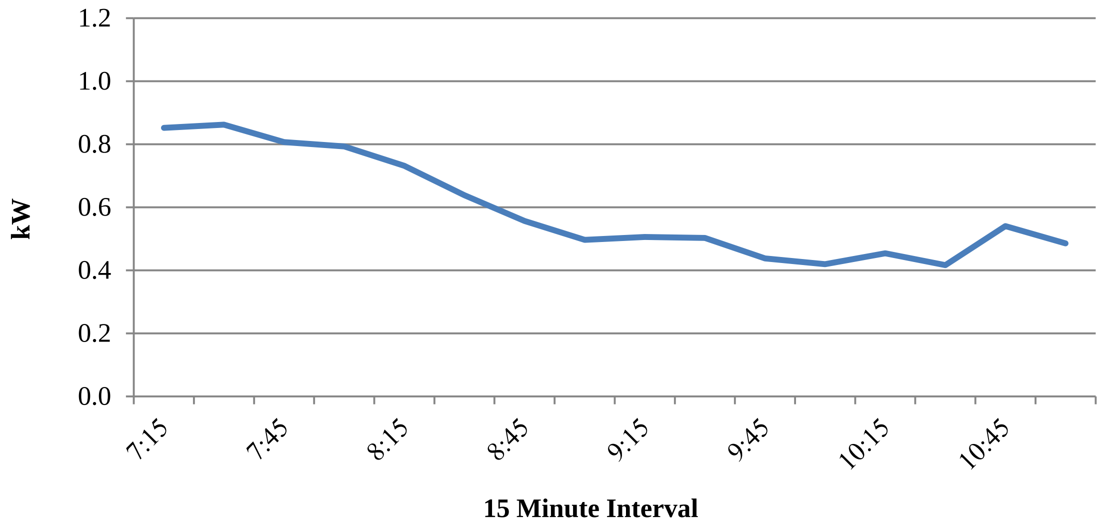
Average Hot Water Tank kW Reduction



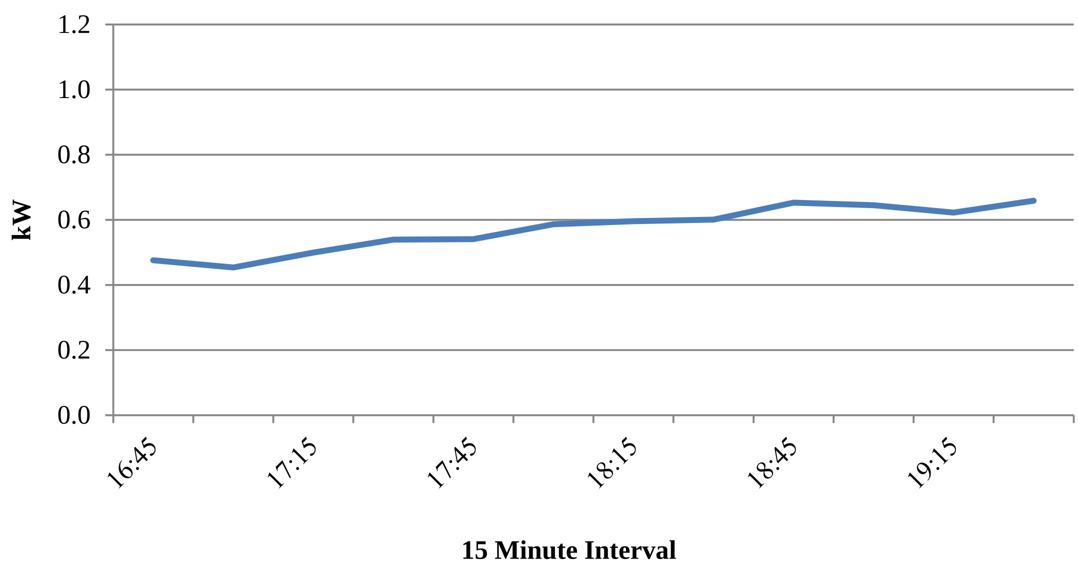

March 16th Event
16:15-20:00
Average Hot Water Tank kW Reduction
kW
1.2
1.0
0.8
0.6
0.4
0.2
-
16:15
16:45
17:15
17:45
18:15
18:45
19:15
19:45
15 Minute Interval


March 20th Event
17:45-20:00
Average Hot Water Tank kW Reduction
kW
1.2
1.0
0.8
0.6
0.4
0.2
0.0
17:45
18:00
18:15
18:30
18:45
19:00
19:15
19:30
19:45
20:00
15 Minute Interval

March 24th Event
7:15-10:45
Average Hot WaterTank kW Reduction



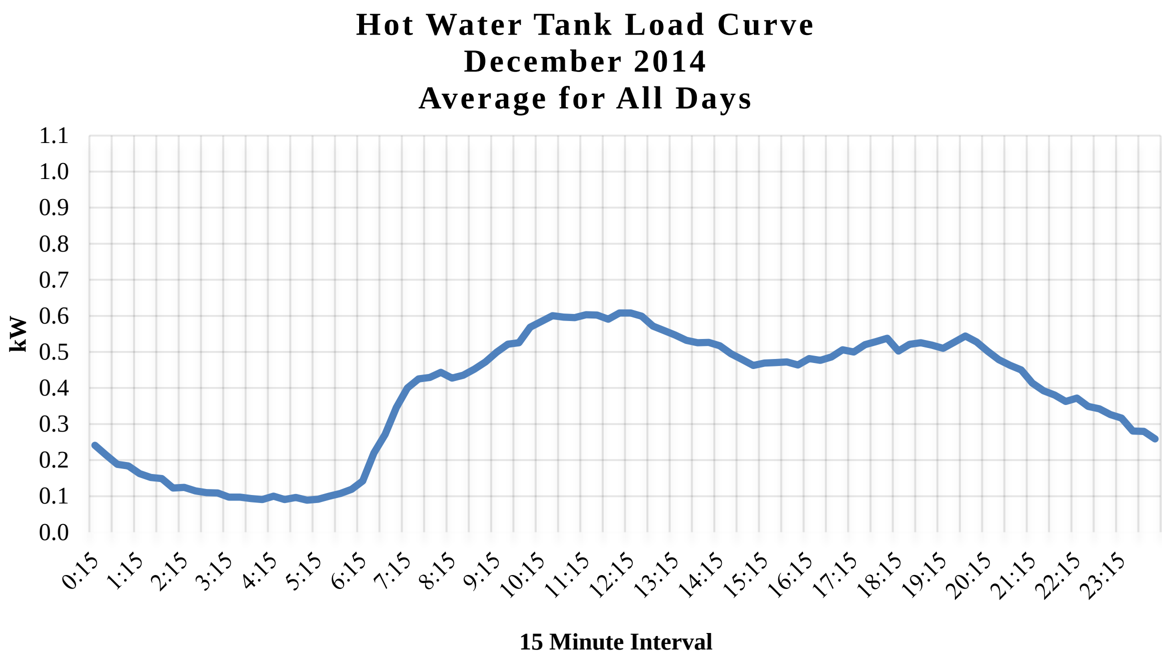
March 31st Event
16:45-19:30
Average Hot Water Tank kW Reduction

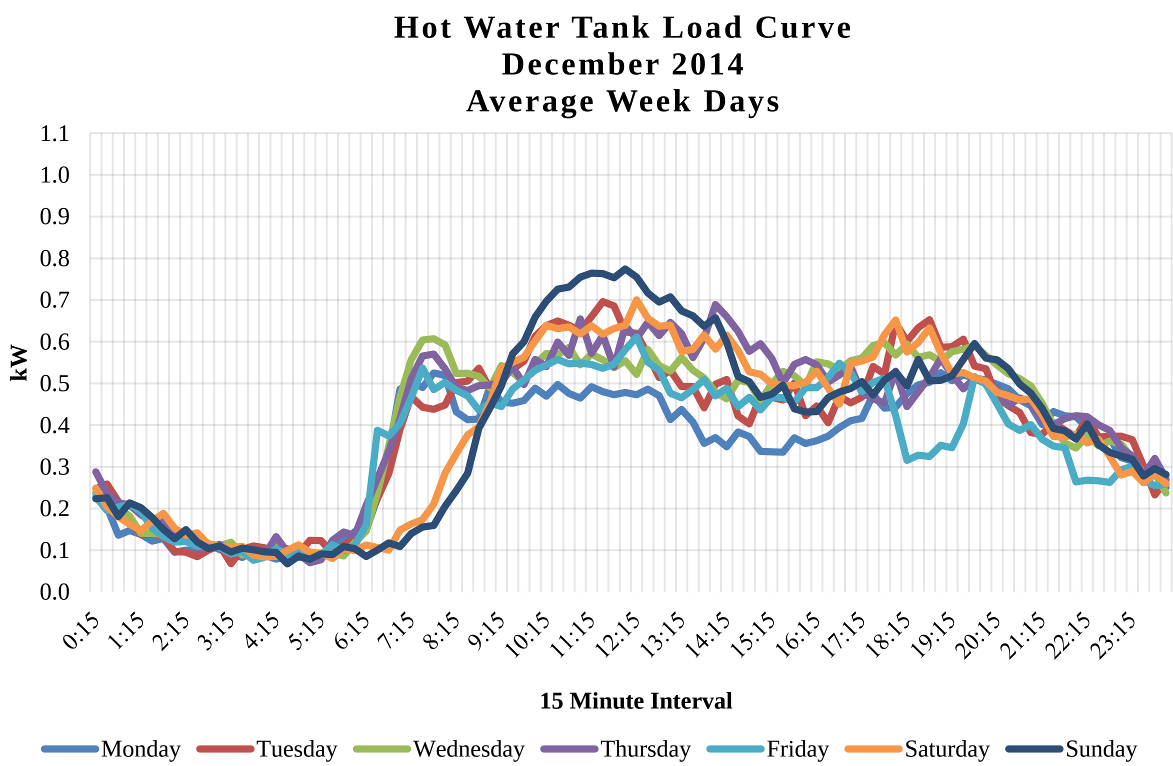


Appendix D

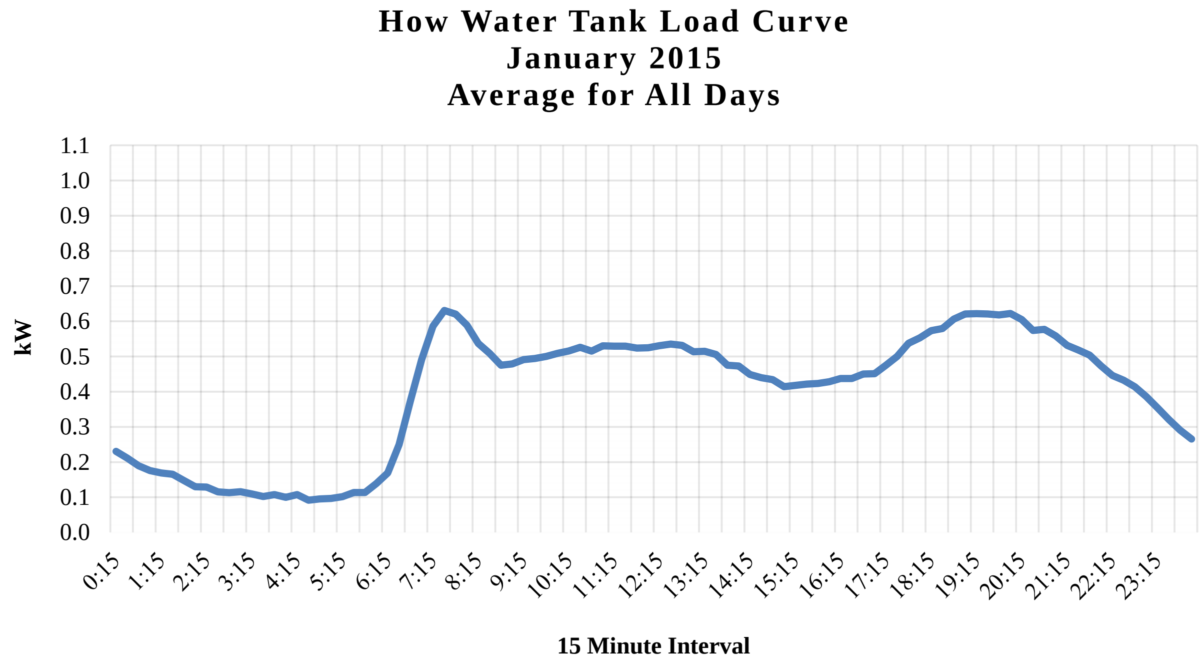
Monthly Average Hot Water Tank Load Profiles

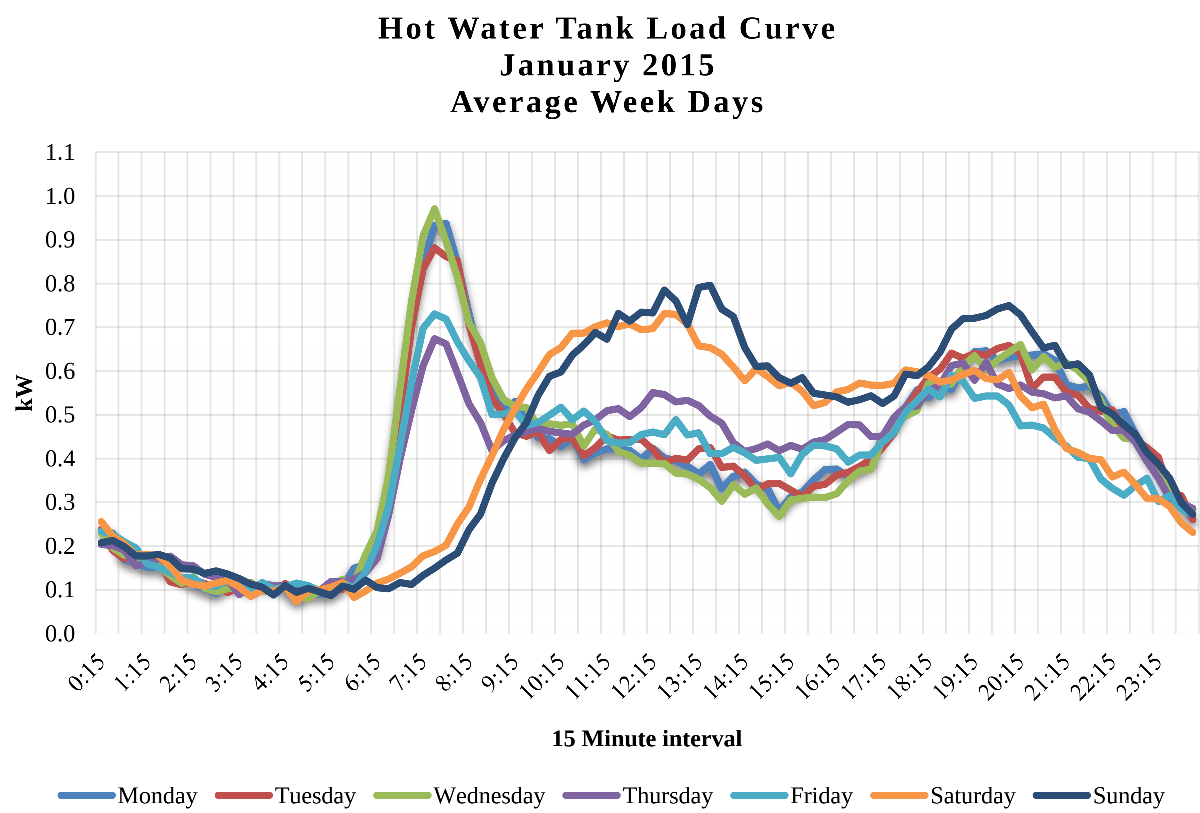
The average monthly load profiles for the entire month as well as the average weekday consumption for the months, December through March, are provided below.[21]

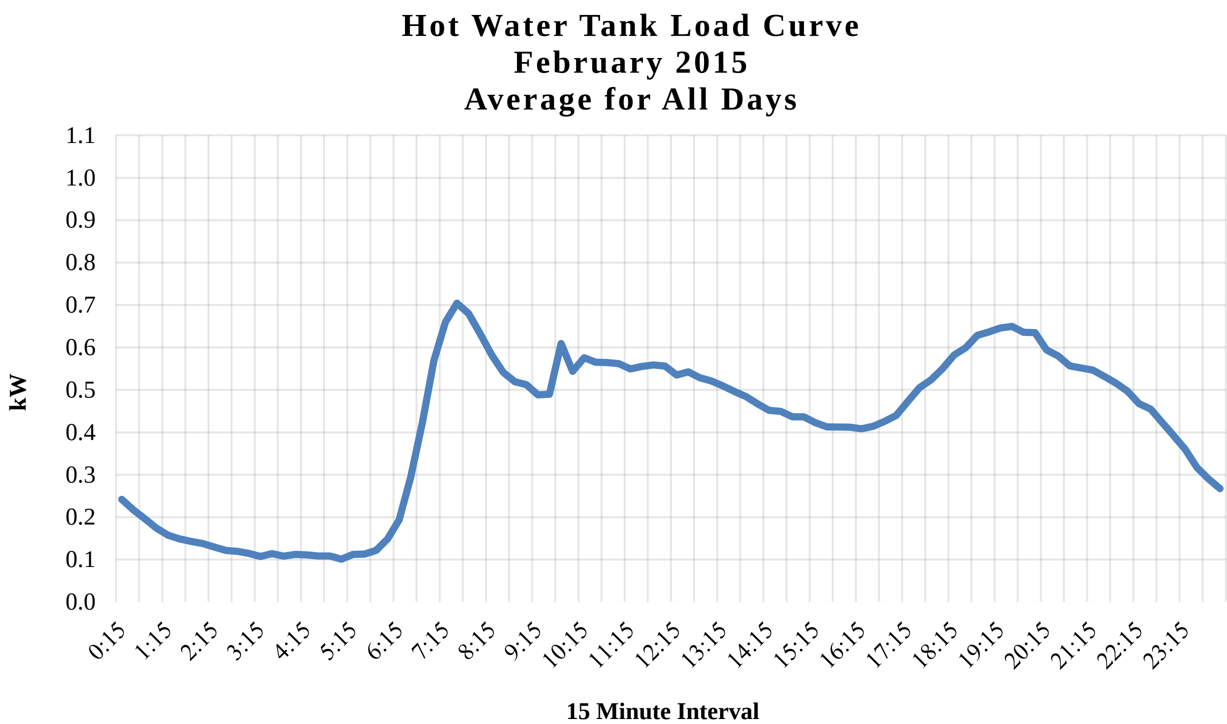


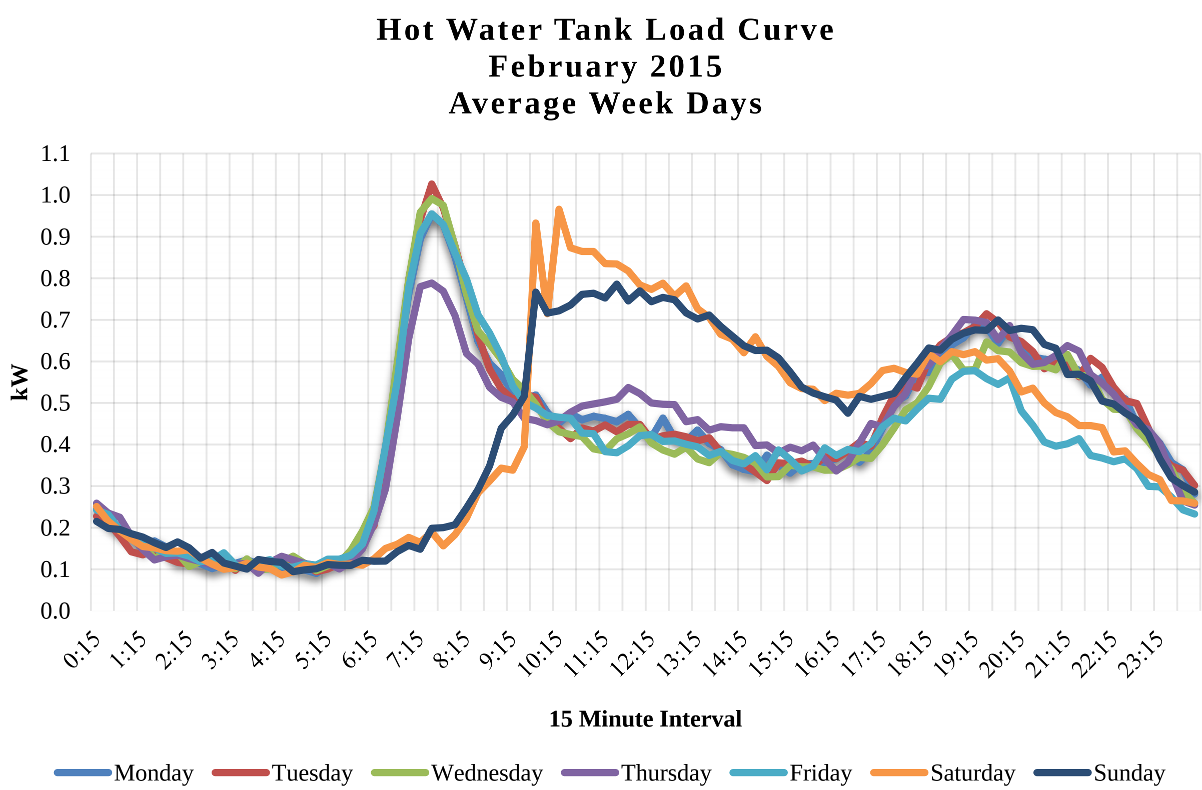


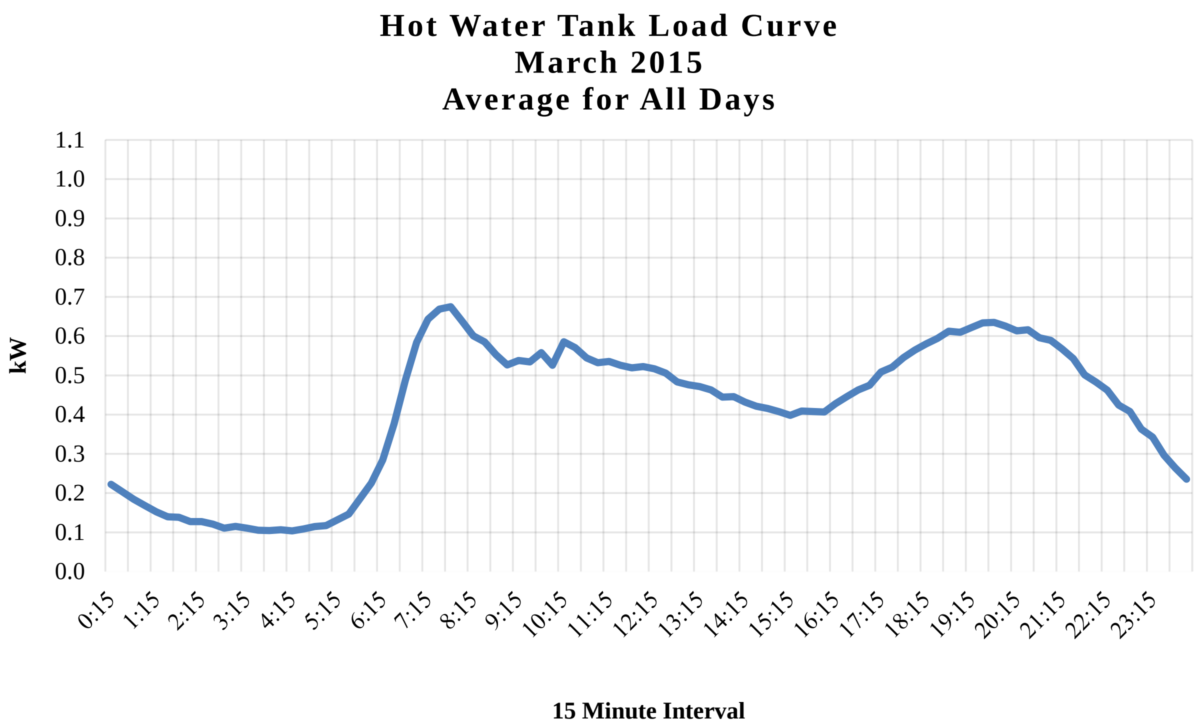
[21] The hot water tank load profiles contain some interval data which is estimated. This is typical for AMI network operation.

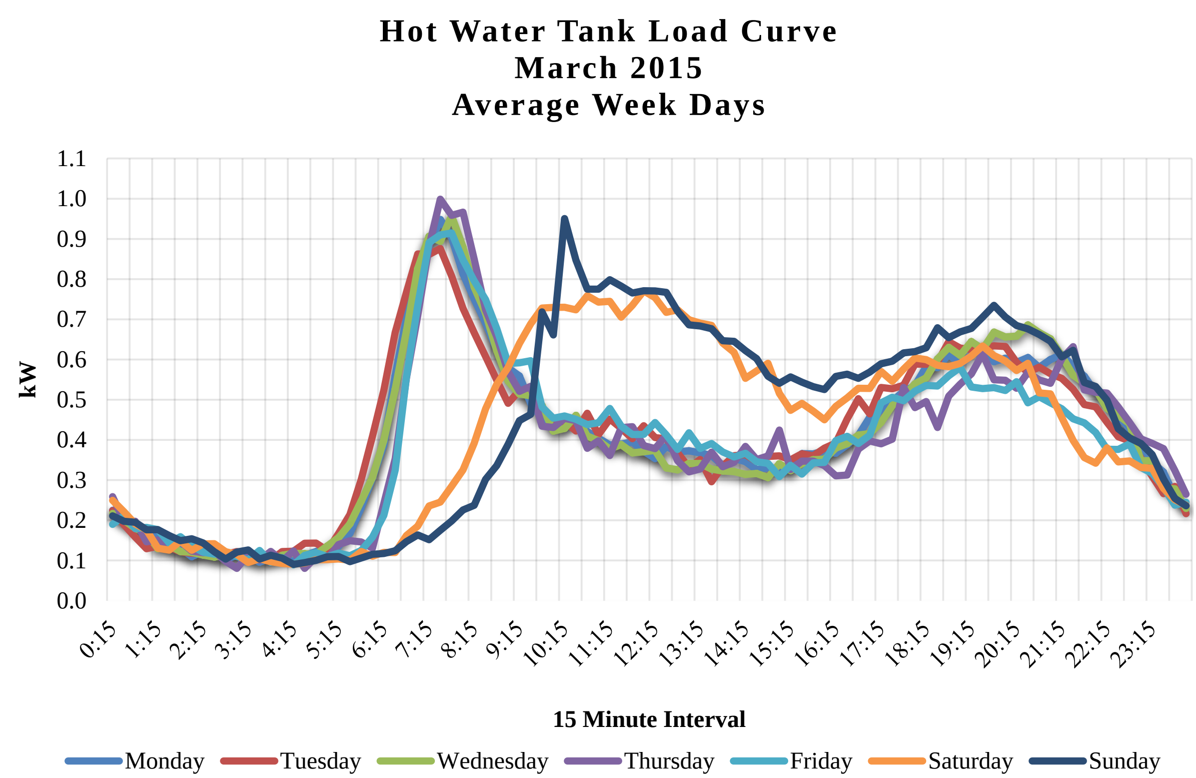

How Water Tank Load Curve
January 2015
Average for All Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute Interval


Hot Water Tank Load Curve
January 2015
Average Week Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute interval
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday


Hot Water Tank Load Curve
February 2015
Average for All Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute Interval


Hot Water Tank Load Curve
February 2015
Average Week Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute Interval
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday


Hot Water Tank Load Curve
March 2015
Average for All Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute Interval


Hot Water Tank Load Curve
March 2015
Average Week Days
kW
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0:15
1:15
2:15
3:15
4:15
5:15
6:15
7:15
8:15
9:15
10:15
11:15
12:15
13:15
14:15
15:15
16:15
17:15
18:15
19:15
20:15
21:15
22:15
23:15
15 Minute Interval
Monday
Tuesday
Wednesday
Thursday
Friday
Saturday
Sunday

Appendix E

Direct Load Control Technology Options

Two Way Communication Options

In the absence of an AMI network, a mesh network can be created through the use of collectors that would be used to communicate with the hot water tank load control switch.[22] These devices offer tamper flags, online status indicators, over the air firmware upgrades, and two-way communication to identify the status of the switch.

The disadvantage to this type of infrastructure is that it does require significant communications infrastructure to be installed which will increase costs. It also requires communication strength to be strong when a load control event is to be called. This is because two separate communications are sent to the load control switch, one to shut it off and another to turn it back on. This creates risk to the customer because the communication strength may be strong enough to receive the first command but if the signal weakens it may not receive the second command to restore power to the tank. This may leave the customer without hot water and result in a service call.

WiFi is an alternative two way communication solution that does not require significant infrastructure but instead relies upon the existing WiFi network within the customer's home. An advantage to this solution is that it can be easily leveraged to use on other electricity consuming devices if required in the future. Also, it does not require significant communication infrastructure to be installed because it relies on the customer's internet connection.

The disadvantage to the WiFi solution is that it is easily disconnected from the network and as a result it may require more administrative effort to have the customer reconnect it. Another disadvantage is that this is a newer solution for load control switches and not all vendors currently have this option available for implementation.

One Way Communication Options

A one way communication switch utilizes existing paging technology and does not require significant further communication infrastructure. One way paging offers the advantage of allowing the load control event to be managed for the duration of the load control event by the device. If the paging device receives the demand response event communication to turn off the tank, the timing to restore power is controlled internally by the switch. It automatically restores power to the tank after a user-specified time-period.

The disadvantage of one-way communication is the inability to measure whether each device or a group of devices has received a demand response command. Unlike two-way communication, there is no confirmation back to the utility that a device has received a load control response command.

[22] A mesh network is a network topology in which each node relays data for the network. All mesh nodes cooperate in the distribution of data in the network.

Appendix F

SmartPeak Program Delivery Costs: 2015-2025

Table F-1 shows the program costs, the estimated demand reduction and the TRC for the life of the program, 2015 through 2025.

Table F-1
Estimated Delivery Costs and Demand Reduction
2015 through 2025

	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
In Home Equipment Costs ($000)	411	3,844	2,688	1,889	1,020	1,061	87	89	90	92	93
Network Costs ($000)	140	232	226	330	290	380	99	169	102	175	106
Program Delivery Costs ($000)	233	397	634	661	798	772	861	781	874	791	900
Total Estimated Costs ($000)	**784**	**4,473**	**3,548**	**2,880**	**2,108**	**2,213**	**1,047**	**1,039**	**1,066**	**1,058**	**1,099**
Total Participation (000)	1	10	16	20	22	24	24	24	24	24	24
Estimated Cumulative Demand Savings (MW)	0.6	6.0	9.6	12.0	13.2	14.4	14.4	14.4	14.4	14.4	14.4
Total Resource Cost (TRC)											**0.8**

2015 Conservation and Demand Management Potential Study

Newfoundland and Labrador Conservation and Demand Management Potential Study: 2015

Residential Sector Final Report

June 2015

Submitted to:
Newfoundland Power Inc.
Newfoundland and Labrador Hydro

Submitted by:
ICF International
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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

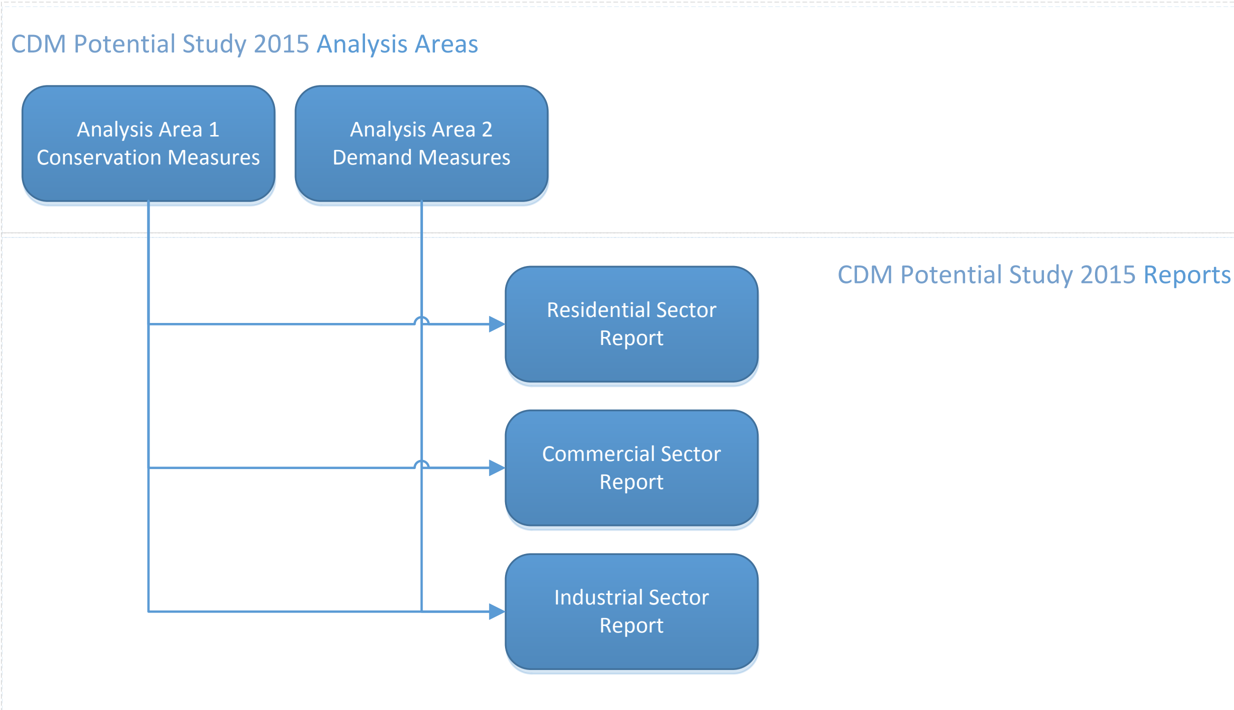
The scope of this study is summarized below:

- **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



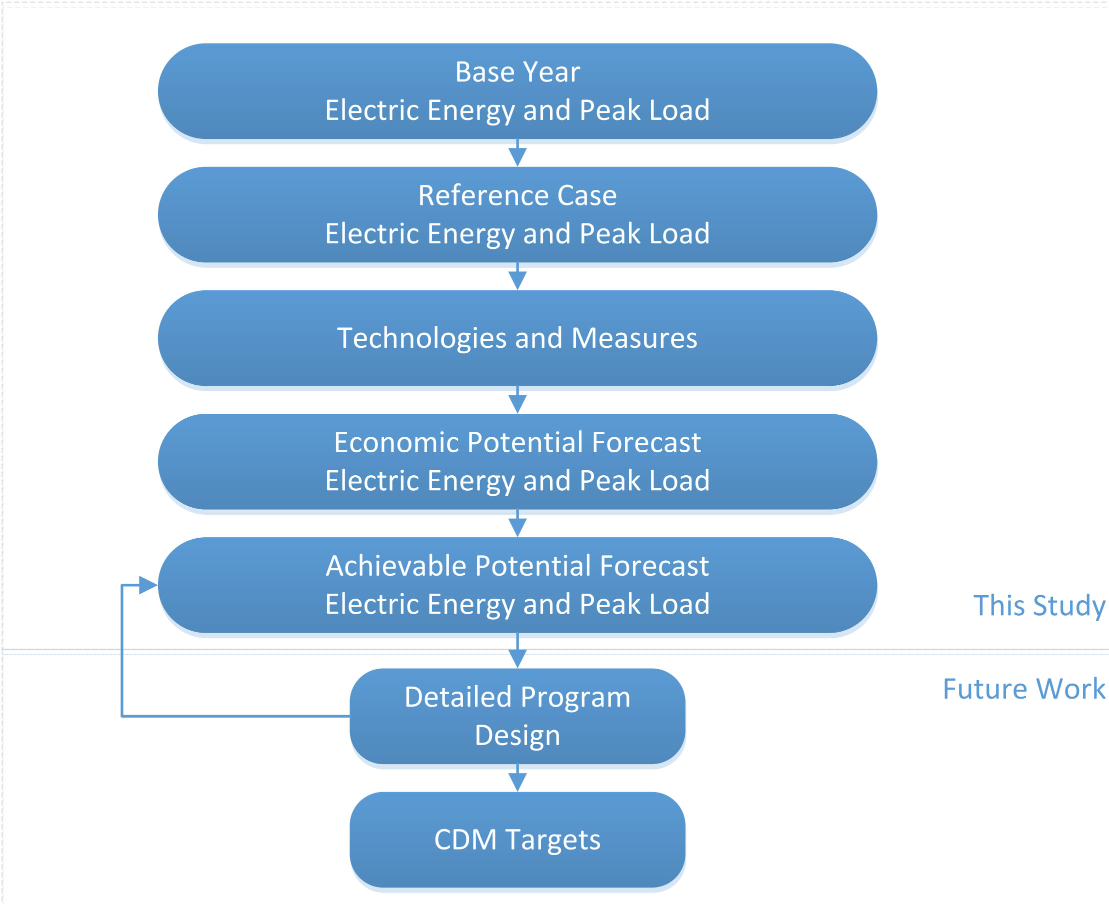
This report presents the results of both Analysis Area 1: Energy-efficiency Technologies and Behaviours and Analysis Area 2: Demand Measures, for Residential sector customers. This report addresses all commercially available electric energy-efficiency and peak load reduction measures that are applicable to NL's Residential 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 detailed end-use analysis of electrical efficiency opportunities in the Residential sector employed two linked modelling platforms: HOT2000,[1] a commercially supported, residential building energy-use simulation software, and RSEEM (Residential Sector Energy End-use Model), an ICF in-house spreadsheet-based macro model.

[1] Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

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,[2] 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 Residential 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 growth in the building stock 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 residential sector.

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

Efficiency improvements would provide between 336 and 650 GWh/yr. of electricity consumption savings by 2029 in, respectively, the Lower and Upper Achievable Potential scenarios. The most significant Achievable Potential savings opportunities were in actions that addressed space heating. Besides space heating, there are significant savings to be found in domestic hot water, refrigerators, clothes dryers[3], televisions, and computers, as well as smaller opportunities in many of the other end uses.

The electricity consumption savings would provide associated peak load reductions of approximately 55 to 101 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 12 to 41 MW by 2029 in, respectively, the Lower and Upper Achievable Potential scenarios. All told, this amounts to peak load reduction potential of between 6% and 12% with respect to the Reference Case residential peak load. Demand reductions do not include demand curtailment; rather, existing and future demand curtailment is included in the industrial sector report.

Summary of Electric Energy Savings in the Residential Sector

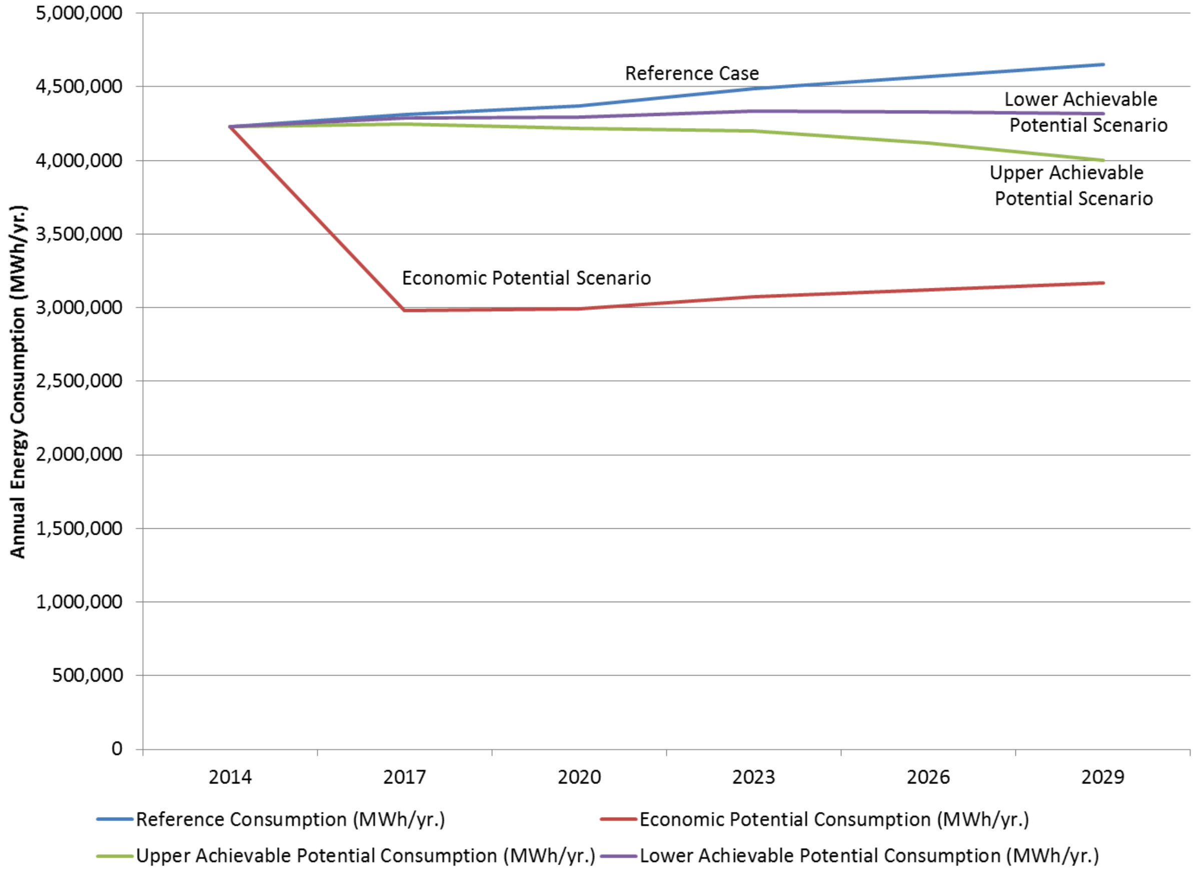
A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CDM Potential Study 2015 is presented in Exhibit ES 3 and Exhibit ES 4, by milestone year.

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

Year	Economic Potential		Upper Achievable		Lower Achievable	
	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	1,336	31%	63	1.5%	28	0.6%
2020	1,378	32%	157	3.6%	78	1.8%
2023	1,411	31%	286	6.4%	151	3.4%
2026	1,455	32%	456	10%	244	5.3%
2029	1,485	32%	650	14%	336	7.2%

[3] Note that the majority of the savings in clothes dryers comes from the adoption of more efficient clothes washers. Efficient clothes washers spin the clothes faster and reduce the drying time and therefore the energy consumption in the dryer. These savings are generally larger than the savings in the washer itself.

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



Base Year Electricity Use

In the Base Year of 2014, NL's Residential sector consumed about 4,227 GWh/yr. Exhibit ES 5 shows that space heating accounts for about 47% of total residential electricity use. Domestic hot water (DHW) accounts for the second largest percentage, at 13%. These are followed by lighting at 6%, clothes dryers and refrigerators at 5% each, and computers (with their peripherals) at 4%. Other end uses account for 3% or less of the total. Indeed, some end uses are extremely small. Air conditioning is assumed to exist only in dwellings where a heat pump has been installed, and even there it is used only occasionally. Block heaters and car warmers are assumed to be used only in Labrador. 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 Residential sector is forecast to rise to about 4,652 GWh/yr. by 2029 in the absence of new utility CDM initiatives.

Exhibit ES 6 shows the distribution of Base Year electricity consumption by dwelling type. As illustrated, single detached housing dwellings account for the largest share (76%) of Residential sector Base Year electricity use. The same exhibit also presents the Reference Case consumption by dwelling type in 2029, at the end of the study period, for comparison.

Reference Case – Electric Energy

Exhibit ES 5 Electricity Use by End Use, Residential Sector, 2014 and 2029

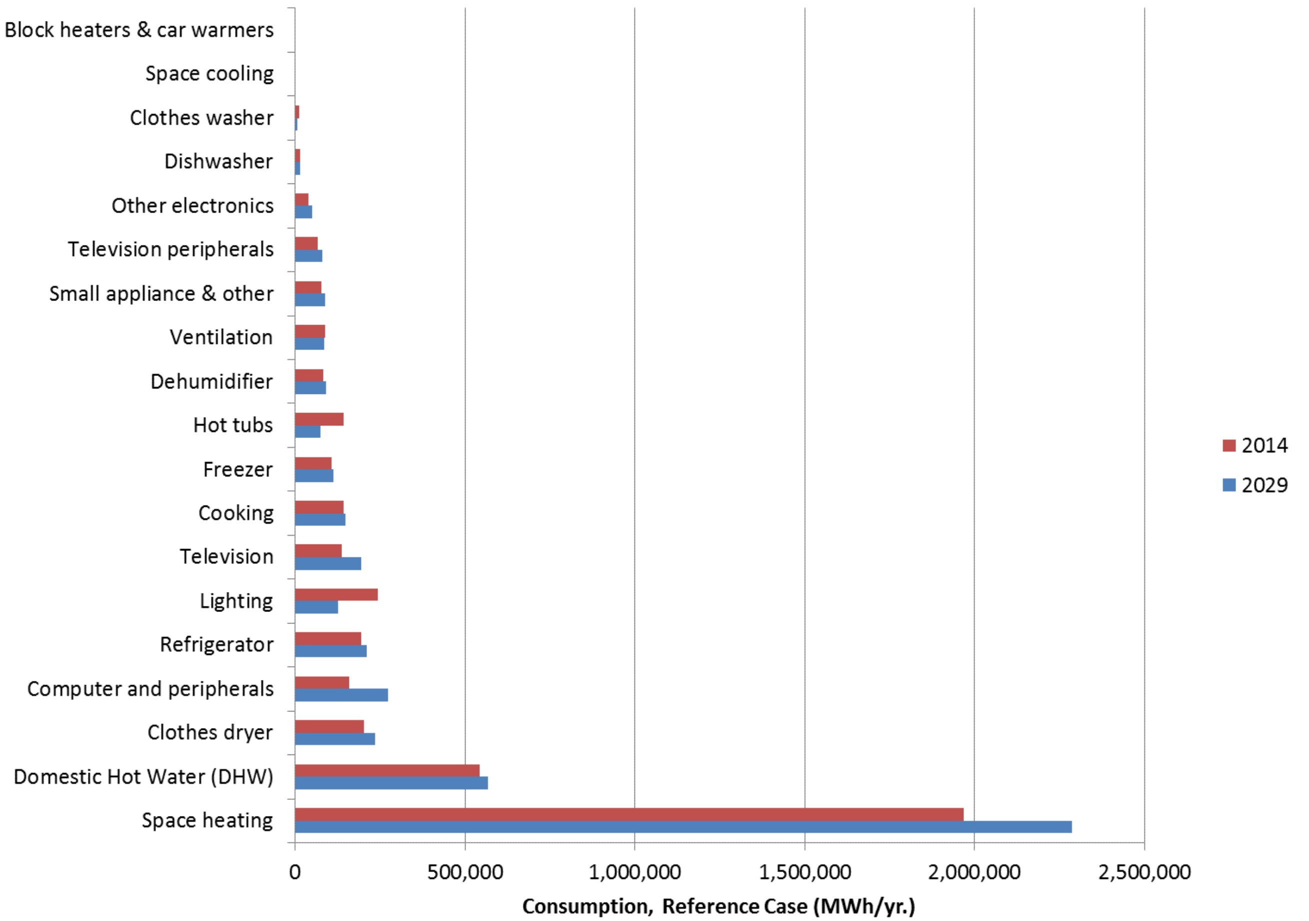
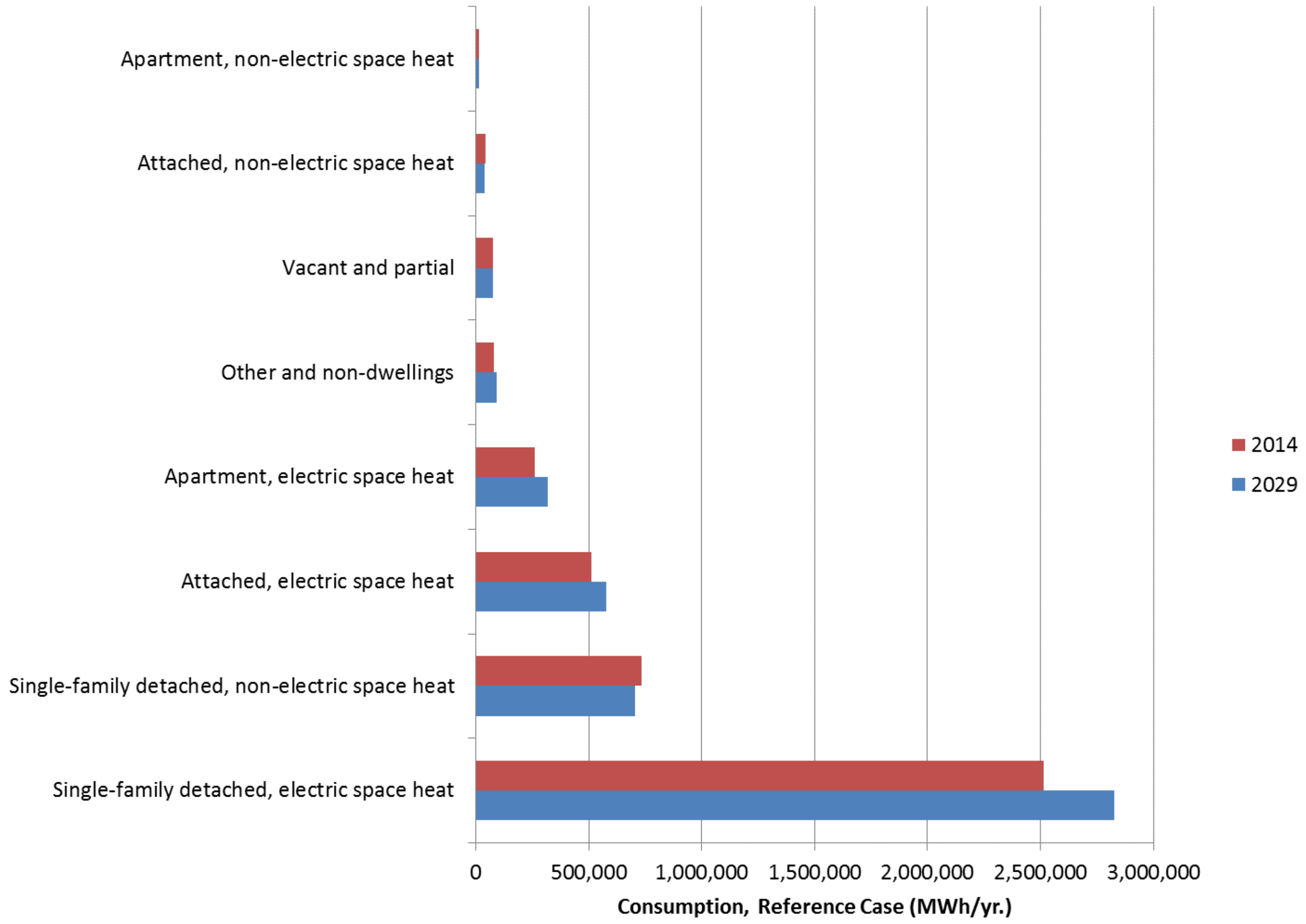


Exhibit ES 6 Electricity Use by Dwelling Type, Residential Sector, 2014 and 2029



Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential scenario,[4] the study estimated that electricity consumption in the residential sector would decrease to approximately 3,167 GWh/yr. by 2029. Savings relative to the Reference case would be approximately 1,485 GWh/yr. or about 32%. The Economic Potential savings in the intermediate milestone years are 1,335 GWh/yr. in 2017, 1,378 GWh/yr. in 2020, 1,411 GWh/yr. in 2023, and 1,455 GWh/yr. in 2026. In each case, the savings amount to approximately 31-32% of the Reference case consumption. 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.[5] In the residential sector, the Achievable Potential for electricity savings was estimated to be 336 and 650 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 most significant Achievable Potential savings opportunities were in actions that addressed space heating. In fact, space heating savings account for over 70% of the opportunities in 2029. Of this, the ductless mini-split heating systems offer the largest savings potential in the residential sector. Besides space heating, there are significant savings to be found in domestic hot water, refrigerators, clothes dryers, televisions, and computers, as well as smaller opportunities in many of the other end uses.

Summary of Peak Load Reductions

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.[6]

Exhibits ES 7 and ES 8 show the 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:

- Electricity savings offered by the Lower and Upper Achievable Potential scenarios would provide peak load reductions of approximately 55 to 101 MW by 2029, a decrease of between 4.5% and 8.5% relative to the reference case.

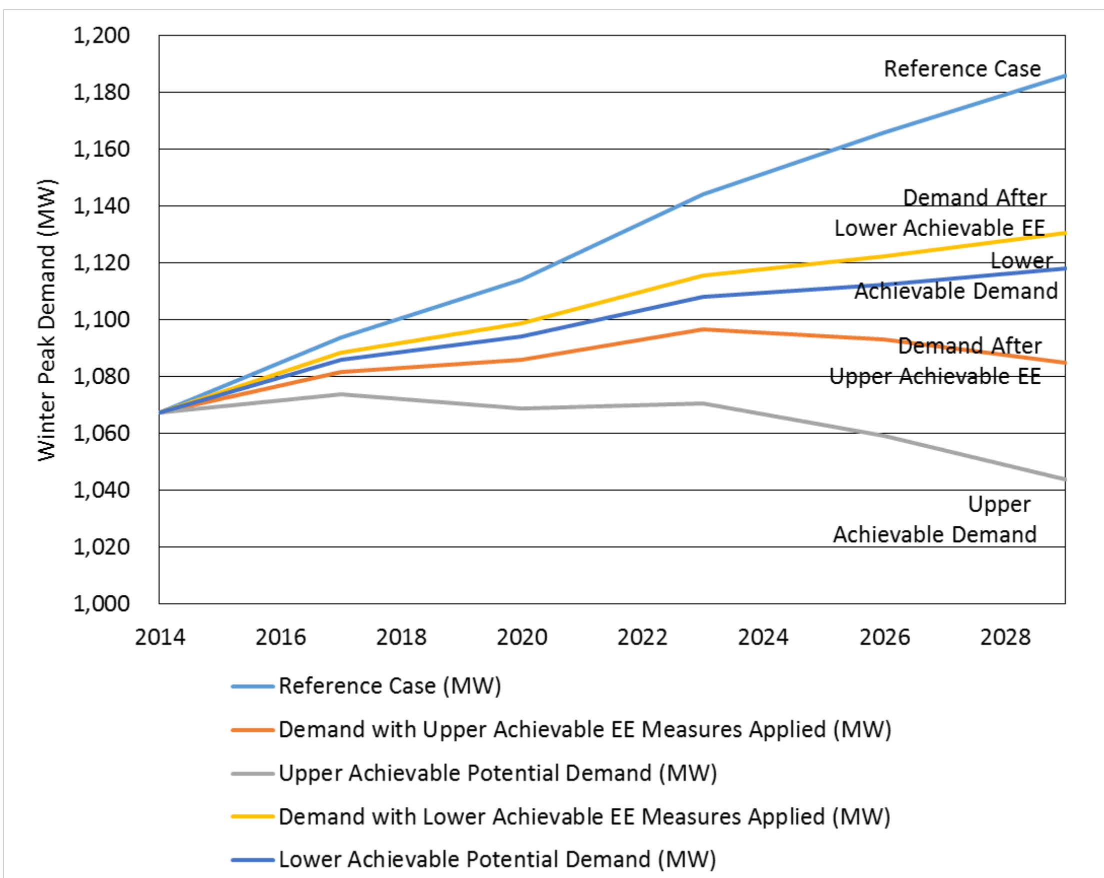
[4] The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold value , which has been set at different prices per kWh for the different regions. (One kWh from the Labrador hydroelectric grid is much less expensive than one kWh from an isolated diesel grid.)
[5] 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.
[6] Source: NL (Feb 2014) http://hydroblog.nalcorenergy.com/meeting-peak-demand/

- Demand reduction measures under the Lower and Upper Achievable Potential scenarios would provide peak load reductions of an additional 12 to 41 MW by 2029, a decrease of a further 1.0% to 3.5%.
- Demand reduction potential is dominated by the reductions associated with energy efficiency measures in both of the achievable potential scenarios.

Exhibit ES 7 Peak Demand Reductions by Milestone Year for Three Scenarios (MW)

Year	Economic Potential		Upper Achievable		Lower Achievable	
	Potential Reductions (MW)	% Reduction Relative to Reference Case	Potential Reductions (MW)	% Reduction Relative to Reference Case	Potential Reductions (MW)	% Reduction Relative to Reference Case
2017	485	44%	20	2%	8	1%
2020	528	47%	45	4%	20	2%
2023	539	47%	73	6%	36	3%
2026	550	47%	107	9%	54	5%
2029	556	47%	142	12%	68	6%

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



Base Year Demand

In the Base Year of 2014, NL's Residential sector demand was approximately 1,067 MW, averaged over the 36-hour peak period. This may be compared against the overall average residential demand for the year, which is:

*4,227 GWh / 8760 hours * 1000 MW/GW = 483 MW*

Exhibit ES 9 shows that space heating accounts for about 61% of total residential electricity use. Domestic hot water (DHW) accounts for the second largest percentage, at 15%. These are followed by lighting at 4% and clothes dryers, ventilation, and cooking at 3% each. Other end uses account for 2% or less of the total. Indeed, some end uses are extremely small. Air conditioning and dehumidification are not expected to operate during the winter peak at all. Block heaters and car warmers are assumed to be used only in Labrador, but in that region they contribute nearly 1.5% of the residential peak demand. The same exhibit also presents the Reference Case peak demand by end use in 2029, at the end of the study period, for comparison. Overall, NL's Residential sector is forecast to rise to about 1,186 MW by 2029 in the absence of new utility CDM initiatives, an increase of approximately 11%

Exhibit ES 10 shows the distribution of Base Year electric peak demand by dwelling type. As illustrated, single detached housing dwellings account for the largest share (77%) of Residential sector Base Year electricity use. The same exhibit also presents the Reference Case peak demand by dwelling type 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, Residential Sector, 2014 and 2029

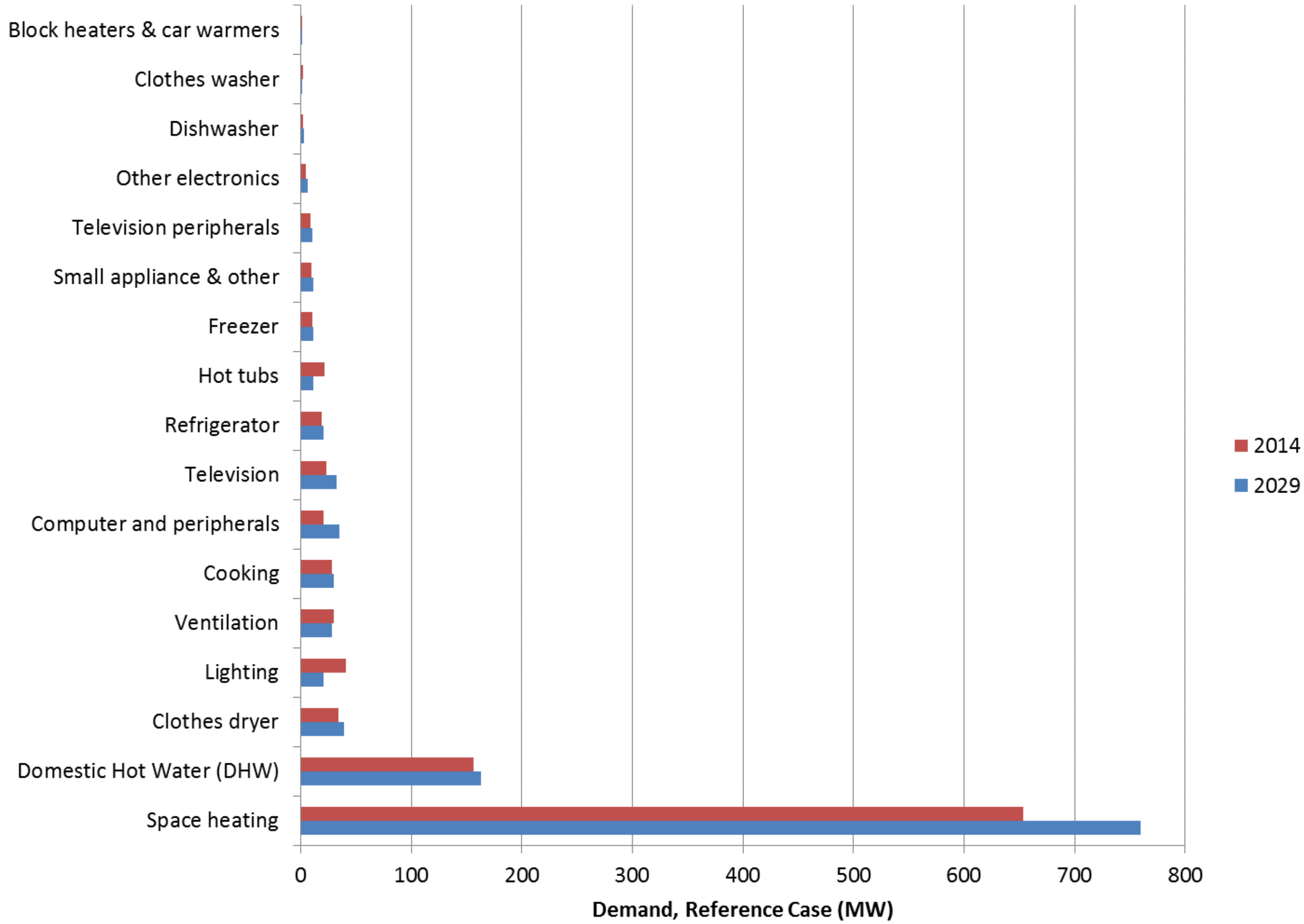
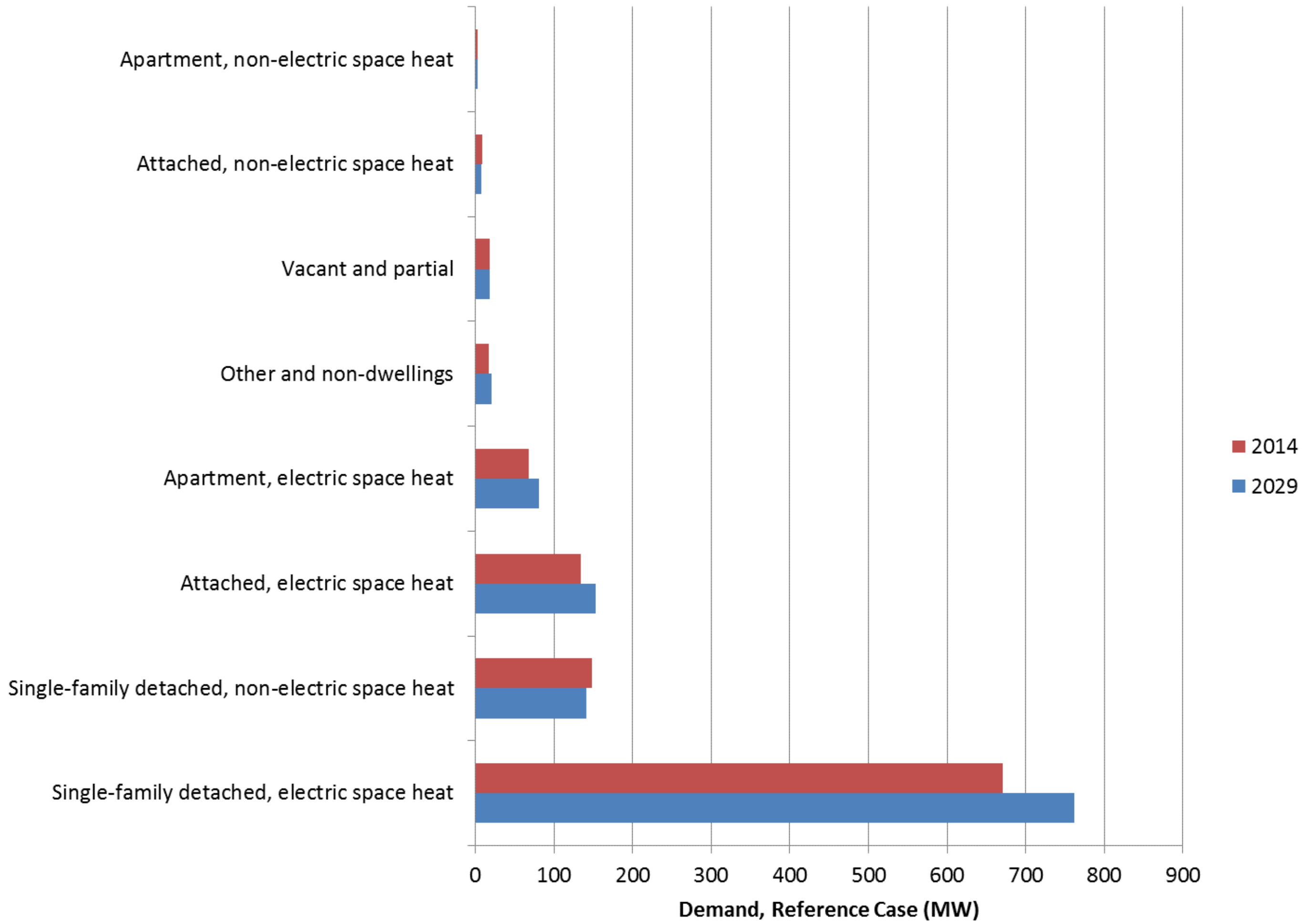


Exhibit ES 10 Electric Peak Demand by Dwelling Type, Residential Sector, 2014 and 2029



Economic Potential Forecast – Electric Peak Demand

Under the conditions of the Economic Potential scenario,[7] the study estimated that electric peak demand in the residential sector would decrease to approximately 630 MW by 2029. Reductions relative to the Reference case would be approximately 556 MW or about 47%. The Economic Potential reductions in the intermediate milestone years are 485 MW in 2017, 528 MW in 2020, 539 MW in 2023, and 550 MW in 2026. In each case, the reductions amount to approximately 44-47% of the Reference case peak demand. 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 residential sector, electricity savings offered by the Lower and Upper Achievable Potential scenarios would provide peak load reductions of approximately 55 to 101 MW by 2029, a decrease of between 4.5% and 8.5% relative to the reference case. Demand reduction measures under the Lower and Upper Achievable Potential scenarios would provide peak load reductions of an additional 12 to 41 MW by 2029, a decrease of a further 1.0% to 3.5%. Thus, demand reduction potential is dominated by the reductions associated with energy efficiency measures in both of the 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.

Among the demand reduction measures the most significant Achievable Potential savings opportunities were in actions that addressed domestic hot water (DHW). In fact, DHW reductions account for over 70% of the opportunities in 2029. Of this, the DHW cycling offers the largest demand reduction potential in the residential sector, aside from the demand reduction associated with energy efficiency measures. Besides DHW, there are significant reduction to be found in space heating measures. Block heater and car warmer measures offer demand reduction potential only in Labrador.

[7] 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

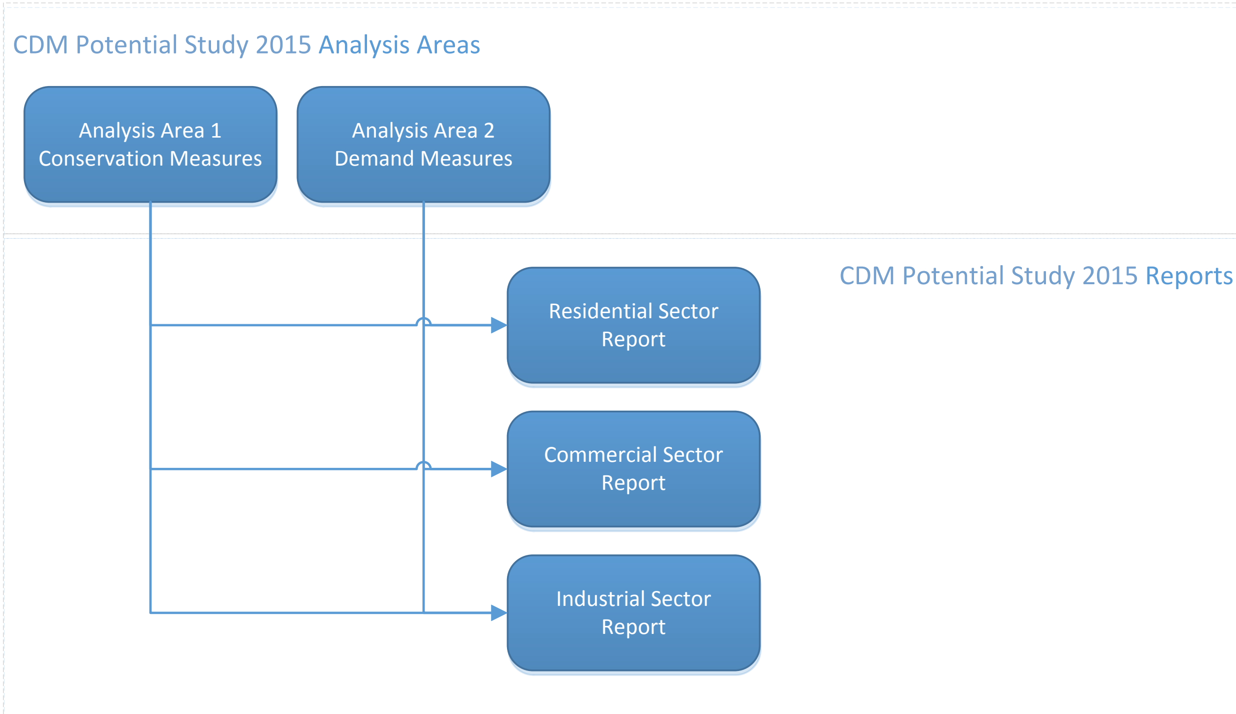
As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the stock of residential buildings and customer willingness 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 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[8] reduction opportunities that could be provided by electrical efficiency technologies that are 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. The results of Analysis Area 1 are presented in three individual sector reports.

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; customer behaviour and operational practices are also addressed. The results of Analysis Area 2 are presented in three individual sector reports.

1.3 Report Organization

This report presents the Residential 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 Residential sector Base Year electricity use in NL.
- Section 4 presents a profile of Residential sector Base Year electric peak load, including the definition of peak periods that are included in this study.

[8] 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 5 presents the Reference Case, which provides a detailed estimate of electricity use in NL's Residential 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 Residential 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 Residential sector.
- Section 8 presents the Residential sector Economic Potential Electricity Forecast for the study period 2014 to 2029, including the potential for both energy efficiency measures and capacity-only peak load reduction measures.
- Section 9 presents the estimated upper and lower Achievable Potential for electric energy savings for the study period 2014 to 2029, including the potential for both energy efficiency measures and capacity-only peak load reduction measures.
- Section 10 lists sources and references.
- Section 11 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 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.

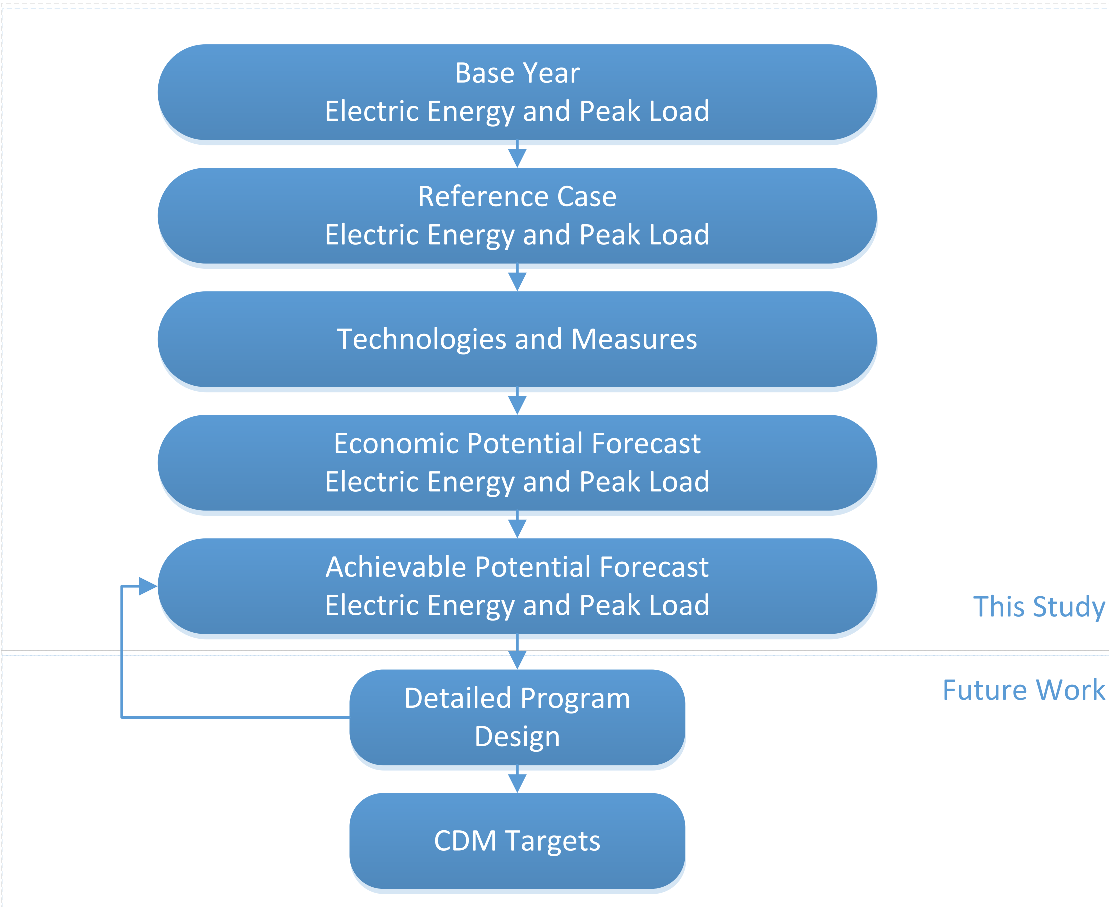
Conservation and Demand Management (CDM) Measures	CDM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace 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[9], 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 load that would occur in the defined peak period 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.

[9] The economic threshold value is related to the cost of new avoided electrical supply. The values for each region 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.
- Calibrate the weather-sensitive load shape ratios for all three sectors to produce regional demand results that agree with the actual utility peak demand.

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 region and milestone year.
- Identify the combinations of energy efficiency upgrade options and building types where the cost of saving one kilowatt-hour 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 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:

- Convert the electricity (electric energy) savings (MWh) calculated in the preceding steps to peak load (electric demand) savings (kW).[10]
- Convert electricity savings to hourly demand, drawing on a library of specific sub-sector and end-use electricity load shapes. Using the load shape data, apply the following steps:
  - Disaggregate annual electricity savings for each combination of sub-sector and end use by month
  - Further disaggregate monthly electricity savings by day type (weekday, weekend day and peak day)
  - Finally, disaggregate each day type by hour.
- Produce a post-efficiency case for peak demand, by region, building type, end use, and milestone year, to serve as a base case for estimating the impacts of peak load measures.

Step 6: Estimate Peak Load Impacts of Electric Demand Measures

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

- Compile utility economic data on the forecast cost of new capacity and set an economic threshold value; different economic threshold values were selected for each region and milestone year.
- Identify the combinations of energy efficiency upgrade options and building types where the cost of reducing one kilowatt of demand is equal to, or less than, the cost of new electric capacity.
- Apply the economically attractive electrical efficiency measures from Step 3 within the demand simulation model developed previously for the Reference Case, using the post-efficiency case as the starting point for the demand measures.

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

- Determine annual electric demand in each building type and end use when the economic demand reduction measures are employed.
- Compare the electric demand levels when all economic demand reduction measures are used with the post-efficiency demand levels and calculate the total demand reduction.

Step 7: Estimate Achievable Potential Electricity Savings and Demand Reduction

Develop an estimated range for the portion of economic potential savings and demand reductions 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 for both efficiency and demand reduction.
- Total potential for demand reduction includes both the demand reductions associated with the energy efficiency measures and the demand reductions from demand management measures.

2.3 Analytical Models

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

- HOT2000,[11] a commercially supported, residential building energy-use simulation software
- RSEEM (Residential Sector Energy End-use Model), an ICF in-house spreadsheet-based macro model.

The consulting team has used this combination of modeling platforms for the residential analysis in conservation potential studies for clients across Canada, including BC Hydro, FortisBC, SaskPower, Manitoba Hydro, Enbridge Gas, Union Gas, NB Power, and Newfoundland Power and Newfoundland Labrador Hydro. During this over ten-year period, HOT2000 has undergone numerous version upgrades as NRCan maintains it. At the same time, each new project has provided an opportunity to refine and enhance the RSEEM model.

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

- Electric, natural gas (not applicable in NL), oil, propane and wood space heating systems
- DHW systems from conventional to high-efficiency condensing systems
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

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

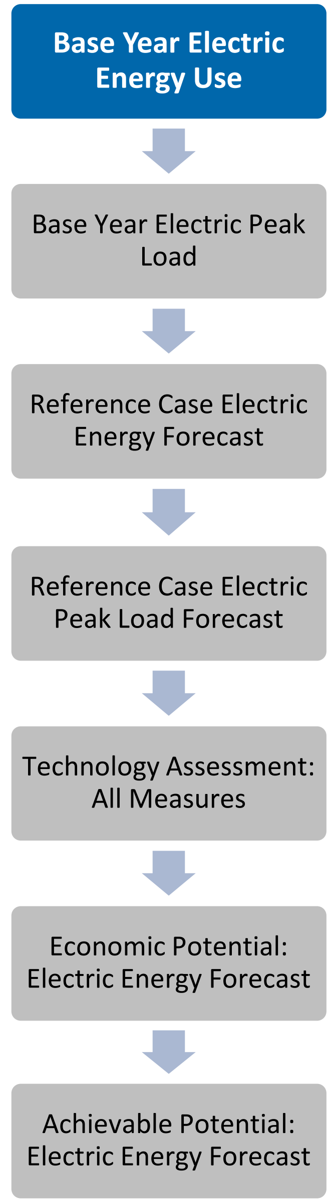
[11] Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

RSEEM consists of three modules:

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

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

3 Base Year (2014) Electric Energy Use



3.1 Introduction

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

- Base Year housing stock
- End uses
- Average electricity use per unit
- Summary of model results.

3.2 Base Year Housing Stock

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

- Dwelling type
- Region (Island Interconnected, Labrador Interconnected, and Isolated)
- Heating category (electrically heated versus non-electrically heated).

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

- Single-family detached, pre-2014 – electric space heat
- Single-family detached, pre-2014 – non-electric space heat
- Attached,[12] pre-2014 – electric space heat
- Attached, pre-2014 – non-electric space heat
- Apartment,[13] pre-2014 – electric space heat
- Apartment, pre-2014 – non-electric space heat
- Other – includes very low use facilities and non-dwellings such as cottages, garages, sheds, wells, etc. Does not include mobile homes, which are included among single-family dwellings.
- Vacant and Partial

As much as possible, utility customer billing data was used to develop a breakdown of the residential sector into the above dwelling types. Where billing data did not provide sufficient detail to subdivide accounts into these groups, it was augmented with results of NL's Residential End Use Survey (REUS).

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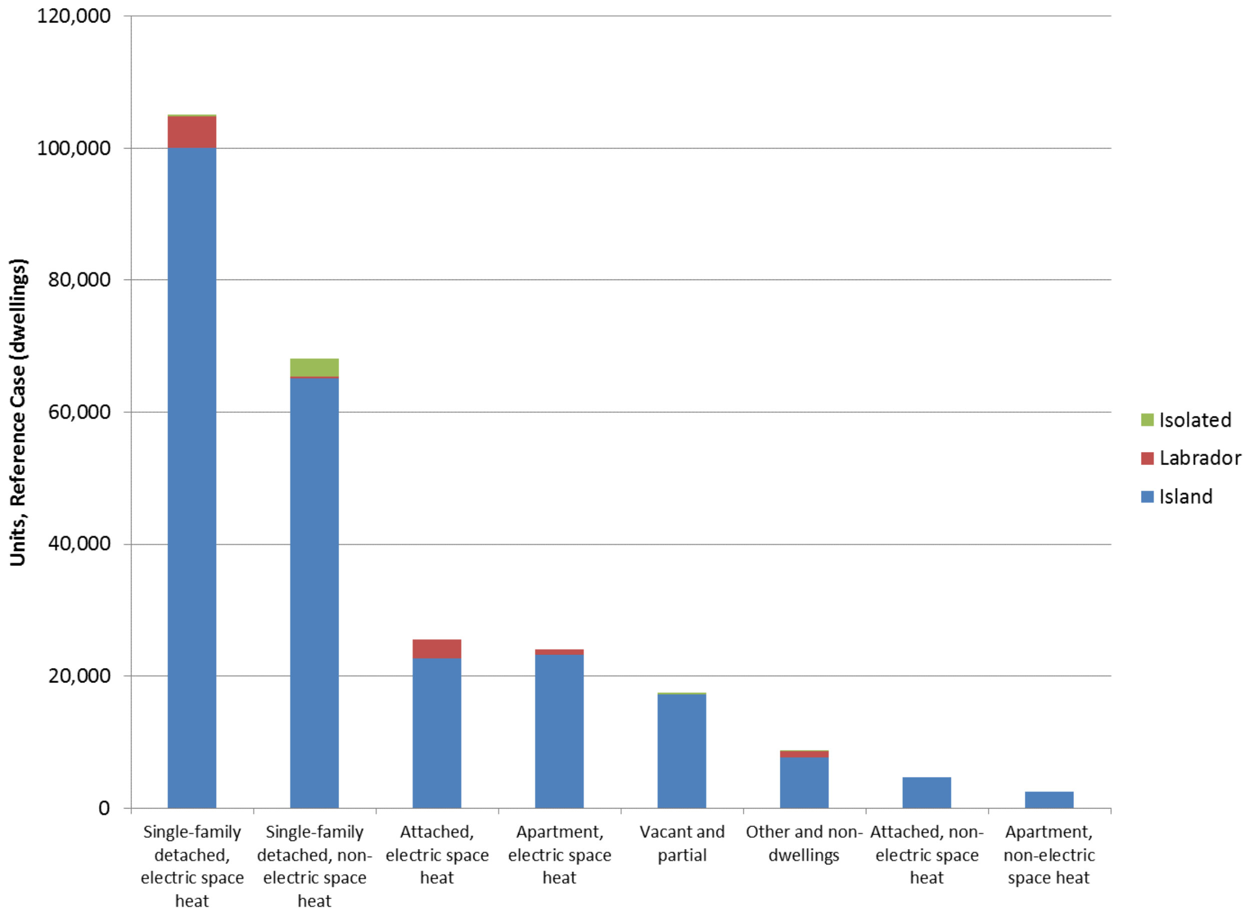
[12] As in the 2008 study, attached dwellings, either electrically or non-electrically heated, include the main dwelling in a house that has a basement apartment.
[13] As in the 2008 study, apartments, either electrically or non-electrically heated, include basement apartments. Basement apartments accounted for close to 50% of the apartment units. They do not include the common areas of the buildings, which are commercial customers.

A summary of the distribution of NL's residential dwellings is provided in Exhibit 3 and Exhibit 4. The first exhibit provides details of the estimated breakdown by dwelling type and region. The column chart shows the breakdown by dwelling type graphically, sorted from the most numerous to least numerous dwelling types.

Exhibit 3 Existing Newfoundland Residential Units by Dwelling Type and Region

Dwelling Types	Dwelling Units			
	Island	Labrador	Isolated	Grand Total
Single-family detached, electric space heat	100,059	4,723	350	105,133
Single-family detached, non-electric space heat	65,078	356	2,680	68,114
Attached, electric space heat	22,738	2,841	-	25,579
Attached, non-electric space heat	4,604	-	-	4,604
Apartment, electric space heat	23,253	822	-	24,075
Apartment, non-electric space heat	2,475	-	-	2,475
Other and non-dwellings	7,636	975	176	8,787
Vacant and partial	17,167	-	318	17,485
Grand Total	243,010	9,717	3,525	256,251

Exhibit 4 Existing NL Residential Units by Dwelling Type



As illustrated in Exhibit 3 and Exhibit 4:

- The NL electric utilities currently service about 256,000 residential accounts.[14]
- Approximately 95% of residential accounts are in the Island Interconnected region, approximately 4% are in the Labrador Interconnected region, and the remaining 1% are on various Isolated diesel grids.
- 68% of the residential accounts are single detached homes, approximately 12% are attached homes (including both side-by-side units and those above a basement apartment), approximately 10% are apartment units (including basement apartments), approximately 7% are vacant or partially occupied dwellings (such as seasonally occupied dwellings), and 3% are other residential buildings, such as cottages, garages and sheds.
- Electricity is the dominant heating fuel in NL. Overall, it is the main heating fuel in two-thirds of the dwellings. In the Island Interconnected region, for example, over 60% of the single detached dwellings are heated by electricity. In the Labrador Interconnected region, over 90% of the single detached dwellings are heated by electricity. Only in the Isolated region are a majority of the dwellings (nearly 90%) heated by fuels other than electricity.

3.3 End Uses

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

A summary of the major residential sector end uses used in this study is provided in Exhibit 5, together with a brief description of each.

[14] This does not include area and yard lighting meters, which have been included in the commercial sector. The measures applicable to these lights are similar to those for lighting in parking lots and along roadways, so they have been included in commercial for ease of analysis.

Exhibit 5 Residential Electric End Uses

End Use	Description
Space heating	All space heating, including both central heating and supplementary heating. The heating provided by a heat pump system is included in this end use.
Space cooling	All space cooling, including both central cooling and window or wall units. The cooling provided by a heat pump system is included in this end use.
Ventilation	Primarily the furnace fan, but also includes the fan in heat recovery ventilators as well as kitchen and bathroom fans
Domestic Hot Water (DHW)	Heating of water for DHW use. Does not include hydronic space heating
Cooking	Includes ranges, separate ovens and cook tops and microwave ovens
Refrigerator	
Freezer	
Dishwasher	
Clothes washer	
Clothes dryer	
Dehumidifiers	
Lighting	Includes interior, exterior and holiday lighting
Computer and peripherals	Includes printers, scanners, modems, faxes, PDA and cell phone chargers
Television	
Television peripherals	Set top boxes, including digital cable converters and satellite converters
Other electronics	Stereos, DVD players, VCRs, boom boxes, radios, video gaming systems, security systems
Block heaters and other car devices	Block heaters, car warmers, and battery blankets
Hot tubs	Both indoor and outdoor hot tubs. Pools are not included.
Small Appliance & Other	There are hundreds of additional items within this category, each accounting for a fraction of a percent of household energy use, e.g., hair dryers, doorbells, garage door openers, block heaters, home medical equipment, electric lawnmowers.

3.4 Average Electricity Use per Dwelling Unit

Exhibit 6 provides a profile of average electricity use within each of the dwelling types that were identified previously. This exhibit is a blended average for all three regions. Individual regional exhibits are provided in Appendix A. The values shown in Exhibit 6 combine three factors:

- **Unit Energy Consumption (UEC).** This is the average amount of electricity that one appliance (e.g., a hot water tank) consumes annually in a given dwelling type.
- **Saturation.** This is the percentage of households within each dwelling type that have the given appliance. For example, in the case of a hot water tank, every household has one and, therefore, the saturation is 100%. However, for some appliances such as refrigerators or televisions, the saturation is often greater than 100%, as many households have more than one refrigerator or television.
- **Electric Fuel Share.** Several appliances, such as hot water tanks, clothes dryers, cooking ranges, etc., can operate on propane gas or other fuels as well as electricity. Electric fuel share, therefore, refers to the percentage of each appliance that operates with electricity.

For most end uses, the primary source of information for saturation and electric fuel share is NL's Residential End Use Survey (REUS). The sources of information for UEC are more varied, and are discussed in detail, end use by end use, in Appendix A.

A sample calculation is provided below for DHW use in single detached homes in the Island Interconnected region. Exhibit 6 shows a blended average of the results of such calculations for the three regions. The exhibits referenced below are contained in Appendix A, which accompanies this report.

Sample Calculation of Annual DHW Electricity Consumption for Single Detached Electrically Heated Homes

UEC, see Exhibit 93	2,629 kWh/yr.
Saturation, see Exhibit 106	100%
Electric Fuel Share, see Exhibit 109	100%[15]

Annual DHW Electricity Consumption = 2,629 x 100% x 100% = 2,629 kWh/yr.
(as shown in Exhibit 112.)

[15] Overall DHW electric share in single detached dwellings is not 100%, according to the NL REUS, but the share of non-electric DHW tanks is smaller than the proportion of houses with predominantly non-electric space heating. For the purposes of this study, the dwellings with non-electric DHW were assumed to be a subset of the dwellings with non-electric space heating, and therefore all the electrically heated dwellings were assumed to have electric DHW tanks.

Exhibit 6 Average Electricity Use per Dwelling Unit, Average of All NL (kWh/yr.)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	13,613	16	248	2,634	639	855	508	70	50	919
Single-family detached, non-electric space heat	1,413	-	739	1,785	541	845	513	62	46	833
Attached, electric space heat	10,369	1	216	2,704	671	881	402	76	52	967
Attached, non-electric space heat	866	-	648	1,500	570	868	390	64	45	831
Apartment, electric space heat	4,949	-	85	1,926	479	474	100	30	29	522
Apartment, non-electric space heat	907	-	205	1,035	324	472	99	21	19	353
Other and non-dwellings	2,710	-	88	1,272	352	590	426	17	27	504
Vacant and partial	1,549	-	25	583	161	122	88	8	12	231

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	395	1,144	701	634	291	170	7	759	266	23,918
Single-family detached, non-electric space heat	355	1,035	639	573	264	154	1	726	240	10,764
Attached, electric space heat	391	1,011	690	612	291	170	18	444	83	20,047
Attached, non-electric space heat	346	874	595	523	251	147	-	380	72	8,970
Apartment, electric space heat	225	508	604	344	249	145	-	-	125	10,795
Apartment, non-electric space heat	179	342	476	270	196	114	-	-	99	5,111
Other and non-dwellings	-	459	366	255	117	68	-	-	1,650	8,900
Vacant and partial	-	280	159	157	72	42	-	-	795	4,285

There have been some changes in assumed average consumption for the end uses, as compared with the similar exhibit included in the 2008 study. The following comments provide some background for these changes:

- Space cooling, dehumidifiers, block heaters and car warmers, and hot tubs, are end uses the previous study did not separate out from the small appliance & other category. The consumption for these four end uses has been removed from the small appliance & other category, so it is smaller than it was in 2008.
- Space cooling in residential primarily occurs in homes that have installed heat pump systems for space heating. Average consumption per dwelling is therefore very low, since most homes do not have the end use at all.
- Block heaters are virtually nonexistent outside of Labrador. The consumption for this end use in Labrador is divided by the total stock of dwellings in the three regions, so the usage per dwelling is very small. The end use consumption per dwelling appears larger for single family dwellings because Labrador single family dwellings are a smaller portion of all single family dwellings in NL compared to Labrador attached dwellings as a portion of all attached dwellings in NL.
- The average consumption for ventilation is assumed to be substantially higher in electrically-heated houses and somewhat lower in non-electrically heated houses. This is because of the high incidence of heat recovery ventilators in NL dwellings – the fan energy for these units is included in this end use. In the homes with forced air systems (most of the non-electrically heated dwellings), improved furnace fan motors have reduced average consumption.
- Domestic hot water systems are assumed to use approximately 20% less energy than was assumed in 2008. This is largely because updated clothes washers and dishwashers use less hot water. In a seven-year period, a substantial number of these appliances reach end of life and are replaced. Clothes washers at the ENERGY STAR® level of performance and above have become very common choices for NL appliance purchasers, as have ENERGY STAR® dishwashers. Utility appliance program activity in the province has further accelerated this uptake.
- Consumption of the large appliances have been updated based on the latest data from NRCan, as discussed in Appendix A, as well as updated information on the number of large appliances in households, from NL's recent Residential End Use Survey (REUS). With this new data, the average consumption values for refrigerators and freezers are somewhat smaller and the consumption values for dryers are somewhat higher. Dishwasher consumption is assumed to be higher, but primarily because more dwellings now have dishwashers.
- Lighting energy is assumed to have dropped by approximately 25%, primarily because of the advent of compact fluorescent and LED lamps.
- Overall, the consumption of the electronic end uses – computers, televisions, television peripherals, and other electronics – are assumed to have increased. There has been some shifting among these four end uses, based on updated assumptions on usage per device and updated information on the number of computers and televisions per dwelling from the REUS.

3.5 Summary of Residential Base Year Electricity Use

This section combines the data on average annual electricity use by dwelling type, shown in the preceding exhibit, with data on the number of each dwelling type to produce a summary of the total electricity use in NL's Residential sector in the Base Year. The results are measured at the customer's point-of-use and do not include line losses; they are presented in five separate exhibits:

- Exhibit 7 presents the results in tabular form by dwelling type and end use
- Exhibit 8, Exhibit 9, and Exhibit 10 present the model results graphically by dwelling type, by region, and by end use, respectively

- Exhibit 11 presents the model results as a series of stacked bars, showing the percentage consumed by end use for each dwelling type.

Additional highlights are provided below.

By Dwelling Type

Single detached dwellings account for the majority of residential electricity use in NL, with approximately 77% of residential electricity consumed. Attached houses (duplexes, row houses, townhouses, and the main house of a building with a basement apartment) account for approximately 13% of residential electricity. Apartment buildings, including only the suites and not the common areas (which are commercial customers), as well as basement apartments, account for the next largest share, using 6% of residential electricity. Other residential buildings, such as cottages, sheds and garages, account for approximately 2% of residential electricity. Vacant and partially occupied dwellings account for the last 2% of residential electricity.

By Region

The Island Interconnected region accounts for 92% of residential electricity consumption. The Labrador Interconnected region accounts for 7% of residential electricity consumption. Residential accounts connected to isolated diesel grids consume the remaining 1% of residential electricity.

By End Use

HVAC accounts for 49% of consumption, with 47% of that being electric space heating and the remainder being fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust. Space cooling is well under 1% of residential consumption.

Domestic appliances (white goods) consume approximately 18% of total residential electricity. Of this, clothes dryers and refrigerators each account for 5%. Cooking appliances and freezers each consume approximately 3%. Dehumidifiers account for approximately 2%. Dishwashers and clothes washers consume less than 1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating accounts for approximately 13% of residential electricity consumption.

Household electronics consume approximately 10% of residential electricity, including 4% by computers and their peripherals, 3% by televisions, 2% by the various set-top boxes associated with televisions, and 1% by other home entertainment electronics.

Indoor, outdoor, and holiday lighting together account for 6% of residential electricity consumption; 5% of this is indoor lighting and 1% is outdoor lighting. Holiday lighting is well under 1%.

Other end uses account for 5% of residential electricity consumption. Of this, 3% is consumed by spa heaters and pumps and 2% is small appliances and other. Less than 1% is consumed by block heaters and car warmers, all of it in Labrador.

By Dwelling Type and End Use

The last exhibit in this section highlights the differences among dwelling types. In general, for example, attached dwellings show a lower percentage of consumption for HVAC and a higher percentage for electronics and appliances than single detached houses.

The exhibit also highlights how much more of the electricity is used for HVAC in an electrically heated dwelling.

Finally, in apartment buildings consumption in the suites is dominated by appliances and electronics. Most of the “other” end uses in an apartment building, such as spas or block heaters, are likely in the common areas of the building, which are not included in the residential sector.

Data Manager – Reference Case 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 dwelling type of interest, such as the electrically heated detached house.
- The user can produce a column chart showing the electricity consumption for kitchen and laundry appliances in each of several dwelling types, with each dwelling type as a separate column and the different appliance consumption values shown stacked on top of each other.
- The user can produce a line chart showing consumption for a particular dwelling type by year.
- The user can produce a column chart showing the consumption of different house types in each rate class (different rate classes within residential distinguish between Island dwellings served by NP versus NLH, for example).
- The user can produce a chart and accompanying table showing the number of refrigerators in NL, by region and house type.

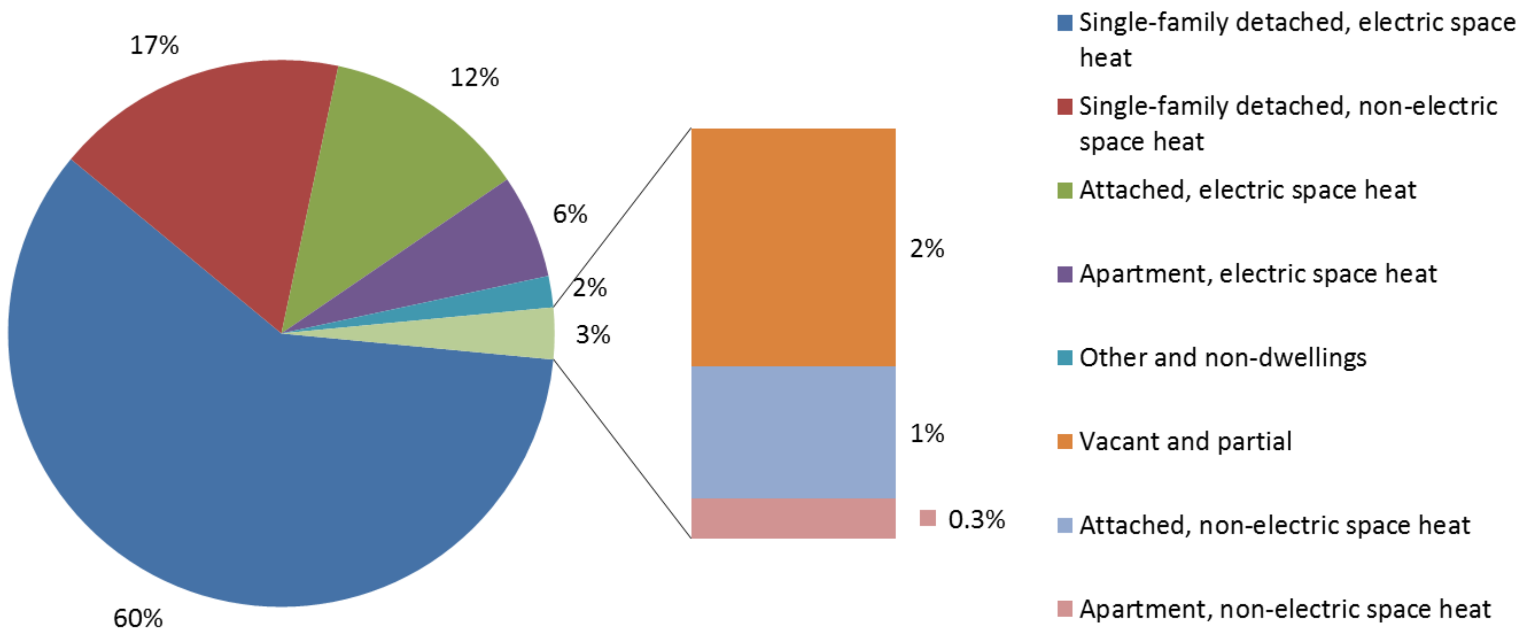
Data Manager has a user interface designed for someone with basic knowledge of Excel.

Exhibit 7 Electricity Consumption by End Use and Dwelling Type in the Base Year (2014), All of NL (MWh/yr.)

Dwelling Types	Reference Case Consumption (MWh/yr.)									
	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	1,431,206	1,723	26,037	276,870	67,172	89,850	53,389	7,350	5,278	96,605
Single-family detached, non-electric space heat	96,232	-	50,318	121,571	36,844	57,569	34,952	4,248	3,106	56,751
Attached, electric space heat	265,226	22	5,529	69,174	17,176	22,527	10,293	1,937	1,325	24,724
Attached, non-electric space heat	3,990	-	2,982	6,908	2,622	3,998	1,798	296	205	3,825
Apartment, electric space heat	119,147	-	2,055	46,365	11,533	11,403	2,416	734	689	12,571
Apartment, non-electric space heat	2,244	-	507	2,561	802	1,167	246	51	48	874
Other and non-dwellings	23,808	-	777	11,173	3,090	5,188	3,742	152	238	4,426
Vacant and partial	27,088	-	436	10,202	2,821	2,129	1,536	139	217	4,041
Grand Total	1,968,940	1,745	88,642	544,824	142,060	193,832	108,372	14,906	11,107	203,817

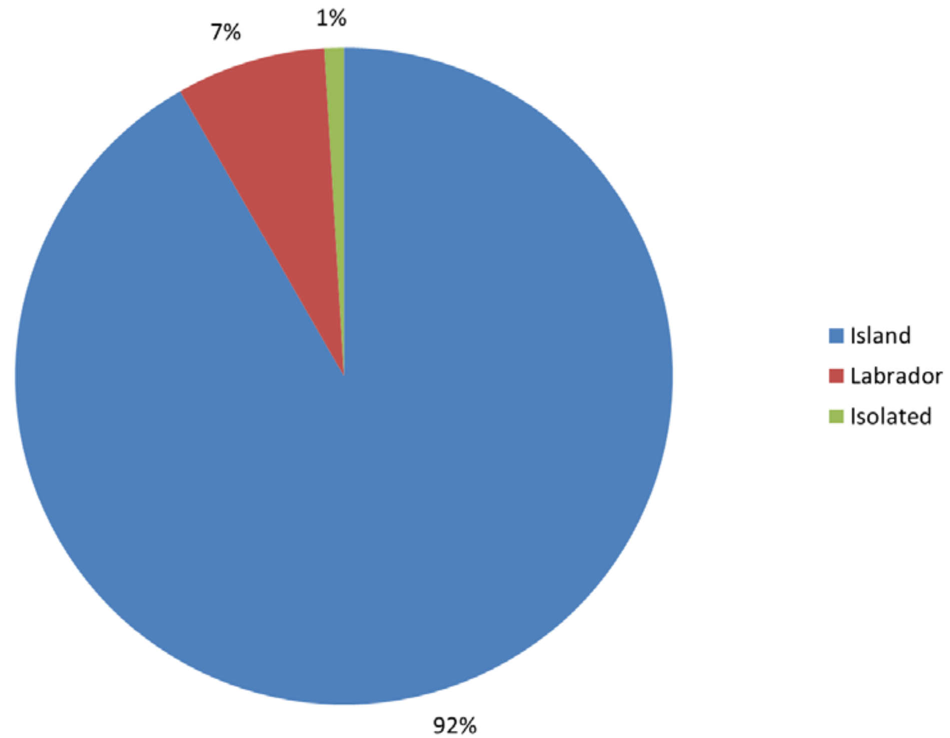
Dwelling Types	Reference Case Consumption (MWh/yr.)									
	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other	Grand Total
Single-family detached, electric space heat	41,535	120,251	73,694	66,679	30,557	17,828	755	79,804	27,937	2,514,522
Single-family detached, non-electric space heat	24,203	70,523	43,495	39,002	17,992	10,498	57	49,467	16,378	733,206
Attached, electric space heat	9,989	25,852	17,658	15,645	7,435	4,338	450	11,368	2,129	512,799
Attached, non-electric space heat	1,592	4,026	2,738	2,407	1,158	675	-	1,750	332	41,302
Apartment, electric space heat	5,422	12,236	14,549	8,272	5,990	3,495	-	-	3,015	259,891
Apartment, non-electric space heat	442	848	1,178	668	486	283	-	-	244	12,650
Other and non-dwellings	-	4,031	3,219	2,241	1,025	598	-	-	14,496	78,204
Vacant and partial	-	4,903	2,785	2,740	1,253	731	-	-	13,900	74,921
Grand Total	83,184	242,671	159,318	137,653	65,895	38,446	1,263	142,388	78,431	4,227,494

Exhibit 8 Distribution of Electricity Consumption, by Dwelling Type in the Base Year (2014)



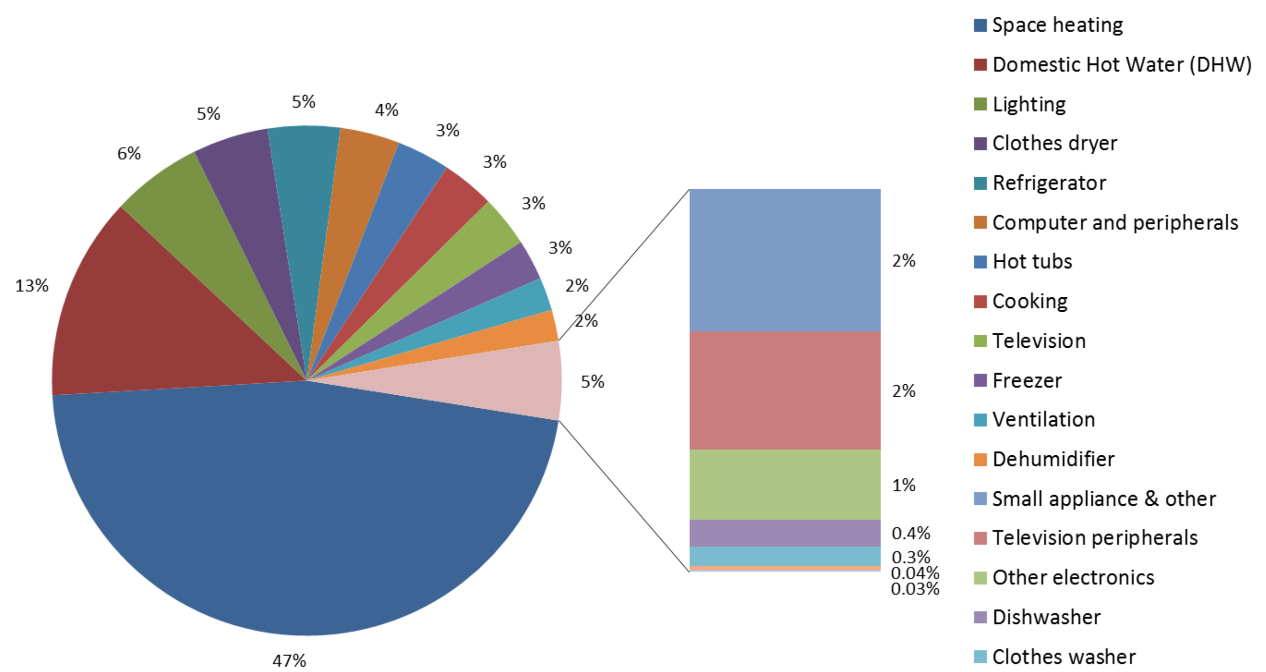
Totals may not add to 100% due to rounding.

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



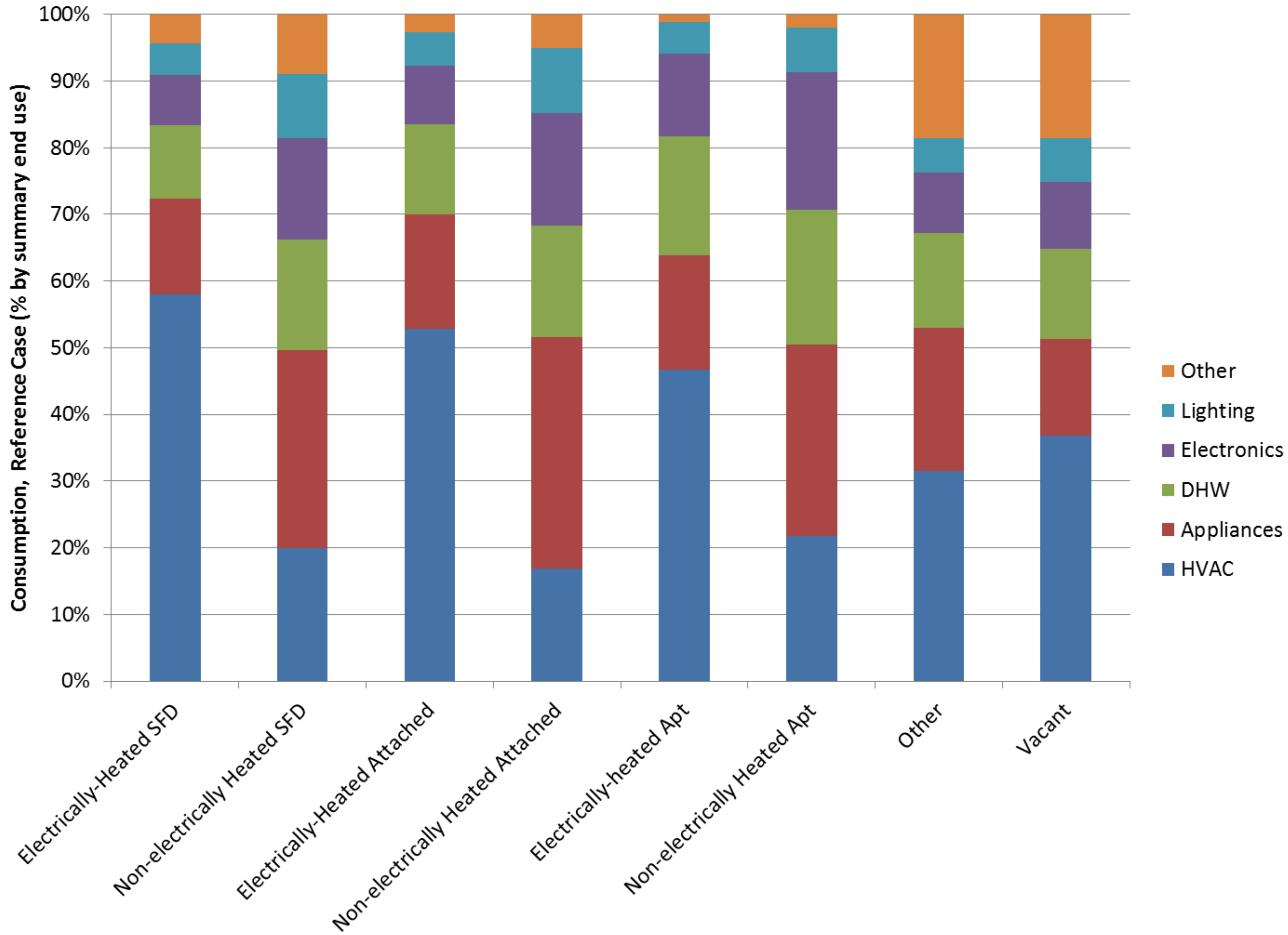
Totals may not add to 100% due to rounding.

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

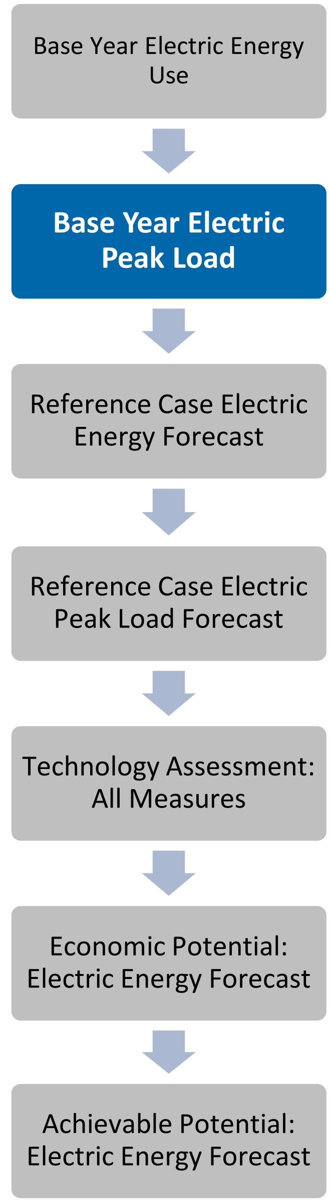


Totals may not add to 100% due to rounding.

Exhibit 11 Distribution of Electricity Consumption, by Dwelling Type 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 Residential 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.[16]

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

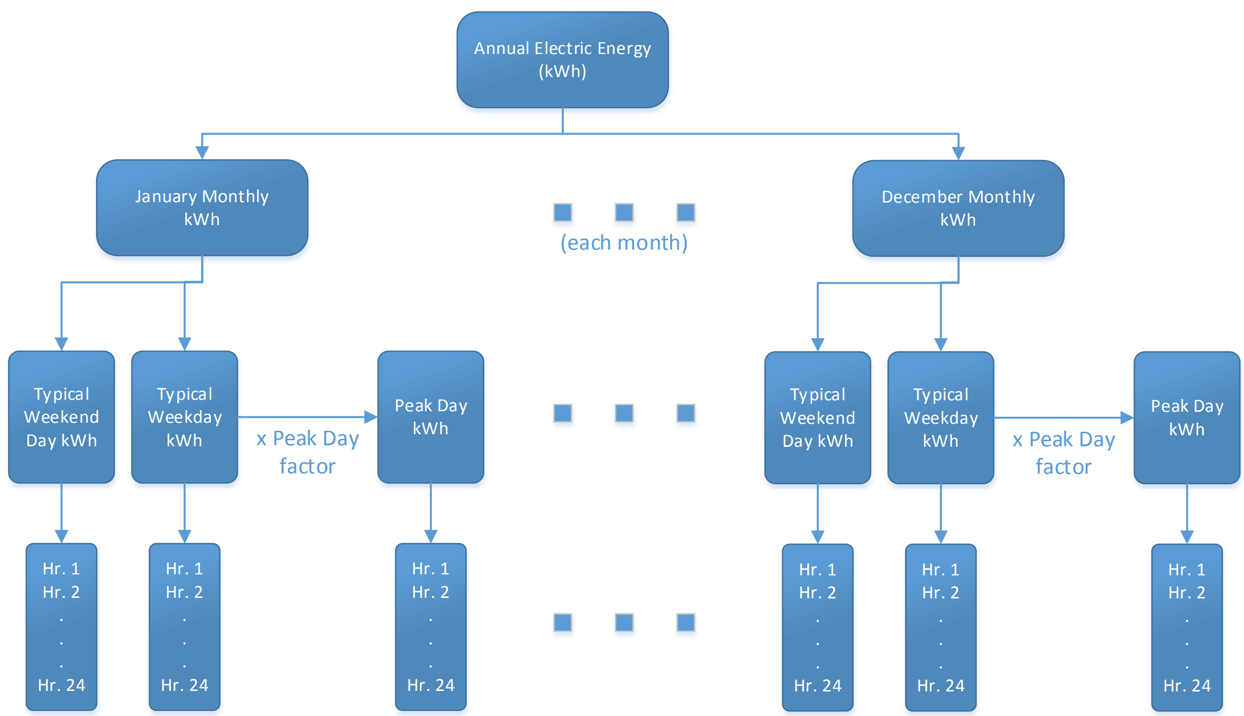
The electric peak load profile converts the annual electric energy use (MWh) presented in Section 3 to hourly demand (MW). Development of the electric peak load estimates employs four specific factors, which are described below and shown graphically in Exhibit 12.

- **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.

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

- **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:** This factor reflects the operating hours of the residential 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 12 Overview of Peak Load Profile Methodology



4.4 Summary of Results

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

Exhibit 13 presents the results for the Residential sector Base Year. The results are presented for each of the three regions in NL, by dwelling type. In each case, the results show the contribution of Residential sector demand that is coincident with the total demand in the peak period.

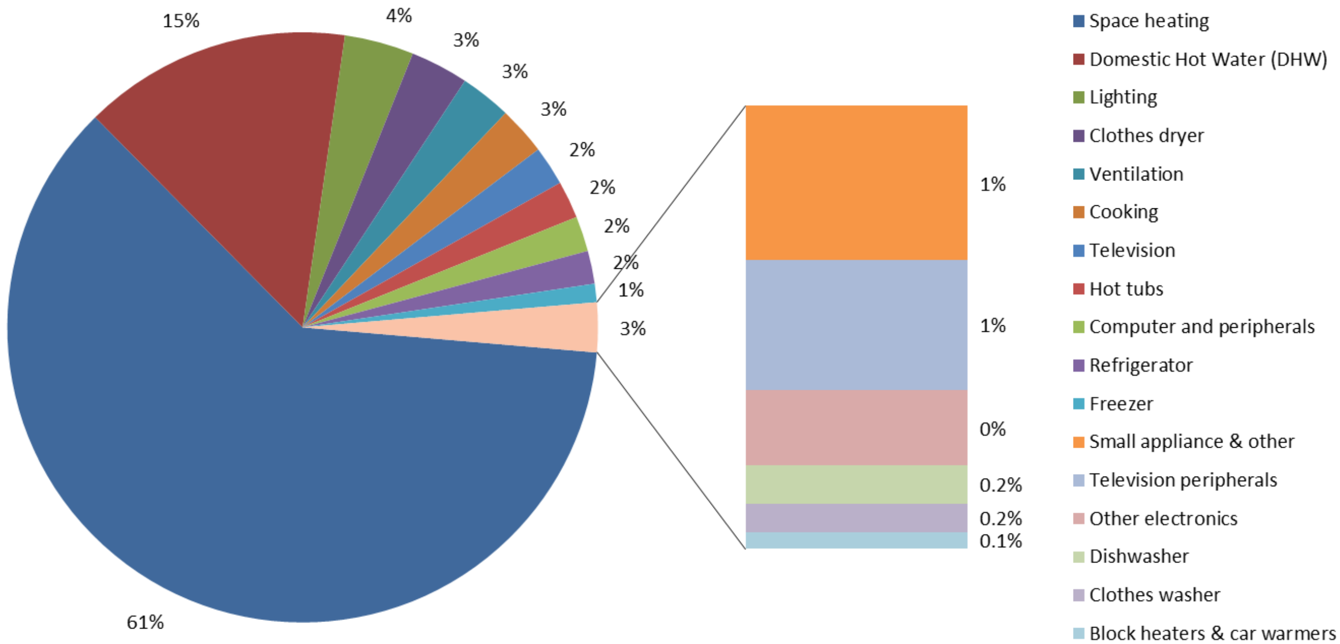
Exhibit 13 Residential Sector Base Year (2014) Aggregate Peak Demand by Region (MW)

Dwelling Types	Reference Case Peak Demand (MW)			
	Island	Labrador	Isolated	Grand Total
Single-family detached, electric space heat	620	48	3	671
Single-family detached, non-electric space heat	141	2	6	149
Attached, electric space heat	109	25	-	134
Attached, non-electric space heat	8	-	-	8
Apartment, electric space heat	65	3	-	68
Apartment, non-electric space heat	3	-	-	3
Other and non-dwellings	15	2	0	17
Vacant and partial	17	-	0	18
Grand Total	979	78	9	1,067

Exhibit 14 shows the contribution, by end use, to the residential component of the peak demand. Some key observations may be made:

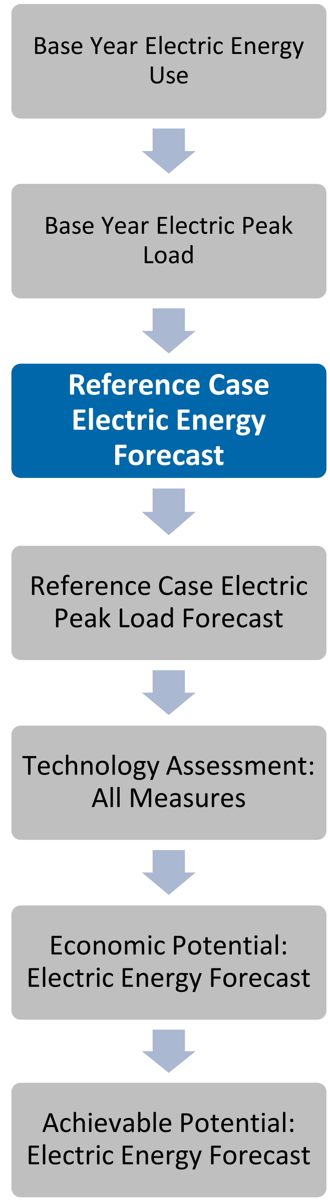
- Space heating is the largest residential component of peak demand. As shown in the previous section, space heating is one of the largest end uses in terms of annual electrical consumption. It also tends to be concentrated in the winter when the NL system peaks.
- Domestic hot water is the second largest residential component of peak demand. It is a large end use and is heavily used during the morning hours when the morning peak occurs.
- Lighting is the third largest residential component of peak demand. As shown in the previous section, indoor lighting is a relatively large end use in terms of annual electrical consumption. It also tends to be used heavily during the evening and morning hours when the NL system peaks.
- Clothes dryers are the fourth largest residential contributor to peak demand. The peak use of clothes dryers coincides fairly closely with the evening part of the peak period.
- Ventilation is the fifth largest residential contributor to peak demand. This is largely because the fan energy for furnaces and heat recovery ventilators peaks at similar times to space heating.
- Hot tubs are not in the top five residential contributors to peak demand for the province as a whole, but if a version of Exhibit 14 is replicated with Labrador Interconnected results only, hot tubs are the fourth largest contributor to residential peak demand in that region. This is because many of them are outside and therefore require considerable heat in a severe climate. Their consumption is relatively coincident with the system's peak during the coldest part of the winter.
- Block heaters and car warmers are a small contributor to the system peak, because they are virtually nonexistent outside Labrador, but their share of peak demand is over three times as large as their share of annual consumption. This is because their consumption is highly concentrated in the morning peak period on the coldest days of the winter. In Labrador they are the seventh largest residential end use contributing to peak demand, as shown in Appendix B.

Exhibit 14 Contribution by End Use to Residential Aggregate Peak Demand, All NL (%)



Additional detail is provided in Appendix B.

5 Reference Case Electric Energy Forecast



5.1 Introduction

This section presents the Residential 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: The growth in the number of residential dwellings was estimated for each type of dwelling.

Step 2: The net space heating and cooling loads for each new dwelling type were estimated. New dwellings are those built after the base year, 2014.

Step 3: Naturally-occurring changes in net space heating loads were estimated for existing dwelling types.

Step 4: Naturally-occurring changes in annual electricity use were estimated for the evolving stock of major residential appliances.

Step 5: Future appliance saturation trends were estimated for each dwelling type.

Step 6: Changes in electricity share for each appliance were estimated for each dwelling type.

Exhibit 15 shows the estimated number of residential units in each milestone period, by dwelling type. The estimates shown are derived from the Utilities' load forecasts.

Higher rates of growth have been applied to the attached houses, compared to the rate of growth for single detached houses. The attached houses are assumed to increase in number 1.08 times as fast as the single detached houses in the Island Interconnected region, and 1.77 times as fast as the single detached houses in the Labrador Interconnected region. (The customer data provided indicated there are no attached homes in the Isolated region, and this was assumed to remain unchanged.) This is based on the ages of houses of different types reported in the NL Residential End Use Survey (REUS). Overall growth rate was calibrated to the expected increase in number of accounts assumed in the load forecast.[17]

Growth rates for electrically heated dwellings are assumed to be much larger than for non-electrically heated dwellings in the Island Interconnected region. According to the REUS, approximately 85% of new homes are being constructed with heating systems that are predominantly electric. In the Labrador Interconnected region, all new dwellings were assumed to be electrically heated. In the Isolated region, 85% of new dwellings were assumed to be electrically heated, including all new homes constructed in L'Anse au Loup.

[17] Note that growth in number of accounts does not translate directly into growth in consumption because the dwelling types have different overall consumption and different mixes of end uses.

Exhibit 15 Residential Accounts by Dwelling Type and Milestone Year

Year	Dwelling Types	Dwelling Units			
		Island	Labrador	Isolated	Grand Total
2014	Single-family detached, electric space heat	100,059	4,723	350	105,133
	Single-family detached, non-electric space heat	65,078	356	2,680	68,114
	Attached, electric space heat	22,738	2,841	-	25,579
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	23,253	822	-	24,075
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	7,636	975	176	8,787
	Vacant and partial	17,167	-	318	17,485
	Year Total	243,010	9,717	3,525	256,251
2017	Single-family detached, electric space heat	104,513	4,899	384	109,797
	Single-family detached, non-electric space heat	65,602	356	2,686	68,643
	Attached, electric space heat	23,831	3,029	-	26,861
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	24,370	876	-	25,247
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	7,872	1,022	178	9,072
	Vacant and partial	17,700	-	322	18,021
	Year Total	250,968	10,182	3,571	264,721
2020	Single-family detached, electric space heat	108,309	5,011	407	113,727
	Single-family detached, non-electric space heat	66,047	356	2,690	69,093
	Attached, electric space heat	24,766	3,151	-	27,918
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	25,326	912	-	26,238
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	8,074	1,052	180	9,306
	Vacant and partial	18,153	-	325	18,478
	Year Total	257,756	10,481	3,602	271,839
2023	Single-family detached, electric space heat	112,551	5,080	451	118,082
	Single-family detached, non-electric space heat	66,547	356	2,698	69,600
	Attached, electric space heat	25,814	3,228	-	29,042
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	26,398	934	-	27,332
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	8,300	1,070	183	9,553
	Vacant and partial	18,661	-	330	18,991
	Year Total	265,349	10,668	3,662	279,679
2026	Single-family detached, electric space heat	115,531	5,146	493	121,169
	Single-family detached, non-electric space heat	66,902	356	2,705	69,963
	Attached, electric space heat	26,552	3,303	-	29,855
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	27,152	956	-	28,108
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	8,459	1,088	186	9,733
	Vacant and partial	19,018	-	335	19,353
	Year Total	270,693	10,848	3,719	285,260
2029	Single-family detached, electric space heat	118,196	5,200	532	123,929
	Single-family detached, non-electric space heat	67,220	356	2,712	70,287
	Attached, electric space heat	27,214	3,365	-	30,579
	Attached, non-electric space heat	4,604	-	-	4,604
	Apartment, electric space heat	27,829	974	-	28,803
	Apartment, non-electric space heat	2,475	-	-	2,475
	Other and non-dwellings	8,601	1,104	189	9,893
	Vacant and partial	19,337	-	340	19,677
	Year Total	275,476	10,998	3,773	290,247

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. The results are measured at the customer's point-of-use and do not include line losses. They are presented in four exhibits:

- Exhibit 16 presents the model results in tabular form, by dwelling type, end use and milestone year
- Exhibit 17 presents the model results for 2029 by dwelling type
- Exhibit 18 presents the model results for 2029 by by region
- Exhibit 19 presents the model results for 2029 by end use
- Exhibit 20 shows the evolving relative contribution of different summary end uses towards the total consumption in different dwelling types.

Selected highlights of electricity use in 2029 are provided below.

By Dwelling Type

Single detached dwellings will continue to account for the majority of residential electricity use in NL, consuming approximately 76% of residential electricity in 2029. Attached houses (duplexes, row houses, townhouses, and the main house of a building with a basement apartment) are expected to account for approximately 13% of residential electricity in 2029. Apartment buildings, including only the suites and not the common areas, as well as basement apartments, are expected account for 7% of residential electricity in 2029. Other residential buildings, such as cottages, sheds and garages, are expected to account for approximately 2% of residential electricity in 2029. Vacant and partially occupied dwellings are expected to account for the last 2% of residential electricity.

By Region

The division of electricity consumption by region is expected to remain stable over the study period, with the Island Interconnected region continuing to account for 92% of residential electricity consumption, the Labrador Interconnected region accounting for 7%, and accounts connected to isolated diesel grids consuming the remaining 1%.

By End Use

HVAC is expected to account for approximately 51% of consumption in 2029. 49% of the 51% is expected to be electric space heating and the remainder being fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust. Space cooling is well under 1% of residential consumption.

Domestic appliances (white goods) are expected to consume approximately 18% of total residential electricity in 2029. Of this, clothes dryers and refrigerators will each account for 5%. Cooking appliances consume approximately 3% and freezers will consume approximately 2.5%. Dehumidifiers will account for approximately 2%. Dishwashers and clothes washers will consume less than 1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Household electronics consume approximately 13% of residential electricity in 2029, which is an increase from the base year. Computers and their peripherals are expected to account for nearly 6% of the 12%, with 4% consumed by televisions, nearly 2% by the various set-top boxes associated with televisions, and approximately 1% by other home entertainment electronics.

Domestic water heating is expected to account for approximately 12% of residential electricity consumption in 2029. This decline is expected to occur primarily because of the steady replacement of clothes washers and dishwashers with newer models that require less hot water. This is a continuation of the trend observed between the 2008 study and the base year for the current study, based on changes observed in Residential End Use Surveys conducted in NL and national appliance data.

Indoor, outdoor, and holiday lighting together are expected to account for only 3% of residential electricity consumption in 2029; 2.5% of this is indoor lighting and 0.5% is outdoor lighting. Holiday lighting is well under 1%. The decrease is expected to occur because of the steady replacement of incandescent lighting with more efficient options.

Other end uses are expected to account for 4% of residential electricity consumption in 2029. Of this, approximately 1.5% is expected to be consumed by spa heaters and pumps and 2% is small appliances and other. Less than 1% is consumed by block heaters and car warmers, all of it in Labrador. The decrease in consumption by spa heaters is primarily due to an assumed increase in the use of heat pump spa heaters. The increase in small appliances and other is partly to account for unknown new end uses that may emerge in the next 15 years.

By Dwelling Type and End Use

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

- Heating, ventilation and circulation, and cooling are expected to modestly increase in share of residential electricity consumption between now and 2029.
- The overall consumption of appliances will account for a relatively stable share of consumption between now and 2029, because the forecast increase in the number of appliances per home will likely be cancelled out by gains in efficiency.
- DHW will account for a reduced share of residential electricity consumption, largely because of reduced consumption in dishwashers and clothes washers.
- Electronics in the home, including computers, televisions and set-top boxes, and other electronics, are expected to account for an increasing share of residential consumption. Even though some of these devices are becoming more efficient, their increasing numbers will more than cancel out any efficiency gains.
- Lighting is expected to account for a steadily diminishing share of residential electricity consumption between now and 2029, even without new CDM intervention, largely because of the growing use of compact fluorescent lamps and LEDs.
- Past experience suggests that electricity consumption per household remains remarkably stable over long periods. As more efficient equipment is introduced for some of the older end uses, new uses for electricity tend to emerge. This is reflected in the increase in consumption for “other” between now and 2029.
- The exhibit also permits comparisons of end-use consumption proportions from one dwelling type to another. These patterns are expected to remain relatively consistent through the study period.

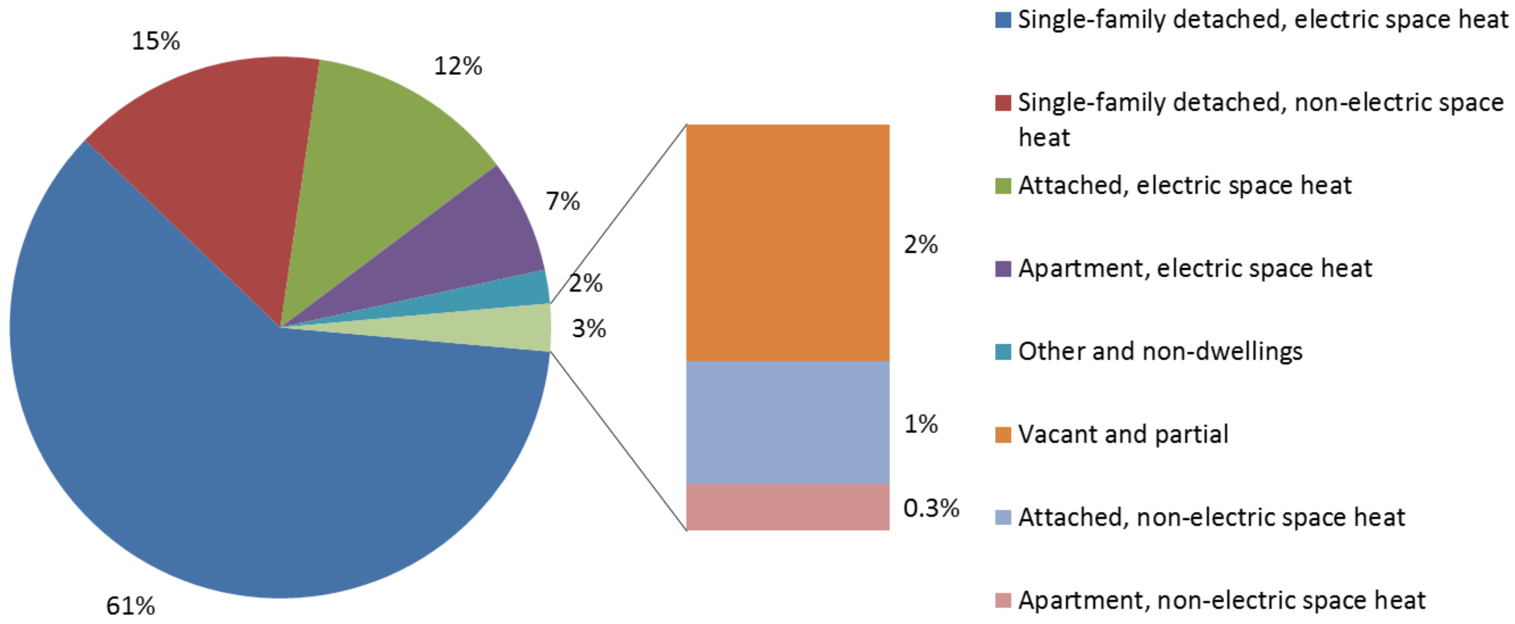
Exhibit 16 Reference Case Electricity Consumption, All Regions, Modelled by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Types	Year	Consumption						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	1,458,966	361,180	276,870	188,758	108,496	120,251	2,514,522
	2017	1,519,696	370,415	283,854	211,447	94,458	90,026	2,569,897
	2020	1,571,019	377,322	288,523	231,226	78,272	74,924	2,621,285
	2023	1,627,172	386,829	293,863	250,746	78,988	68,488	2,706,085
	2026	1,668,288	392,891	295,698	266,645	79,083	65,783	2,768,387
	2029	1,705,386	398,254	296,450	281,051	79,537	65,294	2,825,972
Single-family detached, non-electric space heat	2014	146,550	217,672	121,571	110,987	65,903	70,523	733,206
	2017	145,409	226,075	120,321	129,093	53,993	50,971	725,861
	2020	144,106	224,067	118,899	137,318	43,300	41,243	708,933
	2023	142,919	222,804	117,543	144,573	42,686	36,596	707,121
	2026	141,436	221,424	115,918	150,675	42,152	34,449	706,054
	2029	139,874	220,137	114,206	156,092	41,948	33,602	705,858
Attached, electric space heat	2014	270,777	87,972	69,174	45,076	13,947	25,852	512,799
	2017	283,874	83,351	71,340	50,781	10,600	19,508	519,454
	2020	294,350	86,053	72,794	55,726	7,968	16,331	533,222
	2023	304,787	89,222	74,311	60,544	7,474	14,992	551,330
	2026	312,695	91,315	74,938	64,496	7,138	14,459	565,040
	2029	319,737	93,136	75,268	68,093	6,911	14,404	577,548
Attached, non-electric space heat	2014	6,972	14,337	6,908	6,978	2,081	4,026	41,302
	2017	6,837	15,336	6,779	8,363	1,649	2,891	41,855
	2020	6,703	15,104	6,650	8,841	1,261	2,327	40,885
	2023	6,568	14,908	6,521	9,242	1,227	2,052	40,517
	2026	6,434	14,735	6,392	9,582	1,198	1,923	40,265
	2029	6,300	14,576	6,263	9,876	1,182	1,869	40,066
Apartment, electric space heat	2014	121,202	44,768	46,365	32,306	3,015	12,236	259,891
	2017	126,454	54,821	47,724	40,980	2,817	9,032	281,826
	2020	130,898	55,993	48,665	45,173	3,018	7,406	291,152
	2023	135,792	57,567	49,722	49,269	3,238	6,670	302,258
	2026	139,282	58,590	50,135	52,563	3,427	6,306	310,303
	2029	142,406	59,504	50,350	55,507	3,611	6,159	317,537
Apartment, non-electric space heat	2014	2,751	3,630	2,561	2,616	244	848	12,650
	2017	2,727	5,265	2,513	3,802	181	596	15,084
	2020	2,703	5,182	2,465	4,042	197	470	15,059
	2023	2,680	5,111	2,417	4,238	213	407	15,065
	2026	2,656	5,048	2,370	4,401	228	374	15,077
	2029	2,632	4,992	2,322	4,538	244	356	15,084
Other and non-dwellings	2014	24,585	16,835	11,173	7,083	14,496	4,031	78,204
	2017	25,310	22,302	11,344	11,806	10,115	2,981	83,859
	2020	25,908	22,304	11,432	12,215	11,636	2,457	85,952
	2023	26,543	22,430	11,519	12,687	13,239	2,223	88,642
	2026	27,007	22,487	11,518	13,093	14,807	2,121	91,031
	2029	27,421	22,554	11,484	13,491	16,391	2,092	93,435
Vacant and partial	2014	27,524	10,883	10,202	7,509	13,900	4,903	74,921
	2017	28,268	9,694	10,320	6,865	16,666	3,621	75,434
	2020	28,902	9,691	10,382	7,120	16,495	2,983	75,573
	2023	29,618	9,756	10,464	7,418	16,342	2,698	76,296
	2026	30,121	9,783	10,453	7,673	16,030	2,572	76,633
	2029	30,572	9,816	10,423	7,926	15,664	2,541	76,941

Notes:

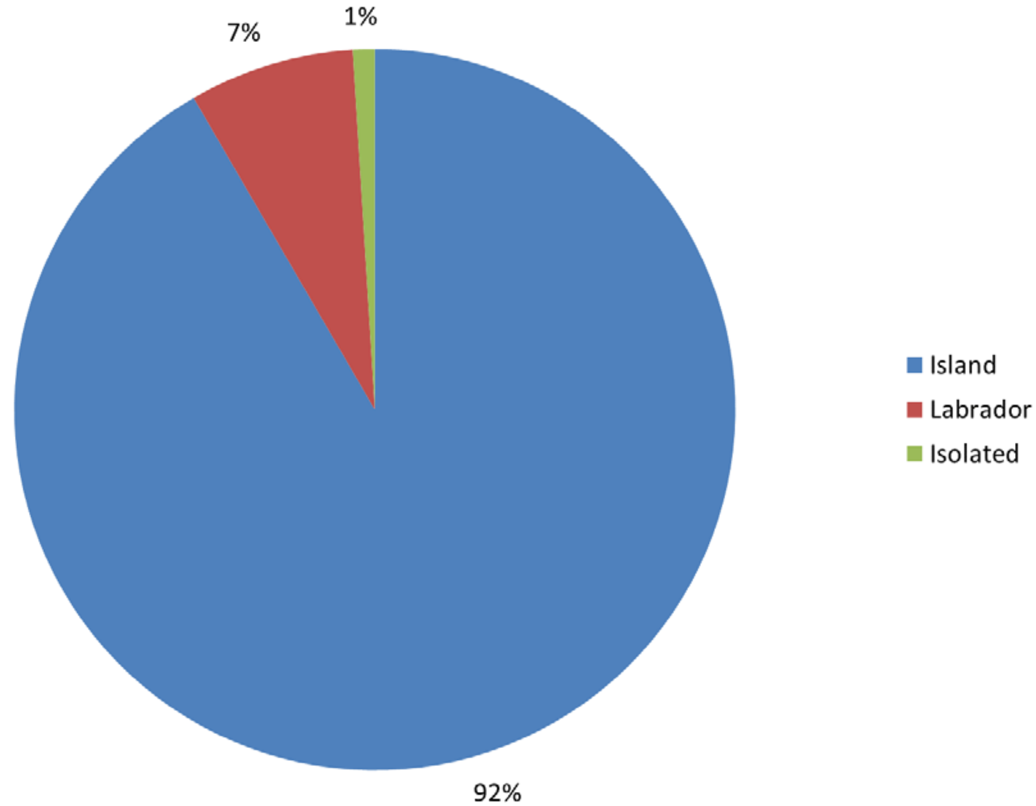
1) Results are measured at the customer's point-of-use and do not include line losses.
2) Any differences in totals are due to rounding.
3) The end uses in this exhibit are summary groupings. Data Manager can be used to display the more disaggregated results.

Exhibit 17 Distribution of Electricity Consumption in 2029 by Dwelling Type



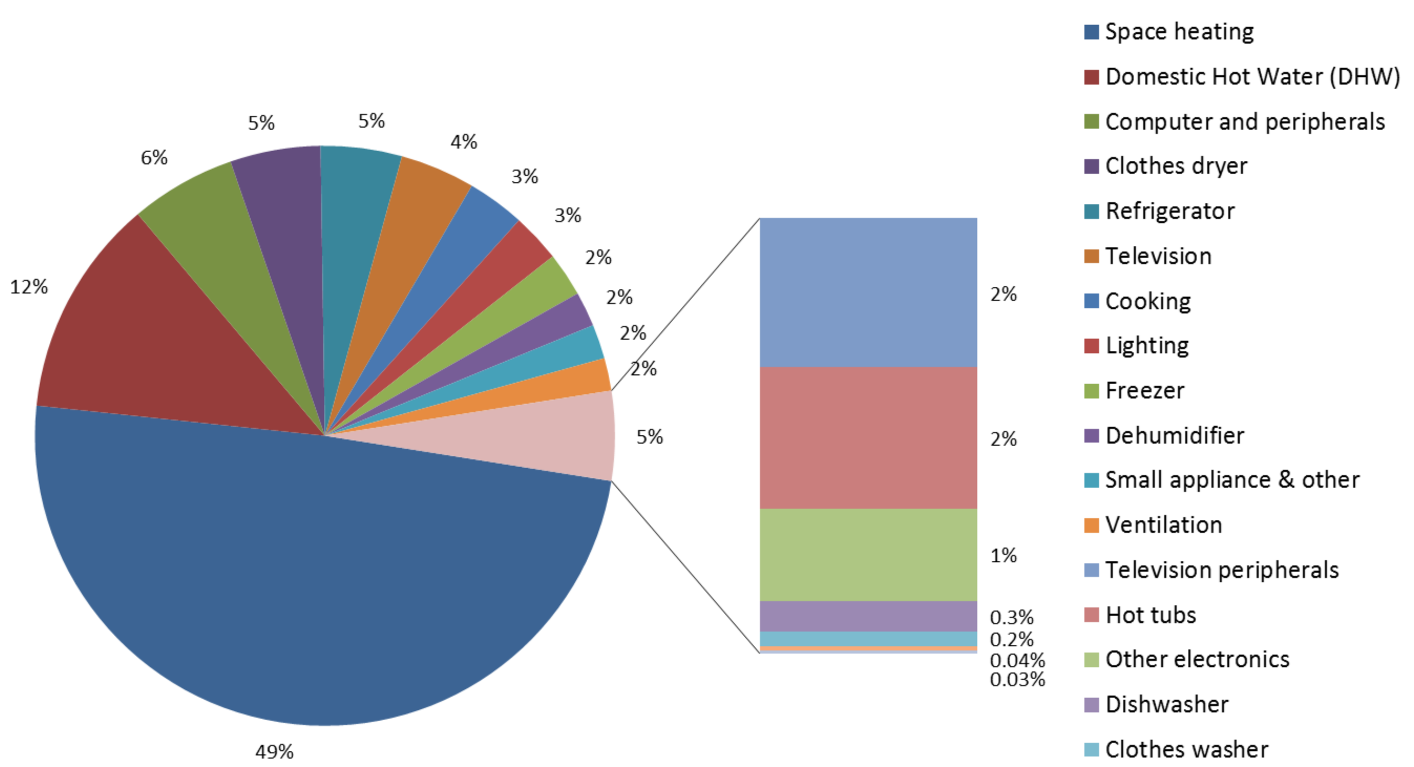
Totals may not add to 100% due to rounding.

Exhibit 18 Distribution of Electricity Consumption, by Region in 2029



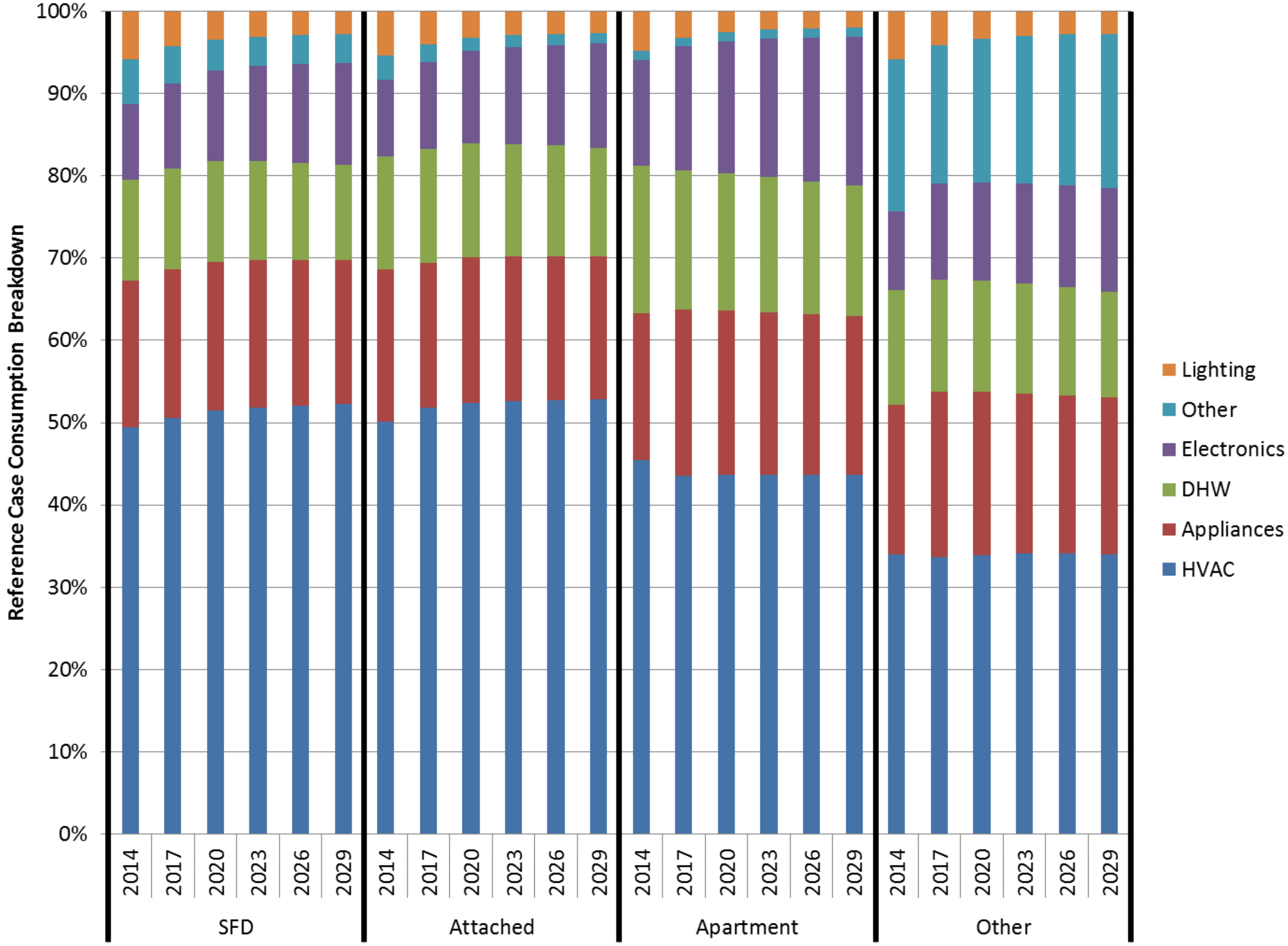
Totals may not add to 100% due to rounding.

Exhibit 19 Distribution of Electricity Consumption in 2029 by End Use

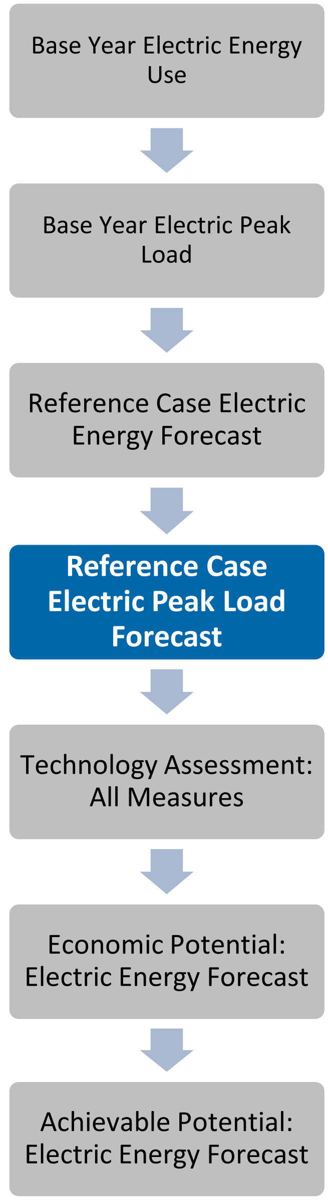


Totals may not add to 100% due to rounding.

Exhibit 20 Distribution of Electricity Consumption, by Dwelling Type and End Use, Trends to 2029



6 Reference Case Electric Peak Load Forecast



6.1 Introduction

This section provides a profile of the electric peak load for NL's residential 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, dwelling type 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 the peak period by dividing the applicable electric energy value for each dwelling type and end use by the corresponding Residential 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 21.

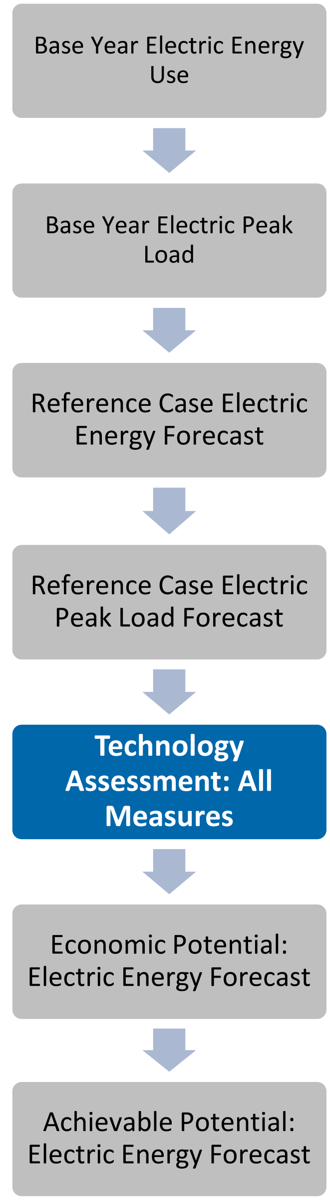
Exhibit 21 Electric Peak Loads, by Milestone Year, Region and Dwelling Type (MW)

Dwelling Types	Year	Reference Case Peak Demand (MW)			
		Island	Labrador	Isolated	Grand Total
Single-family detached, electric space heat	2014	620	48	3	671
	2017	637	49	4	690
	2020	653	50	4	707
	2023	675	51	4	730
	2026	690	52	5	747
	2029	704	52	5	762
Single-family detached, non-electric space heat	2014	141	2	6	149
	2017	140	1	6	147
	2020	137	1	5	144
	2023	136	1	5	143
	2026	135	1	5	142
	2029	135	1	6	141
Attached, electric space heat	2014	109	25	-	134
	2017	111	26	-	137
	2020	114	27	-	141
	2023	118	28	-	146
	2026	121	29	-	150
	2029	124	29	-	153
Attached, non-electric space heat	2014	8	-	-	8
	2017	8	-	-	8
	2020	8	-	-	8
	2023	8	-	-	8
	2026	8	-	-	8
	2029	8	-	-	8
Apartment, electric space heat	2014	65	3	-	68
	2017	69	3	-	72
	2020	71	3	-	74
	2023	74	3	-	77
	2026	76	3	-	79
	2029	77	3	-	80
Apartment, non-electric space heat	2014	3	-	-	3
	2017	3	-	-	3
	2020	3	-	-	3
	2023	3	-	-	3
	2026	3	-	-	3
	2029	3	-	-	3
Other and non-dwellings	2014	15	2	0	17
	2017	16	2	0	18
	2020	17	2	0	19
	2023	17	2	0	19
	2026	17	2	0	20
	2029	18	2	0	20
Vacant and partial	2014	17	-	0	18
	2017	17	-	0	18
	2020	18	-	0	18
	2023	18	-	0	18
	2026	18	-	0	18
	2029	18	-	0	18
Grand Total	2014	979	78	9	1,067
	2017	1,003	81	10	1,094
	2020	1,021	83	10	1,114
	2023	1,049	85	10	1,144
	2026	1,069	87	11	1,166
	2029	1,086	88	11	1,186

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 dwelling types are expected to follow the electricity consumption trends for those dwelling types. Single detached houses, for example, will continue to make the largest residential contribution to peak demand throughout the study period.
- The overall electricity consumption for electric space heating is expected to grow over the study period, and consequently the contribution it makes to the peak demand will also grow, continuing to dominate the peak demand in the residential 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 compact fluorescent lamps and LEDs are adopted, will make a gradually declining contribution towards the peak demand.
- The overall electricity consumption of the electronics end uses trend upwards during the study period, so they would be expected to make a gradually larger contribution towards the peak demand over the course of the study period.

7 Technology Assessment: Energy Efficiency and Peak Load Measures



7.1 Introduction

This section identifies and assesses the economic attractiveness of the selected energy efficiency measures for the Residential sector. It also identifies and assesses the economic attractiveness of selected Residential 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.

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.[18]

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.

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

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:

[18] 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 attic insulation, 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.

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, pool pumps, spas and small appliances), 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 insulation reduces space heating electricity use, as does the installation of a heat pump. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of bundles of measures that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a heat pump heating 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 appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant, both on energy consumption and peak demand. Based on selected building energy use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of 60 kWh in Newfoundland and 70 kWh in Labrador, depending on housing detachment type and vintage.

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 RSEEM 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 dwelling type.

Measures were applied sequentially to account, at least approximately, for interaction between measures. The impact of building shell measures was modelled using HOT2000, but only individually. The full package of measures was not modelled together, nor was the impact of internal gains on space heating and cooling included. These effects are modelled more thoroughly for the Economic Potential calculation, when all the measures that pass the economic screen are modelled together. 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 22 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 22 Energy Efficiency Technologies Included in this Study

Heating: Equipment
- Air-Source Heat Pumps
- Cold Climate Heat Pumps
- Mini-Split Heat Pumps
- Integrated Heating and Domestic Hot Water (DHW) Air-to-Water Heat Pumps
- High Efficiency Heat Recovery Ventilators (HRVs)
- Premium Motors for Apartment Building Ventilation Systems
- Apartment Building Recommissioning
- Electronic Thermostats
- Programmable Thermostats (Central Heating)
- Programmable Thermostats (Baseboard Heating)
- High-Efficiency Furnace Blower Motors (ECPM)
- Temperature Setback (Overnight)
- Temperature Setback (During Day)
- Increase Temperature of AC

Heating: Shell Measures
- Maintain Weather Stripping
- Homeowner Air Sealing
- Professional Air Sealing
- Air Leakage Sealing and Attic Insulation (Old (pre-1980) homes)
- Attic Insulation
- Wall Insulation
- Crawl Space Insulation
- Foundation (Basement) Insulation
- High-Performance (ENERGY STAR®) Solid Exterior Doors
- High-Performance (ENERGY STAR®) Windows and Patio Doors
- Super High-Performance Windows
- Close Windows and Blinds

Heating: Shell (New Homes)
- Net-Zero-Ready Homes
- High-Performance Homes (EGH 80/R2000/ENERGY STAR®)
- LEED Certified Apartment Buildings

Water Heating
- Kitchen faucet aerators
- Low-Flow Faucets
- Ultra Low-Flow Showerheads
- DHW Pipe Insulation
- DHW Tank Insulation
- High Efficiency Electric Storage Water Heaters
- Reduce Temperature of DHW

Lighting
- LED Lamps
- Motion Detectors for Indoor Lighting
- Timers for Outdoor Lighting
- Only Necessary Outdoor Lighting
- Motion Detectors for Outdoor Lighting
- Efficient Fluorescent Fixtures (Replace T12s with T8s) in Common Areas
- Redesign with High-Performance T8 Fluorescent Fixtures (Apartment Buildings)
- Turn Off Lights in Unoccupied Rooms

Appliances
- Convection Ovens - Electric
- High-Efficiency Cooktops (Induction)
- ENERGY STAR® Dehumidifiers
- High-Efficiency (ENERGY STAR®) Dishwashers
- Use Sensor for Clothes Dryer
- Efficient Clothes Dryers
- Heat Pump Clothes Dryers
- Clothes Lines and Drying Racks
- Minimize Hot and Warm Clothes Wash
- High-Efficiency (CEE Tier II) Clothes Washers
- Super High-Efficiency (CEE Tier III) Clothes Washers
- High-Efficiency (ENERGY STAR®) Freezers
- Super High-Efficiency (CEE Tier III) Freezers
- Maintain Proper Freezer Temperature
- High-Efficiency (CEE Tier II) Refrigerators
- Super High-Efficiency (CEE Tier III) Refrigerators
- Maintain Proper Refrigerator Temperature
- Appliance Retirement for Extra Refrigerators

Other
- Unplug Brick Chargers
- Activate PC Power Management
- Energy Efficient (ENERGY STAR®) Computers
- Smart Power Bars (Computers and Peripherals)
- Insulating Hot Tub Covers
- Turn Off TVs When Not in Use
- Energy Efficient (ENERGY STAR®) Televisions
- Smart Power Bars (Televisions and Home Entertainment)
- Timers for Car Warmers
- Timer/Thermostat for Block Heaters
- Timers for Electric Battery Blankets
- Social Benchmarking and Home Energy Monitoring

7.3.1 Technology Screening Results

A summary of the results is provided in Exhibit 23. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis[19] for the CCE that is shown, e.g., full versus incremental
- The measure's average CCE when applied to existing dwellings and to new dwellings. Average CCE refers to a weighted average of the CCE values for the measure in different dwelling types and regions.[20]

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 23 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 dwelling types and on an incremental cost basis in others is shown as "Full/Incr."

[19] See Step 4 in Section 7.2 for a fuller description.
[20] In the subsequent modeling described in Section 8, measure pass or fail the economic screen on the basis of their CCE in the individual dwelling type and region, not on the basis of this weighted average value.

Exhibit 23 Residential Sector Energy Efficiency Technology Measures, Screening Results[21]

Measure Name	Island			Labrador			Isolated		
	Basis (Full/ Incremental)	Average CCE (¢/kWh)		Basis (Full/ Incremental)	Average CCE (¢/kWh)		Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes		Existing Homes	New Homes		Existing Homes	New Homes
Timers for Electric Battery Blankets	Incr.	N/A	N/A	Full	59.3	59.3	Incr.	N/A	N/A
Timer/Thermostat for Block Heaters	Incr.	N/A	N/A	Full	5.9	5.9	Incr.	N/A	N/A
Timers for Car Warmers	Incr.	N/A	N/A	Full	0.9	0.9	Incr.	N/A	N/A
Use Sensor for Clothes Dryer	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Clothes Lines and Drying Racks	Full	0.5	0.5	Full	0.5	0.5	Full	0.5	0.4
Efficient Clothes Dryers	Incr.	101.6	94.7	Incr.	102.5	94.0	Incr.	104.0	92.8
Heat Pump Clothes Dryers	Incr.	72.2	67.4	Incr.	72.9	66.9	Incr.	74.0	66.0
High-Efficiency (CEE Tier II) Clothes Washers	Incr.	6.9	6.6	Incr.	6.9	6.6	Full/Incr.	17.8	17.9
Super High-Efficiency (CEE Tier III) Clothes Washers	Incr.	10.3	10.0	Incr.	10.4	10.0	Full/Incr.	20.2	20.0
Energy Efficient (ENERGY STAR®) Computers	Incr.	6.6	6.6	Incr.	6.6	6.6	Incr.	6.6	6.6
Activate PC Power Management	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Smart Power Bars (Computers and Peripherals)	Full/Incr.	7.3	7.6	Incr.	4.3	3.9	Full/Incr.	8.5	7.6
Convection Ovens - Electric	Incr.	82.1	84.9	Incr.	82.8	84.2	Incr.	84.0	83.1
High-Efficiency Cooktops (Induction)	Incr.	403.3	417.1	Incr.	407.2	413.9	Incr.	413.0	408.6
ENERGY STAR® Dehumidifiers	Incr.	9.4	10.3	Incr.	7.8	8.8	Incr.	5.3	5.3
High-Efficiency (ENERGY STAR®) Dishwashers	Incr.	14.4	14.4	Incr.	14.4	14.6	Incr.	14.6	14.8
DHW Pipe Insulation	Full	1.4	1.4	Full	1.4	1.4	Full	1.4	1.4
DHW Tank Insulation	Full	11.1	11.1	Full	11.2	11.5	Full	11.4	11.6
Reduce Temperature of DHW	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
High Efficiency Electric Storage Water Heaters	Incr.	31.3	31.3	Incr.	31.6	32.4	Incr.	32.1	32.7
Kitchen faucet aerators	Full	0.8	0.8	Full	0.8	0.8	Full	0.8	0.8
Low-Flow Faucets	Full/Incr.	5.8	5.6	Incr.	1.0	1.0	Full	7.3	7.4
Minimize Hot and Warm Clothes Wash	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Ultra Low-Flow Showerheads	Full	1.2	1.2	Full	1.2	1.2	Full	1.2	1.2
High-Efficiency (ENERGY STAR®) Freezers	Incr.	5.8	5.8	Incr.	5.8	5.8	Incr.	5.8	5.8
Maintain Proper Freezer Temperature	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Super High-Efficiency (CEE Tier III) Freezers	Incr.	14.5	14.5	Incr.	14.5	14.5	Incr.	14.5	14.5
Insulating Hot Tub Covers	Full/Incr.	2.8	3.0	Full/Incr.	2.6	2.4	Full/Incr.	2.8	3.6
LED Lamps	Full	3.6	3.6	Full	3.6	3.6	Full	3.6	3.6
Only Necessary Outdoor Lighting	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Motion Detectors for Indoor Lighting	Full	26.4	26.4	Full	26.4	26.4	Full	26.4	26.4
Motion Detectors for Outdoor Lighting	Full	2.8	5.7	Full/Incr.	3.2	4.6	Full	2.6	5.2

[21] Average CCE does not include program costs.

Exhibit 23 Continued: Residential Sector Energy Efficiency Technology Measures, Screening Results

Measure Name	Island			Labrador			Isolated		
	Basis (Full/ Incremental)	Average CCE (¢/kWh)		Basis (Full/ Incremental)	Average CCE (¢/kWh)		Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes		Existing Homes	New Homes		Existing Homes	New Homes
Efficient Fluorescent Fixtures (Replace T12s with T8s) in Common Areas	Incr.	2.4	2.4	Incr.	2.4	2.4	Incr.	2.4	2.4
Timers for Outdoor Lighting	Full	11.0	11.0	Full	11.0	11.0	Full	11.0	11.0
Turn Off Lights in Unoccupied Rooms	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Unplug Brick Chargers	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
High-Efficiency (CEE Tier II) Refrigerators	Incr.	40.4	40.4	Incr.	40.4	40.4	Incr.	40.4	40.4
Appliance Retirement for Extra Refrigerators	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Maintain Proper Refrigerator Temperature	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Super High-Efficiency (CEE Tier III) Refrigerators	Incr.	23.5	23.5	Incr.	23.5	23.5	Incr.	23.5	23.5
Increase Temperature of AC	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Homeowner Air Sealing	Full	16.6	N/A	Full	27.1	N/A	Full	25.9	N/A
Air-Source Heat Pumps	Incr.	17.7	18.9	Incr.	17.9	20.2	Full/Incr.	23.3	25.1
Integrated Heating and Domestic Hot Water (DHW) Air-to-Water Heat Pumps	Incr.	22.2	23.5	Incr.	22.6	24.9	Full/Incr.	26.4	28.1
Attic Insulation	Full	8.4	N/A	Full	8.8	N/A	Full	9.6	N/A
Foundation (Basement) Insulation	Full	10.6	N/A	Full	6.2	N/A	Full	6.4	N/A
Social Benchmarking and Home Energy Monitoring	Full	2.7	3.1	Full	2.8	3.3	Full	3.2	3.7
Close Windows and Blinds	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Cold Climate Heat Pumps	Incr.	17.3	18.5	Incr.	17.6	19.8	Full	10.4	11.2
Crawl Space Insulation	Full	4.2	N/A	Full	5.7	N/A	Full	4.9	N/A
Temperature Setback (During Day)	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
High-Performance (ENERGY STAR®) Solid Exterior Doors	Full/Incr.	3.9	N/A	Full/Incr.	2.1	N/A	Full	4.6	N/A
Electronic Thermostats	Incr.	8.0	8.5	Incr.	8.0	9.2	Full/Incr.	14.5	15.5
High-Performance (ENERGY STAR®) Windows and Patio Doors	Incr.	14.8	N/A	Incr.	35.5	N/A	Incr.	19.9	N/A
High-Performance Homes (EGH 80/R2000/ENERGY STAR®)	Full	N/A	19.2	Full	N/A	22.8	Full	N/A	26.0
LEED Certified Apartment Buildings	Full	N/A	30.5	Full	N/A	30.5	Incr.	N/A	N/A
Mini-Split Heat Pumps	Full/Incr.	9.8	10.4	Incr.	9.3	10.4	Full/Incr.	11.8	12.7
Net-Zero-Ready Homes	Full	N/A	92.1	Full	N/A	106.3	Full	N/A	96.0
Temperature Setback (Overnight)	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
Professional Air Sealing	Full	27.2	N/A	Full	59.8	N/A	Full	51.2	N/A
Programmable Thermostats (Baseboard Heating)	Full/Incr.	8.0	6.2	Incr.	6.0	6.8	Full	10.2	10.9
Programmable Thermostats (Central Heating)	Full	1.9	2.0	Full/Incr.	1.9	2.2	Full	2.0	2.1
Air Leakage Sealing and Attic Insulation	Full	13.5	N/A	Full	22.9	N/A	Full	10.5	N/A
Super High-Performance Windows	Incr.	21.0	N/A	Incr.	26.5	N/A	Incr.	29.4	N/A
Wall Insulation	Full	60.0	N/A	Full	75.0	N/A	Full	73.6	N/A
Maintain Weather Stripping	Full	0.0	N/A	Full	0.0	N/A	Full	0.0	N/A
Energy Efficient (ENERGY STAR®) Televisions	Incr.	8.0	8.0	Incr.	8.0	8.0	Incr.	8.0	8.0
Smart Power Bars (Televisions and Home Entertainment)	Full/Incr.	5.9	5.6	Incr.	3.3	2.9	Full/Incr.	5.7	0.0
Turn Off TVs When Not in Use	Full	0.0	0.0	Full	0.0	0.0	Full	0.0	0.0
High-Efficiency Furnace Blower Motors (ECPM)	Incr.	7.3	8.8	Incr.	9.0	9.6	Full/Incr.	14.1	13.1
High Efficiency Heat Recovery Ventilators (HRVs)	Incr.	34.1	37.1	Incr.	37.5	42.6	Incr.	30.2	32.0

7.4 Demand Reduction Technology Assessment

Exhibit 24 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 24 Demand Reduction Technologies Included in this Study

Heating: Equipment	Water Heating
▪ Air-source heat pump cycling ▪ Sole-Electric heat cycling ▪ Dual-Fuel heat cycling ▪ Electric thermal storage (baseboard heating) ▪ Electric thermal storage (central heating)	▪ Electric DHW cyclic ▪ Three-element water heater **Other** ▪ Timer for block heaters ▪ Timer for car warmers

7.4.1 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[22] for the CEPR that is shown, e.g., full versus incremental
- The measure's average CEPR when applied to existing dwellings and to new dwellings.

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 dwelling types and on an incremental cost basis in others is shown as "Full/Incr."

[22] See Step 4 in Section 7.2 for a fuller description.

Exhibit 25 Residential Sector Demand Reduction Technology Measures, Screening Results[23]

Measure Name	Island			Labrador			Isolated		
	Basis (Full/ Incremental)	Average CEPR ($/kW)		Basis (Full/ Incremental)	Average CEPR ($/kW)		Basis (Full/ Incremental)	Average CEPR ($/kW)	
		Existing Homes	New Homes		Existing Homes	New Homes		Existing Homes	New Homes
Timer/Thermostat for Block Heaters (Demand)	Incr.	N/A	N/A	Full	0.01	0.01	Incr.	N/A	N/A
Timers for Car Warmers (Demand)	Incr.	N/A	N/A	Full	0.00	0.00	Incr.	N/A	N/A
Three-Element Water Heater (Demand)	Incr.	87.38	87.26	Incr.	88.21	90.32	Incr.	89.48	91.18
Electric DHW Cycling (Demand)	Full	41.79	41.74	Full	42.19	43.20	Full	42.80	43.61
Dual Fuel Heat Cycling (Demand)	Full	10.60	11.27	Full	10.76	12.30	Full	11.39	12.24
Sole-Electric Heat Cycling (Demand)	Full	36.61	39.93	Full	38.39	44.27	Full	41.00	44.05
Air-Source Heat Pump Cycling (Demand)	Full	36.61	39.93	Full	38.39	44.27	Full	41.00	44.05
Electric Thermal Storage (Baseboard Heating, Demand)	Incr.	253.55	268.72	Incr.	266.25	301.54	Incr.	298.48	320.71
Electric Thermal Storage (Central Heating, Demand)	Incr.	404.74	429.21	Incr.	425.93	482.77	Incr.	460.36	494.58

23 Average CEPR does not include program costs.

7.5 Energy Efficiency Supply Curve

This sub-section includes energy efficiency 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 23. The following approach was used:

- Measures were introduced in sequence
- Where more than one measure affected the same end use, the savings 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 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 six exhibits:

- Exhibit 26 presents the potential by measure for the Island Interconnected region. The columns provide the savings for the measure, cumulative savings, and CCE, with measures sorted and numbered in order of increasing CCE.
- Exhibit 27 the supply curve for the Island Interconnected region. A few of the larger measures are numbered as landmarks. The numbers match those in Exhibit 26.
- Exhibit 28 presents the potential by measure for the Labrador Interconnected region. 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 the Labrador Interconnected region. A few of the larger measures are numbered as landmarks. The numbers match those in Exhibit 28.
- Exhibit 30 presents the potential by measure for the Isolated region. The columns provide the savings for the measure, cumulative savings, and CCE, with measures sorted and numbered in order of increasing CCE.
- Exhibit 31 presents the supply curve for the Isolated region. A few of the larger measures are numbered as landmarks. The numbers match those in Exhibit 30.

Exhibit 26 Island Interconnected Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
1	Refrigerator Retirement	59,731	59,731	$0.00
2	Min Hot Wash	57,241	116,973	$0.00
3	DHW Temperature	24,438	141,411	$0.00
4	Overnight Setback	19,491	160,902	$0.00
5	Close Blinds	12,812	173,714	$0.00
6	Daytime Setback	11,687	185,401	$0.00
7	Weather Stripping Maintenance	7,243	192,644	$0.00
8	Refrigerator Temperature	3,414	196,058	$0.00
9	Turn Off TVs	2,381	198,440	$0.00
10	Unplug Chargers	2,292	200,732	$0.00
11	Clothes Dryer Sensor	2,058	202,790	$0.00

Exhibit 26 Continued: Island Interconnected Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
12	PC Power Management	1,529	204,319	$0.00
13	Min Outdoor Lighting	1,519	205,838	$0.00
14	Freezer Temperature	1,374	207,211	$0.00
15	AC Temperature	488	207,699	$0.00
16	Turn Off Lights	100	207,799	$0.00
17	Clothes Lines	100,472	308,271	$0.00
18	Faucet Aerator	9,719	317,990	$0.01
19	Showerheads	27,358	345,348	$0.01
20	DHW Pipe Insulation	3,222	348,570	$0.01
21	Prog. Thermostats (Central)	1	348,571	$0.02
22	T8 Fixtures	54	348,625	$0.02
23	Benchmarking	7,019	355,644	$0.03
24	Hot Tub Covers	13,095	368,739	$0.03
25	Door Systems	29,714	398,453	$0.03
26	LED Lamps	8,252	406,704	$0.04
27	Crawl Space Insulation	152,664	559,368	$0.04
28	Motion Detectors - Outdoor	4,760	564,128	$0.04
29	ECPM Fan Motors	22,683	586,811	$0.05
30	ESTAR Freezers	3,128	589,939	$0.06
31	Power Bars (TVs)	36,464	626,402	$0.06
32	Faucets	24,609	651,011	$0.06
33	ESTAR Computers	5,119	656,130	$0.07
34	Basement Insulation	173,942	830,072	$0.07
35	Efficient Clothes Washers	35,767	865,839	$0.07
36	Electronic Thermostats	5,000	870,838	$0.07
37	Power Bars (PCs)	46,238	917,076	$0.07
38	Attic Insulation	43,918	960,995	$0.08
39	ESTAR TVs	85,572	1,046,566	$0.08
40	ESTAR Dehumidifiers	5,108	1,051,674	$0.08
41	Prog. Thermostats	1,814	1,053,487	$0.09
42	Mini-Splits	366,379	1,419,866	$0.09
43	Timers - Outdoor	3,226	1,423,092	$0.11
44	DHW Tank Insulation	5,052	1,428,144	$0.11
45	Sealing & Insul. - Old Homes	96,237	1,524,381	$0.13
46	Super Efficient Clothes Washers	14,768	1,539,149	$0.13
47	Air Sealing	21,000	1,560,149	$0.13
48	ESTAR Windows	11,128	1,571,277	$0.14
49	ESTAR Dishwashers	3,038	1,574,315	$0.14
50	Super Efficient Freezers	8,802	1,583,116	$0.14
51	Air-Source Heat Pump	25,073	1,608,190	$0.17
52	Cold Climate Heat Pump	10,350	1,618,540	$0.18
53	High-Perf. New Homes	44,911	1,663,451	$0.19
54	Air-to-Water Heat Pumps	57,615	1,721,066	$0.20
55	Professional Air Sealing	30,687	1,751,754	$0.22
56	Super Efficient Refrigerators	17,429	1,769,183	$0.24
57	Super Windows	25,144	1,794,327	$0.26
58	Motion Detectors - Indoor	1,594	1,795,920	$0.26
59	LEED Apartments	3,109	1,799,030	$0.31

Exhibit 26 Continued: Island Interconnected Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
60	HRVs	4,764	1,803,794	$0.33
61	Efficient Refrigerators	5,170	1,808,963	$0.40
62	Wall Insulation	124,481	1,933,445	$0.60
63	Convection Ovens	10,034	1,943,479	$0.86
64	Heat Pump Clothes Dryers	54,018	1,997,497	$0.88
65	Net Zero Homes	19,596	2,017,094	$1.00
66	Induction Cooktops	5,169	2,022,263	$4.21

Exhibit 27 Island Interconnected Energy Efficiency Supply Curve

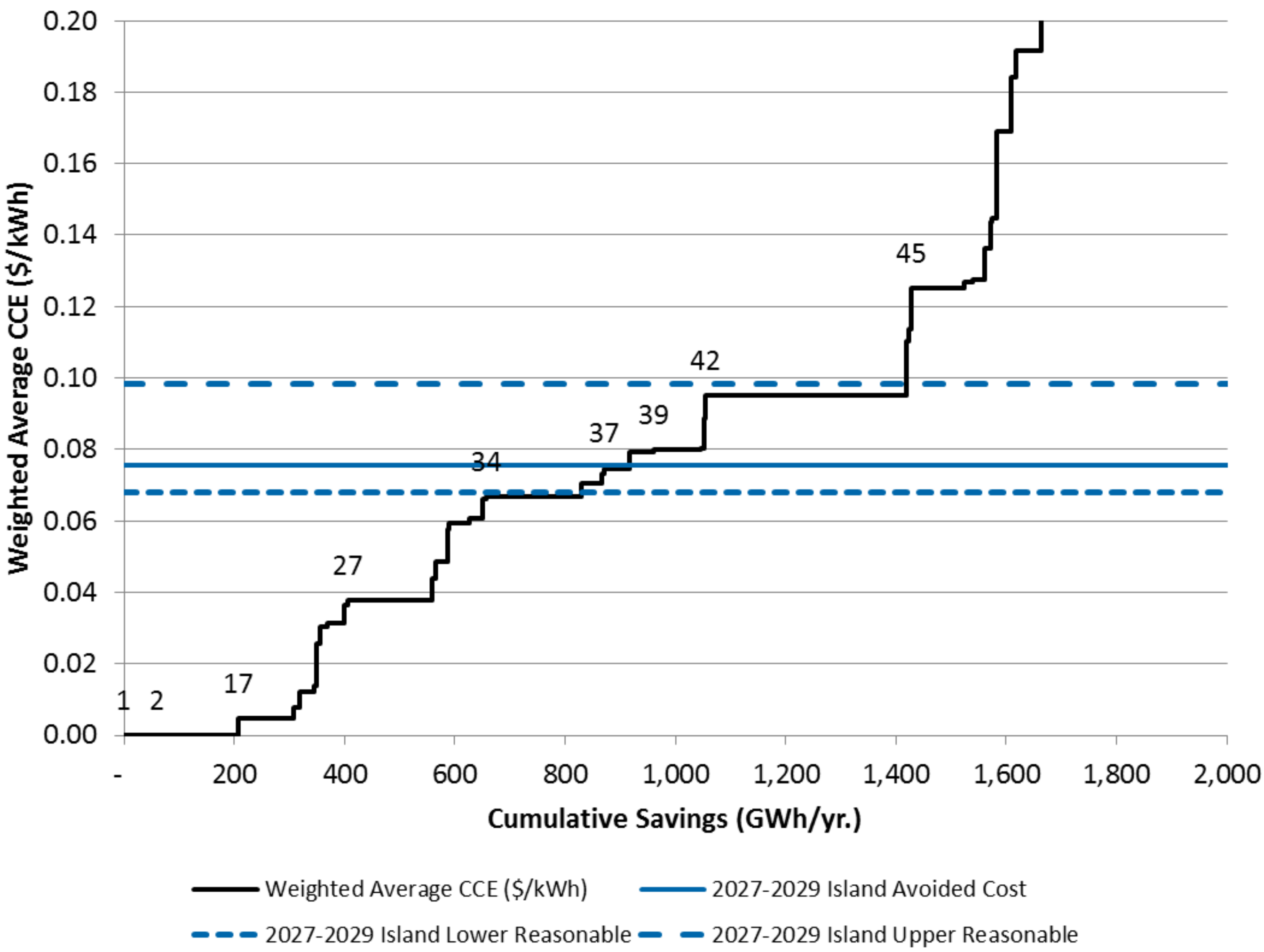


Exhibit 28 Labrador Interconnected Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
1	Min Hot Wash	2,854	2,854	$0.00
2	Refrigerator Retirement	2,797	5,651	$0.00
3	Overnight Setback	1,633	7,284	$0.00
4	DHW Temperature	1,218	8,502	$0.00
5	Daytime Setback	955	9,457	$0.00
6	Close Blinds	951	10,408	$0.00
7	Weather Stripping Maintenance	657	11,066	$0.00
8	Refrigerator Temperature	161	11,227	$0.00
9	Turn Off TVs	103	11,330	$0.00
10	Unplug Chargers	91	11,421	$0.00
11	Clothes Dryer Sensor	86	11,506	$0.00
12	Freezer Temperature	70	11,577	$0.00
13	PC Power Management	66	11,643	$0.00
14	Min Outdoor Lighting	64	11,707	$0.00
15	Turn Off Lights	4	11,712	$0.00
16	Clothes Lines	4,170	15,882	$0.00
17	Faucet Aerator	478	16,360	$0.01
18	Car Warmer Timers	240	16,600	$0.01
19	Faucets	939	17,539	$0.01
20	Showerheads	1,345	18,885	$0.01
21	DHW Pipe Insulation	158	19,043	$0.01
22	Prog. Thermostats (Central)	0	19,043	$0.02
23	Benchmarking	338	19,381	$0.02
24	T8 Fixtures	2	19,384	$0.02
25	Power Bars (TVs)	1,566	20,950	$0.03
26	Hot Tub Covers	1,154	22,104	$0.03
27	LED Lamps	370	22,474	$0.04
28	Motion Detectors - Outdoor	195	22,669	$0.04
29	Door Systems	2,914	25,584	$0.04
30	Power Bars (PCs)	2,009	27,593	$0.04
31	Basement Insulation	31,707	59,299	$0.05
32	Crawl Space Insulation	14,604	73,903	$0.05
33	ESTAR Freezers	160	74,063	$0.06
34	Block Heater Timers	339	74,402	$0.06
35	Prog. Thermostats	173	74,575	$0.06
36	Electronic Thermostats	624	75,199	$0.07
37	ESTAR Computers	222	75,422	$0.07
38	ECPM Fan Motors	380	75,801	$0.07
39	Efficient Clothes Washers	1,565	77,367	$0.07
40	ESTAR Dehumidifiers	173	77,540	$0.07
41	Attic Insulation	6,380	83,920	$0.07
42	ESTAR TVs	3,699	87,620	$0.08
43	Mini-Splits	46,137	133,757	$0.08
44	DHW Tank Insulation	248	134,005	$0.11
45	Timers - Outdoor	145	134,150	$0.11
46	Super Efficient Clothes	654	134,804	$0.12

Exhibit 28 Continued: Labrador Interconnected Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
	Washers			
47	ESTAR Dishwashers	148	134,952	$0.14
48	Super Efficient Freezers	450	135,401	$0.14
49	Air-Source Heat Pump	1,964	137,366	$0.16
50	Cold Climate Heat Pump	787	138,153	$0.17
51	Sealing & Insul. - Old Homes	9,594	147,747	$0.19
52	Air-to-Water Heat Pumps	3,836	151,583	$0.20
53	High-Perf. New Homes	3,753	155,336	$0.20
54	Air Sealing	1,728	157,064	$0.22
55	Super Efficient Refrigerators	821	157,885	$0.24
56	Super Windows	4,869	162,753	$0.24
57	Motion Detectors - Indoor	72	162,825	$0.26
58	LEED Apartments	132	162,957	$0.31
59	ESTAR Windows	607	163,563	$0.31
60	HRVs	303	163,867	$0.35
61	Efficient Refrigerators	243	164,110	$0.40
62	Professional Air Sealing	1,947	166,057	$0.47
63	Battery Blanket Timers	31	166,088	$0.59
64	Wall Insulation	15,658	181,746	$0.62
65	Heat Pump Clothes Dryers	2,254	184,001	$0.81
66	Convection Ovens	442	184,443	$0.82
67	Net Zero Homes	3,189	187,632	$0.92
68	Induction Cooktops	228	187,860	$4.05

Exhibit 29 Labrador Interconnected Energy Efficiency Supply Curve

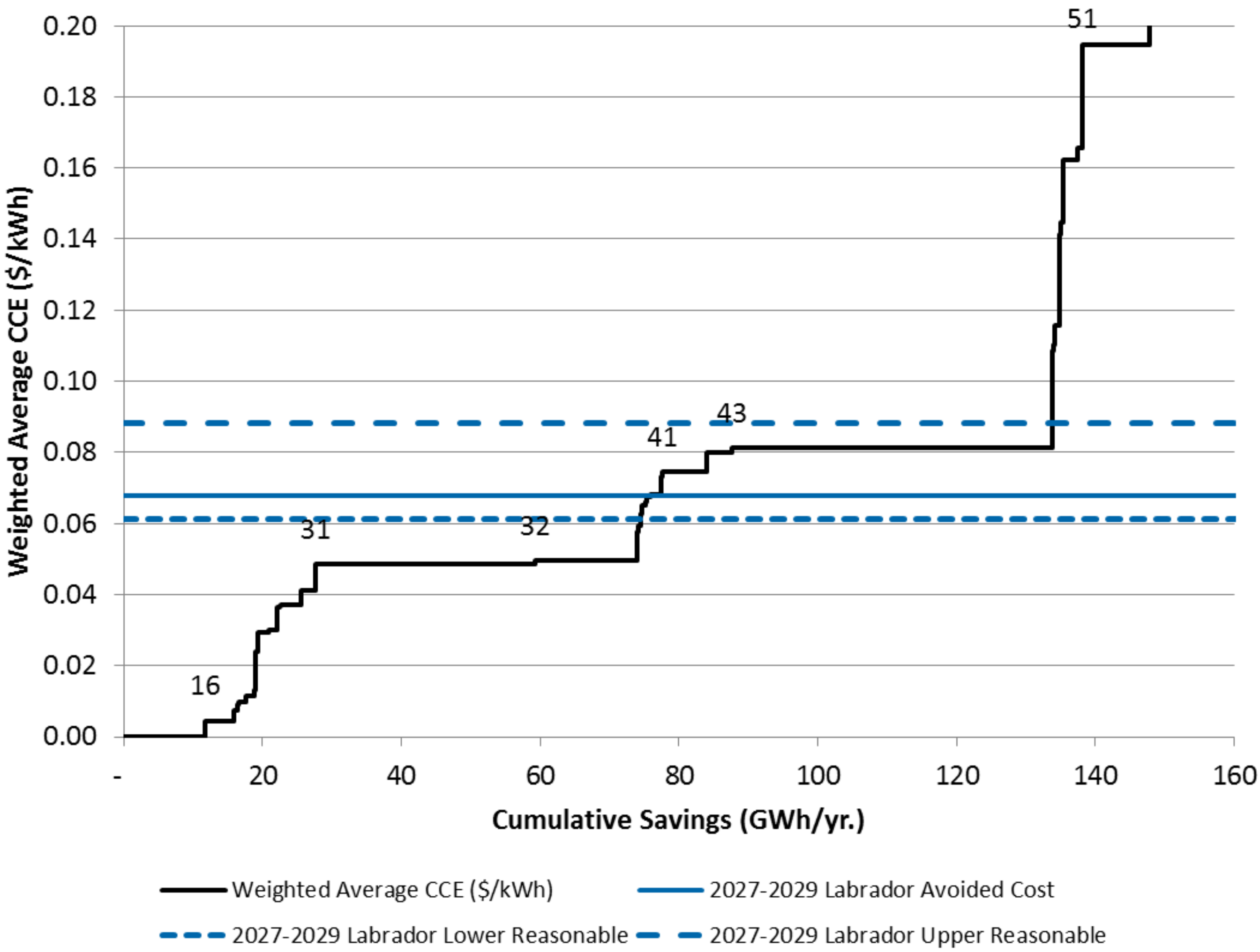


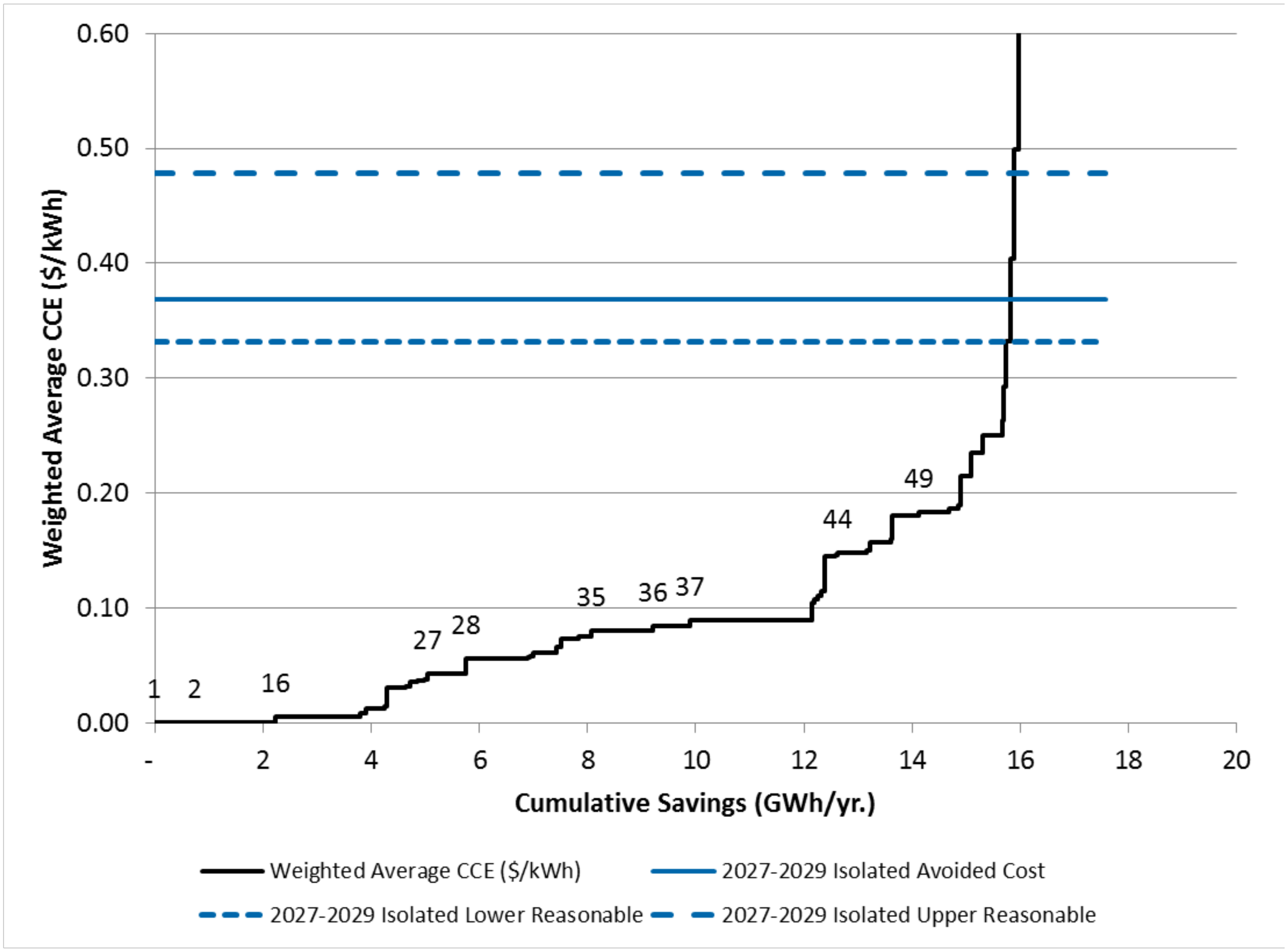
Exhibit 30 Isolated Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
1	Min Hot Wash	740	740	$0.00
2	Refrigerator Retirement	738	1,479	$0.00
3	DHW Temperature	316	1,795	$0.00
4	Overnight Setback	98	1,893	$0.00
5	Daytime Setback	58	1,952	$0.00
6	Close Blinds	58	2,010	$0.00
7	Refrigerator Temperature	38	2,048	$0.00
8	Turn Off TVs	33	2,081	$0.00
9	Unplug Chargers	33	2,114	$0.00
10	Freezer Temperature	32	2,146	$0.00
11	Clothes Dryer Sensor	29	2,175	$0.00
12	PC Power Management	23	2,198	$0.00
13	Min Outdoor Lighting	20	2,219	$0.00
14	Weather Stripping Maintenance	17	2,236	$0.00
15	Turn Off Lights	2	2,237	$0.00
16	Clothes Lines	1,557	3,794	$0.00
17	Faucet Aerator	122	3,916	$0.01
18	Showerheads	343	4,259	$0.01
19	DHW Pipe Insulation	40	4,299	$0.01
20	T8 Fixtures	1	4,300	$0.02
21	Hot Tub Covers	332	4,632	$0.03
22	Benchmarking	99	4,731	$0.03
23	Prog. Thermostats (Central)	0	4,731	$0.03
24	Door Systems	123	4,854	$0.04
25	LED Lamps	129	4,983	$0.04
26	Motion Detectors - Outdoor	64	5,047	$0.04
27	Crawl Space Insulation	712	5,758	$0.04
28	Basement Insulation	1,133	6,892	$0.06
29	ESTAR Dehumidifiers	38	6,930	$0.06
30	ESTAR Freezers	73	7,004	$0.06
31	Power Bars (TVs)	430	7,433	$0.06
32	ESTAR Computers	77	7,511	$0.07
33	Faucets	319	7,829	$0.07
34	Attic Insulation	242	8,072	$0.08
35	ESTAR TVs	1,133	9,204	$0.08
36	Power Bars (PCs)	698	9,902	$0.08
37	Mini-Splits	2,256	12,159	$0.09
38	Electronic Thermostats	45	12,203	$0.10
39	Cold Climate Heat Pump	63	12,267	$0.11
40	Timers - Outdoor	50	12,317	$0.11
41	DHW Tank Insulation	63	12,381	$0.11
42	Super Efficient Freezers	206	12,587	$0.14
43	ESTAR Dishwashers	37	12,623	$0.15
44	ECPM Fan Motors	527	13,151	$0.15
45	Air Sealing	82	13,233	$0.15
46	Sealing & Insul. - Old Homes	387	13,620	$0.16

Exhibit 30 Continued: Isolated Measure Potential and CCE

Ref #	Measure Name	Savings (MWh/yr.)	Cumulative Savings (MWh/yr.)	CCE ($/kWh)
47	Prog. Thermostats	13	13,633	$0.16
48	Efficient Clothes Washers	487	14,120	$0.18
49	High-Perf. New Homes	572	14,693	$0.18
50	Air-Source Heat Pump	169	14,862	$0.19
51	ESTAR Windows	38	14,899	$0.19
52	Super Efficient Clothes Washers	199	15,099	$0.22
53	Super Efficient Refrigerators	201	15,299	$0.24
54	Air-to-Water Heat Pumps	372	15,671	$0.25
55	Motion Detectors - Indoor	25	15,696	$0.26
56	HRVs	43	15,739	$0.29
57	Professional Air Sealing	81	15,820	$0.33
58	Efficient Refrigerators	60	15,879	$0.40
59	Super Windows	94	15,974	$0.50
60	Wall Insulation	623	16,597	$0.63
61	Heat Pump Clothes Dryers	755	17,352	$0.87
62	Convection Ovens	137	17,489	$0.88
63	Net Zero Homes	12	17,501	$1.06
64	Induction Cooktops	71	17,572	$4.35

Exhibit 31 Isolated 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 24. 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 six exhibits:

- Exhibit 32 presents the potential by measure for the Island Interconnected region. The columns provide the reduction for the measure, cumulative reduction, and CEPR, with measures sorted and numbered in order of increasing CEPR.
- Exhibit 33 presents the supply curve for the Island Interconnected region. The numbers match those in Exhibit 32.
- Exhibit 34 presents the potential by measure for the Labrador Interconnected region. The columns provide the savings for the measure, cumulative savings, and CCE, with measures sorted and numbered in order of increasing CCE.
- Exhibit 35 presents the supply curve for the Labrador Interconnected region. The numbers match those in Exhibit 34.
- Exhibit 36 presents the potential by measure for the Labrador Interconnected region. The columns provide the savings for the measure, cumulative savings, and CCE, with measures sorted and numbered in order of increasing CCE.
- Exhibit 37 presents the supply curve for the Isolated region. The numbers match those in Exhibit 36.

Exhibit 32 Island Interconnected Measure Potential and CEPR

Ref #	Measure Name	Demand Reduction (MW)	Cumulative Reduction (MW)	CEPR ($/kW)
1	Dual Fuel Heat Cycling	71	71	$10.84
2	Heat Pump Cycling	8	78	$26.95
3	Electric Heat Cycling	171	250	$33.63
4	DHW Cycling	154	403	$42.72
5	3-Element DHW	29	432	$89.31
6	Thermal Storage (Baseboard)	259	691	$217.22
7	Thermal Storage (Central)	14	706	$329.78

Exhibit 33 Island Interconnected Demand Reduction Supply Curve

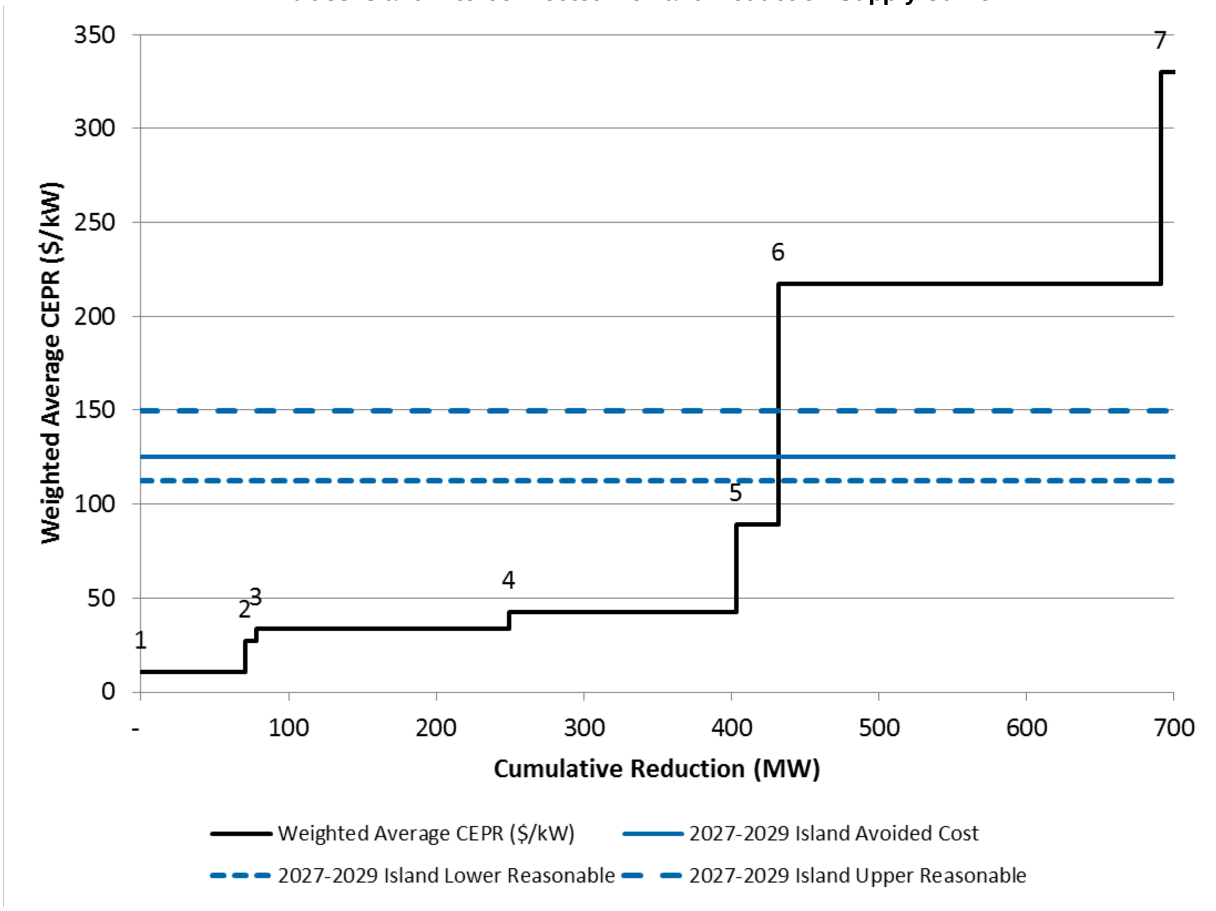


Exhibit 34 Labrador Interconnected Measure Potential and CEPR

Ref #	Measure Name	Demand Reduction (MW)	Cumulative Reduction (MW)	CEPR ($/kW)
1	Car Warmer Demand	0	0	$0.00
2	Block Heater Demand	0	1	$0.01
3	Dual Fuel Heat Cycling	2	3	$12.05
4	Heat Pump Cycling	0	4	$27.16
5	Electric Heat Cycling	17	21	$32.47
6	DHW Cycling	8	28	$40.83
7	3-Element DHW	1	30	$85.36
8	Thermal Storage (Baseboard)	28	57	$222.67
9	Thermal Storage (Central)	1	58	$338.03

Exhibit 35 Labrador Interconnected Demand Reduction Supply Curve

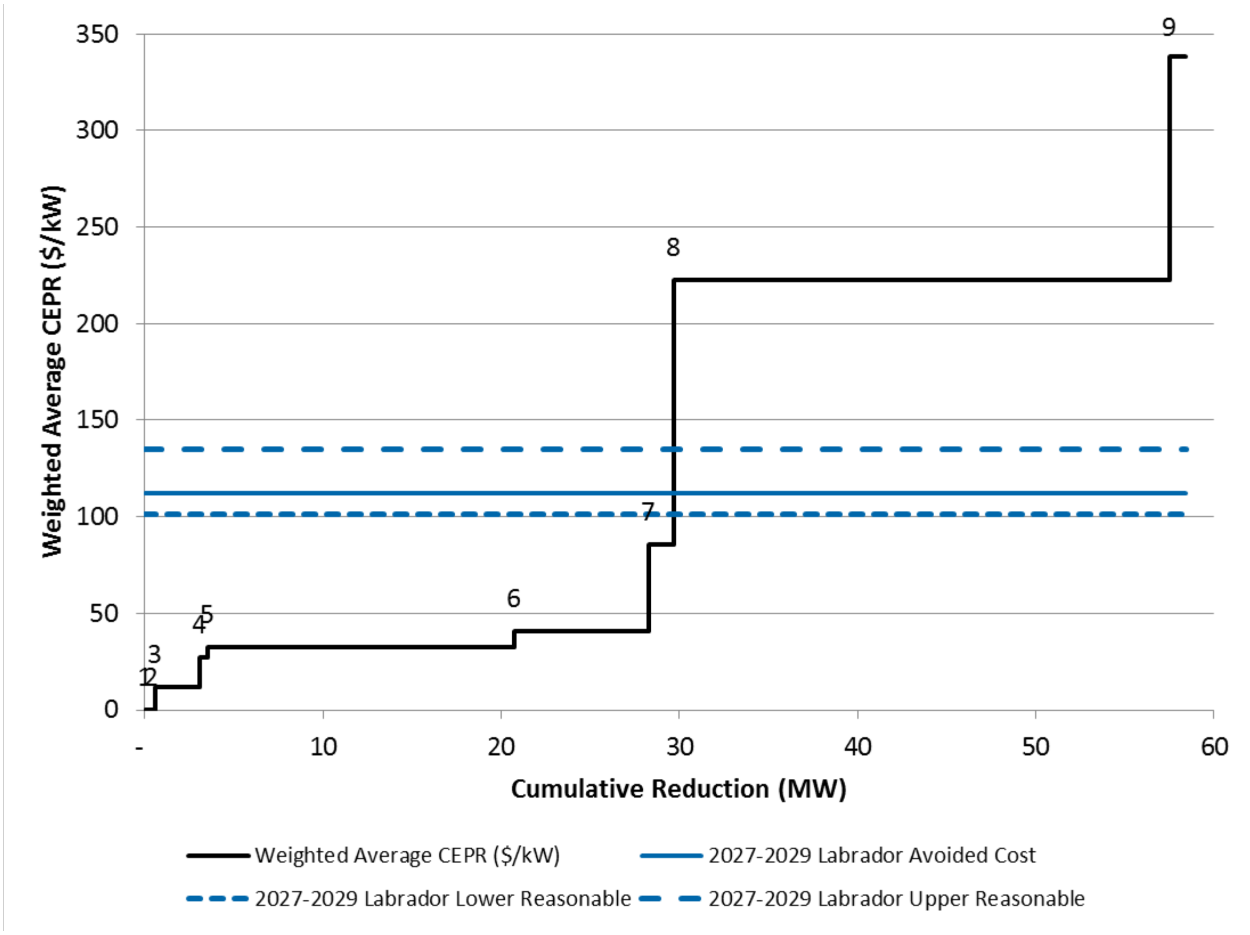
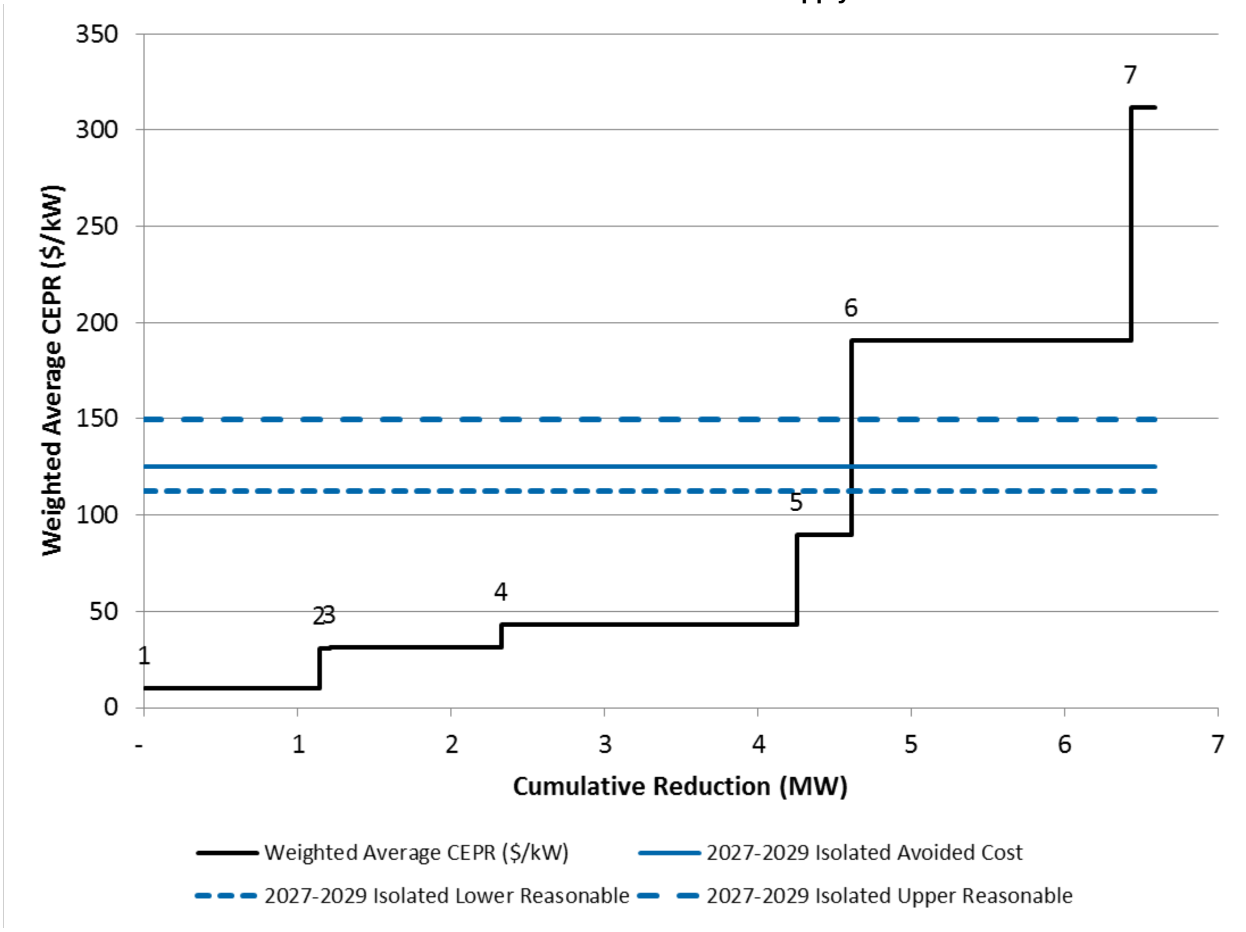


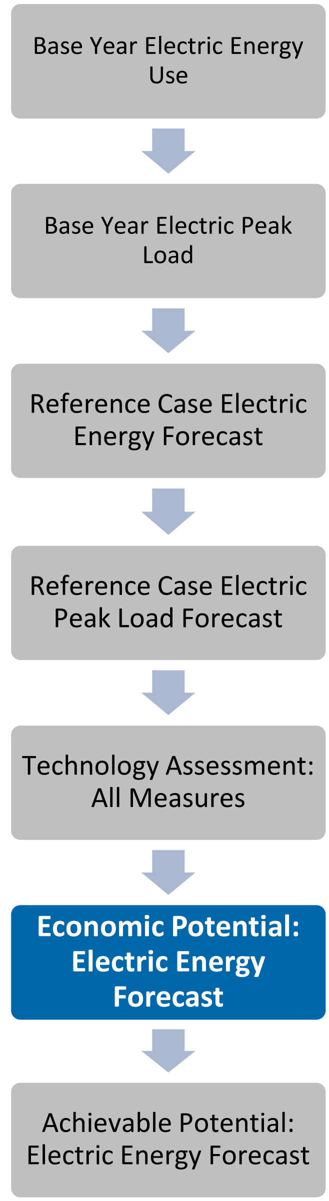
Exhibit 36 Isolated Measure Potential and CEPR

Ref #	Measure Name	Demand Reduction (MW)	Cumulative Reduction (MW)	CEPR ($/kW)
1	Dual Fuel Heat Cycling	1	1	$9.75
2	Heat Pump Cycling	0	1	$30.64
3	Electric Heat Cycling	1	2	$31.01
4	DHW Cycling	2	4	$42.92
5	3-Element DHW	0	5	$89.74
6	Thermal Storage (Baseboard)	2	6	$190.40
7	Thermal Storage (Central)	0	7	$311.83

Exhibit 37 Isolated Demand Reduction Supply Curve



8 Economic Potential: Electric Energy and Demand Forecast



8.1 Introduction

This section presents the Residential 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 and building envelopes were 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 CCE and CEPR used in this study are *measure CCE* and *measure CEPR* values, as distinct from *program CCE* and *program CEPR*. Measure CCE and CEPR values do not include the non-incentive costs of running a program, such as administration or promotion.[24] Technologies that are very close to the margin when the measure CCE or CEPR is compared to avoided costs may not make economic sense for the Utilities once program costs are added.

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 38. Each of the values for the years after 2014 represents the average of the three years in the milestone period.

[24] Incentives do not change the CCE or CEPR calculation, because they change only who pays the cost of the measure, not the overall cost.

Exhibit 38 Avoided Costs of Added 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 39. 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 39 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 38 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 39 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 Residential 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 Residential sector, as well as identify which specific building sub-sectors and end uses provide the most significant opportunities for savings.

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

- The CCE for each of the energy-efficient upgrades presented in Exhibit 23 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 stock reaches the end of its useful life.
- Electricity use within each of the building 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 first measure selected was the one that reduced the electrical load. For example, measures to reduce the overall space heating load (e.g., attic insulation and more efficient windows) were applied before a heat pump.

To develop the Residential 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 24 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 building 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 40 provides a listing of the efficiency technologies included in this forecast. Exhibit 41 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
- Dwelling types to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

Some of the technologies listed in the exhibits below are the subject of current utility programs in the province of NL. The load forecast provided by the Utilities assumed a modest level of continued program activity and continued savings from efficiency improvements made under past programs, but no new program activity. The reference case for this project was constructed to be consistent with that forecast, in that the penetrations of the energy technologies below were not all assumed to remain static at their current levels. Reference case penetrations were assumed to increase, to account for natural adoption and the modest level of program activity assumed in the reference case.

In most cases, current programs are unlikely to capture all the economic potential for the technologies over the next 15 years. Therefore, none of the technologies have actually been removed from consideration in the study. Nonetheless, there are cases where the reference case penetration "catches up" to the economic penetration, and the economic potential diminishes, as can be seen later in this chapter in Exhibit 44. Note the potential for efficient clothes washers, for example. For this measure, economic potential rises in the first milestone and then levels off (because the avoided cost of electricity is expected to decrease in the Island Interconnected region, and the measure fails the economic screen for the middle two milestone periods of the study). During this period when the economic potential levels off, the continuing adoption assumed in the reference case catches up to the economic penetration, and the potential decreases.

Exhibit 40 Efficiency Technologies Included in Economic Potential Forecast

End Use Category	Upgrade Option	Applicability	Rate of Introduction
HVAC Equipment	Air-Source Heat Pump	Electrically heated SFD	At natural rate of replacement
	Cold Climate Heat Pump	Electrically heated SFD	At natural rate of replacement
	ECPM Fan Motors	Forced-air homes	At natural rate of replacement
	Electronic Thermostats	Baseboard heated homes	Immediate
	Mini-Splits	Baseboard heated homes	At natural rate of replacement/Immediate in some house types
	Prog. Thermostats	Baseboard heated homes	Immediate
	Prog. Thermostats (Central)	Centrally-heated homes	Immediate
Building Envelope	Air Sealing	Existing homes	Immediate
	Attic Insulation	Existing homes	Immediate
	Basement Insulation	Existing homes	Immediate
	Crawl Space Insulation	Existing homes	Immediate
	Door Systems	Existing homes	At natural rate of replacement/Immediate in some house types
	ESTAR Windows	Existing homes	At natural rate of replacement
	Sealing & Insul. - Old (pre-1980) homes	Older existing homes	Immediate
	Weather Stripping Maintenance	Existing homes	Immediate
New Construction	High-Perf. New Homes	New homes	As new homes are built
Appliances	Clothes Dryer Sensor	All	At natural rate of replacement
	Efficient Clothes Washers	All	At natural rate of replacement
	ESTAR Dehumidifiers	Homes with dehumidifiers	At natural rate of replacement
	ESTAR Dishwashers	All	At natural rate of replacement
	ESTAR Freezers	All	At natural rate of replacement
	Super Efficient Clothes Washers	All	At natural rate of replacement
	Super Efficient Freezers	All	At natural rate of replacement
DHW	DHW Pipe Insulation	Homes with electric DHW	Immediate
	DHW Tank Insulation	Homes with electric DHW	Immediate
	Faucet Aerator	Homes with electric DHW	Immediate

Exhibit 40 Continued: Efficiency Technologies Included in Economic Potential Forecast

End Use Category	Upgrade Option	Applicability	Rate of Introduction
	Faucets	Homes with electric DHW	Immediate
	Showerheads	Homes with electric DHW	Immediate
Lighting	LED Lamps	All	Immediate
	Motion Detectors - Outdoor	All homes with exterior lighting	Immediate
	T8 Fixtures	The few fluorescent strip fixtures in homes	At natural rate of replacement
	Timers - Outdoor	All homes with exterior lighting	Immediate
Electronics	ESTAR Computers	All	At natural rate of replacement
	ESTAR TVs	All	At natural rate of replacement
	Power Bars (PCs)	All	Immediate
	Power Bars (TVs)	All	Immediate
Other	Block Heater Timers	Labrador only	Immediate
	Car Warmer Timers	Labrador only	Immediate
	Hot Tub Covers	All homes with hot tubs	Immediate
Behaviour	AC Temperature	Homes with heat pump systems	Immediate
	Benchmarking	All	Immediate
	Close Blinds	All	Immediate
	Clothes Lines	All homes with outside areas	Immediate
	Daytime Setback	Electrically heated homes	Immediate
	DHW Temperature	Homes with electric DHW	Immediate
	Freezer Temperature	All	Immediate
	Min Hot Wash	All	Immediate
	Min Outdoor Lighting	All homes with exterior lighting	Immediate
	Overnight Setback	Electrically heated homes	Immediate
	PC Power Management	All	Immediate
	Refrigerator Retirement	Homes with a second refrigerator	Immediate
	Refrigerator Temperature	All	Immediate
	Turn Off Lights	All	Immediate
	Turn Off TVs	All	Immediate

Exhibit 40 Continued: Efficiency Technologies Included in Economic Potential Forecast

End Use Category	Upgrade Option	Applicability	Rate of Introduction
	Unplug Chargers	All	Immediate

Exhibit 41 Load Reduction Technologies Included in Economic Potential Forecast

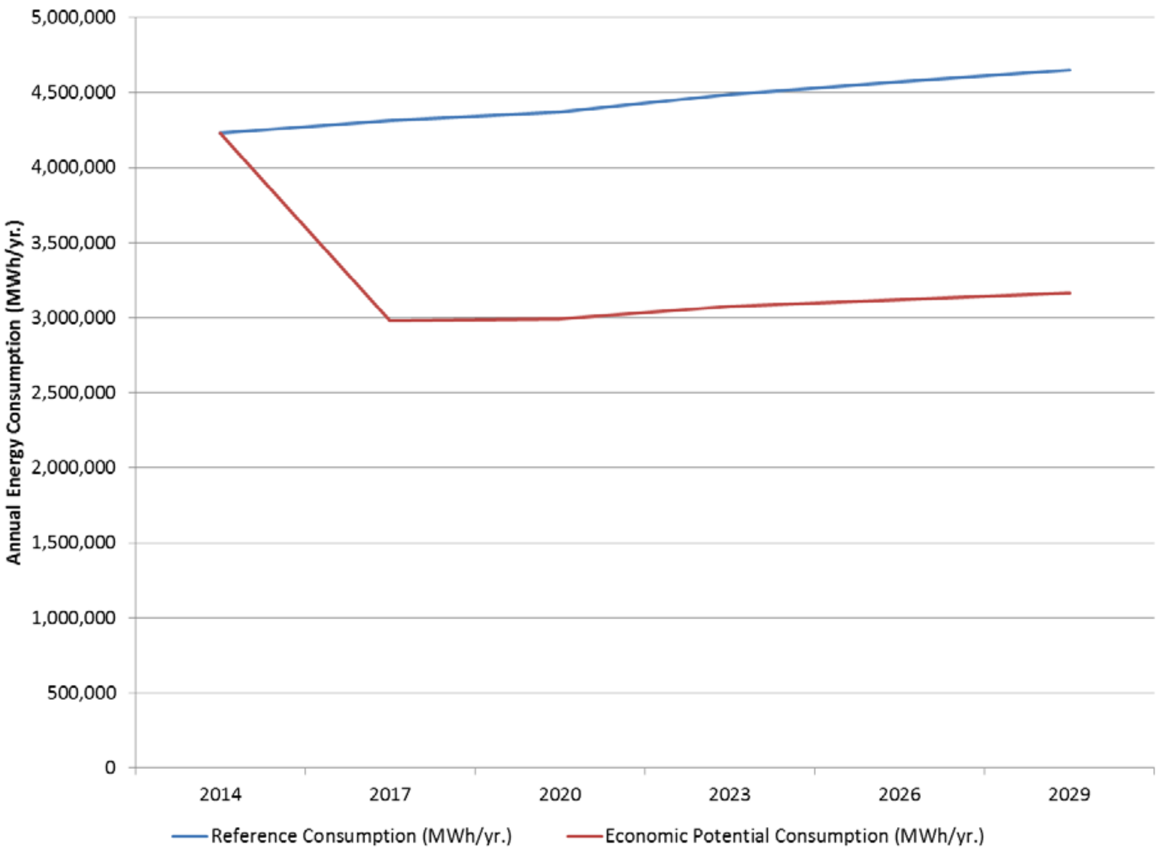
End Use Category	Upgrade Option	Applicability	Rate of Introduction
Space Heating	Electric Heat Cycling	Electrically heated SFD	Immediate
	Dual Fuel Heat Cycling	Electrically heated SFD	Immediate
	Heat Pump Cycling	Forced-air homes	Immediate
DHW	3-Element DHW	Homes with electric DHW	Immediate
	DHW Cycling	Homes with electric DHW	Immediate
Other	Car Warmer Demand	Labrador only	Immediate
	Block Heater Demand	Labrador only	Immediate

8.5 Summary of Electric Energy Savings

Exhibit 42 compares the Reference Case and Economic Potential Electric Energy Forecast levels of residential electricity consumption.[25] As illustrated, under the Reference Case residential electricity use would grow from the Base Year level of 4,227,000 MWh/yr. to approximately 4,652,000 MWh/yr. by 2029. This contrasts with the Economic Potential Forecast in which electricity use would decrease to approximately 3,168,000 MWh/yr. for the same period, a difference of approximately 1,485,000 MWh/yr., or about 32%.

The exhibit shows a large fraction of the economic potential savings occurring in the first milestone period. There are several reasons for this, including a large number of measures that pass on a full-cost basis, and avoided costs in the Island Interconnected region that are forecast to drop sharply after 2018. These factors are discussed in more detail in Section 8.5.2.

Exhibit 42 Reference Case versus Economic Potential Electric Energy Consumption in Residential Sector (MWh/yr.)



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

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:[26]

- Exhibit 43 presents the results by end use, dwelling type and milestone year
- Exhibit 44 provides a further disaggregation of the savings by technology, and milestone year
- Exhibit 45 presents savings by major end use, milestone year and supply system
- Exhibit 46 presents savings by major end use, milestone year and dwelling type
- Exhibit 47 presents 2029 savings by major end use and vintage.

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

Exhibit 43 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Clothes dryer	Television	Refrigerator	Computer and peripherals	Lighting	Ventilation	Hot tubs	Television peripherals
Single Family Dwellings	2017	719,970	124,932	136,281	45,088	54,194	30,906	23,980	10,061	21,620	5,000
	2020	764,890	124,234	138,542	48,284	54,990	30,305	19,427	11,713	15,672	5,225
	2023	777,449	124,978	141,863	51,808	55,743	33,202	17,329	14,431	15,356	5,470
	2026	785,146	129,407	146,570	54,844	56,095	39,924	16,043	22,319	15,004	5,652
	2029	791,294	129,666	149,632	57,742	56,302	40,407	15,270	28,747	14,816	5,826
Attached Houses	2017	34,251	23,839	14,986	7,283	10,101	4,641	3,624	1,120	1,937	861
	2020	35,436	23,961	15,886	7,988	10,319	4,839	2,989	1,135	1,279	924
	2023	34,323	24,329	16,963	8,770	10,536	5,716	2,681	1,294	1,144	991
	2026	33,195	25,679	18,636	9,368	10,662	7,023	2,526	1,491	1,048	1,036
	2029	39,675	25,616	19,373	9,886	10,757	7,200	2,417	3,394	980	1,074
Apartments	2017	7,233	13,315	4,460	4,438	484	2,249	1,399	191	-	673
	2020	6,680	13,666	4,316	4,795	495	2,984	1,094	177	-	711
	2023	5,504	14,214	4,473	5,194	507	4,843	936	176	-	753
	2026	4,413	14,592	4,584	5,528	514	6,428	833	175	-	784
	2029	4,122	14,918	4,684	5,843	520	6,549	761	173	-	816
Other, Vacant and Partial	2017	6,424	5,708	64	1,357	202	660	1,094	146	-	103
	2020	6,571	5,833	(94)	1,450	203	423	881	147	-	107
	2023	6,606	5,999	(89)	1,560	204	442	781	148	-	111
	2026	6,356	6,113	(81)	2,462	204	694	719	149	-	172
	2029	6,200	6,210	(86)	2,628	203	1,259	682	151	-	181
Grand Total	**2017**	767,878	167,794	155,791	58,167	64,981	38,456	30,097	11,519	23,557	6,637
	2020	813,578	167,693	158,649	62,517	66,007	38,551	24,390	13,172	16,951	6,966
	2023	823,882	169,520	163,210	67,333	66,990	44,203	21,727	16,049	16,500	7,326
	2026	829,111	175,792	169,709	72,202	67,475	54,070	20,122	24,134	16,052	7,644
	2029	841,290	176,409	173,603	76,099	67,782	55,415	19,129	32,464	15,796	7,897

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) 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.
4) MWh/yr. savings are not incremental. The space heating 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 space heating consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 43 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Housing Categories	Milestone Years	Dehumidifier	Freezer	Cooking	Other electronics	Clothes washer	Dishwasher	Block heaters & car warmers	Space cooling	Grand Total
Single Family Dwellings	2017	2,245	1,772	2,133	1,406	441	142	247	(147)	1,180,271
	2020	1,718	1,460	2,119	1,476	240	145	250	(150)	1,220,539
	2023	4,445	2,860	2,121	1,552	214	147	253	(158)	1,249,062
	2026	5,830	3,531	2,117	1,618	678	358	254	(163)	1,285,229
	2029	5,504	4,182	2,117	1,683	821	362	253	(168)	1,304,456
Attached Houses	2017	391	241	404	248	72	81	47	3	104,130
	2020	303	194	404	262	39	84	48	4	106,093
	2023	773	378	408	278	36	87	48	4	108,759
	2026	1,063	490	409	292	158	213	49	4	113,341
	2029	1,008	582	411	305	153	217	49	4	123,100
Apartments	2017	117	79	289	217	34	-	19	-	35,198
	2020	119	63	289	231	15	-	19	-	35,652
	2023	123	128	293	245	14	-	20	-	37,424
	2026	127	159	295	258	14	-	20	-	38,723
	2029	132	190	305	270	13	-	20	-	39,316
Other, Vacant and Partial	2017	-	98	141	132	18	-	7	-	16,152
	2020	-	79	139	139	10	-	6	-	15,893
	2023	-	152	138	146	9	-	6	-	16,213
	2026	-	190	137	152	9	-	6	-	17,284
	2029	-	225	148	158	9	-	7	-	17,974
Grand Total	**2017**	2,753	2,189	2,967	2,003	564	223	320	(144)	1,335,751
	2020	2,139	1,796	2,952	2,107	303	230	323	(147)	1,378,178
	2023	5,341	3,518	2,960	2,221	273	233	327	(154)	1,411,457
	2026	7,019	4,370	2,959	2,320	859	572	329	(159)	1,454,577
	2029	6,643	5,178	2,982	2,416	997	579	329	(164)	1,484,845

Notes:
1) The negative value for space cooling is based on the assumption that customers installing heat pumps will begin to use air conditioning that they did not use before.

Exhibit 44 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.)
Mini-Splits	279,764	295,901	313,433	326,181	337,636
Basement Insulation	161,041	184,435	184,608	184,860	192,464
Crawl Space Insulation	151,847	162,775	162,826	162,951	163,099
Clothes Lines	146,203	153,671	158,306	148,432	146,570
Sealing & Insul. - Old Homes	92,681	92,677	92,672	92,708	92,762
Min Hot Wash	64,866	65,825	66,618	65,743	65,530
Refrigerator Retirement	60,832	61,714	62,593	63,006	63,267
Power Bars (TVs)	46,187	49,582	53,332	57,213	60,004
Attic Insulation	42,738	42,728	42,729	47,319	47,371
Door Systems	50,353	46,395	41,280	36,758	32,751
Power Bars (PCs)	29,642	36,628	42,569	44,914	48,377
Overnight Setback	29,200	30,003	31,498	32,448	33,197
Showerheads	28,402	28,689	29,025	29,079	29,046
DHW Temperature	27,693	28,103	28,442	28,068	27,977
Faucets	22,613	23,506	24,471	25,205	25,866
Close Blinds	18,942	19,667	20,733	21,436	21,969
Daytime Setback	17,500	17,986	18,871	19,397	19,808
Air Sealing	18,379	18,378	18,377	18,385	18,396
Hot Tub Covers	21,746	15,647	15,231	14,818	14,581
ESTAR TVs	13,835	14,883	16,047	17,140	18,247
Efficient Clothes Washers	7,665	692	620	25,538	32,783
Weather Stripping Maintenance	13,250	12,907	12,942	12,880	12,813
LED Lamps	19,232	14,504	11,878	10,114	8,751
ECPM Fan Motors	2,730	4,162	7,034	15,335	23,846
Faucet Aerator	10,090	10,192	10,311	10,331	10,319
Benchmarking	8,221	7,758	7,759	7,746	7,833
DHW Tank Insulation	6,074	5,697	5,323	4,891	4,443
Motion Detectors - Outdoor	4,308	4,241	4,483	4,728	5,019
ESTAR Computers	7,663	584	165	7,632	5,419
Refrigerator Temperature	4,149	4,205	4,264	4,291	4,309

Exhibit 44 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.)
DHW Pipe Insulation	4,672	4,385	4,097	3,765	3,421
Turn Off TVs	3,515	3,705	3,913	4,083	4,286
Timers - Outdoor	4,660	3,842	3,479	3,320	3,276
Electronic Thermostats	1,086	1,833	3,360	4,496	6,860
ESTAR Dehumidifiers	1,095	458	3,674	5,349	4,929
Super Efficient Clothes Washers	3,387	3,247	3,061	2,701	2,464
Clothes Dryer Sensor	2,263	2,380	2,454	2,323	2,305
Unplug Chargers	2,003	2,107	2,221	2,320	2,416
Prog. Thermostats	2,011	1,938	1,981	2,194	2,369
Min Outdoor Lighting	1,724	1,645	1,702	1,768	1,877
ESTAR Freezers	527	75	1,766	2,585	3,361
Freezer Temperature	1,620	1,636	1,626	1,619	1,611
PC Power Management	1,151	1,339	1,470	1,523	1,618
AC Temperature	447	460	476	487	496
High-Perf. New Homes	100	169	303	435	565
Air-to-Water Heat Pumps	-	268	310	353	393
Car Warmer Timers	223	230	233	237	240
ESTAR Windows	959	9	16	25	36
Air-Source Heat Pump	109	119	139	156	175
Block Heater Timers	-	-	-	334	339
Super Efficient Freezers	43	84	126	166	206
Turn Off Lights	153	127	115	111	110
Super Efficient Refrigerators	-	88	133	177	206
Cold Climate Heat Pump	52	55	61	65	70
T8 Fixtures	16	26	36	46	57
Super Windows	-	22	34	46	59
Professional Air Sealing	-	-	-	79	81
ESTAR Dishwashers	8	17	29	42	37
HRVs	-	-	20	31	43
Motion Detectors - Indoor	-	-	25	25	25

Exhibit 44 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.)
Prog. Thermostats (Central)	4	3	3	2	1
HVAC Impact from Other Savings	(103,924)	(106,228)	(113,844)	(125,835)	(133,540)
Grand Total	1,335,751	1,378,178	1,411,457	1,454,577	1,484,845

Notes:

1) For some measures, such as Efficient Clothes Washers, the savings decrease after the first milestone and then rise again. This phenomenon emerges in the model because the assumed natural adoption of the measure is “catching up” to the economic potential adoption in those milestone years and is therefore eroding the savings potential. This is particularly likely for measures whose cost of conserved energy is below the avoided cost of electricity in the Island Interconnected region in 2017, but is higher than the avoided cost of electricity in the region after 2018. For these measures, adoption proceeds during the initial milestone periods, then stalls after the forecast avoided cost decreases, and then may later begin proceeding again after forecast avoided costs begin to rise.
2) The last measure in the table, HVAC Impact from Other Savings, accounts for the added load on the electric heating systems in dwellings where savings are occurring for many other end uses in the home. As discussed in Section 8.5.3, the savings for end uses such as lighting, appliances, and electronics are multiplied by a factor based on modeling of NL dwellings. The resulting heating penalty is added as a separate line item in this exhibit.

Exhibit 45 Economic Potential Savings by Major End Use, Year and Region (MWh/yr.)

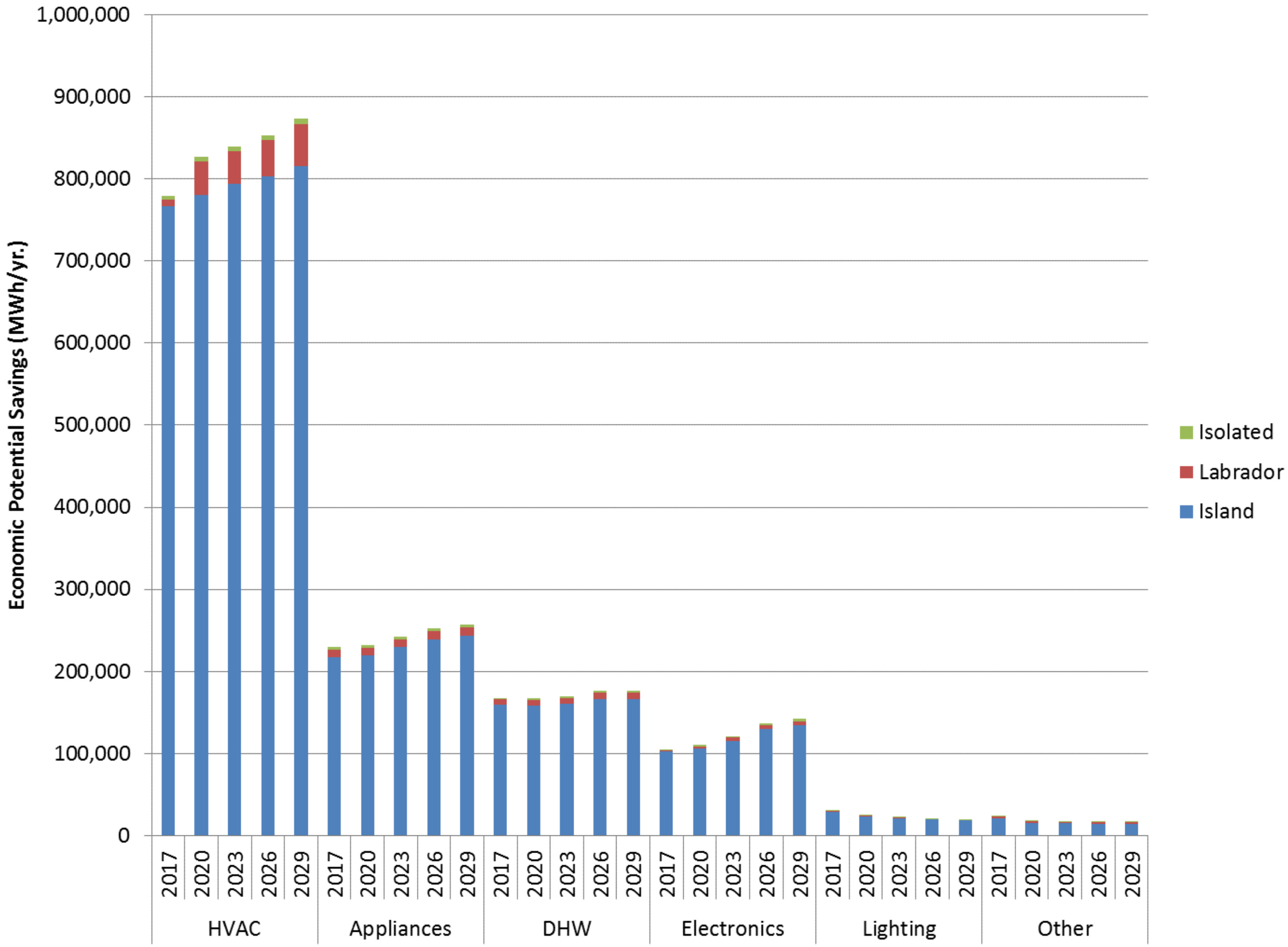


Exhibit 46 Economic Potential Savings by Major End Use, Year and Dwelling Type (MWh/yr.)

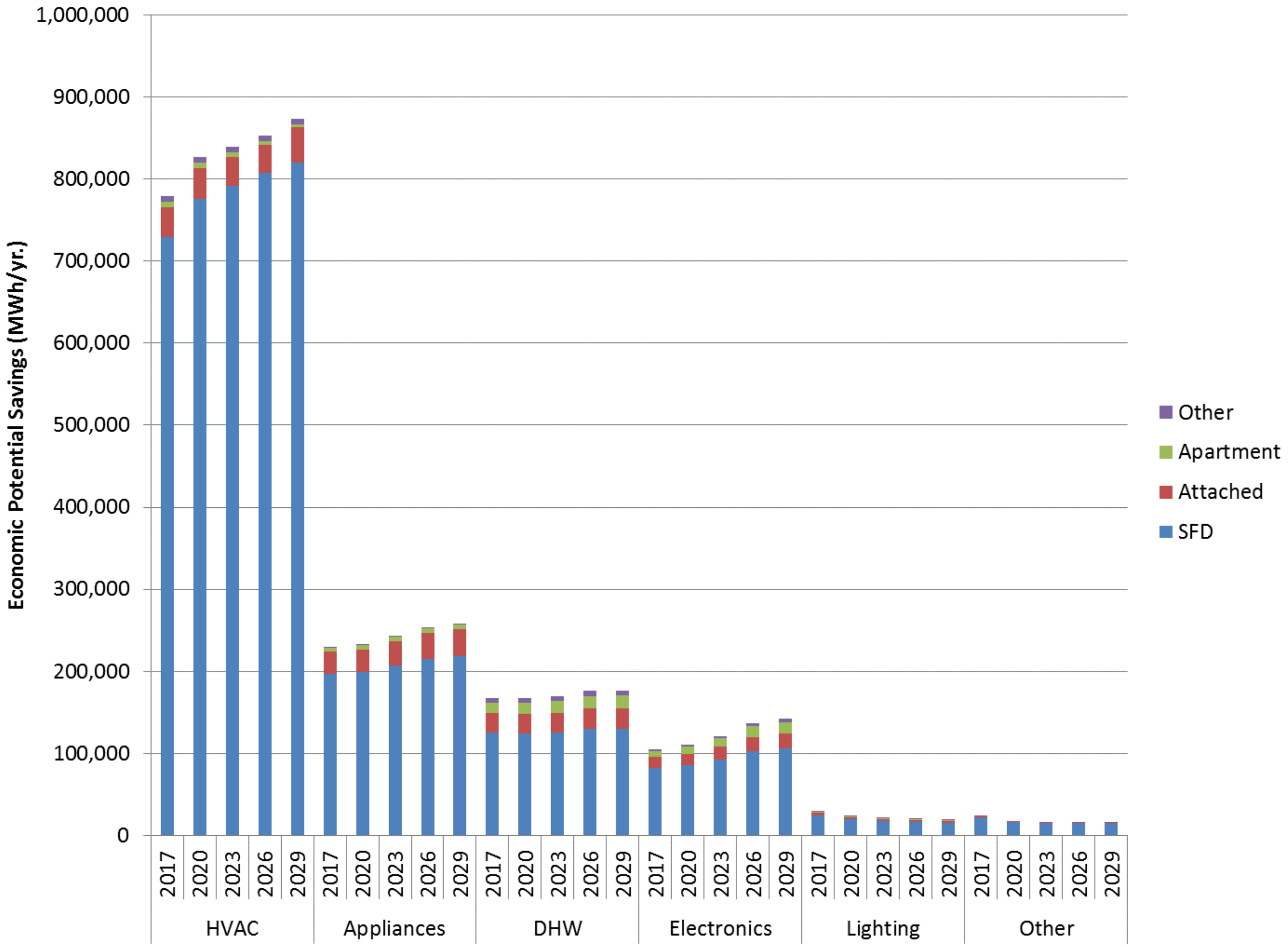
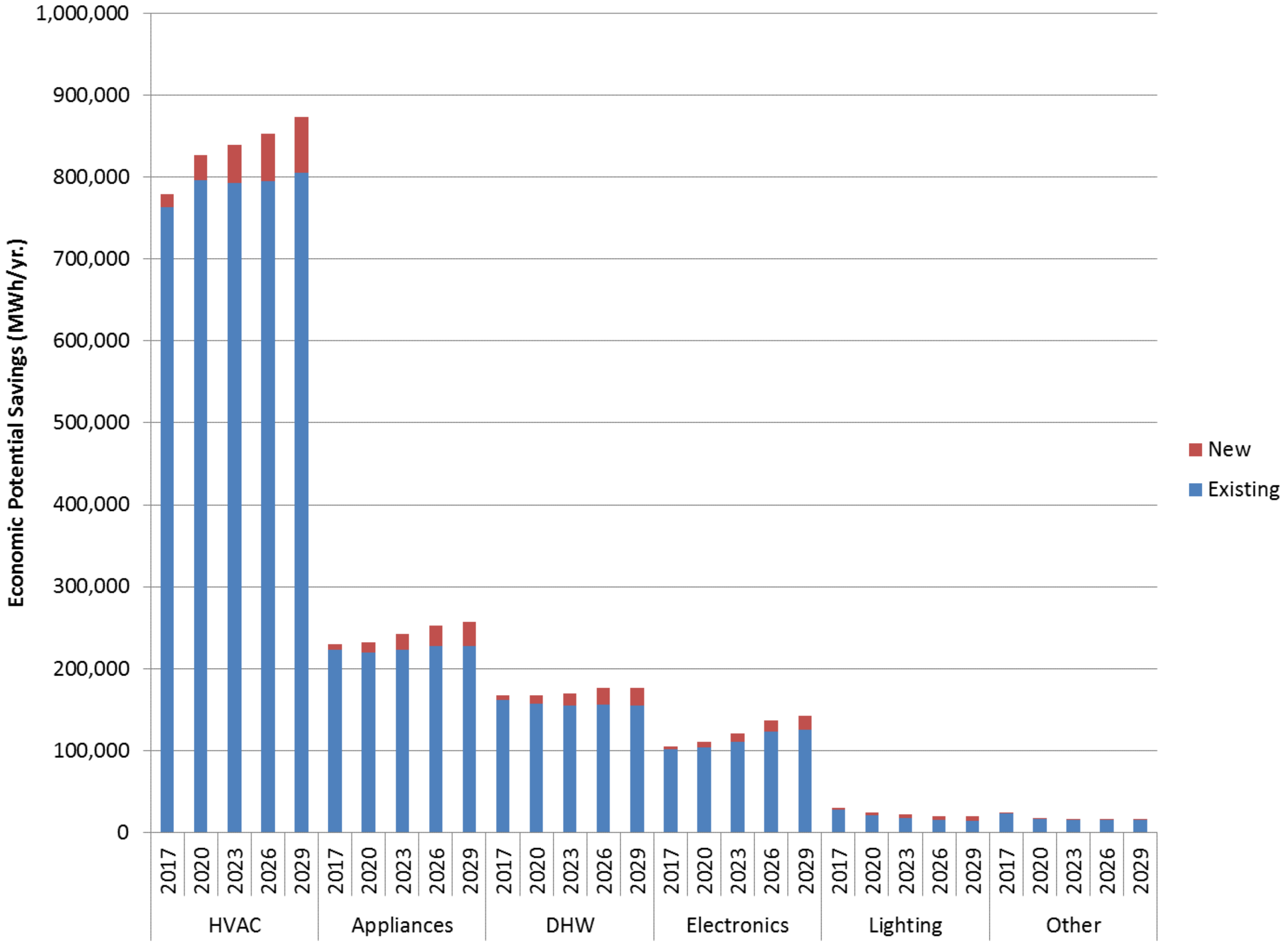


Exhibit 47 Economic Potential Savings by Major End Use, Year and Vintage (MWh/yr.)



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 increase modestly from 1,336,000 MWh/yr. in 2017 to 1,485,000 MWh/yr. in 2029. Nearly 90% of the savings possible at the end of the study period are already economically viable within the first milestone period. There are three 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. Many of the behavior measures offer significant savings, for example, and since they have negligible or no capital cost they can be implemented immediately for all eligible customers. The ductless mini-split heating systems, which offer very large savings, also pass on the basis of full cost and could therefore be implemented in the first milestone period for all eligible customers.
- The avoided costs in the Island Interconnected region are expected to fall significantly after the interconnection is made with Labrador. Consequently, many 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.
- While there are end uses where the opportunities for savings expand, such as space heating and electronics, there are other end uses where the opportunities contract, such as lighting. Lighting in the Reference Case includes the assumption that most of the market moves to lamps as efficient as LEDs by 2029.

Electric Energy Savings by Dwelling Type

Single detached houses account for over 88% of the potential savings; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Savings in attached dwellings account for 8% of the potential savings. Savings in apartments account for 3% of the potential savings. Savings in other residential buildings account for 1% of the potential savings.

By Region

The Island Interconnected region accounts for 95% of the potential savings. The Labrador Interconnected region accounts for 4% of the potential savings, and the Isolated region accounts for 1% of the potential savings.

By Existing Dwellings versus New Construction

Savings in existing dwellings account for almost all of the savings potential at the beginning of the study period, but as new homes are constructed, the savings potential associated with them occupies a progressively larger portion of the total. By 2029, savings from new homes account for 10% of the total potential.

Electric Energy Savings by End Use

Space heating measures dominate the results, including both efficient equipment and building envelope improvements.

Space heating and ventilation savings from upgrades to the building envelope and space heating systems account for approximately 58% of the total electricity savings in the Economic Potential Forecast. Of this, 23% is from ductless mini-split systems, 24% is from basement and crawlspace insulation, 10% is from other air sealing and insulation projects, and 3% is from efficient windows and doors. Other measures account for 2% or less of the savings. It should be noted that the reduction in internal heat loads resulting from measures that save electricity in other end uses will tend to increase heating energy consumption. This increase is subtracted from the overall potential savings, reducing it by approximately 9% overall by 2029.[27]

The measure with the largest potential, the ductless mini-split, is economically attractive relative to the avoided cost of electricity in the Island Interconnected region before the Island grid is connected to Labrador. After the link is complete, the avoided costs are expected to decrease to a level below the CCE for the ductless mini-split systems. In the economic potential model, the mini-split systems are assumed to be widely adopted in the first milestone period. In the context of real programs, where the measure may be deemed uneconomic after the first three years of the study period, the potential for this measure is likely much smaller.

Appliances account for approximately 17% of the total electricity savings in the Economic Potential Forecast. Of this, 4% is from retirement of second (and third) refrigerators and 2% is from ENERGY STAR® clothes washers and Tier3 clothes washers. Other appliance measures account for less than 1% of the savings. Within the appliance end use, the largest economic potential is a behavior measure: use of clothes lines accounts for 9% of the 18%.

DHW measures account for 12% of the total electricity savings in the Economic Potential Forecast. Of this, 4% is from low flow fixtures such as showerheads, faucets, and faucet aerators. The DHW savings associated with more efficient clothes washers account for approximately 1% of the 12%. Other measures account for 1% or less of the potential savings. Within the DHW end use, the largest economic potential is a behavior measure: minimization of hot water wash accounts for 4% of the 12%.

Electronic end uses account for about 8% of the total electricity savings at the beginning of the Economic Potential Forecast and rises to 10% by 2029. Of this, 4% is from power bars for televisions and their peripherals, 3% is from power bars for PCs and their peripherals, and 1% is from ENERGY STAR® televisions. Use of such power bars is likely to be superseded by technical changes in electronics products, reducing their standby losses. Nonetheless, the magnitude of the savings remains the same, although the technology to achieve it will change.

The lighting end uses, including indoor, outdoor and holiday lighting, account for about 2% of the total electricity savings at the beginning of the Economic Potential Forecast but fall to 1% by 2029. This is largely because of the expected natural adoption of LED lighting products or other products of similar efficiency.

The “other” category of end uses, which includes, spas, block heaters and car warmers, and small appliances and other, account for 2% of the electricity savings at the beginning of the Economic Potential Forecast but fall to 1% by 2029. Of this, the largest measure is improved hot tub covers. Block heater and car warmer timers offer savings in Labrador, but are not used in the rest of the province.

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:

[27] This 9% reduction is the reason the percentage savings for individual measures add up to more than 58%.

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

- **There are interactive effects among end uses.** For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy-use simulations using NRCan HOT2000 software, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of up to 60 kWh in the Island Interconnected region (a 60% rate of interaction) and 70 kWh in the Labrador Interconnected region (a 70% rate of interaction). A 60% rate of interaction was used for the Isolated region.

  > 70% is a higher rate of interaction between internal loads and space heating than seen in other studies. It is related mainly to the length of the heating season, rather than its severity.

  The model implements this interaction by multiplying the savings for the internal end uses in a dwelling by the factor for houses in that region. Exhibit 48 provides the interactive factors applied to space heating, by region and end use.[28] This becomes the additional heating load for the dwelling. This is in turn multiplied by the space heating electric share for the type of dwelling, because the non-electric heating sources are assumed to provide their share of the additional heating load.

  Exhibit 44 shows the total heating penalty caused by internal end use savings as a separate line item, just before the grand total. In other words, the heating penalty is not subtracted from the savings of individual measures, but is instead shown as a separate item in the exhibit. To attach the heating penalty to a specific measure, the savings can be reduced by the heating interaction penalty for the region and end use, as indicated in the exhibit. An interior lighting measure saving 100 kWh/yr. in the Island Interconnected region, for example, would actually save only (1 – 60%) x 100 = 40 kWh/yr. **in an electrically heated house.** In an oil-heated house, it would save the full 100 kWh/yr. and the heating penalty would instead affect the consumption of oil.

[28] In the residential model, interactive effects were applied to the total end use savings, rather than on a measure-by-measure basis. This is an approximation that provides good overall results. For most end uses, it is relatively clear whether energy waste occurs within or outside the heated part of the dwelling. For example, almost all televisions are used in the house, so savings from a television measure will interact with the space heating system. Most hot tubs are outside, and therefore savings from a hot tub measure will generally not interact with the space heating system. There is only one lighting end use in the residential model, so it includes both indoor and outdoor lighting. The majority of lighting is indoor, so the interactive factors have been applied to the end use. For individual lighting measures, the factor should be applied if the savings occur inside the dwelling and it should not be applied if they occur outside. DHW is the most complex end use to model. A considerable amount of the DHW heat goes down the drain after the immediate use, and there are also constant heat losses from the tank. Therefore, the interaction between DHW energy savings and the dwelling's heating system are very complex, and likely much weaker than for other end uses. This analysis has neglected the interaction between DHW savings and space heating.

Exhibit 48 Interactive Factors Applied to Space Heating, by End Use

End Use	Heating Interaction Factor Applied		
	Island Interconnected	Labrador Interconnected	Isolated
Space heating	N/A	N/A	N/A
Space cooling	N/A	N/A	N/A
Ventilation	60%	70%	60%
Domestic Hot Water (DHW)	0%	0%	0%
Cooking	60%	70%	60%
Refrigerator	60%	70%	60%
Freezer	60%	70%	60%
Dishwasher	60%	70%	60%
Clothes washer	60%	70%	60%
Clothes dryer	60%	70%	60%
Dehumidifier	0%	0%	0%
Lighting	60%	70%	60%
Computer and peripherals	60%	70%	60%
Television	60%	70%	60%
Television peripherals	60%	70%	60%
Other electronics	60%	70%	60%
Block heaters & car warmers	N/A	0%	N/A
Hot tubs	0%	0%	0%
Small appliance & other	60%	70%	60%

8.6 Electric Peak Load Reductions from Energy Efficiency

Exhibit 49 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 region. 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 50 shows the same information graphically for the winter peak period.

Exhibit 49 and Exhibit 50 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. For example, most of the heat pump measures are assumed not to produce any peak demand savings, because during the winter peak period the heat pumps and mini-splits are expected to revert to back-up electric resistance heating.[29] There will therefore be no net reduction in space heating peak demand for these measures. Accordingly, the demand reductions for the heat pump measures have been manually filtered out of the results presented in these exhibits.

Exhibit 51 shows the demand reductions associated with each electric energy savings measure contained in the Economic Potential Forecast for the milestone year 2029. The heat pump measures are omitted from the exhibit, as with the previous two exhibits. One notable line item in the exhibit is "HVAC Impact from Other Savings" - the impact on peak space heating load resulting from the savings for other end uses within the dwelling. This is to capture the fact that in an electrically-heated dwelling, savings of energy consuming devices within the home will not reduce the winter

[29] In fact, this is a conservative assumption for the Island Interconnected region. Although the demand peak occurs on the coldest winter days, in a climate such as that of St. John's the temperature is typically not very extreme on those peak days. Therefore, many heat pumps will continue to work in heat pump mode and not revert to electric resistance. In this study, we have retained the conservative assumption that they do not provide demand relief.

peak demand. On the coldest winter days, reducing the energy used by a lamp will simply make the electric baseboard beside it work harder. The non-heating end uses do produce some peak load reductions, for example, in homes that are heated by non-electric fuels, in outside light fixtures, or in heated water that drains out of the house while still warm. The impact of demand reductions for other end uses on the space heating demand can be seen graphically in Exhibit 50. As the demand impacts for many of the other end uses rise with time, the demand impacts for space heating actually decreases over time.

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

Exhibit 49 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Housing Categories	Milestone Years	Island Interconnected	Labrador Interconnected	Isolated	Grand Total
Single Family Dwellings	2017	212	3	2	218
	2020	210	12	2	224
	2023	210	13	2	225
	2026	214	14	3	231
	2029	216	14	3	233
Attached Houses	2017	18	1	-	19
	2020	17	2	-	19
	2023	17	2	-	19
	2026	18	2	-	20
	2029	18	4	-	22
Apartments	2017	8	0	-	8
	2020	8	0	-	8
	2023	8	0	-	8
	2026	8	0	-	8
	2029	8	0	-	8
Other, Vacant and Partial	2017	4	0	0	4
	2020	4	0	0	4
	2023	4	0	0	5
	2026	4	0	0	5
	2029	4	0	0	5
Grand Total	**2017**	242	5	2	249
	2020	239	15	2	256
	2023	239	15	3	256
	2026	244	17	3	263
	2029	246	19	3	268

Exhibit 50 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year End Use and Dwelling Type, Winter Peak Period (MW)

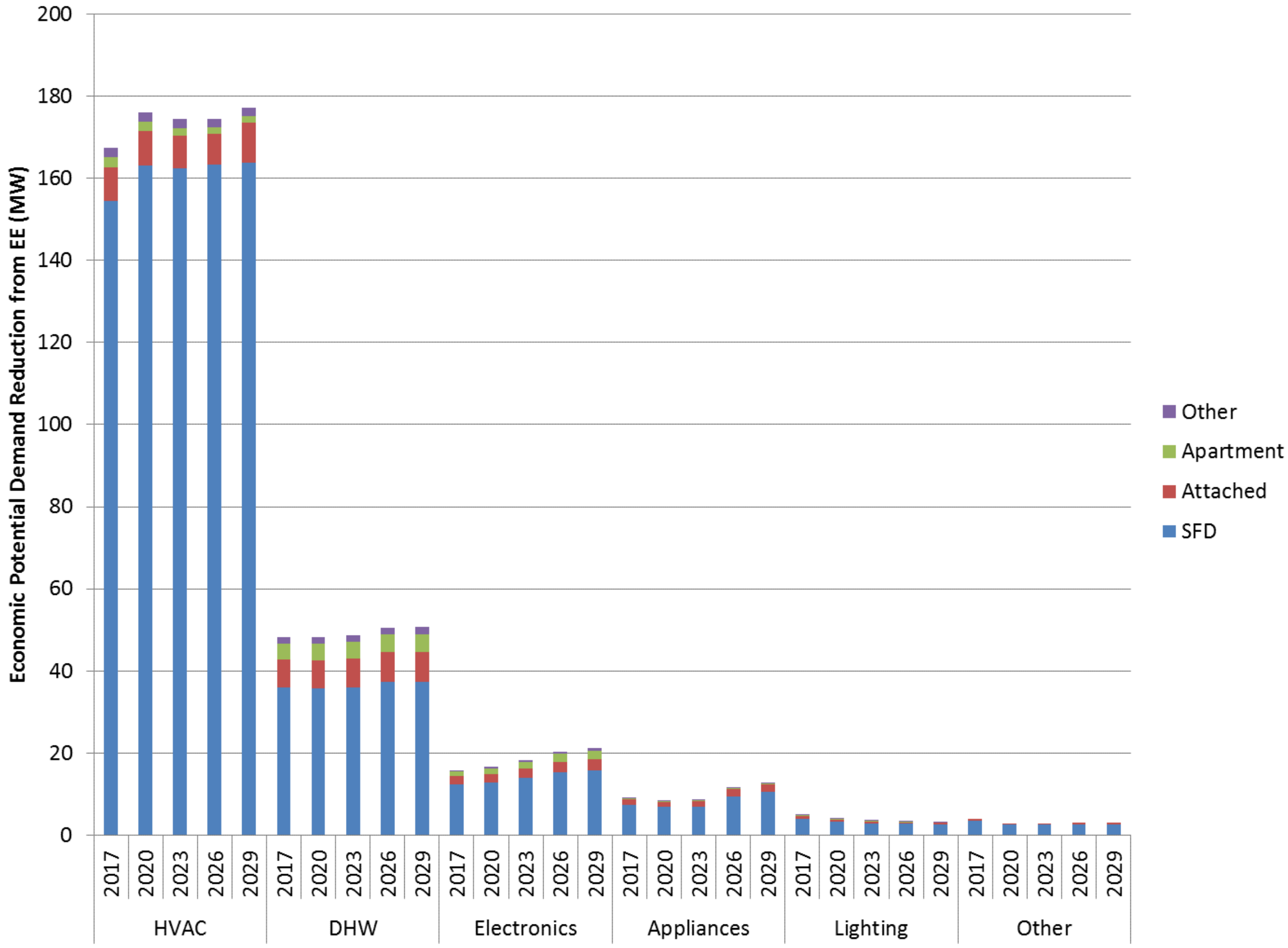


Exhibit 51 Electric Peak Load Reductions from Economic Energy Savings Measures, 2029 (MW)

Measure	Island Interconnected	Labrador Interconnected	Isolated	Grand Total
Basement Insulation	54	9	0	63
Crawl Space Insulation	51	3	0	54
Sealing & Insul. - Old Homes	31	-	0	31
Min Hot Wash	18	1	0	19
Attic Insulation	14	1	0	16
Overnight Setback	10	1	0	11
Door Systems	10	1	0	11
Power Bars (TVs)	9	0	0	10
Showerheads	8	0	0	8
DHW Temperature	8	0	0	8
ECPM Fan Motors	8	0	0	8
Faucets	7	0	0	7
Close Blinds	7	1	0	7
Daytime Setback	6	1	0	7
Efficient Clothes Washers	6	0	0	7
Refrigerator Retirement	6	0	0	6
Power Bars (PCs)	6	0	0	6
Air Sealing	6	-	0	6
Weather Stripping Maintenance	4	0	0	4
ESTAR TVs	3	-	0	3
Faucet Aerator	3	0	0	3
Electronic Thermostats	2	0	0	2
Hot Tub Covers	2	0	0	2
LED Lamps	1	0	0	1
DHW Tank Insulation	1	-	0	1
Benchmarking	1	0	0	1
DHW Pipe Insulation	1	0	0	1
Motion Detectors - Outdoor	1	0	0	1
Prog. Thermostats	1	0	0	1
Turn Off TVs	1	0	0	1
ESTAR Computers	1	0	0	1
Timers - Outdoor	1	-	0	1
Super Efficient Clothes Washers	0	-	0	1
Refrigerator Temperature	0	0	0	0
Clothes Dryer Sensor	0	0	0	0
ESTAR Freezers	0	0	0	0
Min Outdoor Lighting	0	0	0	0
Unplug Chargers	0	0	0	0
High-Perf. New Homes	-	-	0	0
Car Warmer Timers	-	0	-	0
PC Power Management	0	0	0	0
Freezer Temperature	0	0	0	0
Super Efficient Freezers	-	-	0	0
Turn Off Lights	0	0	0	0
ESTAR Windows	-	-	0	0
ESTAR Dishwashers	-	-	0	0
T8 Fixtures	0	0	0	0

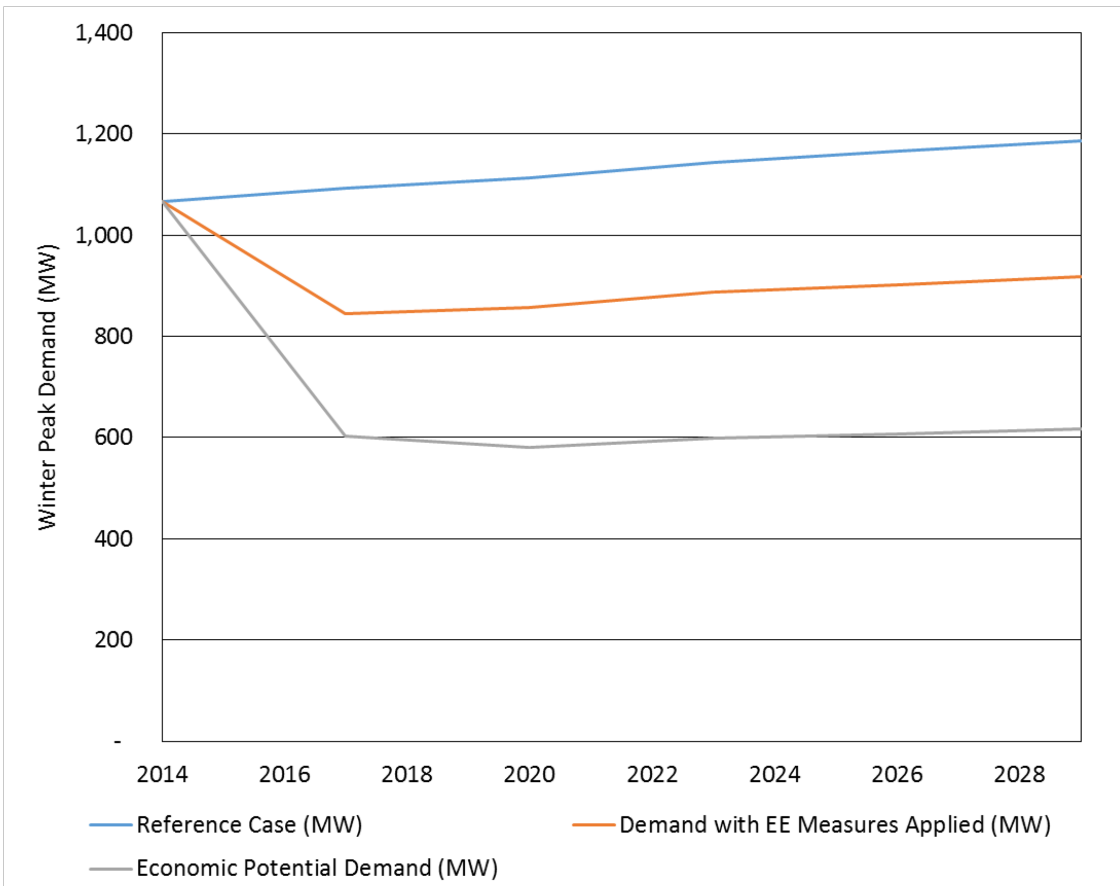
Exhibit 51 Continued: Electric Peak Load Reductions from Economic Energy Savings Measures, 2029 (MW)

Measure	Island Interconnected	Labrador Interconnected	Isolated	Grand Total
Prog. Thermostats (Central)	0	0	0	0
HVAC Impact from Other Savings	(42)	(2)	(0)	(45)
Grand Total	246	19	3	267

8.7 Summary of Peak Load Reduction

Exhibit 52 compares the Reference Case and Economic Potential Peak Demand Forecast levels of winter peak demand.[30] As illustrated, under the Reference Case residential peak demand would grow from the Base Year level of 1,067 MW to approximately 1,186 MW by 2029. This contrasts with the Economic Potential Forecast in which peak demand would decrease to approximately 647 MW for the same period, a difference of approximately 539 MW or about 45%. 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 55% of the reduction comes from the impact of energy efficiency measures.

Exhibit 52 Reference Case Peak Demand versus Economic Potential Peak Demand in Residential Sector (MW)



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

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:[31]

- Exhibit 53 presents the results by end use, dwelling type and milestone year
- Exhibit 54 provides a further disaggregation of the peak demand reduction by technology and milestone year
- Exhibit 55 presents peak demand reduction by major end use, milestone year and region
- Exhibit 56 presents peak demand reduction by major end use, milestone year and dwelling type
- Exhibit 57 presents 2029 peak demand reduction by major end use and vintage.

[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 Economic Potential scenario are implemented.

Exhibit 53 Total Economic Potential Peak Demand Reduction by End Use, Dwelling Type and Milestone Year (MW)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Block heaters & car warmers	Grand Total
Single Family Dwellings	2017	96	81	0	177
	2020	98	95	0	193
	2023	104	98	0	202
	2026	108	96	0	204
	2029	111	96	0	207
Attached Houses	2017	28	16	0	44
	2020	29	19	0	47
	2023	30	19	0	49
	2026	31	19	0	50
	2029	31	19	0	51
Apartments	2017	1	10	-	11
	2020	11	11	-	22
	2023	12	13	-	24
	2026	12	13	-	25
	2029	12	13	-	25
Other, Vacant and Partial	2017	10	0	-	10
	2020	12	2	-	14
	2023	12	2	-	14
	2026	14	2	-	17
	2029	15	2	-	17
Grand Total	**2017**	135	107	0	242
	2020	150	126	0	276
	2023	157	132	0	290
	2026	165	131	0	296
	2029	170	130	0	300

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) 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.
4) MW reductions are not incremental. The space 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 space heating peak demand in 2029 and the space heating peak demand if all the measures included in the Economic Potential scenario are implemented.
5) The values in this exhibit do not include peak demand reductions from energy efficiency measures.

Exhibit 54 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)
DHW Cycling	106	111	112	110	110
Electric Heat Cycling	92	105	110	116	119
Dual Fuel Heat Cycling	39	41	43	45	46
3-Element DHW	0	16	20	20	20
Heat Pump Cycling	4	4	4	4	4
Car Warmer Demand	0	0	0	0	0
Block Heater Demand	0	0	0	0	0
Grand Total	242	276	290	296	300

Exhibit 55 Economic Peak Load Reduction by Major End Use, Year and Region (MW)

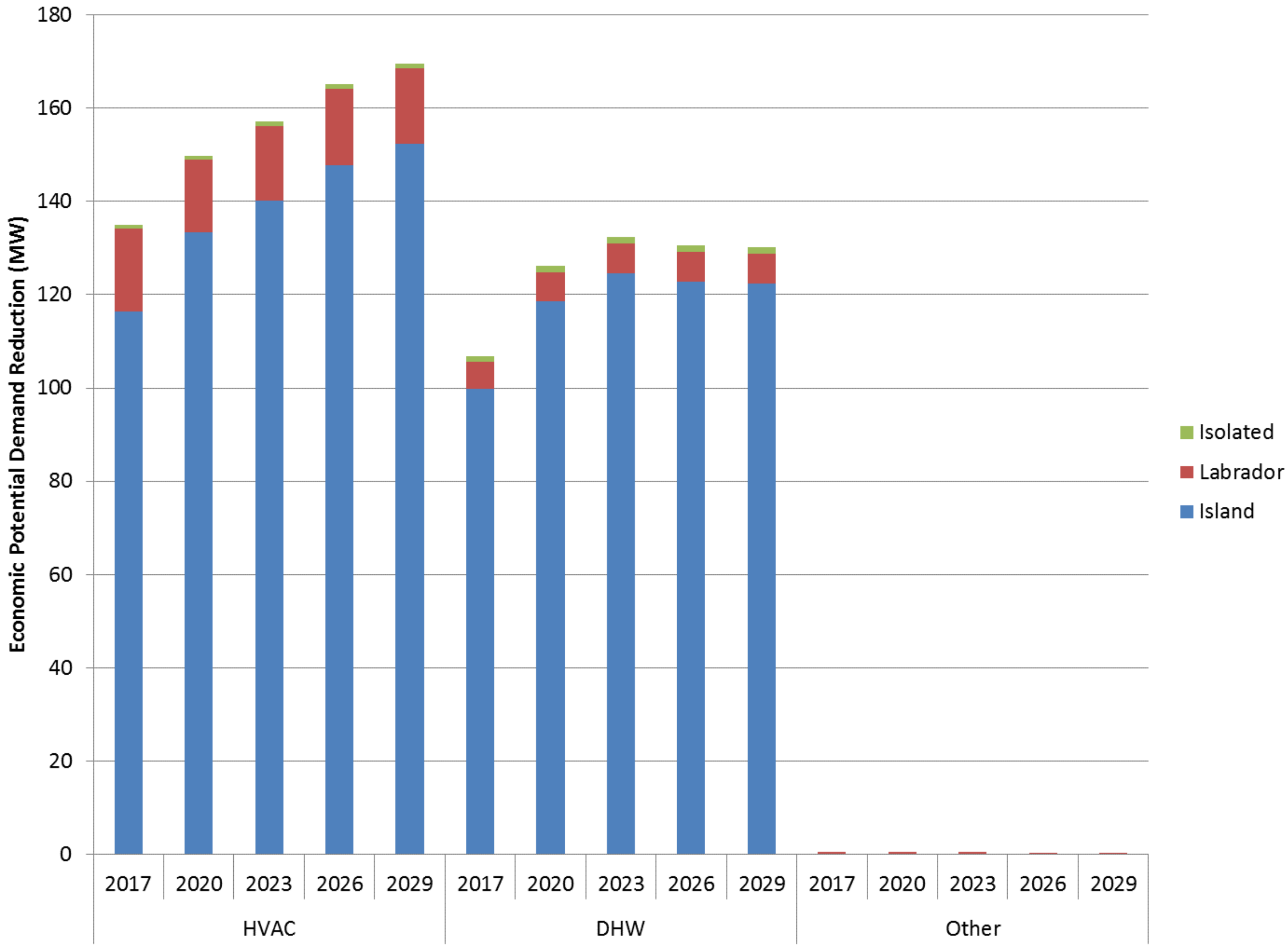


Exhibit 56 Economic Potential Peak Demand Reduction by Major End Use, Year and Dwelling Type (MW)

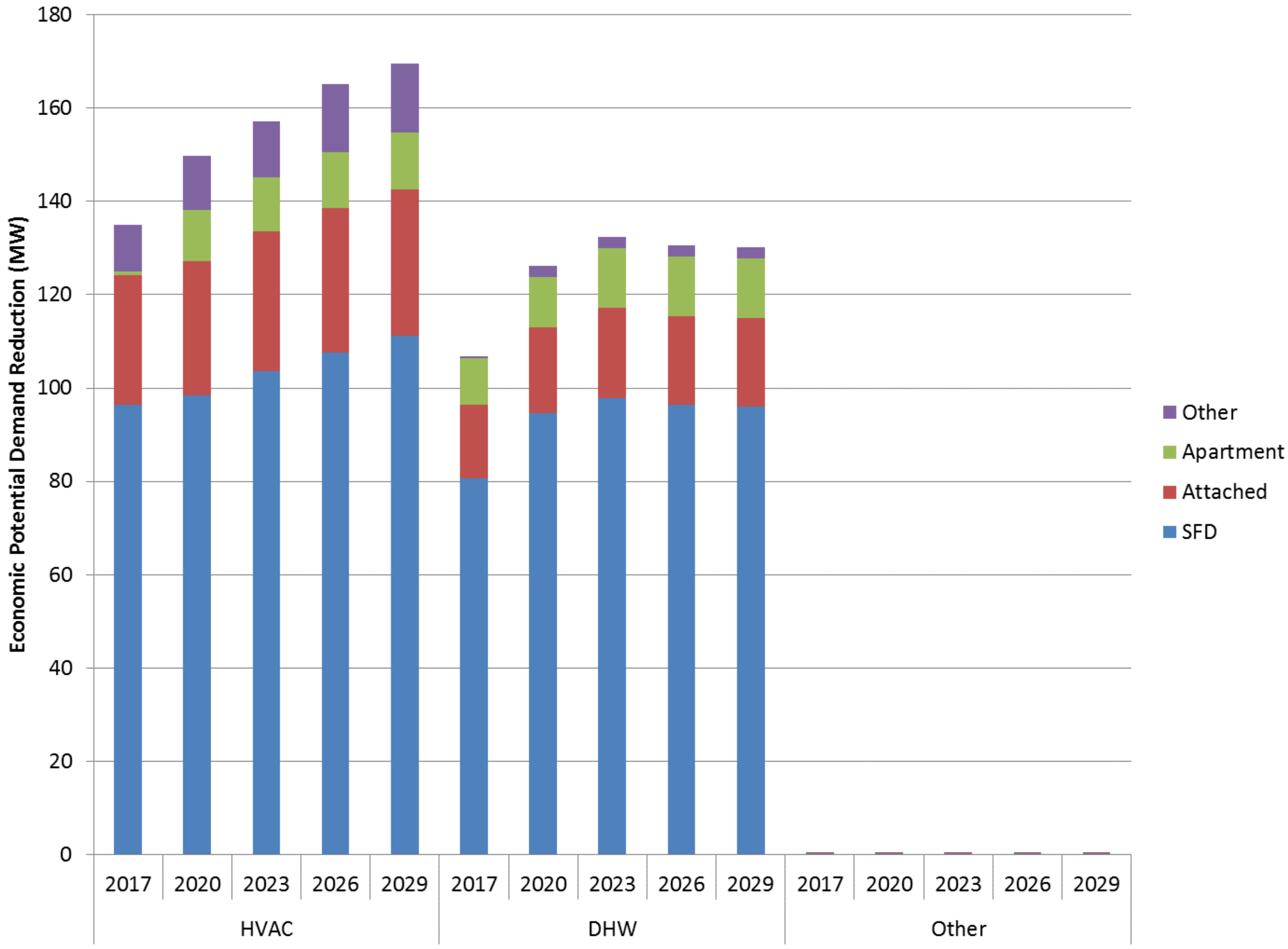
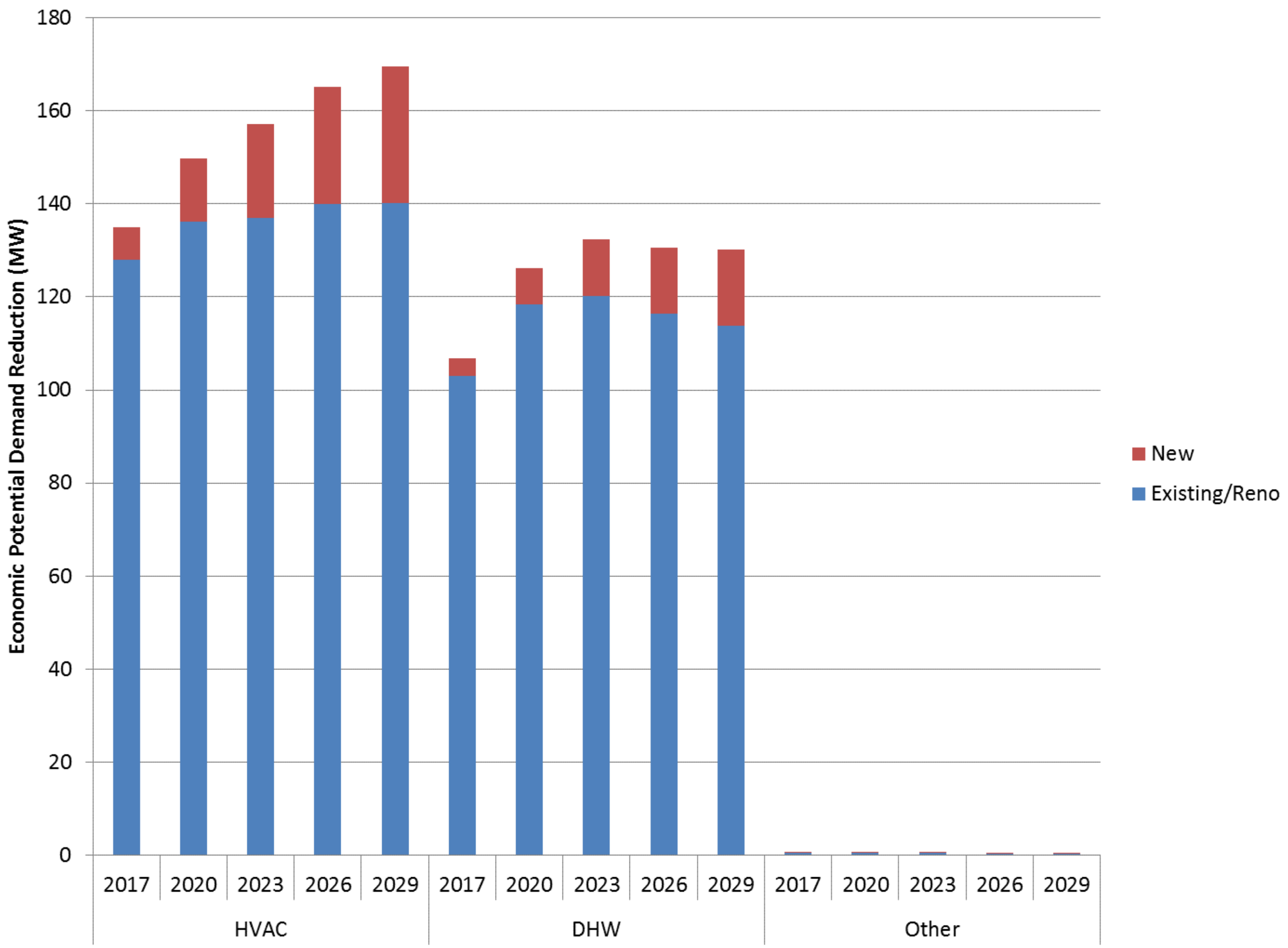


Exhibit 57 Economic Potential Peak Load Reduction by Major End Use, Year and Vintage (MW)



8.7.2 Interpretation of Results

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

Peak Demand Reduction by Milestone Year

The Economic Potential peak load reductions increase modestly from 247 MW in 2017 to 300 MW in 2029. Approximately 82% of the peak reduction possible at the end of the study period is already economically viable within the first milestone 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.

Peak Demand Reduction by Dwelling Type

Single detached houses account for 69% of the potential peak load reductions; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Peak load reductions in attached dwellings account for 17% of the potential savings. Peak load reductions in apartments account for 8% of the potential savings. Peak load reductions in other residential buildings account for 6% of the potential savings.

Peak Demand Reduction By Region

The Island Interconnected region accounts for 91% of the potential peak load reductions. The Labrador Interconnected region accounts for 8% of the potential peak load reductions, and the Isolated region accounts for 1% of the potential peak load reductions.

Peak Demand Reduction By Existing Dwellings versus New Construction

Peak load reductions in existing dwellings account for almost all of the reduction potential at the beginning of the study period, but as new homes are constructed, the load reduction potential associated with them occupies a progressively larger portion of the total. By 2029, peak load reductions from new homes account for 15% of the total potential.

Peak Demand Reduction by End Use

Space heating load reductions account for approximately 55% of the total load reductions in the Economic Potential Forecast, not include load reductions from energy efficiency measures. Of this, 40% is from electric heat cycling, 15% is from heat cycling in dwellings with a second heating fuel option, and 1% is from cycling heat pumps.

DHW measures account for 45% of the total load reductions in the Economic Potential Forecast, not include load reductions from energy efficiency measures. Of this, 37% is from DHW cycling and 7% is from three-element DHW tanks.

Timers for car warmers and block heaters offer a very small portion of the total load reduction opportunity for the province overall, but contribute 2% to the overall potential for the Labrador Interconnected region.

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 58 shows that the results are sensitive to this range of avoided costs. By 2029, the exhibit shows the following changes in potential:

- The lower range of reasonableness produces energy savings that are 6% lower in the Island Interconnected region, 10% lower in the Labrador Interconnected region, and almost unchanged in the Isolated region.
- The lower range of reasonableness produces peak demand reductions that are 6% lower in the Island Interconnected region, 4% lower in the Labrador Interconnected region, and 1% lower in the Isolated region.
- The upper range of reasonableness produces energy savings that are 8% higher in the Island Interconnected region, 71% in the Labrador Interconnected region, and almost unchanged in the Isolated region.
- The upper range of reasonableness produces peak demand reductions that are 1% higher in the Island Interconnected region, almost unchanged in the Labrador Interconnected region[32], and almost unchanged in the Isolated region.

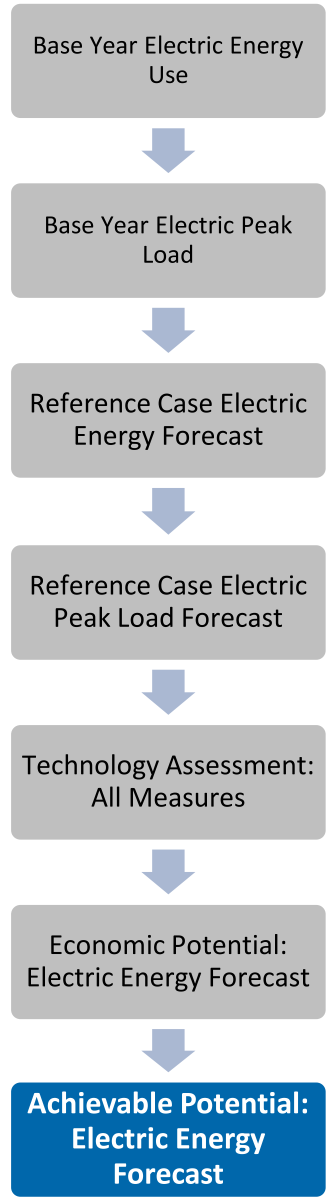
The dramatic change in energy savings potential in the Labrador region with higher avoided costs is mainly because the cost of conserved energy for the ductless mini-splits lies between the base scenario avoided costs and the upper range of avoided costs for most of the milestone years.

[32] The resulting reduction in Labrador space heating in the model caused the demand model to show a 10% reduction in potential for space heat cycling. In fact, however, mini-split systems would be operating in electric resistance mode during the winter peak period, so no such reduction in potential would actually occur

Exhibit 58 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)
Island Interconnected	2017	1,218,122	430	1,295,153	458	1,328,438	478
	2020	1,225,380	463	1,302,489	491	1,341,847	499
	2023	1,252,862	474	1,333,728	504	1,383,832	515
	2026	1,279,722	481	1,370,235	515	1,455,577	521
	2029	1,310,677	490	1,391,573	521	1,498,845	525
Labrador Interconnected	2017	24,837	28	27,825	29	62,068	36
	2020	28,068	30	62,225	37	66,932	38
	2023	63,051	38	63,464	38	92,675	39
	2026	64,176	38	69,178	39	105,725	39
	2029	69,765	40	77,310	42	132,343	38
Isolated	2017	12,713	4	12,774	4	13,107	4
	2020	13,119	5	13,464	5	13,580	5
	2023	14,239	5	14,266	5	14,357	5
	2026	15,113	5	15,164	5	15,220	5
	2029	15,918	5	15,962	5	16,025	5

9 Achievable Potential: Electric Energy Forecast



9.1 Introduction

This section presents the Residential 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:

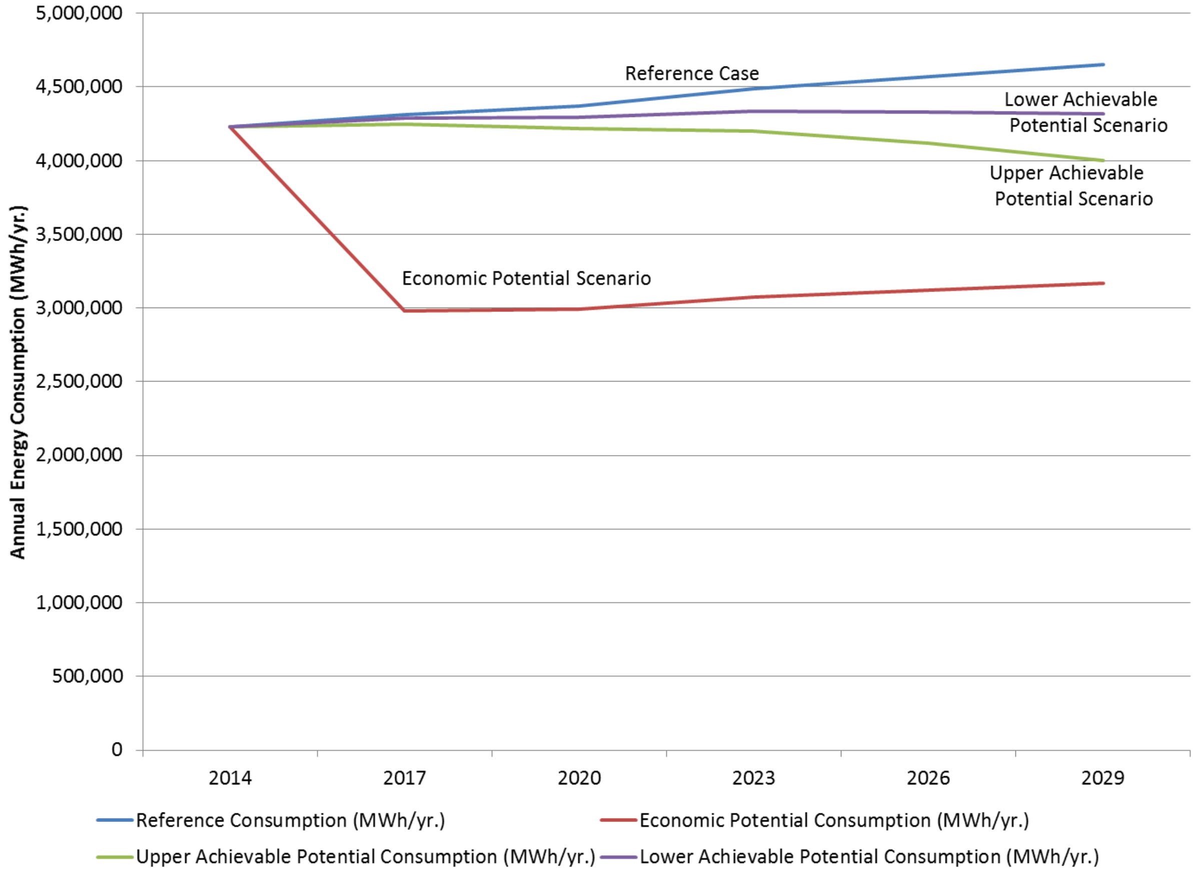
- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability.

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, various levels of government, and the private sector to remove barriers such as those noted above.

Exhibit 59 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 59 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 59 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 59 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector (GWh/yr.)



As also illustrated in Exhibit 59 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.

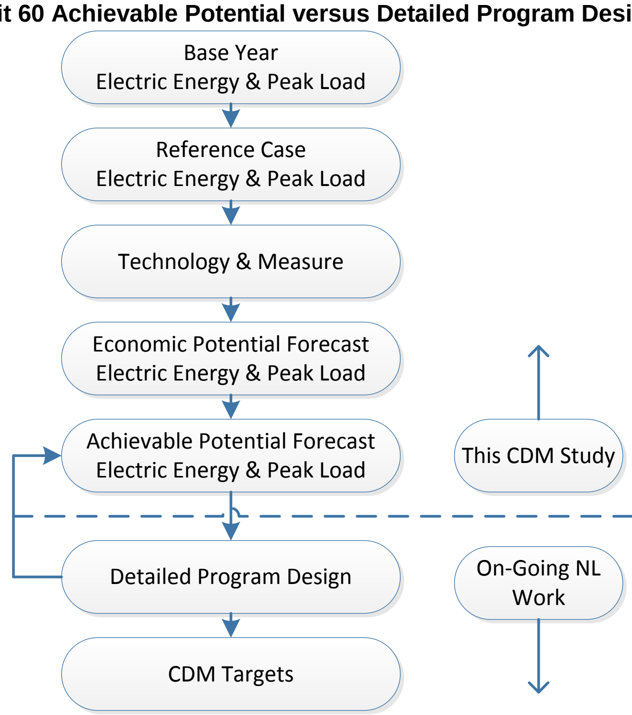
The upper Achievable Potential assumes NL market conditions that aggressively support investment in energy efficiency. For example, this scenario assumes that real electricity prices increase over the study period. It also assumes that federal and provincial government actions to mitigate climate change 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 60 illustrates the relationship between Achievable Potential and the more detailed program design.

Exhibit 60 Achievable Potential versus Detailed Program Design



This study examined more than 80 technologies applicable to residential 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 NL, 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 NL climate, on the costs in the NL 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 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. Several criteria determined selection, including:

- The priority measures should represent a substantial fraction of the overall economic potential
- The priority measures should represent several different energy end uses
- 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, is provided in Exhibit 61.

Exhibit 61 Residential Sector Actions – Energy Efficiency

Measure #	Measure	End Use	Percentage of 2029 Economic Potential	
			Consumption Savings	Demand Savings
R1	Basement Insulation	Space Heating, Ventilation	13%	0%
R2	Mini-Split Heat Pumps	Space Heating	22%	0%
R3	High-Perf. New Homes	HVAC, Lighting, DHW	0%	0%
R4*	Cycling (DHW, Electric, Heat Pump, Dual Fuel)	DHW/Space Heating*	0%	91%
R5*	Electric Thermal Storage (Baseboard/Central)	Space Heating*	0%	0%
R6	Air Sealing (Professional/Homeowner)	Space Heating, Ventilation	1%	0%
R7	Low-Flow Faucets, Ultra Low-Flow Showerheads, Faucet Aerators	DHW	4%	0%
R8	Behavioral (Refrigerator Retirement, Minimize Hot Wash, Clothes Lines)	Refrigerator/DHW/Clothes Dryers	18%	0%
R9	Efficient & Super Efficient Clothes Washers	DWH, Clothes Washers, Clothes Dryers	2%	0%
Grand Total			**62%**	**91%**

* 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 61, in the form of PowerPoint slides. The slides are presented in Appendix G.

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 Dwelling Type and Typical Application —** highlights the dwelling types 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 an estimate of the number of dwellings or appliances that could be affected during the study period if the entire Economic Potential were to be captured.
- **Economic Potential versus Time —** shows the pattern of the changing size of the opportunity over the study period, for existing and new dwellings. Some opportunities grow steadily through the study period, as more and more appliances reach the age when they would be replaced. Other opportunities are economic to capture immediately, and after that the growth over time is limited to opportunities in new dwellings being built. Still other 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 (CCE) —** 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. In the case of demand measures, the Cost of Electricity Peak Reduction (CEPR), per kW, replaced the levelized cost of saving a kWh of electricity.
- **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. This provided an important reference point for the workshop participants when considering potential participation rates. When combined with the preceding CCE or CEPR information, participants were able to roughly estimate the level of financial incentives that could be employed to increase the opportunity's attractiveness to customers without making it economically unattractive to the Newfoundland utilities.
- **Economic Potential in Terms of Applicable Participants (e.g., number of dwellings) —** shows the total number of potential participants in terms of either dwellings or appliances (as appropriate) that could theoretically take part in the opportunity. Numbers shown are from the eligible populations used in the Economic Potential Forecasts.

- **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 (usually 2029, but may be earlier for measures that peak earlier).

- **Achievable Potential in Terms of Applicable Participants (e.g., number of dwellings) —** 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 dwelling types, 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 21, 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 residential 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?

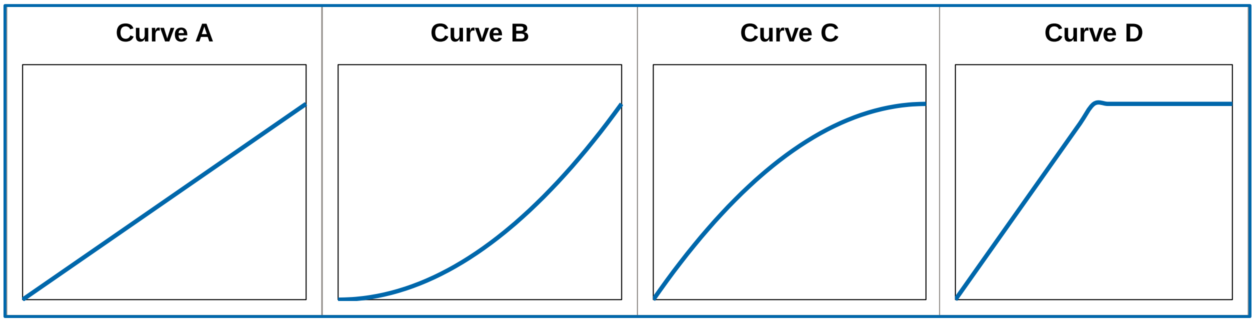
Following discussion of market constraints and potential intervention strategies, the participants' views on potential participation rates were recorded. The process involved the following steps:

- 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 62 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 62 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 the results of the individual opportunities to provide a view of the potential Achievable in both the Residential and Commercial sectors.

9.4 Achievable Workshop Results

The following sub-sections present a summary of the workshop discussions for each of the residential opportunities listed in Exhibit 61 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 Basement Insulation

Achievable workshop participants provided 2029 participation rate estimates of 35% for the upper Achievable Potential scenario and 5-10% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be B, while in the lower Achievable Potential scenario it would most likely be A.

Barriers that tend to lower adoption included the cost of insulation and basement finishing, low awareness of savings potential from basement insulation, as well as difficulties with the practicalities and logistics of implementing a large insulation project. NL has many do-it-yourselfers, who tend to postpone a project of this size. On the other hand, an aging population requires access to contractors, which can be limited outside of the Avalon Peninsula. Concerns were raised about insulation projects being completed incorrectly, installation in homes without ventilation systems, which could exacerbate moisture problems, and completed projects not being properly inspected. Additionally, the disruption caused by undertaking a large basement project could negatively affect participation, particularly for elderly occupants.

Potential strategies for addressing the market barriers include working with home inspectors during home purchases to explain where the best potential is and encourage basement insulation projects when the basement is empty during owner changeovers. Any techniques the utility could use to educate homeowners (and renters) and minimize the effort and disruption of the project would increase adoption. Energy audits could be paid for by the utility, and utilities could consider managing a list of contractors to complete the work. The cost savings due to improved insulation should be highlighted, and a split incentive for renters and landowners should be considered to increase adoption in rental units.

The initial discussion focused on existing single detached homes on the Island. Participants believed participation would be somewhat lower in attached homes and apartments, as well as all dwellings in Labrador and isolated regions due to reduced availability of contractors and materials. Participants also discussed some of the other insulation measures briefly. Improvements of crawl space insulation was thought likely to proceed similarly to basement insulation; wall insulation was deemed to be more difficult to implement and would be adopted less frequently; and attic insulation was thought likely to be adopted more often than basement insulation.

9.4.2 Ductless Mini-Split Heat Pumps

Achievable workshop participants provided 2029 participation rate estimates of 60% for the upper Achievable Potential scenario and 30% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in both Achievable Potential scenarios would be B, and that mini-split heat pumps will be important in the reference case within 15 years.

Barriers that tend to lower adoption included the high cost, unit aesthetics, limited availability of qualified installers and the related variation in user satisfaction with the technology. The cost of materials and installation were estimated to be higher than those provided by the utility; participants estimated costs of around $6,000 - $8,000 total for multiple units, installed. Participants noted the technology must be selected and installed appropriately to ensure customer satisfaction. For example, low quality units may not perform well at low temperatures, improper heat loss calculations can lead to incorrect unit sizing, and homes with multiple heat sources should have the effects of these sources included in the overall heating design approach.

Potential strategies for addressing the market barriers include offering financing to mitigate high up-front costs and insisting on licensed installation to ensure the technology is applied appropriately. Proper installation can help to ensure users have and share positive experiences with the technology. These testimonials, paired with educating customers on product benefits to comfort and the additional function of air conditioning, can increase measure adoption and overcome reluctance to adopt a new technology.

The initial discussion focused on existing single detached homes on the Island grid. Participants believed participation would be somewhat lower in apartments and somewhat higher in new homes. In Labrador and isolated communities, participation would be lower because of the difficulty of finding materials and qualified installers in these communities. Participants also discussed some of the other heat pump measures briefly. Adoption of air-source, cold climate and air-to-water heat pumps were thought likely to proceed somewhat more slowly than adoption of mini-split heat pumps since all require additional materials, such as ducting or a radiant distribution system.

9.4.3 High-Performance New Homes

Achievable workshop participants provided 2029 participation rate estimates of 80% for the upper Achievable Potential scenario and 65% 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.

Barriers that tend to lower adoption included implementation cost, knowledge on the part of consumers and lack of builder experience in building and selling homes beyond the building code requirements. Home owners tend to not stay in the same home long enough to justify the initial costs of high-performing homes unless the home resale value is accordingly higher. Therefore, it is imperative to promote the value of the home rating system in terms of energy cost savings and improved comfort so subsequent buyers also understand the value of the improvements. Government labelling of high-performing homes could also offer useful differentiation; home certification could be subsidized and included in the program. Informing customers about the benefits could encourage homebuilders to create high-performance homes to meet the demand.

For program planning, the participants suggested increasing the performance requirements from an EnerGuide rating of 80 to 83, based on workshop participant understanding of the Nova Scotia ENERGY STAR® qualified New Home Construction program.[33] To achieve an EnerGuide rating of 80, participants typically see homes with rigid wall insulation, improved basement and attic insulation levels over code requirements and an HRV. To achieve a higher rating, in the mid-80s, homes generally need to also have a heat pump installed. Additionally, it was noted that rural new construction is typically not built to code, so overall energy savings could be greater if high-performance homes were implemented successfully in those jurisdictions.

There was some discussion in the workshop session about the percentage energy savings used to evaluate this measure. In the model, a base case energy performance of EnerGuide 76 was assumed for average newly constructed homes, based on data in the Residential End Use Survey and information on typical construction practices provided by client staff. Based on the discussions in the workshop, there is some uncertainty about whether average new homes in NL would be rated that high. If an EnerGuide rating closer to 70 is more accurate, the savings for this measure would be larger.

The initial discussion focused on existing single detached homes in the Island grid. Participants believed participation would be the same for attached homes and lower in Labrador and Isolated communities. Participants also discussed some of the other measures in the new construction

[33] The Efficiency Nova Scotia New Home Construction program considers homes that meet ENERGY STAR® high efficiency requirements and those that have an EnerGuide rating of 85 or higher, R2000 certification or Passive House certification.

categories. Both net-zero homes and LEED apartments were expected to be adopted at a rate lower than that of high-performance new homes.

9.4.4 Heat Cycling

Achievable workshop participants provided 2029 participation rate estimates of 2% for the upper Achievable Potential scenario and no participation for the lower Achievable Potential scenario. Participants thought the most likely adoption curve would be A.

Barriers that tend to lower adoption included customer comfort, loss of temperature control and the necessity for high value incentives. Unless a home has a secondary heating fuel available, adoption rates would be nominal based on comfort alone. Additionally, workshop participants warned that some customers might participate in a heat cycling program for the incentive but install portable heaters to meet their heating requirements, undermining any peak demand savings to the utility. Since the measure is invasive and there are no time-of-use rate charges to customers, a large incentive would be required to encourage participation—an incentive likely larger than its value to the utility, particularly when the cost of cycling equipment and its installation are included.

The initial discussion focused on existing single detached homes in the Island grid. Participants believed participation would be essentially the same across dwelling types and regions. Participants also discussed some of the other cycling measures. Heat cycling in homes with a secondary heating fuel available was expected to be adopted at a much higher rate. DHW cycling was also expected to have much higher adoption rates since the effects would likely go unnoticed by participants with hot water storage tanks. Newfoundland Power has run a pilot program on DHW cycling and was able to provide crucial insight, after the workshop, on likely uptake of a full-scale program targeting that technology.

9.4.5 Electric Thermal Storage

Achievable workshop participants provided 2029 participation rate estimates of 1% for the upper Achievable Potential scenario and no participation for the lower Achievable Potential scenario.

Barriers that tend to lower adoption included the lack of financial incentive for customers to install the unit and aesthetics. Newfoundland does not currently use customer time-of-use rates, so there is no incentive for a customer to shift their peak electrical load. Unless the utility is willing to pay for the whole project cost, there is no reason a customer would implement this measure. The utilities would need to implement time-of-use rates, and upgrade current meters accordingly, in order for this measure to be considered by the customer.

The initial discussion focused on electric thermal storage units with baseboard heaters in existing single detached homes on the Island grid. Participants believed participation would be the same across dwelling types and regions. Participation in a program for a central electric thermal storage unit were estimated to be lower.

9.4.6 Air Sealing

The workshop principally considered homeowner air sealing projects over professionally completed work due to the difference in pricing. Achievable workshop participants provided 2029 participation rate estimates of 65% for the upper Achievable Potential scenario, which assumes a bundling of energy efficiency projects with a home energy audit, and 20% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be A.

Barriers that tend to lower adoption included the lack of homeowner knowledge of leakage areas or awareness of the importance of sealing, as well as the lack of confidence or physical ability to properly complete the project. Without education, the project could be completed incorrectly: sealing would be limited to the “usual suspect” areas, sealing could exacerbate the problem if done incorrectly or the home could be made too tight, which could cause other issues in a home without an HRV. Additionally, homeowners could risk personal injury if they are not physically able to complete the project safely.

Strategies to encourage adoption of homeowner air sealing would include education and demonstrations since cost is not a main barrier. Instructional videos could be made available online, and prepackaged kits with an instructional video to show installation could improve results. Additionally, a home energy audit could be conducted including a blower door test to pinpoint leakage areas. An energy audit approach could be effective at education and would work best with a bundle of envelope measures to justify its cost.

The initial discussion focused on existing single detached homes on the Island grid. Participants believed participation would be somewhat lower in attached homes and apartments. Participation in Labrador was believed to be the same, but lower in the Isolated region where most homes are not electrically heated. Participants also discussed some of the other sealing measures. Weather-stripping maintenance was thought to have similar adoption rates, whereas professional air sealing and a combined air sealing and attic insulation in old (pre-1980) homes measure would have lower participation due to their higher cost.

9.4.7 Low-Flow Water Fixtures

Achievable workshop participants provided 2029 participation rate estimates of 20% for the upper Achievable Potential scenario and 5% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be A.

Barriers that tend to lower adoption included a poor perception of low-flow showerheads and a lack of appreciation for the effect water fixtures have on DHW usage. Low-flow showerheads have historically been perceived to deliver a poor quality shower; improvements to the technology have not completely removed that perception, which could partially explain why 1.25 gpm showerheads are rarely available in the province. Participants also pointed out that low-flow can mean different thresholds for different certifications and consumers cannot always differentiate. The low-flow showerhead measure will never capture those who want rainwater showerheads or those who remove flow restrictors. For faucets, most models already have aerators. In general, customers think that water fixtures most affect water usage, a resource not metered in Newfoundland, and neglect the cost of heating the water.

Strategies to encourage adoption of low-flow water fixtures include educating customers on the cost savings associated with heating less water, distinguishing truly water-saving fixtures from imitations, potentially creating a low-flow kit and directly installing the products.

The initial discussion focused on ultra low-flow showerheads in existing single detached homes on the Island grid. Participants believed participation would be somewhat lower in attached homes and apartments. Participants thought adoption would be the same for homes on the Labrador grid and lower in isolated communities. Washroom faucets would likely have lower adoption due to the higher cost of replacing the full fixture, and kitchen faucet aerators would have higher adoption than showerheads.

9.4.8 Behavioral Measures

Achievable workshop participants first focused on the potential for using clothes lines instead of clothes dryers and then expanded the conversation to refrigerator retirement and minimizing hot water clothes washes. For clothes lines, participants provided 2029 participation rate estimates of 10% for the upper Achievable Potential scenario and no participation above the reference case for the lower Achievable Potential scenario. For refrigerator retirement, participants provided 2029 participation rate estimates of 60% for the upper Achievable Potential scenario and 30% for the lower Achievable Potential scenario. Participation rates for minimizing hot water washing would fall between those rates provided for clothes lines and refrigerator retirement. For all measures, participants thought the most likely adoption curve would be A.

Barriers that tend to lower adoption of clothes lines include subdivision covenants disallowing them and weather constraints. Increasing clothes line use is limited to the number of days when weather is appropriate for outdoor clothes drying, unless a covered space outdoors is available. Using a drying rack inside essentially uses electric heat to dry the clothes and can cause indoor air quality issues, so there is little incentive to encourage this behavioral change. Participants largely perceive that those who can and would already do use clothes lines, and that there is little room for improvement. An education campaign could moderately increase participation.

Barriers to minimizing hot clothes washing include a concern for germs or dust mites and a perception that Newfoundland water is too cold, so a moderate amount of hot water is added even for the cold water wash. Participants agreed that customers generally tend to use hot water to wash bed sheets, but rarely for clothes. Education could capture those who use hot or warm wash for clothing.

Barriers that tend to lower retirement of a second refrigerator include the difficulty of physically removing the refrigerator and properly disposing of it, as well as an ingrained “shed culture” that can include a second refrigerator if the shed has access to electricity. Strategies to encourage removal may include working with retailers to educate consumers about the program and coordinating with service districts to offer free refrigerator removal and disposal. To overcome the “shed” refrigerator phenomenon, the younger generation raised in a recycling culture could be leveraged to encourage older generations to remove extra refrigerators. The cost to operate them is rarely the key factor in removal decisions.

The initial discussion focused on existing single detached homes on the Island grid. Participants noted that the adoption rate for attached homes and apartments would likely be lower since there are fewer opportunities for clothes lines, second refrigerators and, in the case of apartments, individual clothes washer units. Homes in Labrador would have a similar adoption rate, whereas those in isolated communities would have higher rates of adoption due to higher sensitivity to electricity costs.

9.4.9 High Efficiency Clothes Washers

Achievable workshop participants provided 2029 participation rate estimates of 20% for the upper Achievable Potential scenario and 10% for the lower Achievable Potential Scenario. Participants thought the most likely adoption curve both scenarios would be A.

Barriers that tend to lower adoption include a high first cost, lack of engaged retailers and low awareness of the electricity cost of a wash of clothes. The current program relies heavily on retailers effectively educating customers on which models qualify for an incentive, since the program does not reference a standard, such as ENERGY STAR® or CEE. At the same time, the existing program offers an incentive exclusively to customers, not to the retailers. Indeed, working with retailers was noted as the most critical program support action for increased adoption of this measure.

Strategies to encourage adoption of high efficiency clothes washers could include incentives to retailers, a program based on a clear standard instead of "qualifying models" and education programs aimed at consumers to increase awareness of the electricity cost of clothes washers (including drying). It was noted that clothes washers are one of the products with the largest uptake in the current Newfoundland TakeCharge program. It should also be noted that the current program does use a clear standard for clothes washers, but the standard is not referenced in marketing materials, because in the past it has caused confusion and rebate rejection among customers. The qualifying model approach was found to be superior.

The initial discussion focused on existing single detached homes on the Island grid. Participants expected adoption to be higher in new homes, but lower in attached homes and apartments. Lower participation rates were expected in Labrador and Isolated regions due to decreased product accessibility.

Participants discussed some of the other high efficiency appliance measures. Adoption rates of ENERGY STAR® refrigerators and freezers were expected to be lower, whereas ENERGY STAR® dishwashers were expected to have higher adoption rates than high efficiency clothes washers.

9.4.10 Aggregate Results

Exhibit 63 summarizes the participant rate and "ramp up" curve assumptions discussed above.

Exhibit 63 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
R1: Basement Insulation	25%	Curve A	35%	Curve B
R2: Mini-Split Heat Pumps	30%	Curve B	60%	Curve B
R3: High-Perf. New Homes	52%	Curve A	64%	Curve A
R4: Cycling (DHW, Electric, Heat Pump, Dual Fuel)	5%	Curve A	10%	Curve A
R5: Electric Thermal Storage (Baseboard/Central)	0%	N/A	0%	N/A
R6: Air Sealing (Professional/Homeowner)	20%	Curve A	65%	Curve A
R7: Low-Flow Faucets, Ultra Low-Flow Showerheads, Faucet Aerators	5%	Curve A	20%	Curve A
R8: Behavioral (Refrigerator Retirement, Minimize Hot Wash, Clothes Lines)	0% (Clothes Lines) 15% (Hot Wash) 30% (Fridge)	Curve A	10% (Clothes Lines) 35% (Hot Wash) 60% (Fridge)	Curve A
R9: Efficient & Super Efficient Clothes Washers	20% (Efficient) 10% (Super)	Curve A	40% (Efficient) 20% (Super)	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 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 that included all of the eligible technologies.

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 64 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 64 Electricity Savings by Milestone Year for Three Scenarios (GWh/yr.)

Year	Economic Potential		Upper Achievable		Lower Achievable	
	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	1,336	31%	63	1.5%	28	0.6%
2020	1,378	32%	157	3.6%	78	1.8%
2023	1,411	31%	286	6.4%	151	3.4%
2026	1,455	32%	456	10%	244	5.3%
2029	1,485	32%	650	14%	336	7.2%

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 64 are summarized below. Further detail is provided in the following sub-sections and in the accompanying appendices.

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, 24% of the 2029 savings would be achieved by 2020, rising to 44% in 2023 and 70% by 2026. In the lower Achievable Potential scenario, 8% of the 2029 savings would be achieved by 2020, rising to 45% in

2023 and 72% 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 Dwelling Type

Single-family dwellings account for approximately 93% 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 dwelling. In fact, the subset of single-family dwellings predominantly heated by electricity account for 85% of the 2029 upper Achievable Potential and 88% of the 2029 lower Achievable Potential. This reflects the new construction expected during the study period and the substantial amount of electric heat these new dwellings are expected to include.

Savings by Region

The Island Interconnected region accounts are expected to comprise 95% of potential savings in 2029. The Labrador Interconnected region accounts provide 4%, and the Isolated region provides 1% of the potential savings in 2029.

Savings by End Use

Space heating savings account for 71% of the upper Achievable Potential savings in 2029 and 78% of the lower Achievable Potential savings. The most significant measures that save space heating include ductless mini-split heat pumps, basement and crawl space insulation, attic sealing and insulation of old (pre-1980) homes, attic insulation and door systems.

Space heating accounts for a very large percentage of the potential, but the space heating savings potential is also a very large percentage of the reference case space heating consumption. Between 12% and 20% of space heating could potentially be saved, respectively, in the lower and upper Achievable Potential scenarios. The potential in electrically-heated dwellings, as a percentage of their reference case consumption, is just over two times as large as it is in dwellings without electric heat.

Domestic hot water savings account for 7% of 2029 upper Achievable Potential savings and 5% of lower Achievable Potential savings. The measure that saves the most domestic hot water is the behavioral measure to minimize the use of hot water when washing clothes.

Refrigerators account for approximately 6% of 2029 savings, televisions and their peripherals account for approximately 3-4%, and clothes dryers account for 2-4%. The reduction in refrigerator electricity comes principally from retiring second (and third) refrigerators, as well as a small portion is attributed to increasing refrigerator temperature set points to the recommended storage temperature. The savings in televisions and their peripherals are expected to come primarily from the use of smart power bars that reduce standby losses. Clothes lines dominate the savings for clothes dryers in the upper Achievable Potential, whereas the dryer savings from efficient clothes washers dominate lower Achievable Potential savings. (Efficient clothes washers save a great deal of dryer energy because of their faster spin speeds.)

The remaining end uses are all under 3% in both scenarios. There are savings available in 14 other end uses. Together they account for approximately 8% of upper Achievable Potential savings in 2029 and approximately 6% of lower Achievable Potential savings in 2029.

Savings by Measure

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

- Ductless mini-split heat pumps, which account for 39% of the upper Achievable Potential savings in 2029 and 40% of the lower Achievable Potential savings in 2029
- Basement insulation, which accounts for nearly 10% of the upper Achievable Potential savings in 2029 and 14% of the lower Achievable Potential savings in 2029
- Crawl space insulation, which accounts for 8.5% of the upper Achievable Potential savings in 2029 and nearly 12% of the lower Achievable Potential savings in 2029
- Attic sealing and insulation of old (pre-1980) homes, which accounts for 7.4% of the upper Achievable Potential savings in 2029 and 4.4% of the lower Achievable Potential savings in 2029
- Refrigerator retirement, which accounts for 5.7% of the upper Achievable Potential savings in 2029 and 5.5% of the lower Achievable Potential savings in 2029
- Attic insulation, which accounts for 3.1% of the upper Achievable Potential savings in 2029 and 4.3% of the lower Achievable Potential savings in 2029
- Minimize hot water clothes wash, which accounts for 3.8% of the upper Achievable Potential savings in 2029 and 3.2% 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[34] under the upper Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 65 presents the results by region and by milestone year
- Exhibit 66 presents the results for the total NL service territory by dwelling type and milestone year
- Exhibit 67 presents the results for the total NL service territory by end use and milestone year
- Exhibit 68 presents the results for the total NL service territory by technology and milestone year.

Exhibit 65 Upper Achievable Electricity Savings by Region (MWh/yr.)

Region	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Island Interconnected	60,930	150,463	274,926	437,615	621,508	15%	96%
Labrador Interconnected	1,481	4,645	8,407	14,114	22,015	6%	3%
Isolated (Diesel)	723	1,638	2,832	4,363	6,187	14%	1%
Grand Total	63,135	156,746	286,164	456,092	649,710	14%	100%

[34] Note: A value of “0” in the following exhibits means a relatively small number, not an absolute value of zero.

Exhibit 66 Upper Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Apartment, electric space heat	1,649	3,347	5,290	7,329	9,303	3%	1%
Apartment, non-electric space heat	72	116	202	278	329	2%	0%
Attached, electric space heat	3,791	8,049	13,295	20,351	28,796	5%	4%
Attached, non-electric space heat	442	825	1,255	1,706	2,309	6%	0%
Other and non-dwellings	423	866	1,443	2,291	3,196	3%	0%
Single-family detached, electric space heat	46,779	124,913	236,531	385,503	553,925	20%	85%
Single-family detached, non-electric space heat	9,658	18,019	27,225	37,363	50,241	7%	8%
Vacant and partial	321	612	922	1,271	1,611	2%	0%
Grand Total	63,135	156,746	286,164	456,092	649,710	14%	100%

Note: Any difference in totals is due to rounding.

Exhibit 67 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
Space heating	29,570	92,975	188,075	311,525	464,149	20%	71%
Domestic Hot Water (DHW)	8,569	16,993	25,827	36,754	46,039	8%	7%
Refrigerator	7,474	15,137	22,980	30,780	38,554	18%	6%
Clothes dryer	3,833	7,050	10,810	19,633	26,239	11%	4%
Television	4,410	8,388	13,007	18,130	23,475	12%	4%
Computer and peripherals	2,782	5,162	8,627	14,422	17,978	7%	3%
Lighting	3,481	5,504	7,146	8,549	9,799	8%	2%
Ventilation	616	1,518	2,999	6,929	11,828	14%	2%
Hot tubs	1,248	1,829	2,722	3,575	4,443	6%	1%
Television peripherals	450	936	1,466	2,024	2,600	3%	0%
Dehumidifier	166	269	869	1,321	1,467	2%	0%
Cooking	197	391	588	784	987	1%	0%
Freezer	130	230	526	757	1,014	1%	0%
Other electronics	132	278	440	613	797	2%	0%
Clothes washer	37	33	44	251	358	4%	0%
Dishwasher	21	43	65	87	109	1%	0%
Block heaters & car warmers	9	18	28	93	119	8%	0%
Space cooling	10	(8)	(56)	(135)	(245)	-12%	0%
Grand Total	63,135	156,746	286,164	456,092	649,710	14%	100%

Notes: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Space cooling has negative savings in some milestone years because the adoption of mini-splits and other heat pumps is assumed to introduce some new cooling consumption for customers who did not have air conditioning before.

Any difference in totals is due to rounding.

Exhibit 68 Upper Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

Measure	Year					Adoption Curve	Weighted Average CCE (¢/kWh)		
	2017	2020	2023	2026	2029		Island	Labrador	Isolated
Refrigerator Retirement	7,093	14,387	21,882	29,363	36,850	A	0	0	0
Min Hot Wash	4,957	9,961	15,028	19,871	24,626	A	0	0	0
Overnight Setback	3,277	6,559	9,698	12,372	14,451	A	0	0	0
Weather Stripping Maintenance	2,568	4,982	7,135	8,921	10,270	A	0	0	0
Close Blinds	2,048	4,121	6,130	7,869	9,257	A	0	0	0
Daytime Setback	1,963	3,928	5,806	7,402	8,641	A	0	0	0
DHW Temperature	605	1,215	1,833	2,424	3,004	A	0	0	0
Turn Off TVs	353	733	1,144	1,570	2,015	A	0	0	0
Clothes Dryer Sensor	356	736	1,143	1,523	1,919	A	0	0	0
Refrigerator Temperature	381	744	1,088	1,401	1,685	A	0	0	0
Unplug Chargers	132	278	440	613	797	A	0	0	0
Min Outdoor Lighting	140	265	405	548	710	A	0	0	0
PC Power Management	99	223	366	516	680	B	0	0	0
Freezer Temperature	110	222	335	448	560	A	0	0	0
Turn Off Lights	12	19	26	33	40	A	0	0	0
AC Temperature	24	50	81	116	157	A	0	N/A	N/A
Clothes Lines	3,000	6,151	9,467	12,504	15,625	A	0.5	0.5	0.5
Faucet Aerator	492	1,021	1,589	2,160	2,735	A/B	0.8	0.7	0.8
Showerheads	1,109	2,298	3,579	4,863	6,160	A	1.2	1.1	1.2
DHW Pipe Insulation	228	439	632	787	907	A/B	1.4	1.3	1.4
Prog. Thermostats (Central)	0	0	0	0	0	A	1.9	1.5	2.6
T8 Fixtures	1	2	3	5	7	B	2.4	2.4	2.4
Benchmarking	590	1,094	1,646	2,193	2,757	A/B	2.5	2.3	3.1
Hot Tub Covers	1,094	1,610	2,404	3,167	3,947	A	3.1	3.1	3.1
Door Systems	829	3,020	6,040	9,548	13,269	A	3.1	3.8	3.5
Crawl Space Insulation	2,084	8,827	19,866	35,342	55,268	A	3.6	4.2	4.1
LED Lamps	2,935	4,453	5,504	6,274	6,809	A	3.6	3.6	3.6
ECPM Fan Motors	214	538	1,278	4,341	8,236	A	4.6	6.1	14.5
Motion Detectors - Outdoor	209	454	771	1,122	1,521	A	4.8	3.8	4.1
Electronic Thermostats	85	288	765	1,294	2,080	A	5.2	4.9	10.3
ESTAR Dehumidifiers	53	42	520	848	863	A	5.6	5.6	5.6
ESTAR Freezers	18	5	183	296	434	A	5.8	5.8	5.8

Exhibit 68 Continued: Upper Achievable Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Year					Adoption Curve	Weighted Average CCE (¢/kWh)		
	2017	2020	2023	2026	2029		Island	Labrador	Isolated
Power Bars (TVs)	3,357	7,124	11,395	16,149	21,034	A	5.8	3.0	6.1
Basement Insulation	2,244	10,025	22,573	40,177	64,501	A	6.0	4.7	5.4
Faucets	720	1,511	2,385	3,282	4,210	A	6.3	1.0	7.2
Efficient Clothes Washers	580	89	118	8,106	12,151	A	6.4	6.2	18.0
ESTAR Computers	582	76	22	2,354	2,080	A	6.6	6.6	6.6
Attic Insulation	731	2,924	6,578	12,724	19,901	A	7.3	5.8	7.3
Power Bars (PCs)	2,101	4,863	8,239	11,552	15,218	A	7.6	3.9	8.4
Mini-Splits	10,149	40,865	93,543	165,980	256,364	A	8.0	N/A	8.7
Prog. Thermostats	173	319	451	576	668	A	8.0	5.2	13.4
ESTAR TVs	1,059	1,278	1,642	2,036	2,513	A	8.0	N/A	8.0
Super Efficient Clothes Washers	134	154	177	195	217	A	9.6	N/A	20.2
DHW Tank Insulation	243	467	672	837	964	A	10.3	N/A	10.9
Timers - Outdoor	184	310	432	558	699	A/B	11.0	N/A	11.0
Air Sealing	2,387	4,774	7,161	9,552	11,947	A	12.4	N/A	15.0
Sealing & Insul. - Old Homes	9,749	19,462	29,138	38,797	48,435	A	12.5	N/A	15.7
Car Warmer Timers	9	18	28	39	49	A	N/A	0.9	N/A
Block Heater Timers	-	-	-	54	69	B	N/A	5.9	N/A
Cold Climate Heat Pump	1	5	12	22	34	A	N/A	N/A	12.5
Super Efficient Freezers	1	4	8	13	20	A/B	N/A	N/A	14.5
ESTAR Dishwashers	0	1	3	5	5	A	N/A	N/A	14.5
Air-Source Heat Pump	3	11	28	55	92	A	N/A	N/A	17.0
ESTAR Windows	17	0	1	3	7	A	N/A	N/A	17.0
High-Perf. New Homes	13	43	116	223	362	A	N/A	N/A	17.7
Super Efficient Refrigerators	-	6	10	15	20	B	N/A	N/A	23.5
Air-to-Water Heat Pumps	-	24	62	120	202	A	N/A	N/A	24.2
Super Windows	-	1	3	4	6	A	N/A	N/A	25.5
Motion Detectors - Indoor	-	-	3	3	4	A	N/A	N/A	26.4
HRVs	-	-	3	6	9	A	N/A	N/A	28.4
Professional Air Sealing	-	-	-	27	34	A	N/A	N/A	33.2
HVAC Impact from Other Savings	(8,362)	(16,274)	(25,425)	(37,103)	(48,384)				
Grand Total	63,135	156,746	286,164	456,092	649,710				

Note: Curves A and B in this exhibit are as presented in Exhibit 62.
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 68 provides results at a sufficient level of detail that some modeling issues require explanation:

- Some measures show an initially high potential, which then drops off in the second milestone period and begins to increase again towards the end of the study period. This is primarily caused by two details in the model. First, the avoided cost values for the Island Interconnected region, as shown in Exhibit 38, are projected to decrease dramatically after 2018 and then eventually rise again. This causes the adoption of some measures to halt temporarily in the middle of the study. For many measures, there is also an assumed rate of natural adoption in the reference case. For these measures, the reference case adoption may “catch up” to the adoption in the achievable potential scenario, reducing the potential shown by the model.
- In some cases, the potential shown in this exhibit is lower than for the same measure in Exhibit 72. 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 68 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 dwelling types and regions in which the measure is applied in this scenario. For most measures, the CCE varies by dwelling type and region, because of varying savings and costs. If the mixture of dwellings 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.
- The last measure in the table, HVAC Impact from Other Savings, accounts for the added load on the electric heating systems in dwellings where savings are occurring for many other end uses in the home. As discussed in Section 8.5.3, the savings for end uses such as lighting, appliances, and electronics are multiplied by a factor based on modeling of NL dwellings. The resulting heating penalty is added as a separate line item in this exhibit.

9.5.3 Electric Energy Savings – Lower Achievable Scenario

The following exhibits present the potential electricity savings[35] under the lower Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 69 presents the results by supply system, by region and milestone year
- Exhibit 70 presents the results for the total NL by dwelling type and milestone year
- Exhibit 71 presents the results for the total NL by end use and milestone year
- Exhibit 72 presents the results for the total NL by technology and milestone year.

Exhibit 69 Lower Achievable Electricity Savings by Region (MWh/yr.)

Region	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Island Interconnected	26,944	74,101	144,481	231,445	317,592	7%	95%
Labrador Interconnected	553	2,780	5,500	10,122	15,393	4%	5%
Isolated (Diesel)	300	717	1,297	2,074	3,035	7%	1%
Grand Total	27,797	77,598	151,279	243,641	336,020	7%	100%

[35] A value of “0” in the following exhibits means a relatively small number, not an absolute value of zero.

Exhibit 70 Lower Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2017	2020	2023	2026	2029	2029 Savings Relative to Ref Case	Percentage of Total 2029 Savings
Apartment, electric space heat	645	1,334	2,150	2,975	3,684	1%	1%
Apartment, non-electric space heat	29	44	78	109	129	1%	0%
Attached, electric space heat	1,665	3,877	6,816	10,428	14,529	3%	4%
Attached, non-electric space heat	175	321	491	674	939	2%	0%
Other and non-dwellings	201	460	831	1,291	1,653	2%	0%
Single-family detached, electric space heat	21,228	64,452	130,135	213,198	294,438	10%	88%
Single-family detached, non-electric space heat	3,727	6,867	10,411	14,453	19,994	3%	6%
Vacant and partial	128	242	367	512	654	1%	0%
Grand Total	27,797	77,598	151,279	243,641	336,020	7%	100%

Note: Any difference in totals is due to rounding.

Exhibit 71 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
Space heating	14,749	53,110	113,485	186,256	262,011	11%	78%
Refrigerator	3,713	7,528	11,440	15,340	19,236	9%	6%
Domestic Hot Water (DHW)	2,939	5,779	8,792	12,931	16,280	3%	5%
Television	1,973	3,706	5,734	7,989	10,357	5%	3%
Computer and peripherals	1,236	2,220	3,702	6,380	7,892	3%	2%
Lighting	1,632	2,544	3,250	3,828	4,316	3%	1%
Ventilation	300	829	1,725	3,822	6,236	7%	2%
Clothes dryer	417	449	672	3,575	5,329	2%	2%
Hot tubs	340	498	740	972	1,208	2%	0%
Television peripherals	193	401	629	870	1,118	1%	0%
Dehumidifier	75	119	410	628	693	1%	0%
Cooking	84	168	252	336	423	0%	0%
Freezer	57	99	239	347	468	0%	0%
Other electronics	57	119	189	263	342	1%	0%
Clothes washer	18	15	19	123	176	2%	0%
Dishwasher	9	19	28	37	47	0%	0%
Block heaters & car warmers	2	5	7	23	30	2%	0%
Space cooling	3	(8)	(36)	(80)	(141)	-7%	0%
Grand Total	27,797	77,598	151,279	243,641	336,020	7%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Space cooling has negative savings in some milestone years because the adoption of mini-splits and other heat pumps is assumed to introduce some new cooling consumption for customers who did not have air conditioning before.
Any difference in totals is due to rounding.

Exhibit 72 Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

Measure	Year					Adoption Curve	Weighted Average CCE (¢/kWh)		
	2017	2020	2023	2026	2029		Island	Labrador	Isolated
Refrigerator Retirement	3,546	7,193	10,941	14,682	18,425	A	0	0	0
Min Hot Wash	2,133	4,303	6,519	8,676	10,807	A	0	0	0
Overnight Setback	1,415	2,869	4,324	5,691	6,992	A	0	0	0
Close Blinds	884	1,801	2,728	3,607	4,451	A	0	0	0
Daytime Setback	848	1,718	2,588	3,405	4,182	A	0	0	0
Weather Stripping Maintenance	795	1,561	2,274	2,923	3,524	A	0	0	0
Clothes Dryer Sensor	178	368	572	771	978	A	0	0	0
Turn Off TVs	154	323	510	711	924	A	0	0	0
Refrigerator Temperature	166	331	495	651	801	A	0	0	0
Unplug Chargers	57	119	189	263	342	A	0	0	0
Min Outdoor Lighting	61	117	181	250	328	A	0	0	0
PC Power Management	43	95	157	222	292	A	0	0	0
Freezer Temperature	47	95	144	192	240	A	0	0	0
Turn Off Lights	5	8	11	14	18	A	0	0	0
AC Temperature	10	21	33	47	62	A	0	N/A	N/A
Faucet Aerator	123	255	397	540	684	A	0.8	0.7	0.8
Showerheads	277	575	895	1,216	1,540	A	1.2	1.1	1.2
DHW Pipe Insulation	57	110	158	197	227	A	1.4	1.3	1.4
Prog. Thermostats (Central)	0	0	0	0	0	A	1.9	1.5	2.6
T8 Fixtures	0	0	1	1	2	A	2.4	2.4	2.4
Benchmarking	253	471	710	949	1,196	A	2.4	2.3	3.1
Hot Tub Covers	273	402	601	792	987	A	3.1	3.1	3.1
Door Systems	828	3,017	6,034	8,592	9,649	A/B	3.1	3.8	3.5
Crawl Space Insulation	2,082	8,819	19,847	31,747	40,038	A/B	3.6	4.2	4.1
LED Lamps	1,467	2,226	2,752	3,137	3,405	A	3.6	3.6	3.6
ECPM Fan Motors	107	269	639	2,194	4,207	A	4.6	6.1	14.5
Motion Detectors - Outdoor	52	113	193	280	380	A	4.8	3.8	4.1
Electronic Thermostats	21	74	201	354	600	A	5.2	4.9	10.2
ESTAR Dehumidifiers	27	21	260	424	432	A	5.6	5.6	5.6
ESTAR Freezers	9	2	92	148	217	A	5.8	5.8	5.8
Power Bars (TVs)	1,443	3,064	4,905	6,957	9,071	A	5.8	3.0	6.1
Basement Insulation	2,241	10,011	22,542	36,293	47,561	A/B	6.0	4.7	5.4

Exhibit 72 Continued: Lower Achievable Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Year					Adoption Curve	Weighted Average CCE (¢/kWh)		
	2017	2020	2023	2026	2029		Island	Labrador	Isolated
Faucets	180	378	596	821	1,053	A	6.3	1.0	7.2
Efficient Clothes Washers	290	44	59	4,053	6,075	A	6.4	6.2	18.0
ESTAR Computers	291	38	11	1,177	1,040	A	6.6	6.6	6.6
Attic Insulation	730	2,920	6,570	11,461	14,503	A/B	7.3	5.8	7.3
Power Bars (PCs)	902	2,086	3,534	4,980	6,559	A	7.6	3.9	8.4
Mini-Splits	5,105	20,676	47,591	85,454	135,335	B	8.0	N/A	8.7
Prog. Thermostats	44	82	119	157	193	A	8.0	5.2	13.3
ESTAR TVs	530	639	821	1,018	1,257	A	8.0	N/A	8.0
Super Efficient Clothes Washers	67	77	89	99	112	A	9.6	N/A	20.2
DHW Tank Insulation	61	117	168	209	241	A	10.3	N/A	10.9
Timers - Outdoor	46	78	108	140	175	A	11.0	N/A	11.0
Air Sealing	735	1,469	2,203	2,939	3,676	A	12.4	N/A	15.0
Sealing & Insul. - Old Homes	3,004	6,003	8,999	11,998	14,997	A	12.5	N/A	15.7
Car Warmer Timers	2	5	7	10	12	A	N/A	0.9	N/A
Block Heater Timers	-	-	-	14	17	A	N/A	5.9	N/A
Cold Climate Heat Pump	1	3	6	11	18	B	N/A	N/A	12.6
Super Efficient Freezers	1	2	4	7	10	A	N/A	N/A	14.5
ESTAR Dishwashers	0	1	1	2	2	A	N/A	N/A	14.5
Air-Source Heat Pump	1	6	14	28	48	B	N/A	N/A	16.9
ESTAR Windows	17	0	1	2	5	A/B	N/A	N/A	17.0
High-Perf. New Homes	10	35	95	181	294	A	N/A	N/A	17.7
Super Efficient Refrigerators	-	3	5	8	10	A	N/A	N/A	23.5
Air-to-Water Heat Pumps	-	12	31	62	105	B	N/A	N/A	24.2
Super Windows	-	1	1	2	3	A	N/A	N/A	25.5
Motion Detectors - Indoor	-	-	1	1	1	A	N/A	N/A	26.4
HRVs	-	-	2	3	5	A	N/A	N/A	28.4
Professional Air Sealing	-	-	-	8	10	A	N/A	N/A	33.2
HVAC Impact from Other Savings	(3,825)	(7,431)	(11,651)	(17,129)	(22,297)				
Grand Total	27,797	77,598	151,279	243,641	336,020				

Note: Curves A and B in this exhibit are as presented in Exhibit 62.
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 68, Exhibit 72 provides results at a sufficient level of detail that some modeling issues require explanation:

- As explained following Exhibit 68, some measures show an initially high potential, which then drops off in the second milestone period and begins to increase again towards the end of the study period. As described before, this is primarily caused by the changing avoided cost values for the Island Interconnected region through the study period, and by the reference case adoption rates "catching up" to the adoption rates in the achievable potential scenario.
- In some cases, the potential shown in this exhibit is higher than for the same measure in Exhibit 68. 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 72 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 dwelling types and regions in which the measure is applied in this scenario.
- The last measure in the table, HVAC Impact from Other Savings, accounts for the added load on the electric heating systems in dwellings where savings are occurring for many other end uses in the home. As discussed in Section 8.5.3, the savings for end uses such as lighting, appliances, and electronics are multiplied by a factor based on modeling of NL dwellings. The resulting heating penalty is added as a separate line item in this exhibit.

9.6 Electric Peak Load Reductions from Energy Efficiency

Exhibit 73 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, region and dwelling type 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 74 and Exhibit 75 show the lower and upper Achievable Potential savings by region, dwelling type and principal end use for each milestone year.

Exhibit 73, Exhibit 74 and Exhibit 75 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. For example, most of the heat pump measures will not produce any peak demand savings, because during the winter peak period the heat pumps and mini-splits will revert to back-up electric resistance heating.[36] Therefore, there will be no net reduction in space heating peak demand for these measures. Accordingly, the demand reductions for the heat pump measures have been manually filtered out of the results presented in these exhibits.

Exhibit 76 shows the demand reductions associated with each electric energy savings measure contained in the Achievable Potential Forecast for the milestone year 2029. The heat pump measures are omitted from the exhibit, as with the previous two exhibits. One notable line item in the exhibit is "HVAC Impact from Other Savings" - the impact on peak space heating load resulting from the savings for other end uses within the dwelling. This is to capture the fact that in an electrically-

[36] In fact, this is a conservative assumption for the Island Interconnected region. Although the demand peak occurs on the coldest winter days, in a climate such as that of St. John's the temperature is typically not very extreme on those peak days. Therefore, many heat pumps will continue to work in heat pump mode and not revert to electric resistance. In this study, we have retained the conservative assumption that they do not provide demand relief.

heated dwelling, savings of energy consuming devices within the home will not reduce the winter peak demand. The impact of demand reductions for other end uses on the space heating demand can be seen graphically in Exhibit 74. As the demand impacts for many of the other end uses rise with time, the demand impacts for space heating actually decreases over time.

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

Exhibit 73 Electric Peak Load Reductions from Upper and Lower Achievable Potential Energy Savings Measures by Milestone Year, Region and Dwelling Type (MW)

Housing Categories	Milestone Years	Island Interconnected		Isolated		Labrador Interconnected		Grand Total	
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Single Family Dwellings	2017	4.8	10.4	0.1	0.1	0.1	0.2	4.9	10.8
	2020	12.9	23.9	0.1	0.3	0.6	0.8	13.7	25.1
	2023	24.5	40.9	0.2	0.5	1.3	1.6	26.0	43.0
	2026	37.2	62.2	0.4	0.7	2.4	3.0	40.0	65.9
	2029	46.4	85.6	0.5	1.0	3.4	4.5	50.3	91.0
Attached Houses	2017	0.3	0.7	-	-	0.0	0.1	0.3	0.7
	2020	0.8	1.5	-	-	0.1	0.2	0.9	1.7
	2023	1.5	2.6	-	-	0.1	0.3	1.6	2.8
	2026	2.3	4.0	-	-	0.2	0.4	2.5	4.4
	2029	2.9	5.5	-	-	0.7	1.0	3.6	6.6
Apartments	2017	0.2	0.4	-	-	0.0	0.0	0.2	0.4
	2020	0.3	0.8	-	-	0.0	0.0	0.3	0.8
	2023	0.5	1.3	-	-	0.0	0.0	0.5	1.3
	2026	0.7	1.7	-	-	0.0	0.0	0.7	1.8
	2029	0.9	2.2	-	-	0.0	0.1	0.9	2.2
Other, Vacant and Partial	2017	0.08	0.17	0.00	0.00	0.00	0.01	0.1	0.2
	2020	0.18	0.37	0.00	0.01	0.01	0.02	0.2	0.4
	2023	0.32	0.60	0.01	0.01	0.01	0.03	0.3	0.6
	2026	0.47	0.88	0.01	0.02	0.01	0.04	0.5	0.9
	2029	0.59	1.19	0.02	0.03	0.02	0.05	0.6	1.3
Grand Total	**2017**	5.3	11.6	0.1	0.1	0.1	0.3	5.5	12.1
	2020	14.2	26.6	0.1	0.3	0.7	1.1	15.1	28.0
	2023	26.9	45.3	0.2	0.5	1.4	2.0	28.5	47.7
	2026	40.7	68.8	0.4	0.7	2.7	3.5	43.7	73.0
	2029	50.8	94.5	0.5	1.0	4.1	5.6	55.4	101.1

Exhibit 74 Electric Peak Load Reductions from Upper Achievable Potential Energy Savings Measures, by Milestone Year End Use and Dwelling Type, Winter Peak Period (MW)

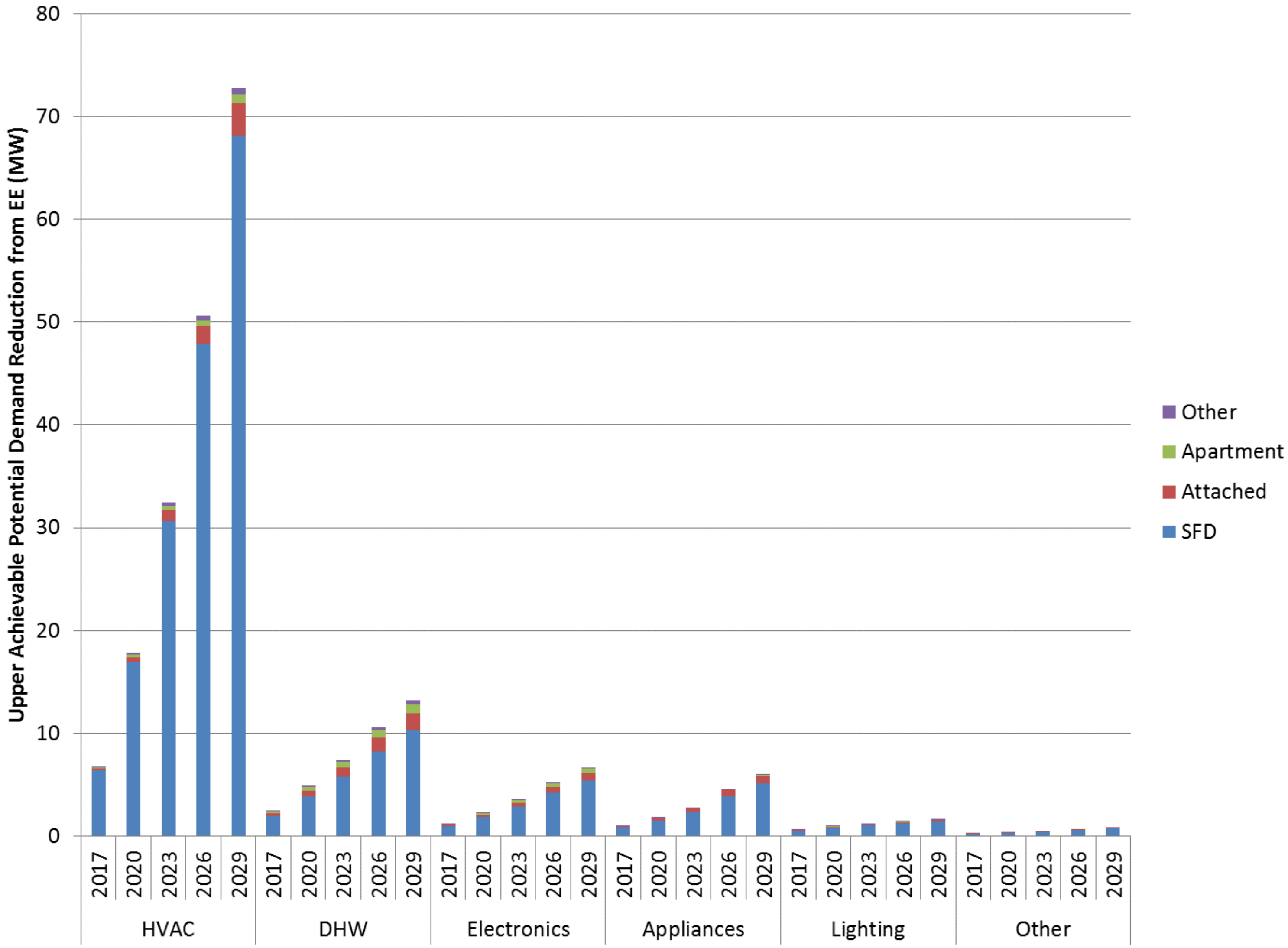


Exhibit 75 Electric Peak Load Reductions from Lower Achievable Potential Energy Savings Measures, by Milestone Year End Use and Dwelling Type, Winter Peak Period (MW)

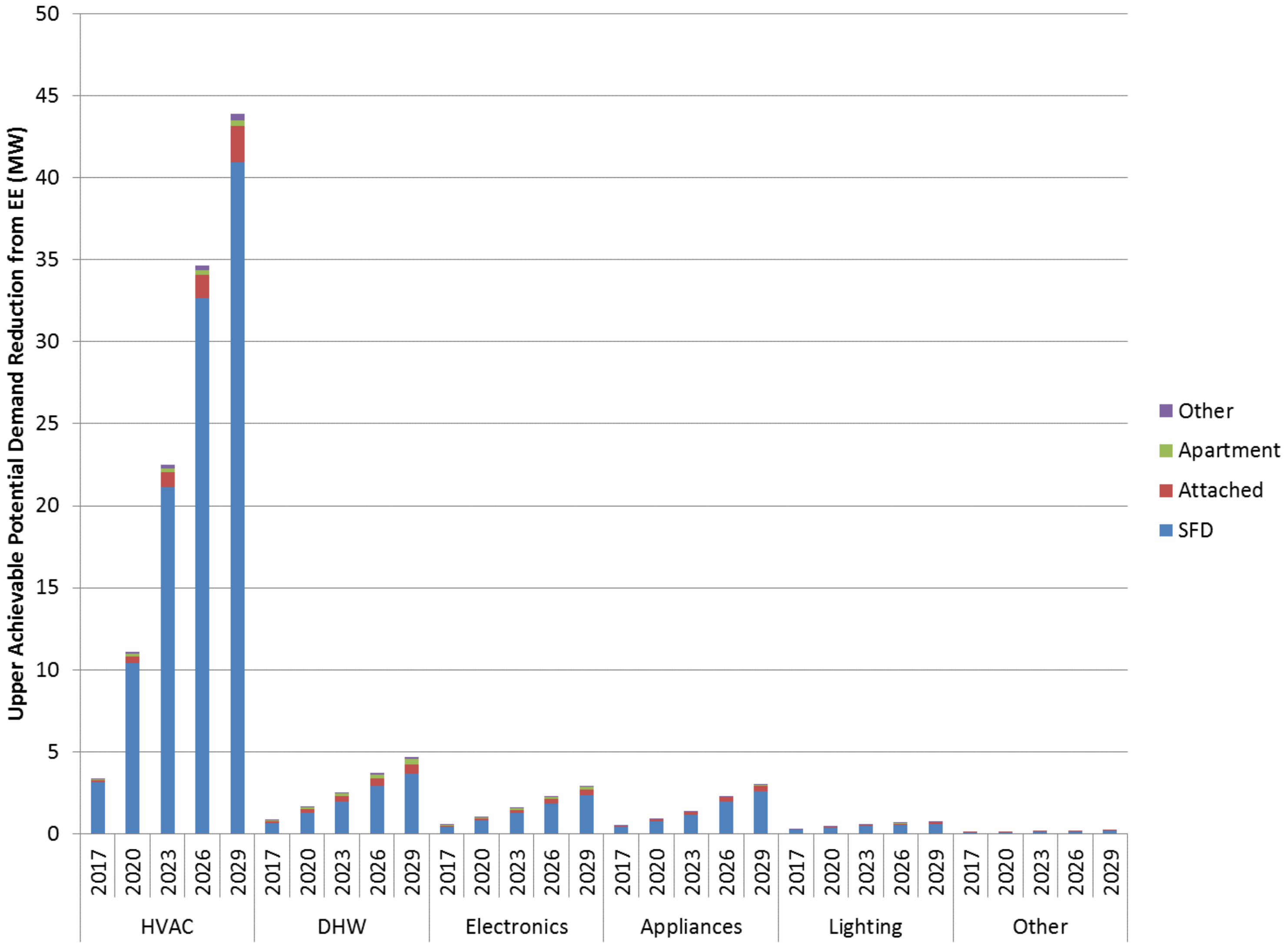


Exhibit 76 Electric Peak Load Reductions from Achievable Potential Energy Savings Measures, 2029 (MW)

Measure	Island Interconnected		Labrador Interconnected		Isolated		Grand Total	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Basement Insulation	13.4	18.7	2.1	2.4	0.1	0.1	15.6	21.2
Crawl Space Insulation	12.5	17.5	0.8	0.9	0.1	0.1	13.3	18.4
Sealing & Insul. - Old Homes	5.0	16.2	-	-	0.0	0.1	5.0	16.3
Min Hot Wash	2.9	6.7	0.1	0.3	0.0	0.1	3.1	7.1
Attic Insulation	4.4	6.1	0.4	0.5	0.0	0.0	4.8	6.6
Overnight Setback	2.2	4.4	0.2	0.4	0.0	0.0	2.3	4.8
Door Systems	3.0	4.2	0.2	0.3	0.0	0.0	3.2	4.4
Air Sealing	1.2	4.0	-	-	0.0	0.0	1.2	4.0
Refrigerator Retirement	1.7	3.5	0.1	0.2	0.0	0.1	1.8	3.7
Power Bars (TVs)	1.4	3.3	0.0	0.1	0.0	0.0	1.5	3.4
Weather Stripping Maintenance	1.1	3.1	0.1	0.3	0.0	0.0	1.2	3.4
Close Blinds	1.4	2.9	0.1	0.2	0.0	0.0	1.5	3.1
Daytime Setback	1.3	2.6	0.1	0.2	0.0	0.0	1.4	2.9
ECPM Fan Motors	1.4	2.7	0.0	0.0	0.0	0.1	1.4	2.8
Efficient Clothes Washers	1.2	2.3	0.0	0.1	0.0	0.0	1.2	2.4
Power Bars (PCs)	0.8	1.9	0.0	0.0	0.0	0.0	0.8	2.0
Showerheads	0.4	1.7	0.0	0.1	0.0	0.0	0.4	1.8
Faucets	0.3	1.2	0.0	0.0	0.0	0.0	0.3	1.2
LED Lamps	0.5	1.1	0.0	0.0	0.0	0.0	0.6	1.1
DHW Temperature	-	0.8	-	0.0	-	0.0	-	0.9
Faucet Aerator	0.2	0.7	0.0	0.0	0.0	0.0	0.2	0.8
Electronic Thermostats	0.2	0.6	0.0	0.1	0.0	0.0	0.2	0.7
Hot Tub Covers	0.1	0.6	0.0	0.0	0.0	0.0	0.2	0.6
ESTAR TVs	0.2	0.4	-	-	0.0	0.0	0.2	0.4
Benchmarking	0.1	0.3	0.0	0.0	0.0	0.0	0.2	0.4
Turn Off TVs	0.1	0.3	0.0	0.0	0.0	0.0	0.2	0.3
Clothes Dryer Sensor	0.2	0.3	0.0	0.0	0.0	0.0	0.2	0.3
DHW Tank Insulation	0.1	0.3	-	-	0.0	0.0	0.1	0.3
ESTAR Computers	0.1	0.3	0.0	0.0	0.0	0.0	0.1	0.3
DHW Pipe Insulation	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.3
Motion Detectors - Outdoor	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.3
Prog. Thermostats	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.2
Refrigerator Temperature	0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.2
High-Perf. New Homes	-	-	-	-	0.1	0.1	0.1	0.1
Min Outdoor Lighting	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1
Timers - Outdoor	0.0	0.1	-	-	0.0	0.0	0.0	0.1
Unplug Chargers	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
PC Power Management	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Freezer Temperature	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Super Efficient Clothes Washers	0.0	0.0	-	-	0.0	0.0	0.0	0.0
ESTAR Freezers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Car Warmer Timers	-	-	0.0	0.0	-	-	0.0	0.0
Turn Off Lights	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESTAR Windows	-	-	-	-	0.0	0.0	0.0	0.0
Super Efficient Freezers	-	-	-	-	0.0	0.0	0.0	0.0

Exhibit 76 Continued: Electric Peak Load Reductions from Achievable Potential Energy Savings Measures, 2029 (MW)

Measure	Island Interconnected		Labrador Interconnected		Isolated		Grand Total	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
ESTAR Dishwashers	-	-	-	-	0.0	0.0	0.0	0.0
T8 Fixtures	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prog. Thermostats (Central)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HVAC Impact from Other Savings	(7.1)	(15.4)	(0.3)	(0.7)	(0.0)	(0.1)	(7.5)	(16.2)
Grand Total	50.8	94.5	4.1	5.5	0.5	1.0	55.4	101.0

As with Exhibit 68, Exhibit 76 provides results at a sufficient level of detail that some modeling issues require explanation:

- As explained following Exhibit 68, some measures show an initially high potential, which then drops off in the second milestone period and begins to increase again towards the end of the study period. As described before, this is primarily caused by the changing avoided cost values for the Island Interconnected region through the study period, and by the reference case adoption rates “catching up” to the adoption rates in the achievable potential scenario.
- 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.
- The last measure in the table, HVAC Impact from Other Savings, accounts for the added load on the electric heating systems in dwellings where savings are occurring for many other end uses in the home. As discussed in Section 8.5.3, the savings for end uses such as lighting, appliances, and electronics are multiplied by a factor based on modeling of NL dwellings. The resulting heating penalty is added as a separate line item in this exhibit.

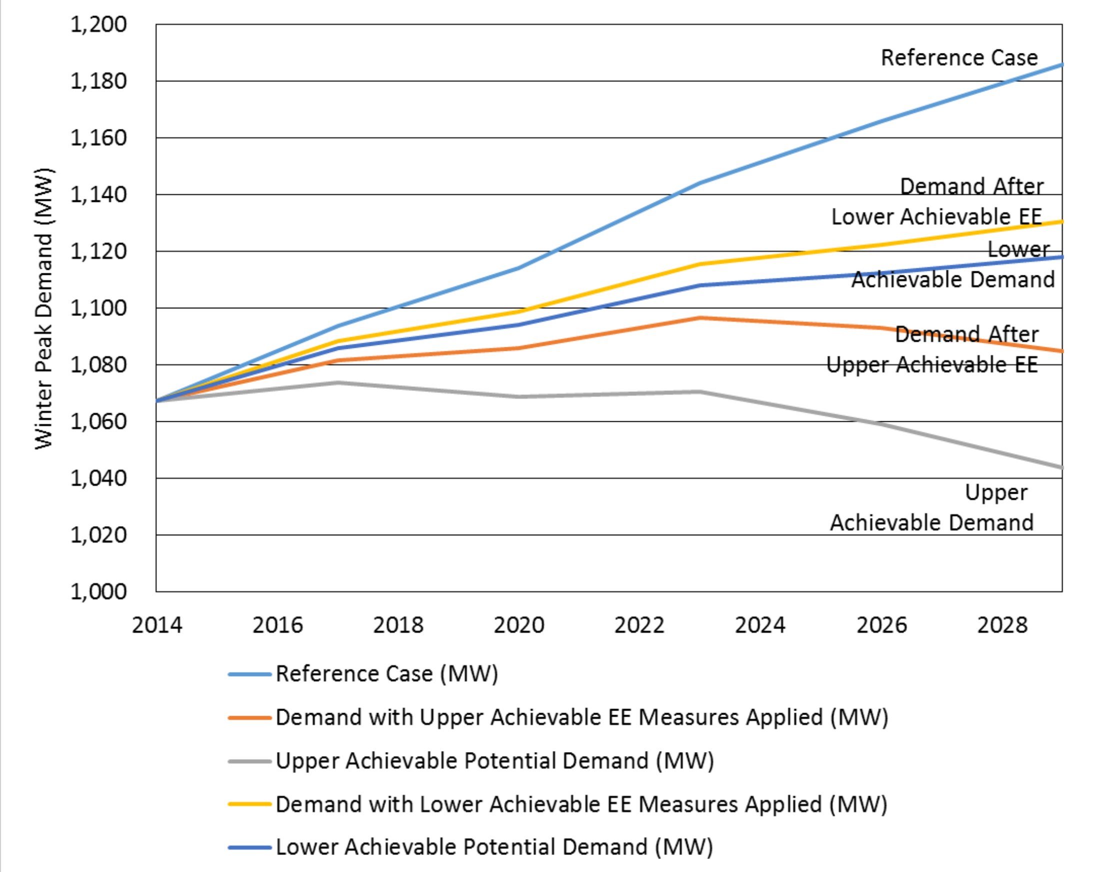
9.7 Summary of Peak Load Reductions

This section presents a summary of the electric peak load reductions that would result from the application of peak demand efficient measures. Exhibit 77 compares the Reference Case, Lower Achievable Potential and Upper Achievable Potential Peak Demand Forecast levels of winter peak demand.[37]

As illustrated, under the Reference Case residential peak demand would grow from the Base Year level of 1,067 MW to approximately 1,186 MW by 2029. This contrasts with the Lower Achievable Potential Forecast in which peak demand would decrease to approximately 1,118 MW for the same period, a difference of approximately 68 MW or about 6%. The Upper Achievable Potential forecasts peak demand at 1,044 MW, a difference of approximately 142 MW or 12%. 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, approximately 72% of the reduction comes from the impact of energy efficiency measures in the Upper Achievable Potential scenario, and approximately 81% of the reduction comes from the impact of energy efficiency measures in the Lower Achievable Potential scenario.

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

Exhibit 77 Peak Demand of Reference Case, Lower Achievable Potential and Upper Achievable Potential in Residential 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:[38]

- Exhibit 78 presents the results by end use, dwelling type and milestone year
- Exhibit 79 provides a further disaggregation of the peak demand reduction by technology and milestone year
- Exhibit 80 and Exhibit 81 present peak demand reduction by major end use, milestone year and region
- Exhibit 82 and Exhibit 83 present peak demand reduction by major end use, milestone year and dwelling type
- Exhibit 84 and Exhibit 85 present 2029 peak demand reduction by major end use and vintage.

[38] 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 78 Total Lower and Upper Achievable Potential Peak Demand Reduction by End Use, Dwelling Type and Milestone Year (MW)

Housing Categories	Milestone Years	Domestic Hot Water (DHW)		Space heating		Block heaters & car warmers		Grand Total	
		Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.	Lower Ach.	Upper Ach.
Single Family Dwellings	2017	1.16	4.58	0.45	1.44	0.00	0.01	1.61	6.02
	2020	2.69	9.79	0.91	2.85	0.01	0.01	3.60	12.65
	2023	4.11	14.65	1.36	4.16	0.01	0.02	5.48	18.83
	2026	5.48	19.26	1.77	5.23	0.01	0.03	7.26	24.52
	2029	6.80	23.60	2.15	5.99	0.02	0.03	8.97	29.62
Attached Houses	2017	0.23	0.89	0.08	0.26	0.00	0.00	0.31	1.16
	2020	0.52	1.92	0.17	0.54	0.00	0.01	0.70	2.47
	2023	0.81	2.91	0.27	0.83	0.01	0.01	1.08	3.75
	2026	1.09	3.86	0.35	1.08	0.01	0.02	1.45	4.96
	2029	1.36	4.77	0.44	1.29	0.01	0.02	1.81	6.08
Apartments	2017	0.14	0.54	0.00	0.01	0.00	0.00	0.14	0.55
	2020	0.29	1.15	0.01	0.10	0.00	0.00	0.30	1.25
	2023	0.52	1.89	0.01	0.16	0.00	0.00	0.53	2.05
	2026	0.70	2.49	0.02	0.22	0.00	0.00	0.72	2.72
	2029	0.87	3.09	0.02	0.28	0.00	0.00	0.89	3.37
Other, Vacant and Partial	2017	0.01	0.02	0.11	0.23	0.00	0.00	0.12	0.25
	2020	0.07	0.26	0.23	0.48	0.00	0.00	0.30	0.73
	2023	0.10	0.38	0.35	0.73	0.00	0.00	0.45	1.11
	2026	0.13	0.50	0.48	1.02	0.00	0.00	0.61	1.52
	2029	0.16	0.62	0.60	1.27	0.00	0.00	0.76	1.90
Grand Total	**2017**	1.53	6.03	0.65	1.93	0.01	0.01	2.18	7.98
	2020	3.57	13.11	1.32	3.97	0.01	0.02	4.90	17.10
	2023	5.54	19.83	1.99	5.88	0.02	0.03	7.54	25.74
	2026	7.40	26.12	2.62	7.55	0.02	0.04	10.04	33.71
	2029	9.19	32.08	3.21	8.84	0.03	0.05	12.43	40.97

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) 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. 4) MW reductions are not incremental. The space 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 space heating peak demand in 2029 and the space heating peak demand if all the measures included in the Economic Potential scenario are implemented.
5) The values in this exhibit do not include peak demand reductions from energy efficiency measures.
6) 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.

Exhibit 79 Lower and Upper Achievable Potential Peak Demand Reduction by Measure and Milestone Year (MW)

Measure	Lower Achievable Potential Peak Demand Reduction (MW)					Upper Achievable Potential Peak Demand Reduction (MW)				
	2017	2020	2023	2026	2029	2017	2020	2023	2026	2029
DHW Cycling	1.52	3.13	4.72	6.26	7.77	6.02	12.25	18.27	23.96	29.41
Dual Fuel Heat Cycling	0.65	1.32	1.99	2.62	3.21	1.29	2.59	3.84	4.90	5.74
Electric Heat Cycling	0.00	0.00	0.00	0.00	0.00	0.61	1.32	1.96	2.54	2.98
3-Element DHW	0.01	0.44	0.82	1.13	1.42	0.01	0.86	1.57	2.16	2.67
Heat Pump Cycling	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.08	0.10	0.12
Car Warmer Demand	0.00	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.04
Block Heater Demand	0.00	0.00	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.02
Grand Total	2.18	4.90	7.54	10.04	12.43	7.98	17.10	25.74	33.71	40.97

Exhibit 80 Lower Achievable Potential Peak Load Reduction by Major End Use, Year and Region (MW)

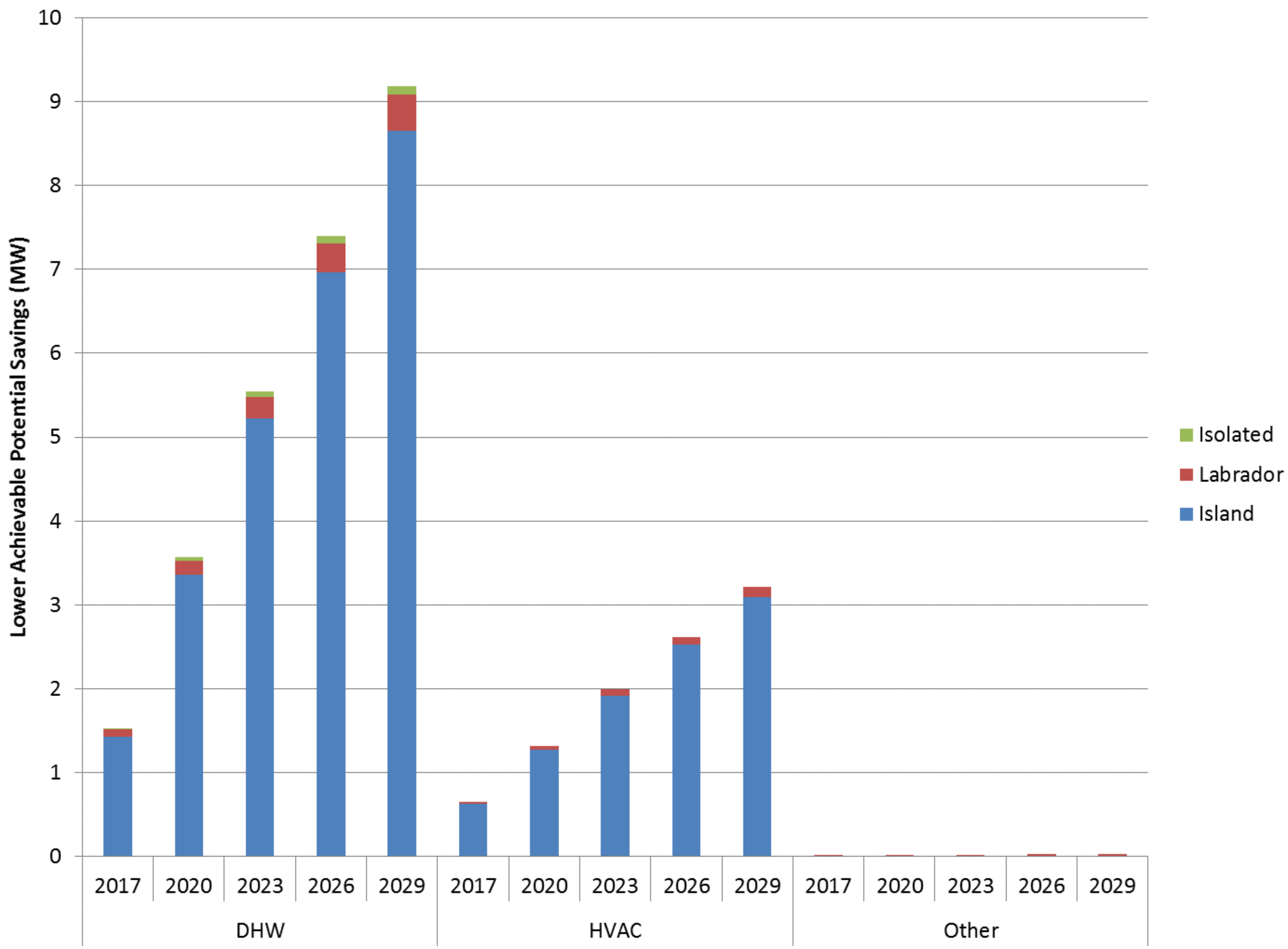


Exhibit 81 Upper Achievable Potential Peak Load Reduction by Major End Use, Year and Region (MW)

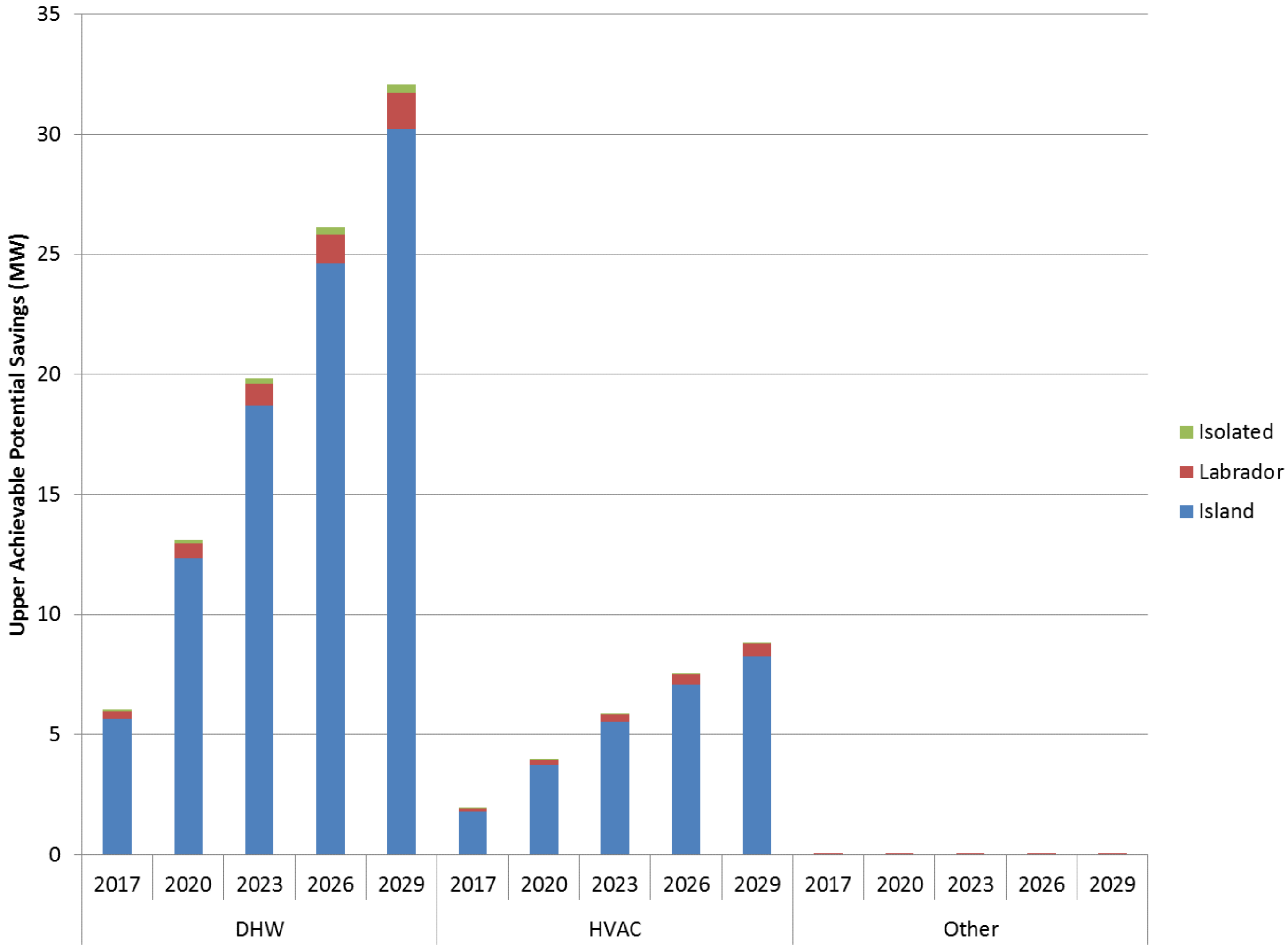


Exhibit 82 Lower Achievable Potential Peak Demand Reduction by Major End Use, Year and Dwelling Type (MW)

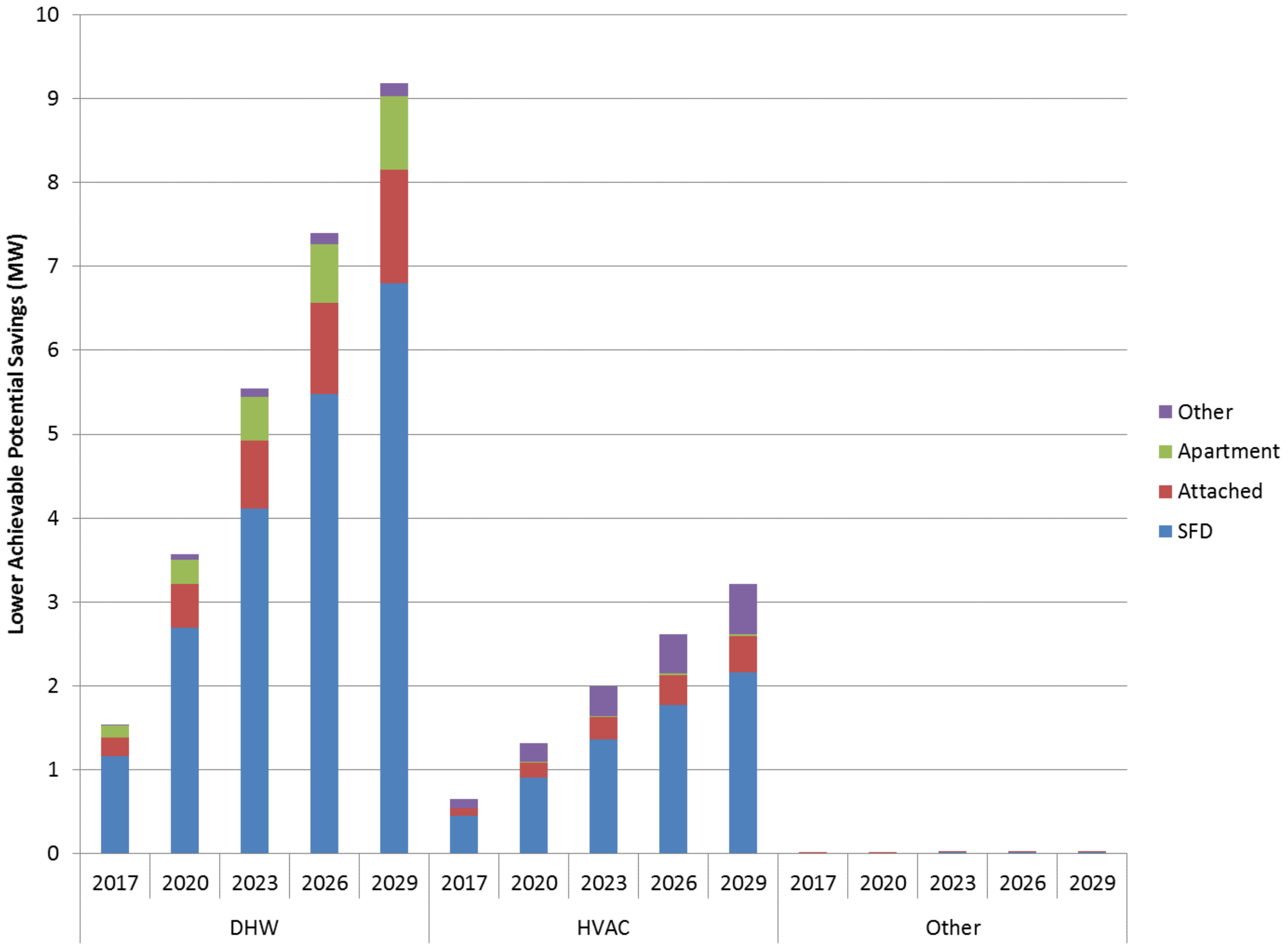


Exhibit 83 Upper Achievable Potential Peak Demand Reduction by Major End Use, Year and Dwelling Type (MW)

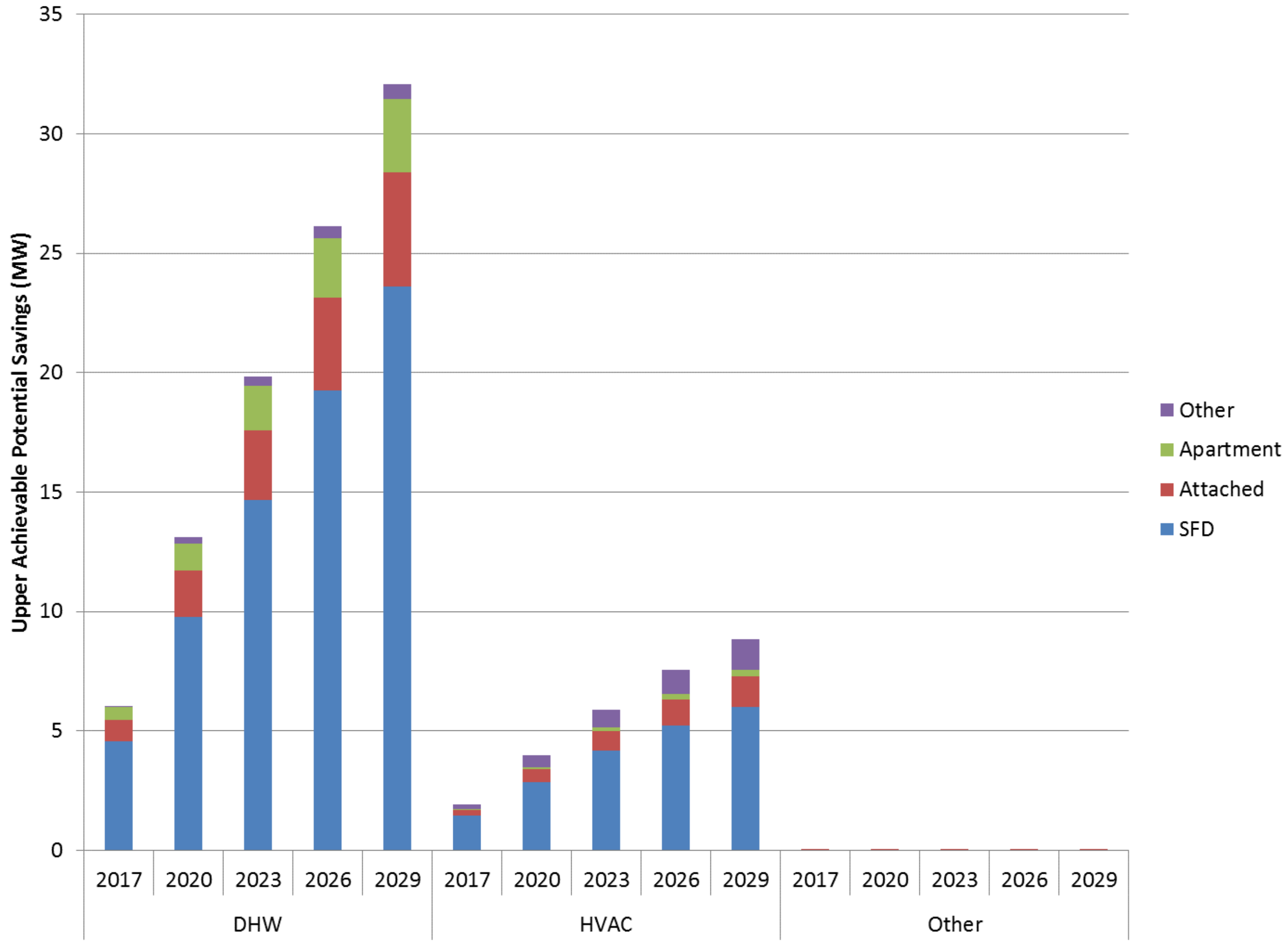


Exhibit 84 Lower Achievable Potential Peak Load Reduction by Major End Use, Year and Vintage (MW)

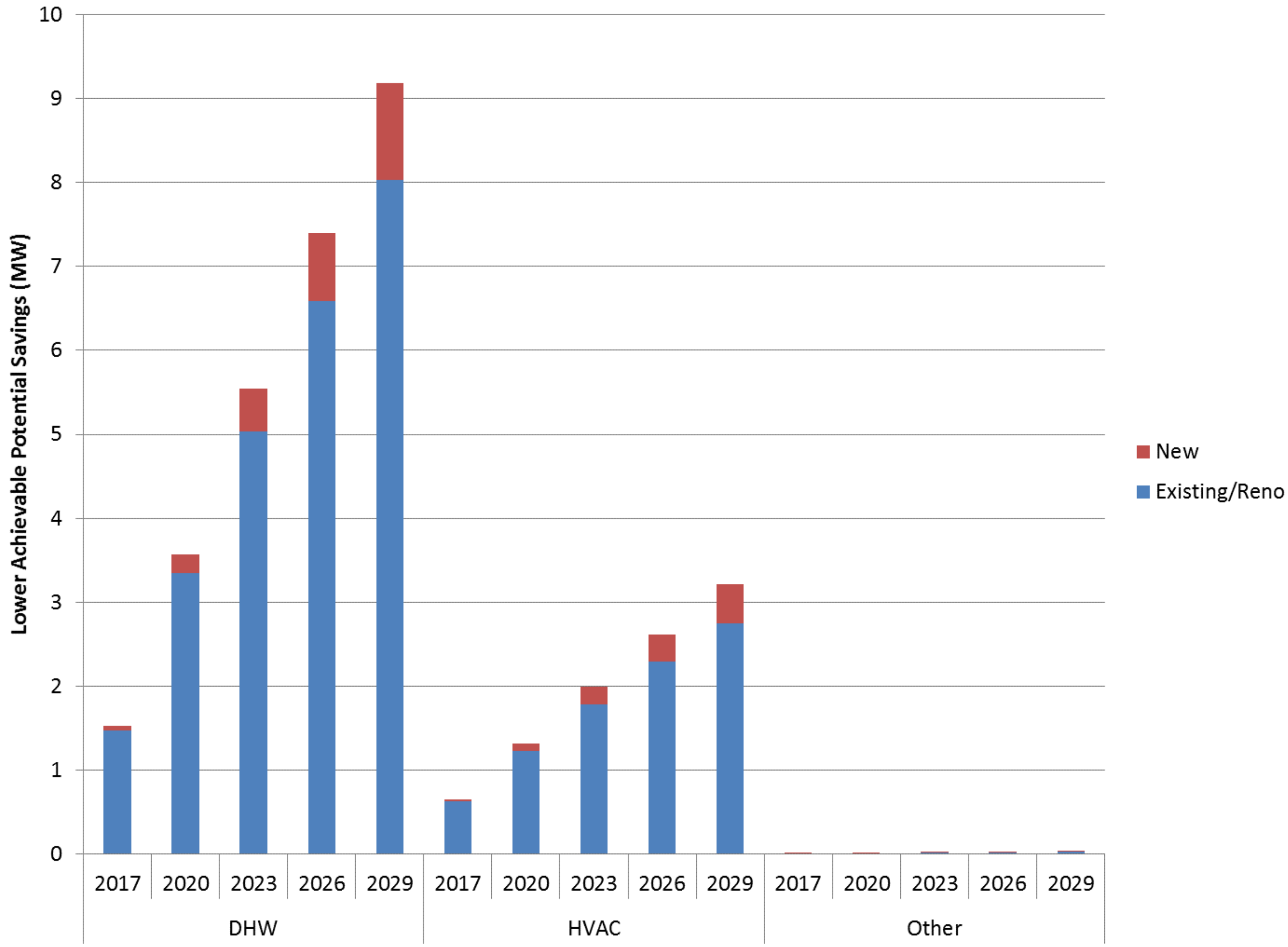
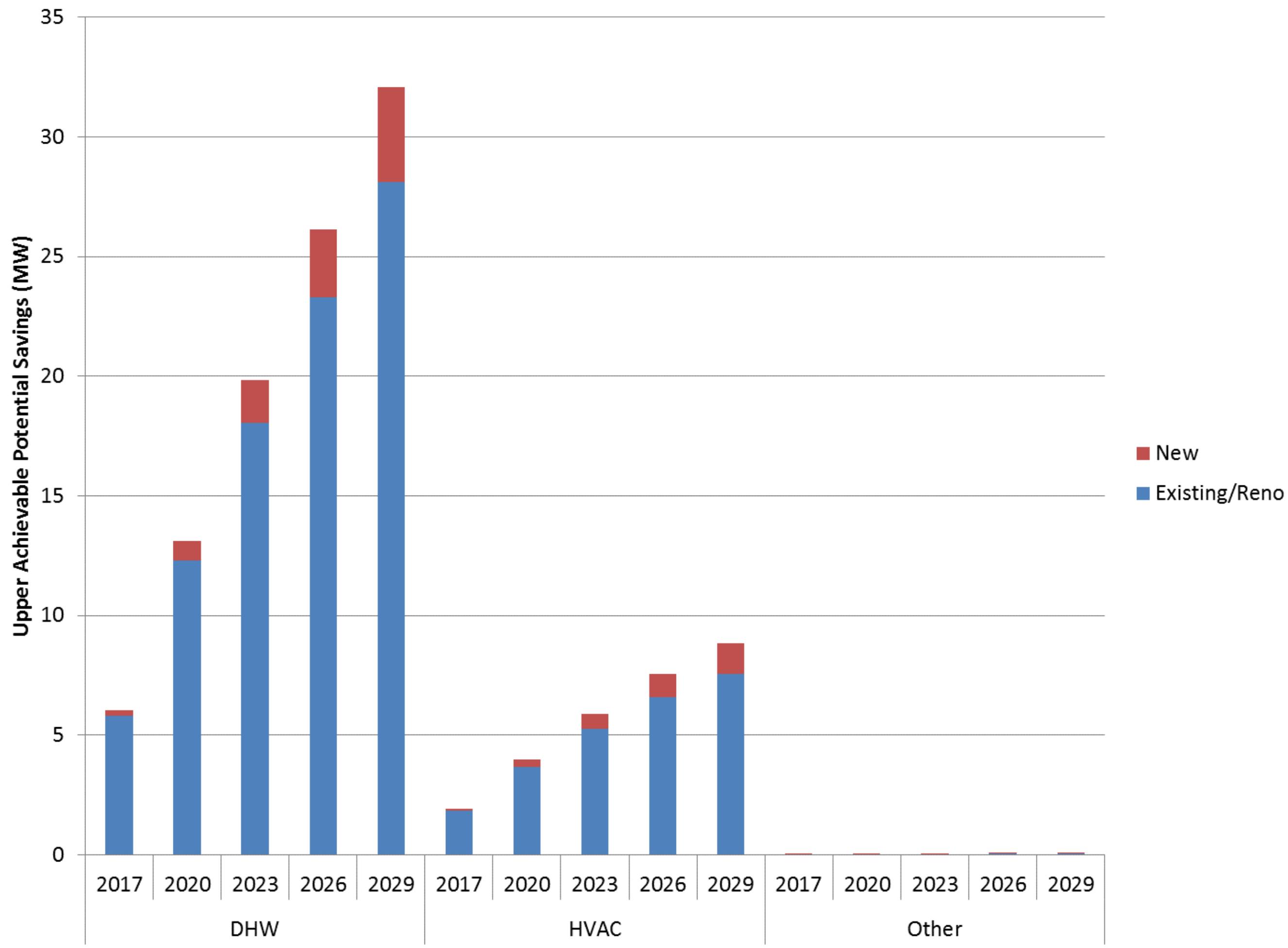


Exhibit 85 Upper Achievable Potential Peak Load Reduction by Major End Use, Year and Vintage (MW)



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 increase from 2.2 MW in 2017 to 12.4 MW in 2029. The Upper Achievable Potential peak load reductions increase from 8.0 MW in 2017 to 41.0 MW in 2029.

Peak Demand Reduction by Dwelling Type

Single detached houses account for 73% of the potential peak load reductions; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Peak load reductions in attached dwellings account for 14% of the potential savings; apartments account for 8% of the potential savings; and other residential buildings account for 5% of the potential savings.

Peak Demand Reduction by Region

The Island Interconnected region accounts for 95% of the potential peak load reductions. The Labrador Interconnected region accounts for 5% of the potential peak load reductions, and the Isolated region accounts for 1% of the potential peak load reductions.

Peak Demand Reduction by Existing Dwellings versus New Construction

Peak load reductions in existing dwellings account for almost all of the reduction potential at the beginning of the study period; as new homes are constructed, the load reduction potential associated with them occupies a progressively larger portion of the total. By 2029, peak load reductions from new homes account for just over 10% of the total potential.

Peak Demand Reduction by End Use

DHW measures account for approximately 76% of the total load reductions in the Upper Achievable Potential Forecast in 2017, not including load reductions from energy efficiency measures; this rises to 78% of the total by 2029. DHW measures account for approximately 71% of the total load reductions in the Lower Achievable Potential Forecast in 2017, not including load reductions from energy efficiency measures; this rises to 74% of the total by 2029. Of the 78% of 2029 reductions that come from DHW in the Upper Achievable Potential, 72% is from DHW cycling. Of the 74% of 2029 reductions that come from DHW in the Lower Achievable Potential, 62% is from DHW cycling.

Space heating load reductions account for approximately 24% of the total load reductions in the Upper Achievable Potential Forecast in 2017, not including load reductions from energy efficiency measures; this decreases to 22% of the total by 2029. Space heating load reductions account for approximately 29% of the total load reductions in the Lower Achievable Potential Forecast in 2017, not including load reductions from energy efficiency measures; this decreases to 26% of the total by 2029. Of the 22% of 2029 reductions that come from space heating in the Upper Achievable Potential, 14% is from heat cycling in dwellings with a second heating fuel and 7% is from heat cycling in dwellings without a second heating fuel. Of the 26% of 2029 reductions that come from space heating in the Lower Achievable Potential, all of it is considered to come from heat cycling in dwellings with a second heating fuel. In the Lower Achievable Potential, there was assumed to be no uptake of heat cycling in homes with no other fuel.

Timers for car warmers and block heaters offer a very small portion of the total load reduction opportunity for the province overall, but contribute between 2% and 5% to the overall potential for the Labrador Interconnected region.

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 86 shows that the lower Achievable Potential results are sensitive to this range of avoided costs. By 2029, the exhibits show the following changes in achievable potential:

- The lower range of reasonableness produces lower Achievable Potential energy savings that are 6% lower in the Island Interconnected region, 10% lower in the Labrador Interconnected region, and almost unchanged in the Isolated region.
- The lower range of reasonableness produces lower Achievable Potential peak demand reductions that are 11% lower in the Island Interconnected region, 10% lower in the Labrador Interconnected region, and 1% lower in the Isolated region.
- The upper range of reasonableness produces lower Achievable Potential energy savings that are 6% higher in the Island Interconnected region and almost unchanged in the other two regions.
- The upper range of reasonableness produces lower Achievable Potential peak demand reductions that are almost unchanged in all regions.

Exhibit 86 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)
Island Interconnected	2017	23,162	6	26,944	7	26,944	7
	2020	66,493	16	74,101	19	74,807	19
	2023	132,805	30	144,481	34	147,821	35
	2026	212,007	44	231,445	50	242,256	51
	2029	298,048	56	317,592	63	336,663	63
Labrador Interconnected	2017	494	0	553	0	956	0
	2020	1,182	0	2,780	1	3,042	1
	2023	5,487	2	5,500	2	6,764	2
	2026	9,049	3	10,122	3	11,280	3
	2029	13,778	4	15,393	5	15,389	5
Isolated	2017	297	0	300	0	297	0
	2020	701	0	717	0	701	0
	2023	1,292	0	1,297	0	1,292	0
	2026	2,060	0	2,074	0	2,060	0
	2029	3,020	1	3,035	1	3,020	1

Exhibit 87 shows that the upper Achievable Potential results are sensitive to this range of avoided costs. By 2029, the exhibits show the following changes in achievable potential:

- The lower range of reasonableness produces upper Achievable Potential energy savings that are 8% lower in the Island Interconnected region, 9% lower in the Labrador Interconnected region, and almost unchanged in the Isolated region.
- The lower range of reasonableness produces upper Achievable Potential peak demand reductions that are 6% lower in the Island Interconnected region and almost unchanged in the other two regions.
- The upper range of reasonableness produces upper Achievable Potential energy savings that are 6% higher in the Island Interconnected region and almost unchanged in the other two regions.
- The upper range of reasonableness produces upper Achievable Potential peak demand reductions that are that are almost unchanged in all regions.

Exhibit 87 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)
Island Interconnected	2017	48,956	15	60,930	19	60,930	19
	2020	126,956	35	150,463	43	151,863	43
	2023	240,557	57	274,926	70	281,437	71
	2026	386,399	83	437,615	101	458,583	101
	2029	569,163	112	621,508	133	658,182	133
Labrador Interconnected	2017	1,398	1	1,481	1	1,892	1
	2020	3,054	1	4,645	2	4,934	2
	2023	8,346	3	8,407	3	9,790	4
	2026	12,971	5	14,114	5	15,382	6
	2029	20,084	7	22,015	8	22,024	8
Isolated	2017	717	0	723	0	732	0
	2020	1,607	0	1,638	0	1,654	0
	2023	2,831	1	2,832	1	2,852	1
	2026	4,343	1	4,363	1	4,355	1
	2029	6,165	1	6,187	1	6,177	1

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. Where measures in the present study were not included in past programs, the net-to-gross ratio for the most similar program was used.

Sources:

The following sources were used to estimate the measure net-to-gross ratios shown in Exhibit 88:

- 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.[39]
- Performance Plus Impact and Process Evaluation, 2012, from the Efficiency Nova Scotia Corporation.[40]
- Emera Maine Heat Pump Pilot Program Final Report, 2014.[41]

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.

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[39] Ontario Energy Board, *Total Resource Cost Guide.* October, 2006.
[40] Efficiency Nova Scotia Corporation, *Performance Plus Impact and Process Evaluation, 2012*. March, 2013.
[41] Emera Maine, *Heat Pump Pilot Program Final Report*. November, 2014.

Results:

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

- Exhibit 88 shows the gross and net upper achievable potential for energy efficiency, by measure and region for the year 2029, along with the net-to-gross ratios used. The gross values do not add up to the same total as in previous exhibits, because the HVAC interaction measure is not included in this exhibit.
- Exhibit 89 shows the gross and net lower achievable potential for energy efficiency, by measure and region for the year 2029, along with the net-to-gross ratios used. The gross values do not add up to the same total as in previous exhibits, because the HVAC interaction measure is not included in this exhibit.
- Exhibit 90 shows the gross and net upper achievable potential for demand reduction, by measure and region for the year 2029, along with the net-to-gross ratios used.
- Exhibit 91 shows the gross and net lower achievable potential for demand reduction, by measure and region 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 88 Gross Versus Net Upper Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)
Mini-Splits	0.88	254,769	224,196	-	-	1,595	1,404
Basement Insulation	0.80	55,847	44,677	8,341	6,673	313	250
Crawl Space Insulation	0.80	51,934	41,547	3,138	2,510	196	157
Sealing & Insul. - Old Homes	0.80	48,272	38,617	-	-	163	131
Refrigerator Retirement	0.90	34,748	31,273	1,548	1,393	554	498
Min Hot Wash	0.70	23,145	16,202	1,100	770	381	266
Power Bars (TVs)	0.95	20,305	19,289	434	413	295	280
Attic Insulation	0.80	18,202	14,562	1,615	1,292	84	67
Clothes Lines	0.70	14,740	10,318	593	415	292	204
Power Bars (PCs)	0.95	14,590	13,860	319	303	309	294
Overnight Setback	0.70	13,064	9,145	1,309	916	79	55
Door Systems	0.50	12,297	6,148	930	465	42	21
Efficient Clothes Washers	0.70	11,617	8,132	380	266	154	108
Air Sealing	0.90	11,904	10,714	-	-	43	38
Weather Stripping Maintenance	0.70	9,154	6,408	1,097	768	19	13
Close Blinds	0.70	8,481	5,937	730	511	45	32
Daytime Setback	0.70	7,829	5,481	764	535	47	33
ECPM Fan Motors	0.90	7,950	7,155	115	104	171	154
LED Lamps	0.95	6,505	6,179	226	214	79	75
Showerheads	0.70	5,829	4,081	271	190	59	41
Faucets	0.70	4,074	2,852	93	65	44	31
Hot Tub Covers	0.90	3,576	3,218	300	270	71	64
DHW Temperature	0.70	2,823	1,976	134	94	46	32
Benchmarking	1.00	2,587	2,587	122	122	48	48
Faucet Aerator	0.70	2,589	1,812	121	84	26	18
ESTAR TVs	0.70	2,281	1,597	-	-	232	163
Electronic Thermostats	0.70	1,868	1,307	196	137	17	12

Exhibit 88 Continued: Gross Versus Net Upper Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)
ESTAR Computers	0.70	1,992	1,394	66	46	22	15
Turn Off TVs	0.70	1,900	1,330	85	59	30	21
Clothes Dryer Sensor	0.70	1,838	1,287	59	42	21	15
Refrigerator Temperature	0.70	1,590	1,113	72	51	22	15
Motion Detectors - Outdoor	0.80	1,464	1,171	42	34	15	12
DHW Tank Insulation	0.95	954	906	-	-	11	10
DHW Pipe Insulation	0.90	858	772	40	36	9	8
ESTAR Dehumidifiers	0.70	831	582	27	19	5	3
Unplug Chargers	0.70	754	528	29	20	15	10
Min Outdoor Lighting	0.70	670	469	29	20	11	8
Timers - Outdoor	0.80	690	552	-	-	9	7
PC Power Management	0.70	640	448	27	19	13	9
Prog. Thermostats	0.85	592	503	72	61	4	3
Freezer Temperature	0.70	519	363	25	18	16	11
ESTAR Freezers	0.70	409	286	18	13	7	5
High-Perf. New Homes	0.76	-	-	-	-	362	275
Super Efficient Clothes Washers	0.70	187	131	-	-	31	22
Air-to-Water Heat Pumps	0.88	-	-	-	-	202	178
AC Temperature	0.70	157	110	-	-	-	-
Air-Source Heat Pump	0.88	-	-	-	-	92	81
Block Heater Timers	0.75	-	-	69	52	-	-
Car Warmer Timers	0.75	-	-	49	37	-	-
Turn Off Lights	0.70	37	26	2	1	1	1
Cold Climate Heat Pump	0.88	-	-	-	-	34	30
Professional Air Sealing	0.90	-	-	-	-	34	30
Super Efficient Freezers	0.70	-	-	-	-	20	14
Super Efficient Refrigerators	0.70	-	-	-	-	20	14
HRVs	0.85	-	-	-	-	9	8
T8 Fixtures	0.75	7	5	0	0	0	0

Exhibit 88 Continued: Gross Versus Net Upper Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)
ESTAR Windows	0.50	-	-	-	-	7	3
Super Windows	0.50	-	-	-	-	6	3
ESTAR Dishwashers	0.70	-	-	-	-	5	3
Motion Detectors - Indoor	0.80	-	-	-	-	4	3
Prog. Thermostats (Central)	0.85	0	0	0	0	0	0
Grand Total	0.82	667,067	551,247	24,590	19,039	6,437	5,307

Exhibit 89 Gross Versus Net Lower Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
Mini-Splits	0.88	134,507	118,366	-	-	829	729
Basement Insulation	0.80	39,891	31,912	7,448	5,958	223	179
Crawl Space Insulation	0.80	37,096	29,676	2,802	2,241	140	112
Refrigerator Retirement	0.90	17,374	15,636	774	697	277	249
Sealing & Insul. - Old Homes	0.80	14,947	11,957	-	-	51	40
Attic Insulation	0.80	13,002	10,401	1,442	1,153	60	48
Min Hot Wash	0.70	10,160	7,112	480	336	167	117
Door Systems	0.50	8,788	4,394	831	415	30	15
Power Bars (TVs)	0.95	8,752	8,315	186	177	132	125
Overnight Setback	0.70	6,388	4,472	565	396	39	28
Power Bars (PCs)	0.95	6,289	5,974	137	131	133	126
Efficient Clothes Washers	0.70	5,808	4,066	190	133	77	54
Close Blinds	0.70	4,113	2,879	315	221	23	16
ECPM Fan Motors	0.90	4,063	3,657	58	52	86	77
Daytime Setback	0.70	3,828	2,680	330	231	23	16
Air Sealing	0.90	3,663	3,296	-	-	13	12
Weather Stripping Maintenance	0.70	3,176	2,223	341	239	7	5
LED Lamps	0.95	3,252	3,090	113	107	40	38
Showerheads	0.70	1,457	1,020	68	48	15	10
ESTAR TVs	0.70	1,140	798	-	-	116	81
Benchmarking	1.00	1,122	1,122	53	53	21	21
Faucets	0.70	1,018	713	23	16	11	8
ESTAR Computers	0.70	996	697	33	23	11	8
Hot Tub Covers	0.90	894	805	75	68	18	16
Clothes Dryer Sensor	0.70	937	656	30	21	11	8
Turn Off TVs	0.70	873	611	37	26	14	10
Refrigerator Temperature	0.70	756	529	34	24	11	8
Faucet Aerator	0.70	647	453	30	21	7	5

Exhibit 89 Continued: Gross Versus Net Lower Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
Electronic Thermostats	0.70	546	382	49	35	5	3
ESTAR Dehumidifiers	0.70	416	291	14	10	2	2
Motion Detectors - Outdoor	0.80	366	293	11	8	4	3
Unplug Chargers	0.70	323	226	12	9	6	4
Min Outdoor Lighting	0.70	310	217	13	9	5	3
High-Perf. New Homes	0.76	-	-	-	-	294	223
PC Power Management	0.70	275	193	11	8	6	4
DHW Tank Insulation	0.95	238	226	-	-	3	3
Freezer Temperature	0.70	223	156	11	8	7	5
DHW Pipe Insulation	0.90	215	193	10	9	2	2
ESTAR Freezers	0.70	204	143	9	6	3	2
Prog. Thermostats	0.85	174	148	18	15	1	1
Timers - Outdoor	0.80	172	138	-	-	2	2
Super Efficient Clothes Washers	0.70	96	67	-	-	16	11
Air-to-Water Heat Pumps	0.88	-	-	-	-	105	93
AC Temperature	0.70	62	43	-	-	-	-
Air-Source Heat Pump	0.88	-	-	-	-	48	42
Cold Climate Heat Pump	0.88	-	-	-	-	18	16
Turn Off Lights	0.70	17	12	1	1	0	0
Block Heater Timers	0.75	-	-	17	13	-	-
Car Warmer Timers	0.75	-	-	12	9	-	-
Professional Air Sealing	0.90	-	-	-	-	10	9
Super Efficient Freezers	0.70	-	-	-	-	10	7
Super Efficient Refrigerators	0.70	-	-	-	-	10	7
HRVs	0.85	-	-	-	-	5	4
ESTAR Windows	0.50	-	-	-	-	5	2
Super Windows	0.50	-	-	-	-	3	2
ESTAR Dishwashers	0.70	-	-	-	-	2	2
T8 Fixtures	0.75	2	1	0	0	0	0
Motion Detectors - Indoor	0.80	-	-	-	-	1	1

Exhibit 89 Continued: Gross Versus Net Lower Achievable EE Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
Prog. Thermostats (Central)	0.85	0	0	0	0	0	0
Grand Total	0.83	338,574	280,240	16,586	12,927	3,157	2,613

Exhibit 90 Gross Versus Net Upper Achievable Demand Reduction Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)	Gross Upper Achievable Potential (MWh/yr.)	Net Upper Achievable Potential (MWh/yr.)
DHW Cycling	1.00	28	28	1	1	0	0
Dual Fuel Heat Cycling	1.00	5	5	0	0	0	0
Electric Heat Cycling	1.00	3	3	0	0	0	0
3-Element DHW	1.00	3	3	0	0	0	0
Heat Pump Cycling	1.00	0	0	0	0	0	0
Car Warmer Demand	1.00	-	-	0	0	-	-
Block Heater Demand	1.00	-	-	0	0	-	-
Grand Total	1.00	38	38	2	2	0	0

Exhibit 91 Gross Versus Net Lower Achievable Demand Reduction Potential by Measure and Region, 2029

Measure	Assumed Net-to-Gross Ratio	Island Interconnected		Labrador Interconnected		Isolated	
		Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)	Gross Lower Achievable Potential (MWh/yr.)	Net Lower Achievable Potential (MWh/yr.)
DHW Cycling	1.00	7	7	0	0	0	0
Dual Fuel Heat Cycling	1.00	3	3	-	-	0	0
3-Element DHW	1.00	1	1	0	0	0	0
Car Warmer Demand	1.00	-	-	-	-	0	0
Block Heater Demand	1.00	-	-	-	-	0	0
Grand Total	1.00	12	12	0	0	1	1

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 commercial 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.

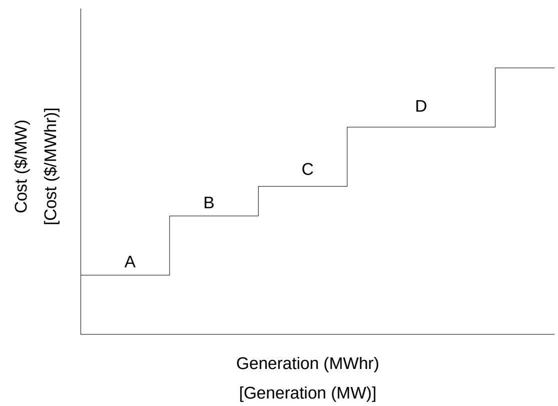
Rate Structure:
The formulas used to calculate charges for the use of electricity. For example, the present rate structures for both NL utilities for most commercial customers consists of a fixed monthly charge and charges for both electric energy usage and monthly peak demand usage.

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. 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 Residential sector Base Year electricity use. The major steps involved are:

- **Step 1:** Determine net space heating and cooling loads for each existing dwelling type
- **Step 2:** Determine annual electricity use for the existing stock of major residential appliances
- **Step 3:** Determine appliance saturation levels for each dwelling type
- **Step 4:** Determine electricity share for each appliance, by dwelling type
- **Step 5:** Calibrate to sales data for the study Base Year of 2014.

A.1 Step 1: Determine Net Space Heating Loads

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains. The net space heating loads for each dwelling type were developed based on the following combination of data sources:

- ICF's database of residential energy consumption from other jurisdictions,
- Responses on house size and insulation values in the building envelope from the Residential End Use Survey (REUS),
- Current utility sales data combined with knowledge of the electricity consumption and saturation of other end uses.

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

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

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

HL_1 was estimated for each dwelling type and service region, based on utility customer sales data for electrically and non-electrically heated dwellings combined with data on the electricity consumption of non-space heating end uses. The values for a_{i1} and s_{i1} were developed based on the estimated share of space heating that is provided by electricity (versus supplementary fuels), as taken from the REUS. The net space heating loads are presented in Exhibit 92.

It should be noted that the values shown in Exhibit 92 are not fuel specific; rather, they represent the total tertiary space heat load for each dwelling. The efficiency of the space heating appliances used to meet these loads is considered in subsequent stages of the analysis.

Exhibit 92 Existing Residential Units, 2010, Net Space Heating Loads by Dwelling Type (kWh/yr.)

Dwelling Type	Island Interconnected	Labrador Interconnected	Isolated
Single-family detached, electric space heat	14,512	28,678	24,794
Single-family detached, non-electric space heat	13,163	28,907	23,306
Attached, electric space heat	9,943	24,165	11,377
Attached, non-electric space heat	8,601	24,165	11,377
Apartment, electric space heat	4,932	6,886	5,742
Apartment, non-electric space heat	3,876	8,920	5,742
Other and non-dwellings	5,520	-	-
Vacant and partial	3,123	4,284	2,311

A.1.1 Development of Thermal Archetypes – Existing Stock

The next major step involved the development of a thermal archetype for each of the major dwelling types noted in Exhibit 92 using HOT2000.

Each HOT2000 file contains a comprehensive physical description of the size, layout and thermal characteristics of each dwelling type. HOT2000 then uses these inputs to create a full computer model of the residence, calculating loads, interactive effects and energy consumption. In each case, the net heating and cooling loads simulated by HOT2000 were calibrated to the values shown in Exhibit 92, which had been established on the basis of the sources described above. The process of calibrating simulation models to the loads estimated from available data served to further confirm the estimated loads. Adjustments were made to the estimates as required.

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

- Data from the NL Residential End Use Survey
- HOT2000 models developed for the 2007-2008 CDM Potential Study in NL
- Natural Resources Canada (NRCan) and Statistics Canada housing data
- Consultations with energy auditors and residential housing experts located in NL.

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

Single detached houses

For the Island and Isolated service region, a typical existing, single-detached dwelling can be defined as a single-story bungalow of approximately 149 m^2 (1600 ft^2), with a finished basement. This home has 12 m^2 (130 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.6 (R-15) insulation values, ceilings RSI-3.5 (R-20) and the basement is insulated to a value of RSI-0.6 (R-3.5). The houses are typically not very airtight with about five air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Over 40% of Island homes have HRV systems, with ductwork dedicated to distributing the ventilation air.[42]

For the Labrador Interconnected service region, a typical existing, single-detached dwelling can be defined as a single-story bungalow of approximately 149 m^2 (1600 ft^2), with a heated basement. This home has 12 m^2 (130 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.1 (R-12) insulation values, ceilings RSI-3.2 (R-18) and there is no

[42] The predominant source of information on house size and insulation levels is averages developed based on survey responses in the NL REUS.

insulation in the basement. The houses are typically not very airtight with about seven air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Approximately 25% of Labrador homes have HRV systems, with ductwork dedicated to distributing the ventilation air.

Attached Dwellings

For the Island and Isolated service region, a "typical" existing, attached dwelling can be defined as a two-story middle-unit of approximately 125 m^2 (1350 ft^2), with a finished basement. This home has 8.5 m^2 (92 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.4 (R-13.5) insulation values, ceilings RSI-4.5 (R-25.5) and the basement is insulated to a value of RSI-0.6 (R-3.5). The houses are typically not very airtight with about five air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Over 40% of Island homes have HRV systems, with ductwork dedicated to distributing the ventilation air.

For the Labrador Interconnected service region, a "typical" existing, attached dwelling can be defined as a two-story middle-unit of approximately 125 m^2 (1350 ft^2), with a heated basement. This home has 8.5 m^2 (92 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.1 (R-12) insulation values, ceilings RSI-2.6 (R-15) and there is no insulation in the basement. The houses are typically not very airtight with about seven air changes per hour (ac/h) at 50 Pascal (Pa) depressurization. Approximately 25% of Labrador homes have HRV systems, with ductwork dedicated to distributing the ventilation air.

A.2 Step 2: Determine Annual Appliance Electricity Use

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

Electrical consumption of appliances is related to age. According to NRCan data[43] most appliances have increased in efficiency over time. Estimates of the evolving energy consumption of the stock of appliances in NL were developed using an appliance stock model that takes into account the expected useful life of each type of appliance, the rate of purchase and retirement of appliances, the average annual consumption of newly purchased appliances in a given year, and the average annual consumption of appliances being retired in a given year. The stock average consumption thus evolves with time. In any specific year, the average age of appliances in place is assumed to be half of the expected useful life of the appliance and the stock average is built up of all the appliances purchased and installed up to that point.

An important driver of appliance electricity consumption is the difference in average number of occupants in different types of homes. This influences the size of some appliances, such as refrigerators, and the intensity of use for others, such as laundry and cooking appliances. The estimated annual electricity consumption of appliances by dwelling type reflects these differences.

The exhibits showing estimated average annual UEC for the current stock mix of major end-uses are provided as follows:

- Exhibit 93 summarizes the UEC values for the Island Interconnected region
- Exhibit 94 summarizes the UEC values for the Labrador Interconnected region
- Exhibit 95 summarizes the UEC values for the Isolated region.

The space heating end use has been omitted from Exhibit 93 through Exhibit 95 because it was presented in Exhibit 92.

[43] NRCan, 2012. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2010.*

Further commentary on the individual end uses is provided below the three following exhibits. An overall summary of changes to end use consumption since the 2008 study is provided in Section 3.4 above.

Exhibit 93 Annual Appliance Unit Electricity Consumption (UEC), Island Interconnected (kWh/yr.)

Dwelling Type	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	224	250	2,629	654	590	426	96	50	937
Single-family detached, non-electric space heat	203	741	2,385	593	590	426	87	46	850
Attached, electric space heat	101	224	2,694	670	590	426	99	52	960
Attached, non-electric space heat	88	648	2,330	580	590	426	85	45	831
Apartment, electric space heat	50	87	1,930	480	398	242	71	37	688
Apartment, non-electric space heat	34	205	1,302	324	398	242	48	25	464
Other and non-dwellings	179	97	1,363	339	590	426	50	26	486
Vacant and partial	46	25	654	163	122	88	24	13	233

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other
Single-family detached, electric space heat	722	1,137	388	238	291	170	14,512	266
Single-family detached, non-electric space heat	655	1,031	352	216	264	154	14,512	241
Attached, electric space heat	722	1,011	388	238	291	170	14,512	83
Attached, non-electric space heat	625	874	335	206	251	147	14,512	72
Apartment, electric space heat	620	507	333	205	250	146	-	126
Apartment, non-electric space heat	487	342	262	161	196	114	-	99
Other and non-dwellings	-	500	213	105	128	75	-	1,715
Vacant and partial	-	283	96	59	72	42	-	800

Exhibit 94 Annual Appliance Unit Electricity Consumption (UEC), Labrador Interconnected (kWh/yr.)

Dwelling Type	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	224	196	2,722	677	590	426	100	52	970
Single-family detached, non-electric space heat	225	741	2,744	683	590	426	101	53	978
Attached, electric space heat	101	155	2,789	694	590	426	102	53	994
Apartment, electric space heat	50	48	1,824	447	398	242	66	34	640
Other and non-dwellings	40	22	1,953	486	590	426	72	37	696

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other
Single-family detached, electric space heat	722	1,283	388	238	291	170	258	28,678	266
Single-family detached, non-electric space heat	728	1,293	391	240	293	171	258	28,678	243
Attached, electric space heat	722	1,009	388	238	291	170	258	28,678	83
Apartment, electric space heat	557	533	299	184	224	131	-	-	113
Other and non-dwellings	-	180	295	33	41	24	-	-	1,305

Exhibit 95 Annual Appliance Unit Electricity Consumption (UEC), Isolated (kWh/yr.)

Dwelling Type	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	224	181	2,677	666	590	426	98	51	954
Single-family detached, non-electric space heat	210	689	2,516	626	590	426	92	48	897
Other and non-dwellings	179	97	581	145	590	426	21	11	207
Vacant and partial	46	25	341	85	122	88	13	7	122

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other
Single-family detached, electric space heat	722	1,168	388	238	291	170	24,794	266
Single-family detached, non-electric space heat	679	1,098	364	224	273	159	24,794	227
Other and non-dwellings	-	215	89	44	54	31	-	718
Vacant and partial	-	149	49	30	37	22	-	495

Occupancy

Occupancy rates[44] for each dwelling type were based on the Newfoundland and Labrador REUS conducted in 2014. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as DHW, laundry and lighting. Exhibit 96 summarizes the occupancy rates assumed for this study. Cells coloured yellow in the exhibit had sample sizes of fewer than 10 respondents in the REUS and were therefore considered too uncertain to be used in this study. They are provided for comparison only.

Exhibit 96 Occupancy Rates by Dwelling Type (average occupants/dwelling)

House Type	Island Interconnected	Labrador Interconnected	Isolated
Detached	2.5	2.6	2.5
Attached Side by Side	2.6	4.0	
Attached Above Apartment	2.5	2.0	5.0
Basement Apartment	2.1	1.0	2.0
Mobile	2.3	1.8	2.7
Apartment in Multi-Unit Building	2.1		

Sample less than 10

Ventilation and Circulation

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

A furnace fan UEC of approximately 510 kWh was assumed for single detached houses with forced air systems. This figure is consistent with estimates used in ICF's most recent studies in other jurisdictions and is somewhat lower than estimates used in earlier studies. This reflects the steady increase in the prevalence of ECM motors as furnaces age out and are replaced with new ones that are typically equipped with the new motors, reaching a penetration of approximately 30% by the base year of this study. The 510 kWh value is also consistent with the range of Canadian end-use metered data reported in a study conducted for Natural Resources Canada.[45]

Typical consumption for an HRV fan was assumed to be 300 kWh per year.[46] The prevalence of HRVs in different types of houses in NL was drawn from the REUS. Exhibit 97 shows the percentage of dwellings with HRVs, by dwelling type and region, based on the REUS. Cells shown in yellow in the exhibit had too small a sample size to be reliable. Those values were not used in the study.

[44] Electricity use related to personal consumption increases with number of occupants in dwelling.
[45] This area is the focus of extensive research efforts. *See*: Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.
[46] Source: http://www.greenbuildingadvisor.com/blogs/dept/musings/are-hrvs-cost-effective

Exhibit 97 Prevalence of HRVs by Dwelling Type (percentage of dwellings with HRV)

House Type	Island Interconnected	Labrador Interconnected	Isolated
Detached	43.1%	25.0%	20.0%
Attached Side by Side	31.7%	0.0%	
Attached Above Apartment	61.5%	100.0%	0.0%
Basement Apartment	51.9%	100.0%	50.0%
Mobile	33.3%	25.0%	66.7%
Apartment in Multi-Unit Building	38.5%		

Sample less than 10

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

The UEC for a forced air system includes the electricity consumed by the furnace fan, the HRV fan and the exhaust fans. Overall UEC for forced air systems is assumed to be lower in this study than in the 2008 study, because improvements to the furnace fans outweigh the energy used by HRV fans. The UEC for a baseboard electric system includes only the electricity consumed by the latter two. Overall UEC for baseboard systems is assumed to be higher in this study than in the 2008 study, because of the inclusion of HRV fan energy in the end use.

Note: The ventilation and circulation UEC values shown previously in Exhibit 93 reflect the mix between forced air systems and baseboard systems.

Ventilation and circulation UEC values for the Labrador Interconnected and the Isolated regions are scaled based on the tertiary heating loads to best fit the electricity sales for those regions.

Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day and a temperature rise of 45°C. Exhibit 98 shows the distribution of DHW load by major end use.

Exhibit 98 Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washers	440	17%
Showers	660	25%
Faucets	511	19%
Baths	120	5%
Dishwashers	315	12%
Leaks	179	7%
Tank (Standby) Losses	202	8%
Pipe Losses	202	8%
Total	2,629	100%

Note: Any differences in totals are due to rounding.

The DHW values shown in Exhibit 98 are based on a combination of sources including available data from other jurisdictions, NRCan studies (NRCan, 2005) and the results of other recent ICF studies. Overall DHW UEC is assumed to be lower in this study than in the 2008 study, primarily because of lower hot water use in the newer clothes washers and dishwashers. Data from the NL REUS were used to update the efficiency of clothes washers and dishwashers, based on reported average ages of these appliances. DHW consumption by dwelling type was varied based on the reported average occupancies in the REUS.

UEC values for DHW and other non-HVAC end uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Indoor Lighting

The indoor lighting loads shown in Exhibit 93 were developed from the following sources:

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

Exhibit 99 shows the estimated counts of different types of lighting based on the data from the REUS and residential lighting data from other ICF studies. Lighting counts have increased as larger houses have been built in Canada, but the hours of use for each lighting fixture has decreased at the same time.

The average wattage and hours of use per year shown in the exhibit are based on ICF's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall indoor lighting energy consumption for different dwelling types. Overall UECs for lighting in the new study are assumed to be lower than in the 2008 study, primarily because of the increased penetration of compact fluorescent and LED lighting.

UEC values for lighting in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 99 Indoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	LED Lamps	
SDH	10.7	0.7	9.0	1.4	2.2	(lamps)
Attached	9.6	0.6	8.1	1.3	2.0	(lamps)
Apartment	4.9	0.3	4.1	0.7	1.0	(lamps)
Average Wattage	60	28	15	45	12	(w atts)
Average Hours/Year	1,032	344	1,548	1,032	1,548	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)						Total
SDH	664	7	208	67	41	986
Attached	597	6	187	60	37	887
Apartment	300	3	94	30	18	446

Outdoor Lighting

The outdoor lighting loads shown in Exhibit 93 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- NL's REUS

- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit 100 shows the estimated counts of different types of lighting based on the data from the REUS and residential lighting data from other ICF studies.

The average wattage and hours of use per year shown in the exhibit are based on ICF's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall outdoor lighting energy consumption for different dwelling types.

UEC values for lighting in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 100 Outdoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	LED Lamps	
SDH	1.7	0.2	1.5	0.3	0.4	(lamps)
Attached	1.5	0.2	1.4	0.3	0.4	(lamps)
Apartment	0.7	0.1	0.6	0.1	0.2	(lamps)
Average Wattage	60	28	15	45	12	(w atts)
Average Hours/Year	730	243	1460	730	1460	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)						Total
SDH	73	2	34	10	7	126
Attached	66	1	30	9	6	113
Apartment	31	1	14	4	3	53

Holiday Lighting

The holiday lighting loads shown in Exhibit 93 were developed from the following sources:

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

Exhibit 101 shows the estimated counts of different types of holiday lighting based on the data on residential lighting data from other ICF studies.

The average wattage and hours of use per year shown in the exhibit are based on ICF's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall holiday lighting energy consumption for different dwelling types.

UEC values for lighting in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 101 Holiday Lighting by Dwelling Type

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	2	9	2	6	(lamps)
Attached	1	5	1	4	(lamps)
Apartment	1	2	0	0	(lamps)
Average Wattage	60	1	60	1	(w atts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	11	1	15	1	28
Attached	6	0	8	1	14
Apartment	6	0	0	0	6

Cooking Appliances, Refrigerator, Freezer and Dishwasher

UEC estimates for the existing stock of this group of food preparation and storage appliances were obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2010* (NRCan, 2012). The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC. Average consumption values for refrigerators, freezers, and dishwashers have all decreased over time, according to the NRCan data. Cooking appliances have remained relatively stable.

UEC values for appliances and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Clothes Washer and Dryer

Appliance UEC data was obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2010* (NRCan, 2012). The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC. Average consumption values for clothes washers have decreased over time, according to the NRCan data. The NRCan data indicates that average consumption for new dryers has actually been rising slightly in recent years.

UEC values for appliances and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Computers

UEC data for computers is based on calculations drawing on data from the *Survey of Household Energy Use 2007: Detailed Statistical Report* (NRCan, 2007) and is consistent with ICF's previous work for studies in other jurisdictions.

UEC values for electronics and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Television

UEC data for televisions was obtained from *Technology and Market Profile: Consumer Electronics* (ICF, 2006). Saturation of televisions (number of sets per household) is adjusted by dwelling type based on data from the REUS, and consumption per television is varied modestly by dwelling type in this study based on assumed differences in occupancy.

UEC values for electronics and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Television Peripherals

UECs, saturations and numbers per household for television peripherals were obtained from *Technology and Market Profile: Consumer Electronics* (ICF, 2006) and other published data. In some parts of Canada, internet protocol television (IP-TV) is becoming a major player in the marketplace. The equipment for IP-TV uses about 40% less than the average cable or satellite system. IP-TV is assumed to occupy only a very small part of the NL market at this time, and has not been included in the calculations for this study. The weighted UEC for this end use as a whole was generated from the numbers shown in Exhibit 102. UEC was varied by dwelling type based on differences in occupancy.

UEC values for electronics and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 102 Derivation of UEC for Television Peripherals

	% of TVs in households	UEC kWh/yr.
Digital Cable Service	138%	
Digital Adaptor	138%	78
Standard Digital STB	61%	185
Advanced Digital STB	77%	309
Average UEC		332
Satellite Service	60%	
Standard Satellite STB	30%	134
Advanced Satellite STB	30%	260
Average UEC		197
Total Weighted UEC		291

Home Entertainment Electronics

Due to the large presence of electronic entertainment devices in many residential dwellings, this end use was separated from the general "other" category. UECs were obtained from *Technology and Market Profile: Consumer Electronics* (ICF, 2006), *Residential Miscellaneous Electricity Use* (LBL) and other published data. A weighted UEC for the end use as a whole was generated based on recent ICF studies, as shown in Exhibit 103.

UEC values for electronics and all the other non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 103 Derivation of UECs for Other Electronics

	Saturation (average number per household)	UEC (kWh/yr.)	Weighted UEC (kWh/yr.)
DVD	66%	35	23
VCR	18%	55	10
Audio System	38%	55	21
Surround Sound	25%	50	13
Compact Audio	119%	25	30
Game Console	44%	55	24
Other Electronic Entertainment	228%	22	50
Total Weighted UEC			170

Spas

This end use includes only spas. The incidence of swimming pools in NL is assumed to be small. The UEC includes the spa heater if it is electric, and also includes the consumption of the pump. Figures are derived from ICF's previous work in other jurisdictions and manufacturer literature on spa heater consumption. Exhibit 104 shows the derivation of the UECs used in Exhibit 93. The market penetration numbers in the exhibit are estimates of the shares of each technology within the subset of spas with that electric end use. For example, the estimate of 75% spa heaters using resistance heating elements is the share of electrically heated spas using resistance heat. Spas that are heated with propane or solar are not included.

UEC values for all non-HVAC uses in the Labrador Interconnected and the Isolated regions were scaled to best fit actual electricity sales to the accounts in those regions.

Exhibit 104 Derivation of UECs for Spas, Island Interconnected Region

	UEC (kWh/yr.)	Market Penetration	Weighted UEC (kWh/yr.)
Spa Heaters			
Resistance	15,870	75%	11,903
Heat Pump	5,290	25%	1,323
		Weighted UEC	13,225
Spa Pumps			
Standard	1,500	75%	1,125
High Efficiency	900	25%	225
		Weighted UEC	1,350
Total Weighted UEC			14,575

Block Heaters and Car Warmers

Consumption for block heaters was based on previous studies in other jurisdictions. Block heaters typically draw 500 watts. They were assumed to be used several hours per day for 90 days of the year. Approximately one-quarter of them were assumed to be on timers, which would reduce their runtime by 70%. The resulting total consumption of block heaters was estimated at 228 kWh/yr. The car warmers use more power, typically 1200 watts. They were assumed to be used fewer hours per day, but over a longer season of 110 days. More of them were assumed to be on timers – nearly half – with savings of about 50% of runtime. There are typically fewer car warmers than block heaters in use. Therefore, the car warmers were assumed to add only about 30 kWh/yr. to the total consumption for this end use, bringing it to 258 kWh/yr. The block heater end use is included only in the Labrador Interconnected region. The incidence of these devices in the other two regions is considered to be so small that any consumption for them is included under the Small Appliances and Other end use.

Small Appliances and Other

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

Exhibit 105 illustrates the major items included in this end use and presents sample UEC data estimated in earlier studies undertaken in other jurisdictions.[47] It should be noted that actual UECs for individual appliances will vary from those shown in Exhibit 105 and are affected by factors such as saturations by dwelling type and occupancy rates. Saturation information from LBL was not applied for this study because reliable information for NL was not available. The “other” category is not built up based on detailed analysis, but is an approximation only. The LBL data provided should be treated as being illustrative of the types of energy-using items in the category and how much electricity they typically use.

Consumption for the Small Appliances and Other end use is assumed to be lower in this study than in the 2008 study, largely because the consumption for space cooling, block heaters, and hot tubs has been separated into distinct end uses.

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

Exhibit 105 Typical UECs for Selected "Other" Appliances

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

A.3 Step 3: Determine Appliance Saturation, by Dwelling Type

Exhibit 106 through Exhibit 108 summarize the saturation levels that are used in the present analysis. The assumed saturation levels are developed from the most recent REUS. End uses fall into several categories:

- For the purposes of this study, saturation is defined as the presence of the end use. It does not include fuel share, which is discussed in the next section. The saturation of 100% for space heating, for example, indicates that all dwellings are assumed to be heated with some kind of fuel. The number of people who do not heat their homes at all is assumed to be vanishingly small.

- Some end uses are present in 100% of fully-occupied dwellings, including space heating,[48] ventilation and circulation, DHW, indoor and outdoor lighting, cooking, home entertainment electronics, and small appliance and other. These end uses are analyzed on the basis of UEC per dwelling, rather than UEC per appliance. Some of these end uses are not assumed to be present in all of the seasonal accounts, as the exhibit shows.
- Most of the remaining end uses are analyzed on the basis of UEC per appliance. Their saturation, as indicated in the table, reflects the average number of appliances per household. For example, the average household includes more than one refrigerator, and the saturation values in the exhibit reflect that.

The saturation levels by region are provided as follows:

- Exhibit 106 provides the estimated saturation levels for the Island Interconnected region
- Exhibit 107 provides the estimated saturation levels for the Labrador Interconnected region
- Exhibit 108 provides the estimated saturation levels for the Isolated region.

[48] As noted, the saturation of space heating, DHW, and cooking do not reflect how many households use electricity for those purposes. Electric share is discussed in the next section.

Exhibit 106 Appliance Saturation Levels, Island Interconnected Region (%)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer
Single-family detached, electric space heat	100%	8%	100%	100%	100%	144%	118%	72%	100%
Single-family detached, non-electric space heat	100%	0%	100%	100%	100%	144%	118%	72%	100%
Attached, electric space heat	100%	1%	100%	100%	100%	147%	92%	75%	100%
Attached, non-electric space heat	100%	0%	100%	100%	100%	147%	92%	75%	100%
Apartment, electric space heat	100%	0%	100%	100%	100%	118%	41%	43%	78%
Apartment, non-electric space heat	100%	0%	100%	100%	100%	118%	41%	43%	78%
Other and non-dwellings	100%	0%	100%	100%	100%	100%	100%	33%	100%
Vacant and partial	100%	0%	100%	100%	100%	100%	100%	33%	100%

Dwelling Type	Clothes dryer	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other
Single-family detached, electric space heat	98%	55%	100%	180%	265%	100%	100%	5%	100%
Single-family detached, non-electric space heat	98%	55%	100%	180%	265%	100%	100%	5%	100%
Attached, electric space heat	100%	55%	100%	177%	254%	100%	100%	3%	100%
Attached, non-electric space heat	100%	55%	100%	177%	254%	100%	100%	3%	100%
Apartment, electric space heat	76%	37%	100%	182%	168%	100%	100%	0%	100%
Apartment, non-electric space heat	76%	37%	100%	182%	168%	100%	100%	0%	100%
Other and non-dwellings	100%	33%	100%	167%	267%	100%	100%	0%	100%
Vacant and partial	100%	33%	100%	167%	267%	100%	100%	0%	100%

Exhibit 107 Appliance Saturation Levels, Labrador Interconnected Region (%)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	100%	0%	100%	100%	100%	163%	150%	81%	100%	100%
Single-family detached, non-electric space heat	100%	0%	100%	100%	100%	163%	150%	81%	100%	100%
Attached, electric space heat	100%	0%	100%	100%	100%	166%	117%	85%	100%	102%
Apartment, electric space heat	100%	0%	100%	100%	100%	134%	52%	48%	78%	78%
Other and non-dwellings	100%	0%	100%	100%	100%	100%	100%	33%	100%	100%

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other
Single-family detached, electric space heat	44%	100%	193%	294%	100%	100%	62%	6%	100%
Single-family detached, non-electric space heat	44%	100%	193%	294%	100%	100%	62%	6%	100%
Attached, electric space heat	44%	100%	184%	281%	100%	100%	62%	3%	100%
Apartment, electric space heat	29%	100%	187%	186%	100%	100%	53%	0%	100%
Other and non-dwellings	33%	100%	167%	267%	100%	100%	65%	0%	100%

Exhibit 108 Appliance Saturation Levels, Isolated Region (%)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer
Single-family detached, electric space heat	100%	0%	100%	100%	100%	120%	188%	48%	100%
Single-family detached, non-electric space heat	100%	0%	100%	100%	100%	120%	188%	48%	100%
Other and non-dwellings	100%	0%	100%	100%	100%	100%	100%	33%	100%
Vacant and partial	100%	0%	100%	100%	100%	100%	100%	33%	100%

Dwelling Type	Clothes dryer	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other
Single-family detached, electric space heat	96%	28%	100%	205%	248%	100%	100%	4%	100%
Single-family detached, non-electric space heat	96%	28%	100%	205%	248%	100%	100%	4%	100%
Other and non-dwellings	100%	33%	100%	167%	267%	100%	100%	0%	100%
Vacant and partial	100%	33%	100%	167%	267%	100%	100%	0%	100%

A.4 Step 4: Determine Fuel Share, by End Use and Dwelling Type

Data on fuel shares, for all end uses except space heating, is taken from the most recent NL REUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as reported in the REUS, but the actual fuel share includes not only the presence of different appliances but also how much they are used. In particular it is affected by supplementary heating appliances, such as:

- Electric space heaters in non-electrically heated dwellings
- Non-electric sources (e.g., wood stoves) in electrically heated dwellings.

The space heating fuel shares presented in the exhibit[49] have been selected on the basis that they provide a reasonable fit with:

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

The following exhibits summarize the electricity fuel shares assumed for each of the end uses by region, as follows:

- Exhibit 109 shows the assumed fuel shares for the Island Interconnected Region
- Exhibit 110 shows the assumed fuel shares for the Labrador Interconnected Region
- Exhibit 111 shows the assumed fuel shares for the Isolated Region.

Exhibit 109 Electricity Fuel Shares, Island Interconnected Region (%)

Dwelling Type	Space heating	Domestic Hot Water (DHW)	Cooking
Single-family detached, electric space heat	89%	100%	97%
Single-family detached, non-electric space heat	11%	75%	91%
Attached, electric space heat	88%	100%	100%
Attached, non-electric space heat	10%	64%	98%
Apartment, electric space heat	99%	100%	100%
Apartment, non-electric space heat	23%	79%	100%
Other and non-dwellings	50%	90%	100%
Vacant and partial	50%	90%	100%

[49] Adjustment of fuel shares for space heating was done in tandem with the adjustment of space heating loads described in Section 3.4 above.

Exhibit 110 Electricity Fuel Shares, Labrador Interconnected Region (%)

Dwelling Type	Space heating	Domestic Hot Water (DHW)	Cooking
Single-family detached, electric space heat	97%	100%	100%
Single-family detached, non-electric space heat	26%	75%	96%
Attached, electric space heat	96%	100%	100%
Apartment, electric space heat	99%	100%	100%
Other and non-dwellings	60%	90%	100%

Exhibit 111 Electricity Fuel Shares, Isolated Region (%)

Dwelling Type	Space heating	Domestic Hot Water (DHW)	Cooking
Single-family detached, electric space heat	74%	100%	100%
Single-family detached, non-electric space heat	3%	75%	96%
Other and non-dwellings	56%	90%	100%
Vacant and partial	56%	90%	100%

A.5 Step 5: Calibrate to sales data for the study Base Year of 2014

The Utilities provided electricity sales data for the year 2014, which was the latest year for which a complete year of data was available at the time of the study. Electricity sales were divided among the dwelling types and vintages according to the best information available from the utilities' customer databases and from ICF's energy end-use modelling. The RSEEM model was populated with data for UEC, saturation and electricity share and calibrated for a close match to the 2014 sales data.

A.6 Results by Region

This section of the appendix presents the base year electricity consumption for the Island Interconnected, Labrador Interconnected, and Isolated regions. For each region, versions of Exhibit 6 and Exhibit 7 (which appear in Section 3 of the main body of the report) are provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by region. In general, the sample sizes for the Isolated region are too small to develop these detailed assumptions for the houses there. Instead, the end use consumptions are scaled to calibrate the model to the sales of electricity in the Isolated region.

This section also does not replicate the pie charts and other graphs presented in Section 3. If those graphs are needed for each region, they can be created using the Data Manager.

Exhibit 112 Average Electricity Use per Dwelling Unit, Island Interconnected (kWh/yr.)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	12,921	17	250	2,629	637	850	501	69	50	916
Single-family detached, non-electric space heat	1,405	-	741	1,780	538	850	501	63	45	831
Attached, electric space heat	8,753	1	224	2,694	669	868	390	74	52	960
Attached, non-electric space heat	866	-	648	1,500	570	868	390	64	45	831
Apartment, electric space heat	4,883	-	87	1,930	480	472	99	30	29	523
Apartment, non-electric space heat	907	-	205	1,035	324	472	99	21	19	353
Other and non-dwellings	2,760	-	97	1,227	339	590	426	17	26	486
Vacant and partial	1,561	-	25	589	163	122	88	8	13	233

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	399	1,137	698	631	291	170	709	266	23,143
Single-family detached, non-electric space heat	362	1,031	633	573	264	154	709	241	10,721
Attached, electric space heat	400	1,011	688	604	291	170	380	83	18,312
Attached, non-electric space heat	346	874	595	523	251	147	380	72	8,970
Apartment, electric space heat	227	507	606	344	250	146	-	126	10,738
Apartment, non-electric space heat	179	342	476	270	196	114	-	99	5,111
Other and non-dwellings	-	500	355	279	128	75	-	1,715	9,020
Vacant and partial	-	283	161	158	72	42	-	800	4,318

Exhibit 113 Average Electricity Use per Dwelling Unit, Labrador Interconnected (kWh/yr.)

Dwelling Type	Space heating	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	27,934	196	2,722	677	959	639	81	52	970
Single-family detached, non-electric space heat	7,380	741	2,047	653	959	639	82	53	978
Attached, electric space heat	23,297	155	2,789	694	980	498	87	54	1,017
Apartment, electric space heat	6,817	48	1,824	447	532	127	32	27	498
Other and non-dwellings	2,571	22	1,757	486	590	426	24	37	696

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	316	1,283	748	700	291	170	160	1,792	266	39,956
Single-family detached, non-electric space heat	318	1,293	754	706	293	171	160	1,792	243	19,263
Attached, electric space heat	316	1,009	713	670	291	170	159	960	83	33,940
Apartment, electric space heat	162	533	561	343	224	131	-	-	113	12,417
Other and non-dwellings	-	180	492	89	41	24	-	-	1,305	8,740

Exhibit 114 Average Electricity Use per Dwelling Unit, Isolated Region (kWh/yr.)

Dwelling Type	Space heating	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	18,298	181	2,677	666	709	801	47	51	916
Single-family detached, non-electric space heat	811	689	1,878	599	709	801	44	48	861
Other and non-dwellings	1,290	97	523	145	590	426	7	11	207
Vacant and partial	894	25	307	85	122	88	4	7	122

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	202	1,168	795	591	291	170	992	266	28,819
Single-family detached, non-electric space heat	190	1,098	747	556	273	159	992	227	10,681
Other and non-dwellings	-	215	149	117	54	31	-	718	4,580
Vacant and partial	-	149	82	81	37	22	-	495	2,519

Exhibit 115 Electricity Consumption by End Use and Dwelling Type in the Base Year (2014), Island Interconnected (MWh/yr.)

Dwelling Type	Space heating	Space cooling	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	1,292,846	1,723	25,048	263,075	63,738	85,070	50,091	6,950	5,014	91,701
Single-family detached, non-electric space heat	91,434	-	48,207	115,811	35,005	55,329	32,579	4,100	2,958	54,095
Attached, electric space heat	199,039	22	5,089	61,251	15,204	19,743	8,878	1,691	1,173	21,836
Attached, non-electric space heat	3,990	-	2,982	6,908	2,622	3,998	1,798	296	205	3,825
Apartment, electric space heat	113,543	-	2,015	44,866	11,166	10,966	2,312	707	667	12,162
Apartment, non-electric space heat	2,244	-	507	2,561	802	1,167	246	51	48	874
Other and non-dwellings	21,074	-	739	9,368	2,590	4,508	3,252	127	199	3,711
Vacant and partial	26,804	-	428	10,105	2,794	2,091	1,508	137	215	4,002
Grand Total	1,750,974	1,745	85,015	513,943	133,923	182,872	100,664	14,059	10,480	192,205

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	39,973	113,782	69,884	63,165	29,082	16,968	70,990	26,589	2,315,689
Single-family detached, non-electric space heat	23,580	67,121	41,225	37,262	17,156	10,010	46,172	15,685	697,729
Attached, electric space heat	9,091	22,986	15,633	13,741	6,609	3,856	8,640	1,893	416,374
Attached, non-electric space heat	1,592	4,026	2,738	2,407	1,158	675	1,750	332	41,302
Apartment, electric space heat	5,289	11,797	14,088	7,991	5,805	3,387	-	2,922	249,684
Apartment, non-electric space heat	442	848	1,178	668	486	283	-	244	12,650
Other and non-dwellings	-	3,818	2,714	2,134	976	569	-	13,097	68,875
Vacant and partial	-	4,856	2,759	2,714	1,241	724	-	13,742	74,121
Grand Total	79,968	229,235	150,219	130,081	62,513	36,473	127,552	74,503	3,876,424

Exhibit 116 Electricity Consumption by End Use and Dwelling Type in the Base Year (2014), Labrador Interconnected (MWh/yr.)

Dwelling Type	Space heating	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	131,947	926	12,857	3,200	4,532	3,017	383	246	4,583
Single-family detached, non-electric space heat	2,624	263	728	232	341	227	29	19	348
Attached, electric space heat	66,188	440	7,923	1,972	2,784	1,415	247	152	2,889
Apartment, electric space heat	5,604	40	1,499	367	437	104	26	22	409
Other and non-dwellings	2,506	22	1,713	474	576	415	23	36	679
Grand Total	208,869	1,691	24,720	6,245	8,670	5,179	709	476	8,908

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Block heaters & car warmers	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	1,492	6,060	3,532	3,307	1,373	801	755	8,466	1,255	188,733
Single-family detached, non-electric space heat	113	460	268	251	104	61	57	637	86	6,849
Attached, electric space heat	898	2,866	2,026	1,904	826	482	450	2,727	236	96,425
Apartment, electric space heat	133	438	461	282	184	108	-	-	93	10,207
Other and non-dwellings	-	175	479	87	40	23	-	-	1,273	8,522
Grand Total	2,636	9,999	6,766	5,830	2,527	1,474	1,263	11,831	2,944	310,735

Exhibit 117 Electricity Consumption by End Use and Dwelling Type in the Base Year (2014), Isolated Region (MWh/yr.)

Dwelling Type	Space heating	Ventilation	Domestic Hot Water (DHW)	Cooking	Refrigerator	Freezer	Dishwasher	Clothes washer	Clothes dryer
Single-family detached, electric space heat	6,413	63	938	233	248	281	17	18	321
Single-family detached, non-electric space heat	2,174	1,847	5,033	1,606	1,899	2,146	119	129	2,308
Other and non-dwellings	227	17	92	25	104	75	1	2	36
Vacant and partial	284	8	98	27	39	28	1	2	39
Grand Total	9,098	1,936	6,160	1,892	2,290	2,529	138	151	2,704

Dwelling Type	Dehumidifier	Lighting	Computer and peripherals	Television	Television peripherals	Other electronics	Hot tubs	Small appliance & other	Total
Single-family detached, electric space heat	71	409	279	207	102	59	348	93	10,100
Single-family detached, non-electric space heat	509	2,942	2,002	1,489	732	427	2,658	607	28,628
Other and non-dwellings	-	38	26	21	9	6	-	127	807
Vacant and partial	-	47	26	26	12	7	-	157	800
Grand Total	580	3,436	2,333	1,743	855	499	3,006	984	40,335

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 Residential sector Base Year peak loads. The discussion is organized as follows:

- Overview of peak load methodology
- Segmentation of residential dwellings
- 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 residence.

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 peak period defined in this study. Exhibit 118, 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 36-hour winter peak period is used. The winter peak is defined as follows:

> *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.*[50]

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

Exhibit 118 Illustrative Application of Annual Energy to Peak Period Value Factors

The Winter Peak demand is computed based on the average demand for the 36-hour period. The NL peak is assumed to occur on the four coldest days in December and January.

The following steps are required:

- **Step 1:** The monthly usage allocation factor for December and January are applied to the annual energy use to calculate December and January energy use.
- **Step 2:** The average weekday in December and January 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.

$$\frac{1}{Days\ in\ Month \times \left[\frac{5}{7} + \left(\frac{2}{7} \times Weekend\ Ratio\right)\right]}$$

- **Step 3:** The peak day factor is then applied to the average weekday electric energy use to determine the peak day use for the four peak days (as defined by the NL utilities).
- **Step 4:** The average peak over the 9 hours of peak period per day is then calculated based on allocating the peak day use according to the per unit hourly load factor for a peak winter day, using the percentage of use in those hours versus the daily usage for the peak day.

It should be noted that the methodology shown in Exhibit 118 produces aggregate diversified average loads for all customers or end uses in the defined sub-sector.

Exhibit 119 provides a specific numeric example for the calculation of Winter Peak Period demand (kW). The example presented in Exhibit 119 is for DHW use in electrically heated single detached homes, prior to adjustment for fuel share. The example shows how the annual consumption of 2,629 kWh can be converted to a peak demand value for the Winter Peak Period by the calculation of a corresponding hours-use value.

Exhibit 119 Sample Hours-Use Calculation for Electric Water Heating

Winter Peak Period =

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

Peak Period Average Demand =

$$\frac{2{,}629\ [\text{Ann. kWh}] \times\ 17.44\%\ [\text{Mo. Alloc.}]}{62 \times \left[\frac{5}{7} + \left(\frac{2}{7} \times 1.0\ [\text{Wkend Ratio}]\right)\right]} \times 1.0\ [\text{Peak Day Fact.}]\ \times 0.10223\ [\text{Peak Hrs \% Day kWh}]$$

= 0.756 kW

$$\frac{2{,}629\ [\text{annual kWh}]}{0.756\ [\text{Winter Peak Period}]} = 3{,}476\ [\text{Winter Peak Hours Use}]$$

This means that any applicable single-family detached annual water heating kWh can be converted to average demand in kW during the 36-hour winter peak period by dividing by 3,476 hours.

B.2 Segmentation of Residential Dwellings

The Residential 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 dwelling type and end use.

Exhibit 120 shows the residential dwelling types that were addressed.

Exhibit 120 Residential Dwelling Types Used for Electric Peak Load Calculations

Dwelling Type (SDH, Row house and main houses above basement apartments, Apartments including basement apartments, Other)
Heating Fuel (Electric vs. Non-electric)

B.3 Hours-Use Factors

Exhibit 121 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., 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 peak demand used the hours-use factors from the 2008 CDM Potential Study. 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 121 Residential End Use Load Shape Parameters

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1001	Space Heating, general – not used in this study	N/A	N/A	N/A	N/A
1002	Central A/C – All	Assumed 100% off winter peak	1.00 various studies	Assumed 100% off winter peak	RG&E 1991 Study
1003	Room A/C – All	Assumed 100% off winter peak	1.00 various studies	Assumed 100% off winter peak	RG&E 1991 Study
1004	Water Heating – All	RG&E 1991 Study	1.00 various studies	1.0 Assumed	RG&E 1991 Study
1005	Cooking – All	Mass. JUMP	Mass JUMP[51, 52]	1.0 Assumed	Mass. JUMP
1006	Refrigerator – All	Mass. JUMP	1.00 various studies	1.0 Assumed	Mass. JUMP
1007	Freezer – All	Mass. JUMP Refrigerator	Mass. JUMP	1.0 Assumed	Mass. JUMP
1008	Dishwasher – All	LILCO DSM Program Eval 1988-1991	1.00 various studies	1.0 Assumed	ELCAP DOE[53]
1009	Clothes Washer – All	LILCO DSM			
1010	Clothes Dryer – All	Mass. JUMP Refrigerator	Mass. JUMP	1.0 Assumed	Mass. JUMP
1011	Lighting – All	LILCO Direct Install Program 1991 adj. by DOE[54] Seasonality	LILCO[55]	1.0 Assumed	LILCO Direct Install Program 1991 adj. by DOE Seasonality
1012	Computer – All	USDOE Building America 2008 Misc. Electric Loads[6]	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load
1013	Television – All	California Energy Commission			
1014	Television Peripherals – All	USDOE Building America 2008 Misc. Electric Loads[6]	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load
1015	General Plug Loads	USDOE Building America 2008 Misc. Electric Loads[6]	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load

[51] Massachusetts JUMP Update and Analysis (Appliance Monitoring Project), AEIC Northeast Regional Conference and Proceedings; Hartford, CT; September 16, 1988; S. Chiara (ComEnergy) and J. Lopes (AEG).
[52] Massachusetts Joint Utility End Use Monitoring Project Final Report – Final Report; Applied Energy Group, Inc.; Feb 15, 1989.
[53] Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest (ELCAP), DOE/BP-13795-21, PNNL; ref. in "Building America Research Benchmark Definition"; Jan. 2008.
[54] Building America Research Benchmark Definition – Updated December 20, 2007; USDOE Renewable Energy Laboratory NREL/TP-550-42662; January 2008.
[55] Long Island Lighting Company; DSM Program Evaluations; 1988 – 1991.

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1016	Space Heating – Single Family Detached	St. John's Newfoundland 1971-2000 (30-year) Normal HDD; then calibrated to actual utility demand	1.09 BCH Residential Premise Load Model - SFD[56]	Adj. From BCH 10-yr. Avg. Monthly Peak/Wkday HDD Ratio[57]	Hr end 6pm = 5.57% of daily kWh BCH Residential Premise Load Model - SFD
1017	Space Heating – Attached, Apartment, Isolated, Other, Vacant and Partial	St. John's Newfoundland 1971-2000 (30-year) Normal HDD; then calibrated to actual utility demand	1.06 BCH Residential Premise Load Model - Row	Adj. From BCH 10-yr. Avg. Monthly Peak/Wkday HDD Ratio	Hr end 6pm = 5.54% of daily kWh BCH Residential Premise Load Model - Row
1018	Pool Pumps, Hot Tubs	BCH REUS[58] & SCE RAEUS[59]; then calibrated to actual utility demand	SCE RAEUS	SCE RAEUS	Hr End 7pm SCE RAEUS
1019	Engine Block Heater	Monthly shape for Labrador assumed similar to SK; then calibrated to actual utility demand	1.00 assumed	Peak Day factor assumed similar to SK	Flat, average 7.9 hrs/day for 90 days[60]

Exhibit 122 shows the distinct hour-use values developed for each combination of region, residential 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 space heating in single detached houses by the hours-use value for the Winter Peak Period (i.e., 2,980 for Island Interconnected) will convert annual MWh to demand at the annual system winter peak period.

[56] BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SFD – Single Family; Row – Row Houses)
[57] To account for longer winter, used BCH Nov Peak Day Factors for NL Oct; BCH Oct for NL Sept; BCH April for NL May; BCH June for NL May
[58] BC Hydro REUS (Appliance Saturation Study) estimates of saturation of component appliances (outdoor and indoor pools, outdoor hot tubs and indoor Jacuzzis), and SCE RAEUS monthly energy use used to calculate weighted monthly energy use for monthly allocation averages.
[59] Southern California Edison 1988 RAEUS (End Use) Study – Indoor/outdoor Pool Pumps and Electric Spas/Jacuzzis.
[60] Ontario Power Authority – OPA Measures and Assumptions List (prescriptive) as of January 31, 2010; 1450 watts at 7.9 hours/day x 90 days.

Exhibit 122 Residential Sector Load Shape Hours-Use Values

Code	Sector Type	Sub-Sector	Region	End Use	End Use Sub	Measure	Hours-Use Factor
1001	Res	All	All	Space Heat	All	Base	2,849
1002	Res	All	All	Space Cool	All	Base	1.00E+15
1003	Res	All	All	Room A/C	All	Base	1.00E+15
1004	Res	All	All	Water Heat	All	Base	3,476
1005	Res	All	All	Stove	All	Base	5,042
1006	Res	All	All	Refrigerator	All	Base	10,066
1007	Res	All	All	Freezer	All	Base	10,066
1008	Res	All	All	Dishwasher	All	Base	6,012
1009	Res	All	All	Clothes Washer	All	Base	6,012
1010	Res	All	All	Dryer	All	Base	6,012
1011	Res	All	All	Lighting	All	Base	5,994
1012	Res	All	All	Computer	All	Base	7,758
1013	Res	All	All	Television	All	Base	5,994
1014	Res	All	All	TV Peripherals	All	Base	7,758
1015	Res	All	All	General Plug Loads	All	Base	7,758
1016	Res	SFD	Island	Space Heat	All	Base	2,980
1017	Res	Row	Island	Space Heat	All	Base	2,895
1018	Res	All	Island	Pools and Hot tubs	All	Base	6,444
1019	Res	All	Island	Engine Block Heaters	All	Base	964
1020	Res	SFD	Labrador	Space Heat	All	Base	3,550
1021	Res	Row	Labrador	Space Heat	All	Base	3,448
1022	Res	All	Labrador	Pools and Hot tubs	All	Base	7,676
1023	Res	All	Labrador	Engine Block Heaters	All	Base	1,148
1024	Res	SFD	Isolated	Space Heat	All	Base	2,537
1025	Res	Row	Isolated	Space Heat	All	Base	2,465
1026	Res	All	Isolated	Pools and Hot tubs	All	Base	5,487
1027	Res	All	Isolated	Engine Block Heaters	All	Base	821

Since the Utilities do not conduct regular class or end-use load analysis studies, there is no actual total (or dwelling type) 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 during the 2008 study based on the sources listed in Exhibit 121.

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 1016 through 1027 above, along with similar end uses in the commercial and industrial 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 exhibits shows peak demand by dwelling type and end use for the peak period identified for this study. This is followed by three more showing the results by region.

Note that in each of the exhibits, the end uses are sorted from largest peak demand to smallest peak demand, so they do not appear in the same order in the three exhibits.

Exhibit 123 Residential Sector Base Year (2014) Peak Hour Demand, by Dwelling Type and End Use, All NL (MW)*

Dwelling Types	Reference Case Peak Demand (MW)								
	Space heating	Domestic Hot Water (DHW)	Lighting	Clothes dryer	Ventilation	Cooking	Television	Hot tubs	Computer and peripherals
Single-family detached, electric space heat	473	80	20	16	9	13	11	12	9
Single-family detached, non-electric space heat	32	35	12	9	17	7	7	8	6
Attached, electric space heat	88	20	4	4	2	3	3	2	2
Attached, non-electric space heat	1	2	1	1	1	1	0	0	0
Apartment, electric space heat	41	13	2	2	1	2	1	-	2
Apartment, non-electric space heat	1	1	0	0	0	0	0	-	0
Other and non-dwellings	8	3	1	1	0	1	0	-	0
Vacant and partial	9	3	1	1	0	1	0	-	0
Grand Total	654	157	40	34	30	28	23	22	21

Dwelling Types	Reference Case Peak Demand (MW)								
	Refrigerator	Freezer	Small appliance & other	Television peripherals	Other electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Grand Total
Single-family detached, electric space heat	9	5	4	4	2	1	1	1	671
Single-family detached, non-electric space heat	6	3	2	2	1	1	1	0	149
Attached, electric space heat	2	1	0	1	1	0	0	0	134
Attached, non-electric space heat	0	0	0	0	0	0	0	-	8
Apartment, electric space heat	1	0	0	1	0	0	0	-	68
Apartment, non-electric space heat	0	0	0	0	0	0	0	-	3
Other and non-dwellings	1	0	2	0	0	0	0	-	17
Vacant and partial	0	0	2	0	0	0	0	-	18
Grand Total	19	11	10	8	5	2	2	1	1,067

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

Exhibit 124 Residential Sector Base Year (2014) Peak Hour Demand, Island Interconnected, by Dwelling Type and End Use (MW)*

Dwelling Types	Reference Case Peak Demand (MW)								
	Space heating	Domestic Hot Water (DHW)	Lighting	Clothes dryer	Ventilation	Cooking	Television	Hot tubs	Computer and peripherals
Single-family detached, electric space heat	434	76	19	15	8	13	11	11	9
Single-family detached, non-electric space heat	31	33	11	9	16	7	6	7	5
Attached, electric space heat	69	18	4	4	2	3	2	1	2
Attached, non-electric space heat	1	2	1	1	1	1	0	0	0
Apartment, electric space heat	39	13	2	2	1	2	1	-	2
Apartment, non-electric space heat	1	1	0	0	0	0	0	-	0
Other and non-dwellings	7	3	1	1	0	1	0	-	0
Vacant and partial	9	3	1	1	0	1	0	-	0
Grand Total	591	148	38	32	29	27	22	20	19

Dwelling Types	Reference Case Peak Demand (MW)							
	Refrigerator	Freezer	Small appliance & other	Television peripherals	Other electronics	Dishwasher	Clothes washer	Grand Total
Single-family detached, electric space heat	8	5	3	4	2	1	1	620
Single-family detached, non-electric space heat	5	3	2	2	1	1	0	141
Attached, electric space heat	2	1	0	1	0	0	0	109
Attached, non-electric space heat	0	0	0	0	0	0	0	8
Apartment, electric space heat	1	0	0	1	0	0	0	65
Apartment, non-electric space heat	0	0	0	0	0	0	0	3
Other and non-dwellings	0	0	2	0	0	0	0	15
Vacant and partial	0	0	2	0	0	0	0	17
Grand Total	18	10	10	8	5	2	2	979

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

Exhibit 125 Residential Sector Base Year (2014) Peak Hour Demand, Labrador Interconnected, by Dwelling Type and End Use (MW)*

Dwelling Types	Reference Case Peak Demand (MW)								
	Space heating	Domestic Hot Water (DHW)	Lighting	Hot tubs	Clothes dryer	Cooking	Block heaters & car warmers	Television	Computer and peripherals
Single-family detached, electric space heat	37	4	1	1	1	1	1	1	0
Single-family detached, non-electric space heat	1	0	0	0	0	0	0	0	0
Attached, electric space heat	19	2	0	0	0	0	0	0	0
Apartment, electric space heat	2	0	0	-	0	0	-	0	0
Other and non-dwellings	1	0	0	-	0	0	-	0	0
Grand Total	59	7	2	2	1	1	1	1	1

Dwelling Types	Reference Case Peak Demand (MW)								
	Refrigerator	Ventilation	Freezer	Small appliance & other	Television peripherals	Other electronics	Dishwasher	Clothes washer	Grand Total
Single-family detached, electric space heat	0	0	0	0	0	0	0	0	48
Single-family detached, non-electric space heat	0	0	0	0	0	0	0	0	2
Attached, electric space heat	0	0	0	0	0	0	0	0	25
Apartment, electric space heat	0	0	0	0	0	0	0	0	3
Other and non-dwellings	0	0	0	0	0	0	0	0	2
Grand Total	1	1	1	0	0	0	0	0	78

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

Exhibit 126 Residential Sector Base Year (2014) Peak Hour Demand, Isolated, by Dwelling Type and End Use (MW)*

Dwelling Types	Reference Case Peak Demand (MW)								
	Space heating	Domestic Hot Water (DHW)	Ventilation	Lighting	Hot tubs	Clothes dryer	Cooking	Computer and peripherals	Television
Single-family detached, electric space heat	2.5	0.3	0.0	0.1	0.1	0.1	0.0	0.0	0.0
Single-family detached, non-electric space heat	0.9	1.4	0.6	0.5	0.5	0.4	0.3	0.3	0.2
Other and non-dwellings	0.1	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0
Vacant and partial	0.1	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0
Grand Total	3.6	1.8	0.6	0.6	0.5	0.4	0.4	0.3	0.3

Dwelling Types	Reference Case Peak Demand (MW)							
	Freezer	Refrigerator	Small appliance & other	Television peripherals	Other electronics	Clothes washer	Dishwasher	Grand Total
Single-family detached, electric space heat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2
Single-family detached, non-electric space heat	0.2	0.2	0.1	0.1	0.1	0.0	0.0	5.8
Other and non-dwellings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Vacant and partial	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Grand Total	0.3	0.2	0.1	0.1	0.1	0.0	0.0	9.4

*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 residential sector Reference Case electricity use. The major steps involved are:

- **Step 1:** Estimate net space heating and cooling loads for each new dwelling type
- **Step 2:** Estimate naturally-occurring changes in net space heating and cooling loads for existing dwelling types
- **Step 3:** Estimate naturally-occurring changes in annual electricity use for the evolving stock of major residential appliances
- **Step 4:** Estimate future appliance saturation trends for each dwelling type
- **Step 5:** Estimate changes in electricity share for each appliance, by dwelling type
- **Step 6:** Estimate the growth in number of residential dwellings, by type.

C.1 Step 1: Estimation of Net Space Heating and Cooling Loads—New Dwellings

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

- Estimated electricity consumption per dwelling from the NL load forecast,
- Comparisons of housing characteristics between the dwellings built since 2000 and the average dwellings, as reported in the REUS,
- Review of experience in other jurisdictions.

Based on consideration of the best available data from the above sources, this study assumes that the net space heating loads in new dwellings are likely to decrease slightly compared to existing dwellings. This conclusion recognizes that while thermal efficiencies are improving in new dwellings, they are being partially offset by changing construction practices.

Examples of these offsetting trends include:

- Overall, window, wall and roofing thermal efficiency levels have increased in new residential buildings and air leakage rates have been reduced compared to typical existing dwellings
- The amount of window area in new houses tends to be greater compared to typical existing homes
- The new stock tends to have floor areas that are slightly larger, on average, than existing dwellings, though this trend has levelled off recently
- Buildings also feature an increase in exterior wall surface area. This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

Exhibit 127 summarizes the resulting new net space heating and cooling loads.

Exhibit 127 New Residential Units—Net Space Heating Loads by Dwelling Type, (kWh/yr.)

Dwelling Type	Island Interconnected	Labrador Interconnected	Isolated
Single-family detached, electric space heat	13,577	27,764	25,309
Single-family detached, non-electric space heat	12,205	27,736	23,745
Attached, electric space heat	9,220	23,186	11,591
Attached, non-electric space heat	7,975	23,186	11,591
Apartment, electric space heat	4,573	6,607	5,850
Apartment, non-electric space heat	3,594	8,559	5,850
Other and non-dwellings	5,118	4,111	2,355
Vacant and partial	2,895	-	1,632

C.1.1 Development of Thermal Archetypes – New Stock

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

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

Single detached houses

For the Island and Isolated service region, a typical new single-family detached dwelling can be defined as a single-story bungalow of approximately 176 m^2 (1,900 ft^2), including a finished basement. This home has approximately 20.0 m^2 (215 ft^2) of window area, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-3.5 (R-20) insulation values and ceilings by RSI-4.3 (R-24). The houses are reasonably airtight with about 1.5 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

For the Labrador Interconnected service region, a typical new, single-detached dwelling is expected to be similar to the new detached dwelling in the Island Interconnected region, though the consumption data indicates it may be slightly larger. All new homes are assumed to have an HRV, with ductwork to distribute the ventilation air.

Attached Dwellings

A typical new attached dwelling can be defined as a one-story end unit of approximately 137 m^2 (1,470 ft^2), including a finished basement. This home has 12 m^2 (130 ft^2) of windows, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-3.5 (R-20) insulation values, as are the ceilings. The houses are reasonably airtight, with an air change rate of about 1.5 ACH@50Pa.

For the Labrador Interconnected service region, a typical new, attached dwelling is expected to be similar to the new attached dwelling in the Island Interconnected region, though the consumption data indicates it may be slightly larger. All new homes are assumed to have an HRV, with ductwork to distribute the ventilation air.

C.2 Step 2: Natural Changes to Space Heating Loads – Existing Dwellings

In addition to new dwellings, space heating loads in existing dwellings are also expected to change over the study period. However, no specific data are available and, as outlined in the preceding discussion of new dwellings, contrary trends[61] are occurring.

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

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

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

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

Dwellings that undergo a major energy retrofit to the building shell are moved from the existing dwelling category into renovated dwellings. On average, these projects are assumed to include two building envelope retrofits (though they may not all happen in the same month), such as replacement of half the windows and the addition of insulation to the attic. In past projects, window replacement has been used as an indicator of the percentage of dwellings being renovated. Window sales are typically divided roughly evenly between installation in new homes and replacement in existing homes. A typical window replacement project involves approximately half the windows in the dwelling. Therefore, the rate of renovation is approximately double the rate of new construction.

Trial energy simulation runs were undertaken in HOT2000, assuming a variety of combinations of retrofit measures. The results varied widely, from a 2% to 15% reduction in space heat and cooling loads, depending on assumptions related to the number of windows replaced, or the part of the house being insulated. These decreases will be partly or wholly offset in those renovation jobs that also increase the floor area of the dwelling.

In the absence of more comprehensive data, this study assumes that a renovation to a home built after 1980 would experience a net reduction in space heating load of 3%. An older home (in which it was assumed more likely there would be an addition to the floor area) would experience a net reduction in space heating load of 2%. This study assumed a net improvement of 2%.

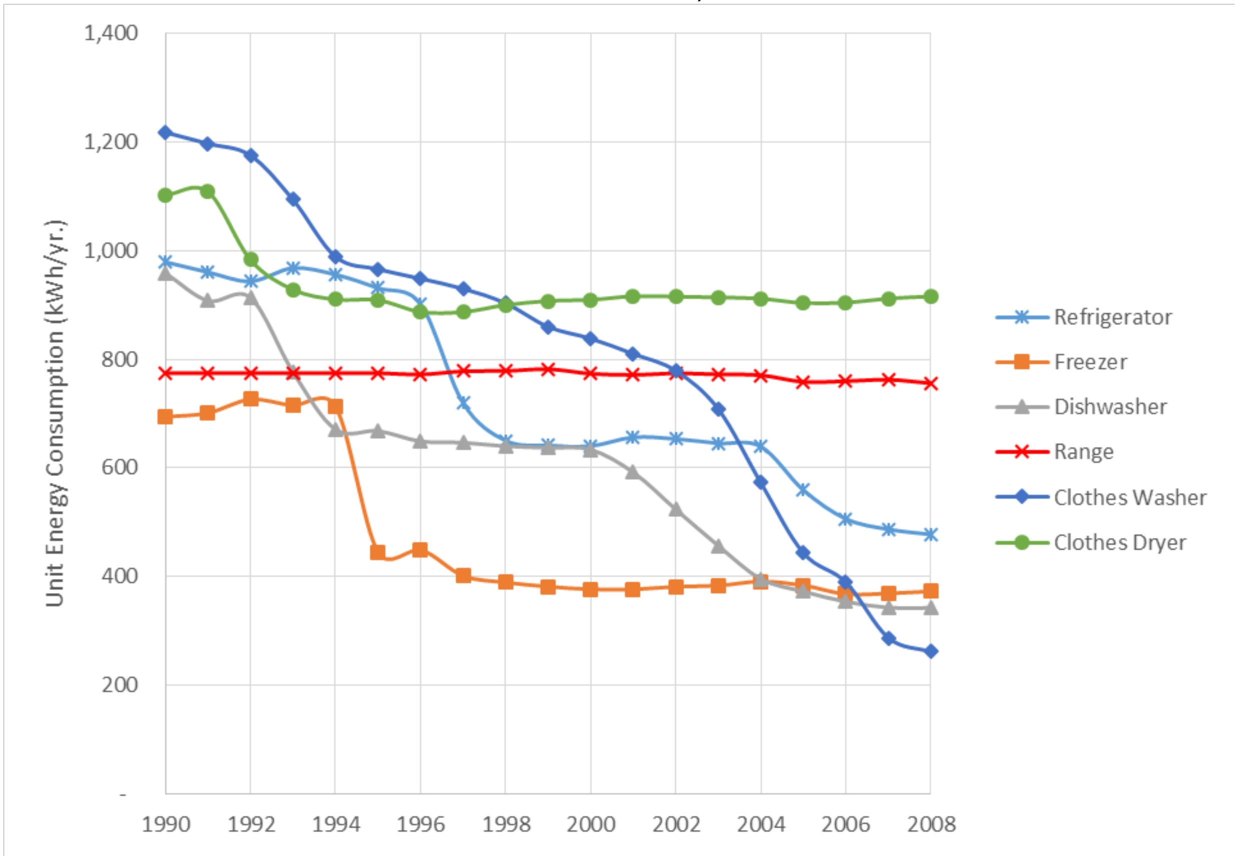
[61] Replacement of the heating equipment itself is not one of these factors because it does not actually change the net heating load.

C.3 Step 3: Natural Changes to Electric Appliance UECs

This section identifies the annual unit electricity consumption (UEC) for the major household appliances and equipment for both “stock in place” and new sales for the period 2010 to 2029.

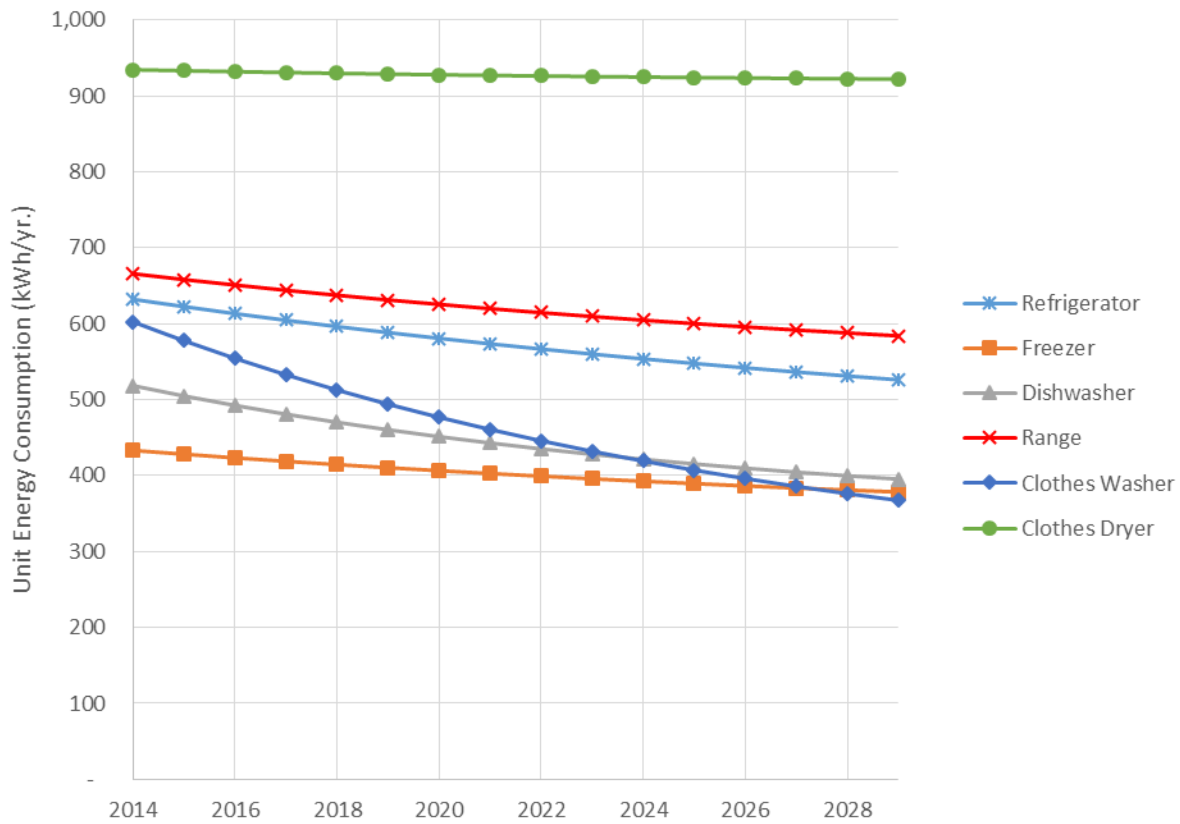
Exhibit 128 shows Canadian trend information for the new sales of white goods for the period 1990 to 2008. Exhibit 129 incorporates the average consumption data for new sales into ICF’s appliance stock model to develop forecasts for average consumption of the white goods appliances throughout the study period.

Exhibit 128 Canadian White Goods, UECs for New Sales



Source: NRCan, *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2010*.

Exhibit 129 Canadian White Goods, UECs for Existing Stock



Source: Original NRCan UEC data for new sales (see source note for previous exhibit), incorporated into ICF's appliance stock model.

As shown in Exhibit 129, the annual UEC for most major household white good type appliances in existing stock is expected to decline steadily due to stock turnover and to continuing improvements in new stock. Future regulations or innovations may bring additional improvements in the white goods in the later years of the study period, but no assumptions have been made to that effect. Instead, the consumption improvements of the different appliances are assumed to slow down towards the end of the study period.

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

Cooking

A UEC, which includes both ranges and microwave ovens, of 670 kWh/yr. is assumed in the Base Year, declining to 588 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of cooking appliances), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a cooking UEC of 599 kWh/yr. on average, declining to 588 kWh/yr. by 2029.

Refrigerator

A UEC of 610 kWh/yr. is assumed in the Base Year, declining to 508 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of refrigerators), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a refrigerator UEC of 523 kWh/yr. on average, declining to 508 kWh/yr. by 2029.

Freezer

A UEC of 436 kWh/yr. is assumed in the Base Year, declining to 381 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of freezers), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a freezer UEC of 389 kWh/yr. on average, declining to 381 kWh/yr. by 2029.

Dishwasher

A UEC of 98 kWh/yr. is assumed in the Base Year, declining to 74 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of dishwashers), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dishwasher UEC of 77 kWh/yr. on average, declining to 74 kWh/yr. by 2029.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 19% of the values reflected in Exhibit 129. Hot water use is included with the DHW UEC.

Clothes Washer

A UEC of 52 kWh/yr. is assumed in the Base Year, declining to 31 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes washers), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a clothes washer UEC of 34 kWh/yr. on average, declining to 31 kWh/yr. by 2029.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 8% of the values reflected in Exhibit 129. Hot water use is included with the DHW UEC.

Clothes Dryer

A UEC of 940 kWh/yr. is assumed in the Base Year, declining to 927 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes dryers), follows the pattern shown in Exhibit 93. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dryer UEC of 929 kWh/yr. on average, declining to 927 kWh/yr. by 2029.

Ventilation

Ventilation energy in existing stock is assumed to decrease modestly over the study period. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, there is a trend towards manufacturers' use of larger fan motors (1/2-HP versus 1/3-HP) in new furnaces. This means that furnaces replaced in the study period may have a larger furnace fan motor. However, the trend towards larger fan motors is likely to be more than offset by efficiency improvements. Efficient ventilation fan motors are assumed to reduce fan energy by approximately 65% and are assumed to be installed in 80% of the replacement furnaces being installed. Overall, more efficient but larger fan motors would have the effect of reducing furnace fan energy in existing homes with forced air systems by approximately 22% by 2029, from approximately 740 kWh/yr. to 575 kWh/yr.

In new stock, average ventilation energy (including furnace fans, HRV fans, other fans such as exhaust fans in the kitchen, and pumps in boiler systems) was assumed to increase by nearly 40%, relative to existing systems with larger but more efficient fans, to approximately 810 kWh/yr. This value was based on the HOT2000 modeling of newer homes with the furnace fan operating continuously. According to previous studies in other jurisdictions, occupants of newer dwellings are more likely to run their furnace blower fan continuously. All new homes are also assumed to have HRVs installed.

Domestic Hot Water

Exhibit 130 summarizes the DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Appendix A) shows a significant reduction for hot water use in clothes washing, with slightly more modest changes for personal consumption.

DHW electricity for new and existing appliances is obtained from NRCan, as discussed above (see Exhibit 130). For existing and retrofitted buildings, the DHW UEC is assumed to decrease as dishwashers and clothes washers are replaced in the appliance stock, but is otherwise assumed to be constant. The UEC for DHW in new buildings is assumed to be constant.

Exhibit 130 Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washers	267	11%
Showers	660	28%
Faucets	511	21%
Baths	120	5%
Dishwashers	243	10%
Leaks	179	8%
Tank (Standby) Losses	202	8%
Pipe Losses	202	8%
Total	2,384	100%

Indoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced primarily by LED lamps. It is assumed that all remaining incandescent lamps would be replaced by the end of the study period and that 50% of CFL lamps would also be replaced by LED if there was no utility involvement in CDM programming or revision of efficiency standards. Exhibit 131 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall indoor lighting energy consumption for different dwelling types in 2029.

Exhibit 131 Indoor Lighting by Dwelling Type, 2029

Dwelling Types	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	LED Lamps	
SDH	0.7	4.5	0.5	18.3	(lamps)
Attached	0.6	4.0	0.4	16.5	(lamps)
Apartment	0.3	1.8	0.2	7.5	(lamps)
Average Wattage	23	15	45	12	(w atts)
Average Hours/Year	344	1,548	1,032	1,548	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	5	104	23	341	473
Attached	5	94	21	306	425
Apartment	2	42	9	139	193

Outdoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by LED lamps. It is assumed that all remaining incandescent lamps would be replaced by the end of the study period and that 50% of the CFL lamps would also be replaced by LED if there was no utility involvement in CDM programming or revision of efficiency standards. Exhibit 132 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall outdoor lighting energy consumption for different dwelling types in 2029.

Exhibit 132 Outdoor Lighting by Dwelling Type, 2029

Dwelling Types	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	LED Lamps	
SDH	0.2	0.8	0.1	3.1	(lamps)
Attached	0.2	0.7	0.1	2.8	(lamps)
Apartment	0.1	0.3	0.0	1.2	(lamps)
Average Wattage	23	15	45	12	(w atts)
Average Hours/Year	243	1460	730	1460	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	1	17	2	54	74
Attached	1	15	2	49	67
Apartment	0	6	1	20	28

Holiday Lighting

The holiday lighting UEC was assumed to decrease as incandescent strings are phased out and replaced by LED strings. This transition is assumed to be complete by the end of the study period. Exhibit 133 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall holiday lighting energy consumption for different dwelling types in 2029.

Exhibit 133 Holiday Lighting by Dwelling Type, 2029

Dwelling Types	Indoor LED Holiday Strings	Outdoor LED Holiday Strings	
SDH	11	8	(lamps)
Attached	6	5	(lamps)
Apartment	3	0	(lamps)
Average Wattage	1	1	(w atts)
Average Hours/Year	95	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)			Total
SDH	1	1	2
Attached	1	1	1
Apartment	0	0	0

Televisions

The North American television industry has been converting to digital broadcasting since August 31, 2011. These broadcast changes have been occurring at a time when television technology and programming options are also rapidly changing. Some television technology changes, such as the introduction of liquid crystal display (LCD) and plasma models, have had significant impacts on household electricity consumption. For example, these changes have increased rate of turnover in the current stock of televisions to models that are better able to take advantage of the high definition (HD) digital signal.

LCD is now the dominant television technology. Although LCD screens typically use less electricity per square inch of screen, consumers typically choose screens that are larger when purchasing an LCD screen compared to cathode ray tube screens (CRTs). When CRTs predominated, the most popular size was 27” but consumers are now more likely to buy a 40” widescreen TV, or even larger. This trend has the effect of reducing the electricity advantage that would be gained from a direct switch to the new LCD technology.

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

In the long term, ENERGY STAR® and improved energy efficiency standards for electronics will start to bring down the average electricity use per television, even in the absence of new CDM programs in NL. The effects of these improvements will likely be masked by the effects of increasing television size and resolution until after 2020.

In light of these changes, UECs for televisions are assumed to increase from 238 kWh/yr. to 269 kWh/yr. by 2029. These assumptions draw on both a 2006 ICF study, *Technology and Market Profile: Consumer Electronics*,[62] and subsequent work for the Ontario Power Authority in 2009.

[62] ICF Resource Consultants. Technology and Market Profile: Consumer Electronics, September 2006.

Television Peripherals

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

Industry representatives estimate that each Canadian subscriber household had, on average, 1.5 set-top boxes by 2006.[63] The number of STBs has continued to increase since then and is now estimated at over two per subscriber household. The growing number of STBs is factored into the UEC estimates for this end use, rather than being reflected in increasing saturation percentage.

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

At the same time, ENERGY STAR® and improved energy efficiency standards for electronics will begin to affect STBs. Currently, many of these products consume a substantial fraction of their electricity when no one is watching the television. Standards that specify maximum consumption in standby mode will therefore make a dramatic difference in the UEC for these devices.

In light of these changes, UECs per dwelling for television peripherals are assumed to increase modestly from 291 kWh/yr. to 308 kWh/yr. over the study period.[64]

Computers and Peripherals

Electricity consumption for personal computers is expected to decrease modestly, as monitors move to more energy-efficient flat screen technology and ENERGY STAR® increasingly predominates. This is somewhat counteracted by a growing preference for larger screens, a trend towards longer operating hours both in full operating mode and in idle mode, and the increasing numbers of peripherals. The growth in the number of computers per household is discussed in the saturation section of this appendix (Section C.4).

UECs for personal computers and their peripherals are assumed to decrease from 388 kWh/yr. to 384 kWh/yr. over the study period.

Spas

No increase in the size or heating load of spas has been assumed. In a previous ICF study for the OPA in 2009, assumptions were developed on the trend towards the use of heat pumps to heat pools and spas. By 2029, the electric resistance heaters are assumed to be completely phased out, even in the absence of new CDM programs in NL.

The analysis also assumes that high-efficiency pumps will gradually become more popular in the market, without new CDM intervention, reaching a penetration of 60% by 2029.

UECs for spas, including both the electric heating units (resistance or heat pump) and the pumps, are expected to decline from 14,575 kWh/yr. in 2010 to 7,081 kWh/yr. in 2029.

[63] Ibid.
[64] Ibid.

Home Entertainment Electronics

As functionality increases, other entertainment devices, such as computer games and music systems are becoming more powerful. For example, the new PlayStation 3 games console uses 360 Watts compared to its predecessor, which uses only 45 Watts. One of the selling features of the Nintendo Wii and other next generation products is that they can be left on-line for 24 hours a day.

UECs for both the home entertainment electronics category and the small appliances and other category are likely to increase over the study period. UECs for home entertainment electronics are assumed to increase from 170 kWh/yr. to 191 kWh/yr. over the study period.

Block Heaters and Car Warmers

No change was assumed in the consumption of block heaters and car warmers over the study period, in the absence of new utility CDM initiatives.

Small Appliances and Other

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

Based on the changes observed in previous studies, new end uses are constantly emerging, some of which are substantial consumers of electricity. One example is electric vehicle charging. Electric cars and plug-in hybrids could achieve substantial penetration by the end of the study period; charging of a typical electric vehicle would require approximately 7,000 kWh/yr.[65]

The UEC for this category is assumed to remain relatively stable over the study period. The growth rate in this end use was adjusted to improve the calibration between the model and the NL load forecast, and little change was required. Because there is so much uncertainty in the emergence of new “other” end uses and considerably more knowledge of trends in other end uses, this miscellaneous category was used to increase the consumption per account to match the forecast. The forecast changes in consumption per house vary among the three regions. No growth was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house in the Island Interconnected region. A growth rate of over 0.2% per year was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house in the Labrador Interconnected region. A growth rate of over 0.6% per year was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house in the Isolated region.

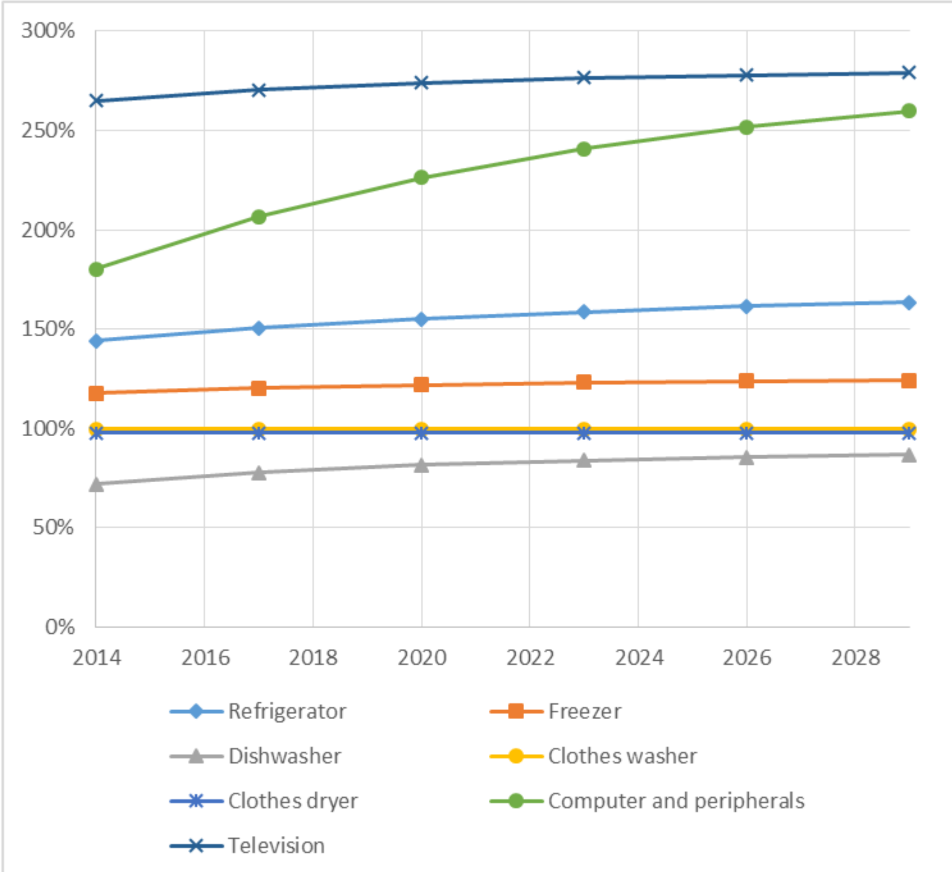
C.4 Step 4: Appliance Saturation Trends

To develop estimates of the future saturation of residential equipment, references from NL and previous studies in other jurisdictions were reviewed along with data on trends in the increasing use of entertainment-based electronics.

We have applied the growth rates from these sources to estimate saturations to the end of the study period. The results are shown in Exhibit 134.

[65] California EPA, Air Resources Board. *Fact Sheet: Battery Electric Vehicles*, Sacramento, CA, 2003, http://www.arb.ca.gov/msprog/zevprog/factsheets/clean_vehicle_incentives.pdf.

Exhibit 134 Trends in Appliance Saturation, 2014 to 2029



All of the end-use appliances shown in Exhibit 134 are forecast to increase in saturation per household. For the white goods end uses, this results in a relatively stable overall consumption per household because the increase in saturation is approximately cancelled out by the decrease in UEC that is expected to occur over the same period. For the three electronics end uses shown in the exhibit, the overall consumption is expected to rise during the period, as increases in saturation will likely have a larger effect than improvements in efficiency.

C.5 Step 5: Fuel Shares

No changes in the fuel shares for any end uses are assumed over the study period.

C.6 Step 6: Estimate Growth in Dwellings, by Type

This step involved the development and application of estimated levels of growth in each dwelling type over the study period.

The Utilities provided the forecast growth dwelling units as estimated numbers by milestone year for each region. The REUS provided data on the percentage of recently-built dwellings in the Island Interconnected region that are predominantly heated by electricity – approximately 85%. Relative growth rates were adjusted to approximately match this but also to match the Utilities' estimated growth in consumption in electrically heated versus non-electrically heated dwellings. REUS data were also used to estimate the relative growth rate in attached versus detached dwellings. In the

Island Interconnected region, attached dwellings appear to be growing at only about 1.1 times the rate of detached dwellings. In the Labrador Interconnected region, in contrast, attached dwellings appear to be growing at nearly 1.8 times the rate of detached dwellings. The relative growth rates were adjusted to capture this difference.

Exhibit 135 presents a summary of the resulting percentage stock growth, by year and dwelling type, for NL as a whole.

Exhibit 135 Residential Stock Growth Rates, 2014 to 2029

Dwelling Types	Annualized Stock Growth Rates by Period				
	2014 - 2017	2017 - 2020	2020 - 2023	2023 - 2026	2026 - 2029
Single-family detached, electric space heat	1.5%	1.2%	1.3%	0.9%	0.8%
Single-family detached, non-electric space heat	0.3%	0.2%	0.2%	0.2%	0.2%
Total Single Family	1.0%	0.8%	0.9%	0.6%	0.5%
Attached, electric space heat	1.6%	1.3%	1.3%	0.9%	0.8%
Attached, non-electric space heat	0.0%	0.0%	0.0%	0.0%	0.0%
Total Attached	1.3%	1.1%	1.2%	0.8%	0.7%
Apartment, electric space heat	1.6%	1.3%	1.4%	0.9%	0.8%
Apartment, non-electric space heat	0.0%	0.0%	0.0%	0.0%	0.0%
Total Apartment	1.0%	0.8%	0.9%	0.6%	0.6%
Other and non-dwellings	1.1%	0.9%	0.9%	0.6%	0.5%
Vacant and partial	1.0%	0.8%	0.9%	0.6%	0.6%
Grand Total	1.1%	0.9%	1.0%	0.7%	0.6%

Exhibit 136 provides growth rates by region.

Exhibit 136 Residential Stock Growth Rates by Region, 2014 to 2029

Regions	Annualized Stock Growth Rates by Period				
	2014 - 2017	2017 - 2020	2020 - 2023	2023 - 2026	2026 - 2029
Island Interconnected	1.1%	0.9%	1.0%	0.7%	0.6%
Labrador Interconnected	1.6%	1.0%	0.6%	0.6%	0.5%
Isolated	0.4%	0.3%	0.6%	0.5%	0.5%
Grand Total	1.1%	0.9%	1.0%	0.7%	0.6%

C.6 Results by Region

This section of the appendix presents the base year electricity consumption for the three regions. For each region, a version of Exhibit 16 is provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by region. This section also does not replicate the pie charts and other graphs presented in Section 5. If those graphs are needed for each region, they can be created using the Data Manager.

Exhibit 137 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Island Interconnected Region (MWh/yr.)

Dwelling Types	Year	Consumption						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	1,319,617	342,538	263,075	179,099	97,579	113,782	2,315,689
	2017	1,373,901	351,593	269,656	200,644	85,120	85,161	2,366,075
	2020	1,420,642	358,299	274,134	219,518	70,800	70,887	2,414,279
	2023	1,472,884	367,669	279,346	238,252	71,574	64,833	2,494,560
	2026	1,510,176	373,587	281,071	253,436	71,707	62,272	2,552,249
	2029	1,543,766	378,839	281,753	267,134	72,152	61,806	2,605,451
Single-family detached, non-electric space heat	2014	139,641	207,647	115,811	105,652	61,857	67,121	697,729
	2017	138,528	215,998	114,563	123,088	50,632	48,484	691,292
	2020	137,255	214,113	113,147	130,943	40,653	39,207	675,319
	2023	136,092	212,960	111,791	137,878	40,077	34,768	673,567
	2026	134,635	211,675	110,166	143,706	39,571	32,707	672,461
	2029	133,099	210,475	108,456	148,804	39,373	31,881	672,087
Attached, electric space heat	2014	204,149	77,616	61,251	39,839	10,533	22,986	416,374
	2017	212,767	73,449	62,997	44,788	8,024	17,298	419,324
	2020	220,166	75,805	64,223	49,141	5,997	14,467	429,799
	2023	228,506	78,803	65,641	53,495	5,586	13,297	445,328
	2026	234,371	80,722	66,183	57,018	5,317	12,822	456,434
	2029	239,629	82,408	66,463	60,204	5,133	12,773	466,610
Attached, non-electric space heat	2014	6,972	14,337	6,908	6,978	2,081	4,026	41,302
	2017	6,837	15,336	6,779	8,363	1,649	2,891	41,855
	2020	6,703	15,104	6,650	8,841	1,261	2,327	40,885
	2023	6,568	14,908	6,521	9,242	1,227	2,052	40,517
	2026	6,434	14,735	6,392	9,582	1,198	1,923	40,265
	2029	6,300	14,576	6,263	9,876	1,182	1,869	40,066
Apartment, electric space heat	2014	115,559	43,269	44,866	31,272	2,922	11,797	249,684
	2017	120,432	52,857	46,145	39,532	2,717	8,701	270,383
	2020	124,615	53,982	47,043	43,573	2,913	7,132	279,258
	2023	129,331	55,533	48,082	47,551	3,130	6,426	290,053
	2026	132,648	56,531	48,479	50,739	3,316	6,075	297,787
	2029	135,621	57,426	48,684	53,582	3,497	5,933	304,743
Apartment, non-electric space heat	2014	2,751	3,630	2,561	2,616	244	848	12,650
	2017	2,727	5,265	2,513	3,802	181	596	15,084
	2020	2,703	5,182	2,465	4,042	197	470	15,059
	2023	2,680	5,111	2,417	4,238	213	407	15,065
	2026	2,656	5,048	2,370	4,401	228	374	15,077
	2029	2,632	4,992	2,322	4,538	244	356	15,084
Other and non-dwellings	2014	21,813	14,387	9,368	6,393	13,097	3,818	68,875
	2017	22,403	19,353	9,478	10,739	8,642	2,821	73,435
	2020	22,906	19,353	9,536	11,116	10,110	2,324	75,345
	2023	23,472	19,487	9,612	11,563	11,674	2,102	77,910
	2026	23,868	19,542	9,602	11,941	13,203	2,005	80,161
	2029	24,221	19,608	9,567	12,312	14,752	1,978	82,439
Vacant and partial	2014	27,232	10,747	10,105	7,438	13,742	4,856	74,121
	2017	27,967	9,520	10,223	6,760	16,503	3,587	74,561
	2020	28,593	9,520	10,286	7,013	16,328	2,955	74,696
	2023	29,298	9,586	10,368	7,308	16,169	2,674	75,403
	2026	29,791	9,613	10,358	7,560	15,851	2,550	75,723
	2029	30,231	9,646	10,319	7,807	15,479	2,515	75,997

Exhibit 138 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Labrador Interconnected Region (MWh/yr.)

Dwelling Types	Year	Consumption						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	132,873	17,454	12,857	9,012	10,477	6,060	188,733
	2017	138,545	17,546	13,170	10,038	8,933	4,536	192,768
	2020	142,544	17,689	13,301	10,848	7,130	3,753	195,266
	2023	145,439	17,703	13,313	11,496	7,040	3,371	198,363
	2026	148,259	17,731	13,314	12,077	6,971	3,217	201,569
	2029	150,775	17,736	13,280	12,639	6,948	3,175	204,552
Single-family detached, non-electric space heat	2014	2,887	1,309	728	684	780	460	6,849
	2017	2,892	1,267	719	730	640	332	6,580
	2020	2,897	1,251	710	771	498	268	6,395
	2023	2,902	1,234	701	806	484	238	6,365
	2026	2,907	1,219	692	836	473	224	6,351
	2029	2,912	1,205	683	866	467	219	6,351
Attached, electric space heat	2014	66,628	10,357	7,923	5,237	3,414	2,866	96,425
	2017	71,106	9,902	8,343	5,992	2,577	2,210	100,130
	2020	74,184	10,247	8,571	6,585	1,971	1,864	103,423
	2023	76,281	10,419	8,669	7,049	1,888	1,695	106,002
	2026	78,324	10,593	8,755	7,477	1,821	1,636	108,606
	2029	80,107	10,728	8,804	7,890	1,778	1,631	110,938
Apartment, electric space heat	2014	5,643	1,499	1,499	1,034	93	438	10,207
	2017	6,023	1,964	1,579	1,447	100	331	11,443
	2020	6,283	2,012	1,622	1,599	104	274	11,894
	2023	6,461	2,035	1,640	1,717	108	244	12,205
	2026	6,634	2,059	1,656	1,824	111	231	12,516
	2029	6,785	2,078	1,666	1,925	114	226	12,794
Other and non-dwellings	2014	2,528	2,203	1,713	629	1,273	175	8,522
	2017	2,655	2,509	1,773	845	1,343	133	9,259
	2020	2,743	2,518	1,802	872	1,392	110	9,439
	2023	2,804	2,513	1,811	892	1,426	100	9,546
	2026	2,863	2,515	1,818	912	1,460	95	9,664
	2029	2,916	2,516	1,819	931	1,491	94	9,767

Exhibit 139 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Isolated Region (MWh/yr.)

Dwelling Types	Year	Consumption						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	6,476	1,189	938	647	441	409	10,100
	2017	7,251	1,276	1,028	766	405	328	11,054
	2020	7,833	1,333	1,088	860	342	285	11,740
	2023	8,848	1,456	1,204	998	374	283	13,163
	2026	9,853	1,572	1,313	1,132	405	294	14,569
	2029	10,845	1,679	1,417	1,277	437	314	15,969
Single-family detached, non-electric space heat	2014	4,021	8,716	5,033	4,651	3,265	2,942	28,628
	2017	3,989	8,810	5,039	5,275	2,721	2,156	27,989
	2020	3,954	8,703	5,041	5,604	2,149	1,768	27,219
	2023	3,924	8,610	5,051	5,889	2,125	1,590	27,188
	2026	3,894	8,530	5,059	6,133	2,108	1,518	27,242
	2029	3,862	8,458	5,067	6,422	2,109	1,502	27,420
Other and non-dwellings	2014	244	244	92	62	127	38	807
	2017	252	440	93	222	131	28	1,166
	2020	258	433	94	226	134	23	1,169
	2023	267	431	95	233	139	21	1,186
	2026	276	430	97	240	144	20	1,207
	2029	284	430	98	248	149	20	1,229
Vacant and partial	2014	292	136	98	71	157	47	800
	2017	301	173	97	105	162	34	873
	2020	309	171	96	107	167	27	877
	2023	320	170	96	110	173	24	893
	2026	330	170	95	113	179	23	910
	2029	341	170	104	119	185	26	944

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 exhibits show the Reference Case peak load profiles for each region.

Exhibit 140 Electric Peak Loads, by Milestone Year, End Use and Dwelling Type, Island Interconnected Region (MW)

Dwelling Types	Year	Reference Case Peak Demand (MW)						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	442	43	76	25	14	19	620
	2017	460	44	78	28	12	14	637
	2020	476	45	79	31	10	12	653
	2023	494	46	80	34	10	11	675
	2026	506	47	81	36	10	10	690
	2029	517	48	81	38	10	10	704
Single-family detached, non-electric space heat	2014	47	26	33	15	9	11	141
	2017	46	27	33	17	7	8	140
	2020	46	27	33	19	6	7	137
	2023	46	27	32	20	6	6	136
	2026	45	27	32	20	6	5	135
	2029	45	27	31	21	6	5	135
Attached, electric space heat	2014	71	10	18	6	2	4	109
	2017	73	9	18	6	1	3	111
	2020	76	9	18	7	1	2	114
	2023	79	10	19	8	1	2	118
	2026	81	10	19	8	1	2	121
	2029	83	10	19	9	1	2	124
Attached, non-electric space heat	2014	2	2	2	1	0	1	8
	2017	2	2	2	1	0	0	8
	2020	2	2	2	1	0	0	8
	2023	2	2	2	1	0	0	8
	2026	2	2	2	1	0	0	8
	2029	2	2	2	1	0	0	8
Apartment, electric space heat	2014	40	6	13	4	0	2	65
	2017	42	7	13	5	0	1	69
	2020	43	7	14	6	0	1	71
	2023	45	7	14	7	0	1	74
	2026	46	8	14	7	0	1	76
	2029	47	8	14	7	0	1	77
Apartment, non-electric space heat	2014	1	0	1	0	0	0	3
	2017	1	1	1	1	0	0	3
	2020	1	1	1	1	0	0	3
	2023	1	1	1	1	0	0	3
	2026	1	1	1	1	0	0	3
	2029	1	1	1	1	0	0	3
Other and non-dwellings	2014	7	2	3	1	2	1	15
	2017	8	3	3	2	1	0	16
	2020	8	3	3	2	1	0	17
	2023	8	3	3	2	2	0	17
	2026	8	3	3	2	2	0	17
	2029	8	3	3	2	2	0	18
Vacant and partial	2014	9	2	3	1	2	1	17
	2017	9	1	3	1	2	1	17
	2020	10	1	3	1	2	0	18
	2023	10	1	3	1	2	0	18
	2026	10	1	3	1	2	0	18
	2029	10	1	3	1	2	0	18

Exhibit 141 Electric Peak Loads, by Milestone Year, End Use and Dwelling Type, Labrador Interconnected Region (MW)

Dwelling Types	Year	Reference Case Peak Demand (MW)						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	37	2	4	1	2	1	48
	2017	39	2	4	1	2	1	49
	2020	40	2	4	2	2	1	50
	2023	41	2	4	2	2	1	51
	2026	42	2	4	2	2	1	52
	2029	43	2	4	2	2	1	52
Single-family detached, non-electric space heat	2014	1	0	0	0	0	0	2
	2017	1	0	0	0	0	0	1
	2020	1	0	0	0	0	0	1
	2023	1	0	0	0	0	0	1
	2026	1	0	0	0	0	0	1
	2029	1	0	0	0	0	0	1
Attached, electric space heat	2014	19	1	2	1	1	0	25
	2017	21	1	2	1	1	0	26
	2020	22	1	2	1	1	0	27
	2023	22	1	2	1	1	0	28
	2026	23	1	3	1	1	0	29
	2029	23	1	3	1	1	0	29
Apartment, electric space heat	2014	2	0	0	0	0	0	3
	2017	2	0	0	0	0	0	3
	2020	2	0	0	0	0	0	3
	2023	2	0	0	0	0	0	3
	2026	2	0	0	0	0	0	3
	2029	2	0	0	0	0	0	3
Other and non-dwellings	2014	1	0	0	0	0	0	2
	2017	1	0	1	0	0	0	2
	2020	1	0	1	0	0	0	2
	2023	1	0	1	0	0	0	2
	2026	1	0	1	0	0	0	2
	2029	1	0	1	0	0	0	2

Exhibit 142 Electric Peak Loads, by Milestone Year, End Use and Dwelling Type, Isolated Region (MW)

Dwelling Types	Year	Reference Case Peak Demand (MW)						
		HVAC	Appliances	DHW	Electronics	Other	Lighting	Grand Total
Single-family detached, electric space heat	2014	2.5	0.2	0.3	0.1	0.1	0.1	3.2
	2017	2.9	0.2	0.3	0.1	0.1	0.1	3.5
	2020	3.1	0.2	0.3	0.1	0.1	0.0	3.8
	2023	3.5	0.2	0.3	0.1	0.1	0.0	4.3
	2026	3.9	0.2	0.4	0.2	0.1	0.0	4.7
	2029	4.3	0.2	0.4	0.2	0.1	0.1	5.2
Single-family detached, non-electric space heat	2014	1.5	1.1	1.4	0.7	0.6	0.5	5.8
	2017	1.5	1.2	1.4	0.7	0.5	0.4	5.6
	2020	1.5	1.1	1.5	0.8	0.4	0.3	5.5
	2023	1.5	1.1	1.5	0.8	0.4	0.3	5.5
	2026	1.4	1.1	1.5	0.9	0.3	0.3	5.5
	2029	1.4	1.1	1.5	0.9	0.3	0.3	5.5
Other and non-dwellings	2014	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2017	0.1	0.1	0.0	0.0	0.0	0.0	0.2
	2020	0.1	0.1	0.0	0.0	0.0	0.0	0.2
	2023	0.1	0.1	0.0	0.0	0.0	0.0	0.3
	2026	0.1	0.1	0.0	0.0	0.0	0.0	0.3
	2029	0.1	0.1	0.0	0.0	0.0	0.0	0.3
Vacant and partial	2014	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2017	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2020	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2023	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2026	0.1	0.0	0.0	0.0	0.0	0.0	0.2
	2029	0.1	0.0	0.0	0.0	0.0	0.0	0.2

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

Introduction

Exhibit 143 provides an example of part of the worksheet that calculates the CCE for clothes lines and drying racks, 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 143 Sample Measure CCE Calculation Worksheet

NP + NLH: Residential, Island - Electric efficiency

Clothes Lines and Drying Racks

Return to Index	Detached (Electric)	Detached (Non-Electric)	Attached (Electric)	Attached (Non-Electric)	Weighted Average	Reference + Notes

Measure Description

Description:	Electric clothes dryers represented approximately 2.4% of all residential consumption in Newfoundland and Labrador in 2014. Switching to passive methods of clothes drying, such as clothes lines during summer months and indoor drying racks, is an effective way of reducing energy consumption at little-to-no cost.
Baseline:	An electric clothes dryer with a moisture sensor
Upgrade:	No clothes dryer
Baseline:	Annual by end use
Heating Fuel Type:	Electricity
Main End Use:	Clothes Dryers
Resource Costs:	Baseload

Fuel	Customer Cost		Avoided Costs (NPV)				Reference + Notes
Electricity	$0.112	$/kWh	$0.938	$0.938	$0.938	$0.938	Please see "Avoided Costs" and "Customer Costs" tabs
Electric Demand	-	$/kW	$1.193	$1.193	$1.193	$1.193	Please see "Avoided Costs" and "Customer Costs" tabs

		Measure Cost Definitions & Calculations				Weighted Average	Reference + Notes
Baseline Consumption	Electricity kWh/yr	940	858	963	838	**826**	
Upgrade Consumption	Electricity kWh/yr	-	-	-	-	-	
	Winter Peak Hours-Use Factor	6,012	6,012	6,012	6,012	**6,012**	
Resource Savings	Electricity (kWh/yr.)	940	858	963	838	**826**	
	Electricity (kW peak)	0.156	0.143	0.160	0.139	**0.14**	
Cost Parameters	Upgrade, Material ($)	$45.00	$45.00	$45.00	$45.00	**$45**	Canadian Tire, average for full clothes line kit or drying rack
	Upgrade, Installation ($)	-	-	-	-	-	
	Baseline, Material ($)	$600.00	$600.00	$600.00	$600.00	**$600**	Sears.ca
	Baseline, Installation ($)	-	-	-	-	-	
	Total Measure Cost [A]	$45	$45	$45	$45	**$45**	
	Basis (Full/Incremental)	Full	Full	Full	Full	**Full**	
	Incremental O&M ($/yr.)	-	-	-	-	-	
Lifetimes	Upgrade (yrs.)	21	21	21	21	**21**	Maximum life based on provided marginal costs
	Baseline (yrs.)	11	11	11	11	**11**	NRC (http://www.nrcan.gc.ca/energy/products/categories/appliances/clothes-washer/13984)
	Cost Savings ($/yr.)	$105	$96	$108	$94	**$92**	
	Simple Payback (yrs.)	0.4	0.5	0.4	0.5	**0.6**	
	NPV of O&M Costs ($) [B]	-	-	-	-	-	
Total Avoided Supply Costs (NPV, $) [C]	Electric Energy	$882	$805	$904	$786	**$775**	
	Electric Demand	$0	$0	$0	$0	**$0**	
Total Customer Bill Reduction (NPV, $) [D]	Electric Energy	$1,218	$1,112	$1,248	$1,086	**$1,071**	
	Electric Demand	-	-	-	-	-	

		Economic Tests				Weighted Average	Reference + Notes
Incentive	Target Payback (yrs.)	5	5	5	5	**5**	
	Percent of Measure Costs	-	-	-	-	-	
	Incentive ($) [E]	-	-	-	-	-	
Administration Costs	% of Incentive [F]	15%	30%	30%	30%	**24%**	
	% of Savings Value to Utility [G]	6%	6%	6%	6%	**6%**	
	Admin. Costs per Unit ($) [H]	$53	$48	$54	$47	**$47**	
	Net-to-Gross Ratio [I]	90%	90%	90%	90%	**90%**	
Total Resource Cost Test	TRC Benefits ($)	$794	$725	$813	$708	**$698**	
	TRC Costs ($)	$93	$89	$95	$88	**$87**	
	Measure TRC ($)	$701	$636	$719	$620	**$611**	
	TRC Benefit/Cost Ratio	8.50	8.16	8.59	8.07	**7.86**	
	Cost of Conserved Electricity (CCE) (¢/kWh)	**0.44**	**0.48**	**0.43**	**0.50**	0.58	
Participant Cost Test	PCT Benefits ($)	$1,218	$1,112	$1,248	$1,086	**$1,071**	
	PCT Costs ($)	$45	$45	$45	$45	**$45**	
	Measure PCT ($)	$1,173	$1,067	$1,203	$1,041	**$1,026**	
	PCT Benefit/Cost Ratio	27.07	24.72	27.74	24.13	**23.80**	
Ratepayer Impact Measure Test	RIM Benefits ($)	$794	$725	$813	$708	**$698**	
	RIM Costs ($)	$1,149	$1,049	$1,178	$1,024	**$1,010**	
	Measure RIM ($)	$882	$805	$904	$786	**$775**	
	RIM Benefit/Cost Ratio	5.58	5.58	5.58	5.58	**5.58**	
Program Administrator Costs Test	PAC Benefits ($)	$794	$725	$813	$708	**$698**	
	PAC Costs ($)	$53	$48	$54	$47	**$47**	
	Measure PAC ($)	$741	$677	$759	$661	**$651**	
	PAC Benefit/Cost Ratio	15.00	15.00	15.00	15.00	**15.00**	

Applies? (Yes = 1, 0 = No) — Resource Savings Assumptions (Percent relative to baseline, not including heating penalties/cooling benefits)

Fuel	End Use	Sub End Use	Baseline	Upgrade	Measure Resource Savings (%)				Weighted Average	Reference + Notes
Electricity	Clothes Dryers	General	1	1	100.0%	100.0%	100.0%	100.0%	**100.0%**	

Applies? (Yes = 1, 0 = No) — Resource Savings Wrap-Up (Percent relative to baseline, main end uses, including heating penalties/cooling benefits)

Fuel	End Use	Baseline	Upgrade	Measure Resource Savings (%)				Weighted Average	Reference + Notes
Electricity	Clothes Dryers	1	1	100.0%	100.0%	100.0%	100.0%	**100.0%**	

Exhibit 144 provides a list of all the residential 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 144 Residential Measures Considered

End Use	Measure		Reasons for Exclusion
Block Heaters and Car Warmers	Block Heater Demand	Included	
	Car Warmer Demand	Included	
	Car Warmer Timers	Included	
	Block Heater Timers	Included	
	Battery Blanket Timers	Included	
Clothes Dryers	Efficient Clothes Dryers	Included	
	Heat Pump Clothes Dryers	Included	
	Clothes Lines	Included	
	Clothes Dryer Sensor	Included	
Clothes Washers	Efficient Clothes Washers	Included	
	Super Efficient Clothes Washers	Included	
Computers and Peripherals	Power Bars (PCs)	Included	
	ESTAR Computers	Included	
	PC Power Management	Included	
Cooking	Induction Cooktops	Included	
	Convection Ovens	Included	
	Microwaves (Behavioral)	Excluded	This measure involves encouraging customers to use microwaves to cook food instead of conventional ovens and ranges, which use more energy. Cooking behaviors are difficult if not impossible to meaningfully change.
Dehumidifier	ESTAR Dehumidifiers	Included	
Dishwashers	ESTAR Dishwashers	Included	
Domestic Hot Water (DHW)	Min Hot Wash	Included	
	Faucets	Included	
	Faucet Aerator	Included	
	DHW Pipe Insulation	Included	
	DHW Tank Insulation	Included	
	Efficient DHW	Included	
	DHW Cycling	Included	
	3-Element DHW	Included	
	DHW Temperature	Included	

End Use	Measure		Reasons for Exclusion
	Showerheads	Included	
	ASHP on HW tanks	Excluded	Current models of air-source heat pumps on DHW tanks are non-ducted and use heat in the surrounding air to heat the water. Since DHW tanks are typically in located in spaces within the home, pulling heat from the interior air results in higher space heating requirements. For a climate like that of Newfoundland and Labrador, this is not an attractive measure. Future studies might consider this technology if ducted ASHP DHW tanks become available that can draw heat from exterior air sources.
Freezers	Super-Efficient Freezers	Included	
	ESTAR Freezers	Included	
	Freezer Temperature	Included	
Hot Tubs	Hot Tub Covers	Included	
Lighting	High-Performance T8s	Included	
	Motion Detectors - Indoor	Included	
	Timers - Outdoor	Included	
	LED Lamps	Included	
	T8 Fixtures	Included	
	Turn Off Lights	Included	
	Motion Detectors - Outdoor	Included	
	Min Outdoor Lighting	Included	
	Lighting Controls	Excluded	Motion detectors and timers included.
	WIFI Control	Excluded	Savings are not different from other lighting control measures.
	Lamp Exchange Program	Excluded	Included in the LED measure's savings.
Other electronics	Unplug Chargers	Included	
Refrigerators	Refrigerator Retirement	Included	
	Super-Efficient Refrigerators	Included	
	Refrigerator Temperature	Included	
	Efficient Refrigerators	Included	
Space Cooling	AC Temperature	Included	
New Homes	LEED Apartments	Included	
	High-Perf. New Homes	Included	
	Net Zero Homes	Included	

End Use	Measure		Reasons for Exclusion
	Passive New Construction	Excluded	Difficult to consider from an aggregate level since passive homes are particular to each location and specific site.
	Complying with Code NBC	Excluded	The National Building Code generally applies to Newfoundland and Labrador jurisdictions. Little is known about the extent of non-compliance and how non-compliant homes are built, making the applicability and defining the baseline unknowns.
Space Heating	Super Windows	Included	
	Air Sealing	Included	
	Cold Climate Heat Pump	Included	
	Wall Insulation	Included	
	Air-Source Heat Pump	Included	
	Sealing & Insul. - Old (pre-1980) homes	Included	
	Crawl Space Insulation	Included	
	Basement Insulation	Included	
	Attic Insulation	Included	
	Close Blinds	Included	
	ESTAR Windows	Included	
	Prog. Thermostats	Included	
	Mini-Splits	Included	
	Overnight Setback	Included	
	Electronic Thermostats	Included	
	Door Systems	Included	
	Professional Air Sealing	Included	
	Weather Stripping Maintenance	Included	
	Prog. Thermostats (Central)	Included	
	Thermal Storage (Baseboard)	Included	
	Daytime Setback	Included	
	Thermal Storage (Central)	Included	
	Apt Recommissioning	Included	
	Air-to-Water Heat Pumps	Included	

End Use	Measure		Reasons for Exclusion
	Convect Air Heaters	Excluded	Convect air heaters are essentially resistance heaters of the same efficiency as baseboard heaters that employ various techniques to transfer the heat to the surrounding air. Manufacturers argue better heat transfer and user perceptions of warmer ambient temperatures; savings are related to a subsequent reduction in the temperature set point. As such, savings for this measure are captured in the temperature setback measures.
	Heat Pump Cycling	Included	
	Electric Heat Cycling	Included	
	Dual Fuel Heat Cycling	Included	
	Wood/Pellet Stoves	Excluded	Fuel switching is out of the scope of this study.
	Wood/Pellet Furnaces	Excluded	Fuel switching is out of the scope of this study.
	Proper Installation of Heat Pumps	Excluded	All measures assume proper installation of new equipment.
	Wi-Fi Thermostats	Excluded	Savings are not different from other programmable thermostats.
Televisions	Power Bars (TVs)	Included	
	Turn Off TVs	Included	
	ESTAR TVs	Included	
	LCD TVs	Excluded	This has become the baseline technology.
Ventilation	Premium Ventilation Motors	Included	
	ECPM Fan Motors	Included	
	HRVs	Included	
	Exhaust Fans Bathroom Timers	Excluded	Runtimes vary significantly and can even increase overall consumption. Collectively decided to remove this measure.
Other	Product Installation	Excluded	All measures assume proper installation of new equipment.
	Electric Vehicles	Excluded	Out of the scope of this study. Increase of energy consumption due to new technologies in considered in the load forecast.
	Energy Audits	Excluded	Energy audits are a delivery mechanism, not a savings measure.
	Education on Code Requirements	Excluded	Similar to "Complying with Code NBC", savings are generally not considered for following baseline building requirements.
	Benchmarking	Included	

End Use	Measure		Reasons for Exclusion
	Home Automation	Excluded	In an Ontario ICF study, the savings for this measure are essentially the sum of several other related measures--not unique savings. Additionally, the cost to implement home automation is greater than the sum of the cost to implement the individual measures.
	Home Energy Monitoring	Excluded	Considered with the benchmarking measure since the two employ home energy monitoring systems and customer feedback.
	Load Reduction Reward Program	Excluded	Programs are a delivery mechanism, not a savings measure.

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

Introduction

The following three exhibits provide the economic potential energy efficiency results for the island Interconnected, Labrador Interconnected, and Isolated regions, respectively. The three exhibits following those provide the economic potential load reduction results for the Island Interconnected, Labrador Interconnected, and Isolated regions, respectively. The latter three exhibits do not include the load reduction associated with energy efficiency measures, which were already presented by region in Exhibit 49.

Exhibit F 1 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Island Interconnected (MWh/yr.)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Clothes dryer	Television	Refrigerator	Computer and peripherals	Lighting	Ventilation	Hot tubs
Single Family Dwellings	2017	711,050	119,215	129,621	43,880	51,617	30,041	22,877	9,065	19,578
	2020	723,705	118,382	131,801	46,539	52,314	28,964	18,542	10,592	14,187
	2023	735,620	119,017	135,050	49,477	53,023	31,518	16,522	13,389	13,906
	2026	738,543	123,340	139,687	52,136	53,335	38,079	15,293	21,320	13,581
	2029	744,149	123,323	142,610	54,770	53,522	38,410	14,557	27,578	13,406
Attached Houses	2017	32,537	21,654	13,479	7,022	9,019	4,499	3,357	1,106	1,551
	2020	32,378	21,671	14,246	7,505	9,207	4,514	2,750	1,110	1,026
	2023	31,646	21,968	15,244	8,044	9,410	5,192	2,476	1,270	912
	2026	30,778	23,120	16,768	8,524	9,524	6,402	2,308	1,467	835
	2029	30,389	22,996	17,436	8,997	9,610	6,488	2,210	3,325	780
Apartments	2017	7,041	12,902	4,294	4,388	466	2,245	1,359	190	-
	2020	6,562	13,233	4,143	4,703	477	2,888	1,062	176	-
	2023	5,445	13,767	4,297	5,055	489	4,689	910	175	-
	2026	4,377	14,132	4,404	5,366	496	6,245	810	173	-
	2029	4,111	14,446	4,501	5,673	502	6,340	740	172	-
Other, Vacant and Partial	2017	6,131	5,190	(113)	1,336	182	626	1,066	139	-
	2020	6,277	5,296	(284)	1,414	179	377	859	139	-
	2023	6,301	5,445	(290)	1,508	178	392	761	139	-
	2026	5,996	5,545	(295)	2,393	176	642	700	139	-
	2029	5,850	5,629	(299)	2,503	175	1,192	663	139	-
Grand Total	**2017**	756,758	158,962	147,281	56,627	61,285	37,411	28,659	10,500	21,129
	2020	768,922	158,582	149,907	60,161	62,177	36,744	23,213	12,016	15,213
	2023	779,012	160,196	154,302	64,084	63,100	41,792	20,669	14,972	14,818
	2026	779,693	166,136	160,565	68,419	63,530	51,367	19,112	23,099	14,417
	2029	784,499	166,395	164,248	71,943	63,808	52,430	18,171	31,214	14,185

Exhibit F 1 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Island Interconnected (MWh/yr.)

Housing Categories	Milestone Years	Television peripherals	Dehumidifier	Freezer	Cooking	Other electronics	Clothes washer	Dishwasher	Space cooling	Grand Total
Single Family Dwellings	2017	4,847	2,190	1,636	2,030	1,338	402	235	(147)	1,149,475
	2020	5,030	1,653	1,272	2,017	1,404	208	237	(150)	1,156,696
	2023	5,232	4,367	2,619	2,020	1,477	187	238	(158)	1,183,505
	2026	5,395	5,629	3,162	2,018	1,540	655	239	(163)	1,213,787
	2029	5,549	5,313	3,739	2,018	1,601	783	239	(168)	1,231,399
Attached Houses	2017	822	372	218	365	224	69	42	3	96,340
	2020	860	283	171	365	237	36	43	4	96,404
	2023	902	753	355	368	251	33	43	4	98,872
	2026	935	976	431	370	263	143	44	4	102,891
	2029	966	926	513	372	275	139	44	4	105,471
Apartments	2017	668	117	77	289	211	34	19	-	34,299
	2020	700	119	60	289	224	15	19	-	34,671
	2023	737	123	126	293	238	14	20	-	36,378
	2026	765	127	153	295	250	14	20	-	37,627
	2029	792	129	182	297	262	13	20	-	38,180
Other, Vacant and Partial	2017	102	-	88	138	128	17	7	-	15,038
	2020	106	-	68	136	135	9	6	-	14,718
	2023	110	-	139	135	142	8	6	-	14,973
	2026	171	-	167	134	148	8	6	-	15,930
	2029	175	-	197	134	154	7	6	-	16,524
Grand Total	**2017**	6,439	2,679	2,019	2,822	1,902	522	303	(144)	1,295,153
	2020	6,696	2,054	1,571	2,808	2,000	268	305	(147)	1,302,489
	2023	6,980	5,243	3,238	2,817	2,108	243	307	(154)	1,333,728
	2026	7,266	6,731	3,913	2,817	2,201	819	308	(159)	1,370,235
	2029	7,483	6,368	4,630	2,820	2,292	943	308	(164)	1,391,573

Exhibit F 2 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Labrador Interconnected (MWh/yr.)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Clothes dryer	Refrigerator	Television	Hot tubs	Computer and peripherals	Lighting	Block heaters & car warmers
Single Family Dwellings	2017	5,293	3,637	4,224	1,798	473	1,538	248	684	142
	2020	37,032	3,743	4,301	1,817	859	1,118	581	552	145
	2023	37,138	3,818	4,346	1,817	1,277	1,088	925	484	147
	2026	41,347	3,890	4,392	1,816	1,469	1,063	1,086	444	358
	2029	41,375	4,144	4,506	1,810	1,533	1,050	1,232	414	362
Attached Houses	2017	1,714	2,185	1,507	1,082	261	386	142	267	81
	2020	3,058	2,290	1,640	1,112	483	253	325	239	84
	2023	2,677	2,362	1,719	1,126	726	231	524	204	87
	2026	2,417	2,560	1,868	1,139	844	213	622	218	213
	2029	9,285	2,619	1,936	1,147	889	200	712	207	217
Apartments	2017	193	413	166	17	50	-	4	40	-
	2020	118	433	172	18	93	-	96	31	-
	2023	59	447	176	18	139	-	154	26	-
	2026	36	460	180	18	162	-	183	23	-
	2029	11	471	183	18	170	-	210	21	-
Other, Vacant and Partial	2017	104	464	150	16	4	-	4	18	-
	2020	109	482	154	16	6	-	9	14	-
	2023	112	493	157	15	8	-	14	13	-
	2026	113	505	159	15	9	-	17	12	-
	2029	88	515	161	15	48	-	33	12	-
Grand Total	**2017**	7,304	6,699	6,047	2,913	789	1,925	398	1,010	223
	2020	40,317	6,947	6,267	2,962	1,441	1,371	1,011	836	230
	2023	39,986	7,120	6,398	2,976	2,150	1,319	1,617	728	233
	2026	43,913	7,414	6,599	2,988	2,484	1,276	1,909	697	572
	2029	50,760	7,750	6,787	2,990	2,641	1,250	2,186	653	579

Exhibit F 2 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Labrador Interconnected (MWh/yr.)

Housing Categories	Milestone Years	Ventilation	Television peripherals	Freezer	Dehumidifier	Cooking	Other electronics	Clothes washer	Dishwasher	Grand Total
Single Family Dwellings	2017	57	68	48	33	66	42	5	8	18,366
	2020	294	109	48	34	65	44	4	8	50,755
	2023	311	151	48	34	64	46	4	8	51,709
	2026	359	169	122	144	64	48	4	8	56,783
	2029	608	178	143	135	64	50	21	8	57,634
Attached Houses	2017	14	39	22	19	39	24	3	5	7,790
	2020	25	64	23	20	39	26	2	5	9,689
	2023	24	90	23	20	39	27	2	5	9,887
	2026	23	101	58	87	39	29	15	5	10,450
	2029	69	108	69	82	40	30	14	5	17,629
Apartments	2017	1	5	2	-	-	6	-	-	899
	2020	1	10	2	-	-	7	-	-	982
	2023	1	16	2	-	-	7	-	-	1,046
	2026	2	18	6	-	-	7	-	-	1,096
	2029	2	23	7	3	8	8	0	1	1,136
Other, Vacant and Partial	2017	1	-	6	-	-	2	-	-	770
	2020	1	0	6	-	-	3	-	-	799
	2023	1	0	6	-	-	3	-	-	822
	2026	1	0	14	-	-	3	-	-	849
	2029	1	5	17	-	12	3	1	1	911
Grand Total	**2017**	74	112	79	52	105	75	7	13	27,825
	2020	322	184	79	54	105	79	7	13	62,225
	2023	337	258	79	54	104	83	6	13	63,464
	2026	385	288	201	231	103	87	18	13	69,178
	2029	680	314	236	219	123	91	36	14	77,310

Exhibit F 3 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Isolated (MWh/yr.)

Housing Categories	Milestone Years	Space heating	Clothes dryer	Domestic Hot Water (DHW)	Television	Refrigerator	Computer and peripherals	Ventilation	Hot tubs	Lighting
Single Family Dwellings	2017	3,627	2,436	2,079	735	779	617	939	504	418
	2020	4,154	2,440	2,109	886	859	760	827	366	334
	2023	4,690	2,466	2,143	1,055	902	758	731	362	323
	2026	5,256	2,491	2,178	1,239	944	760	641	359	306
	2029	5,769	2,516	2,198	1,439	970	765	560	360	298
Attached Houses	2017	189	26	54	17	4	30	6	-	10
	2020	186	35	55	30	8	36	7	-	8
	2023	193	45	60	44	11	36	8	-	7
	2026	248	55	63	60	13	35	9	-	7
	2029	262	52	66	77	14	34	11	-	7
Grand Total	**2017**	3,816	2,462	2,133	752	783	647	945	504	428
	2020	4,339	2,475	2,164	916	868	797	834	366	342
	2023	4,883	2,510	2,204	1,099	913	794	739	362	330
	2026	5,504	2,546	2,241	1,299	957	794	650	359	312
	2029	6,031	2,568	2,264	1,516	984	799	571	360	305

Housing Categories	Milestone Years	Freezer	Television peripherals	Dehumidifier	Cooking	Other electronics	Clothes washer	Dishwasher	Grand Total
Single Family Dwellings	2017	88	85	21	37	25	34	4	12,429
	2020	140	86	32	37	27	28	5	13,088
	2023	193	88	44	36	28	23	6	13,848
	2026	247	89	57	36	30	20	8	14,659
	2029	301	99	56	36	32	17	7	15,423
Attached Houses	2017	3	0	-	3	1	0	0	344
	2020	5	0	-	3	1	1	0	377
	2023	7	0	-	3	1	1	0	417
	2026	9	0	-	3	1	1	0	505
	2029	11	1	-	3	2	1	0	539
Grand Total	**2017**	91	85	21	40	27	35	4	12,774
	2020	145	87	32	39	28	29	5	13,464
	2023	201	88	44	39	30	24	6	14,266
	2026	256	89	57	39	31	21	8	15,164
	2029	312	100	56	39	33	18	7	15,962

Exhibit F 4 Economic Potential Load Reduction by End Use, Dwelling Type and Milestone Year, Island Interconnected (MW)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Grand Total
Single Family Dwellings	2017	84	76	161
	2020	89	89	178
	2023	94	91	185
	2026	98	91	189
	2029	102	91	193
Attached Houses	2017	19	14	33
	2020	20	16	36
	2023	21	17	38
	2026	19	17	36
	2029	18	17	35
Apartments	2017	0	10	10
	2020	11	10	21
	2023	11	12	23
	2026	12	12	24
	2029	12	12	24
Other, Vacant and Partial	2017	9	-	9
	2020	11	2	13
	2023	11	2	13
	2026	14	2	16
	2029	14	2	16
Grand Total	**2017**	113	100	212
	2020	130	118	247
	2023	137	122	260
	2026	143	122	264
	2029	146	121	267

Exhibit F 5 Economic Potential Load Reduction by End Use, Dwelling Type and Milestone Year, Labrador Interconnected (MW)

Housing Categories	Milestone Years	Space heating	Domestic Hot Water (DHW)	Block heaters & car warmers	Grand Total
Single Family Dwellings	2017	8.2	3.2	0.3	11.6
	2020	8.2	3.4	0.3	11.9
	2023	7.1	3.4	0.2	10.7
	2026	6.6	3.4	0.2	10.2
	2029	6.3	3.3	0.2	9.9
Attached Houses	2017	5.5	1.9	0.2	7.6
	2020	5.8	2.1	0.2	8.1
	2023	5.4	2.1	0.1	7.7
	2026	5.4	2.1	0.1	7.6
	2029	4.1	2.1	0.1	6.4
Apartments	2017	0.8	0.4	-	1.2
	2020	0.8	0.4	-	1.2
	2023	0.9	0.4	-	1.3
	2026	0.9	0.4	-	1.3
	2029	0.7	0.4	-	1.1
Other, Vacant and Partial	2017	0.4	0.3	-	0.8
	2020	0.5	0.3	-	0.8
	2023	0.5	0.3	-	0.8
	2026	0.5	0.4	-	0.9
	2029	0.5	0.4	-	0.9
Grand Total	**2017**	15.0	5.8	0.4	21.2
	2020	15.3	6.2	0.5	22.0
	2023	13.9	6.3	0.3	20.5
	2026	13.4	6.3	0.3	20.0
	2029	11.7	6.2	0.3	18.3

Exhibit F 6 Economic Potential Load Reduction by End Use, Dwelling Type and Milestone Year, Isolated (MW)

Housing Categories	Milestone Years	Domestic Hot Water (DHW)	Space heating	Grand Total
Single Family Dwellings	2017	1.2	0.6	1.8
	2020	1.3	0.7	2.0
	2023	1.4	0.8	2.2
	2026	1.4	0.9	2.3
	2029	1.5	1.0	2.4
Attached Houses	2017	0.0	0.1	0.1
	2020	0.0	0.1	0.1
	2023	0.0	0.1	0.1
	2026	0.0	0.1	0.1
	2029	0.0	0.1	0.1
Grand Total	**2017**	1.2	0.7	1.9
	2020	1.4	0.8	2.1
	2023	1.4	0.9	2.3
	2026	1.4	1.0	2.4
	2029	1.5	1.1	2.6

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

INTERNATIONAL

CDM Potential Study

Newfoundland and Labrador

Agenda

1. Overview of the CDM Study Approach, Tools, Outputs
2. Overview of the Residential technology results to date
3. Discussion of Residential 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 Residential Sector Technology Results to Date and Workshop Discussion Format
10:15 am– 10:30 am	Break
10:30 am – 11:30 am	Discussion of Residential Opportunity # 1 Basement Insulation
11:30 am – 12:00 pm	Discussion of Residential Opportunity #2 Mini-splits
12:00 pm – 12:30 pm	Lunch
12:30 pm – 1:00 pm	Discussion of Residential Opportunity #3 HPNC
1:00 pm – 1:30 pm	Discussion of Residential Opportunity #4 Heat cycling
1:30 pm – 2:00 pm	Discussion of Residential Opportunity #5 ETS
2:00 pm – 2:30 pm	Discussion of Residential Opportunity #6 Air Sealing
2:30 pm – 2:45 pm	Break
2:45 pm – 3:15 pm	Discussion of Residential Opportunity #7 Water Measures
3:15 pm – 3:45 pm	Discussion of Residential Opportunity #8 Behavioural group (clothes lines, minimize hot water wash, second fridge retirement)
3:45 pm – 4:30 pm	Wrap up and Next Steps

1

Overview of the CDM Study Approach, Tools, Outputs

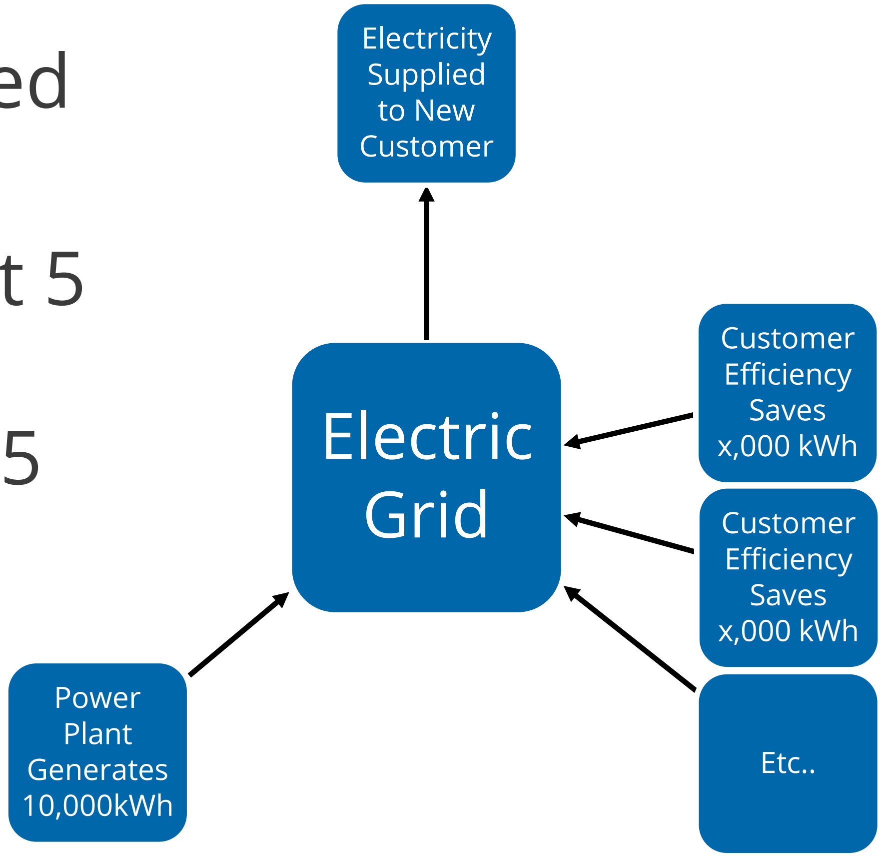
Study Background & Objectives

"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."

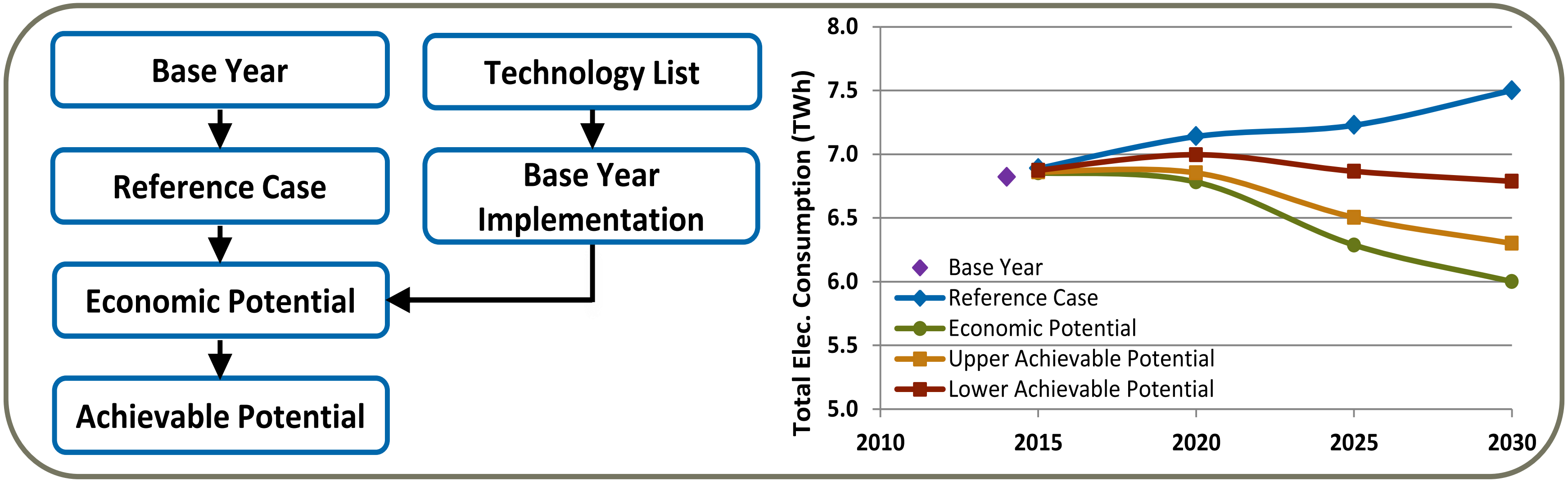
- Characterize available equipment and behaviours: EE and load reduction measures
- Estimate achievable potential EE (GWh) and DR (MW) load reduction

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

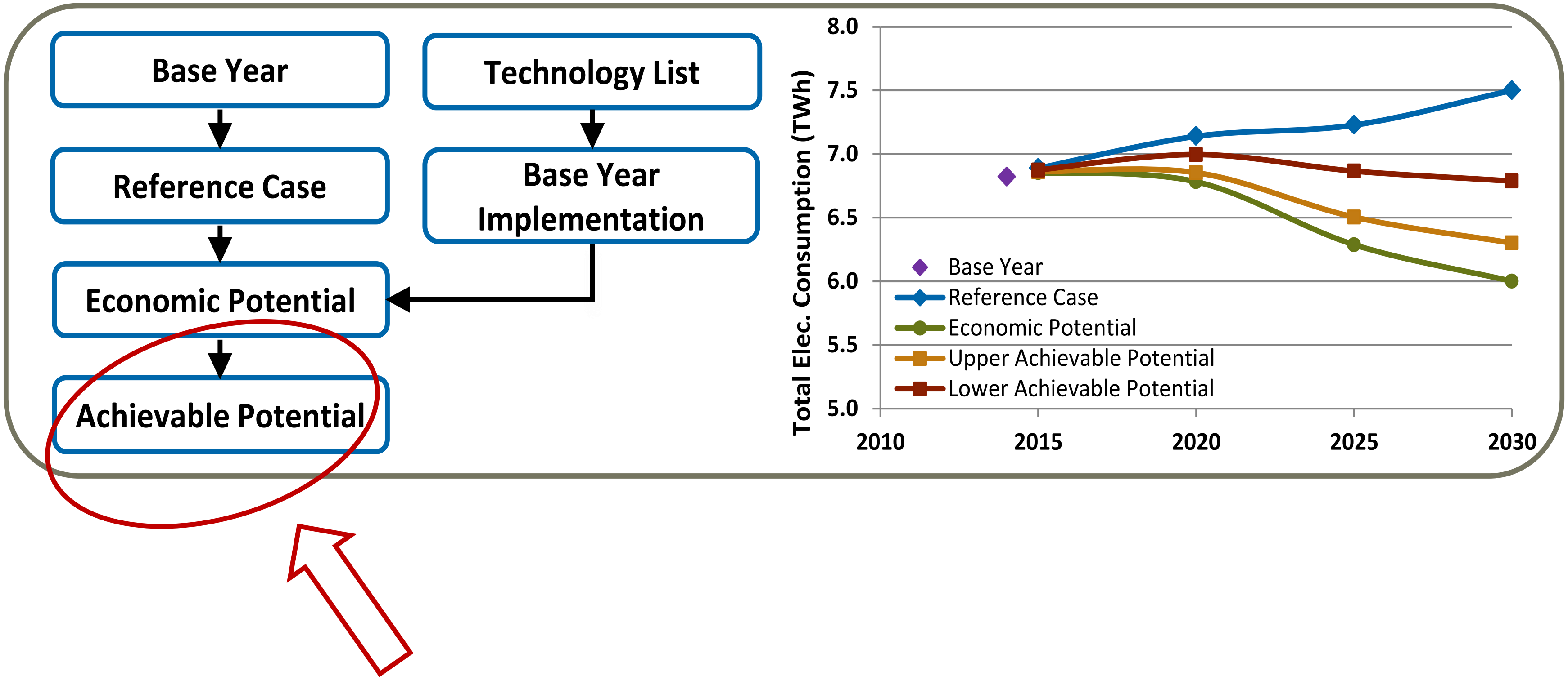
More on these later

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


Base Year
Technology List
Reference Case
Base Year Implementation
Economic Potential
Achievable Potential
Total Elec. Consumption (TWh)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
2010
2015
2020
2025
2030
Base Year
Reference Case
Economic Potential
Upper Achievable Potential
Lower Achievable Potential

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.*

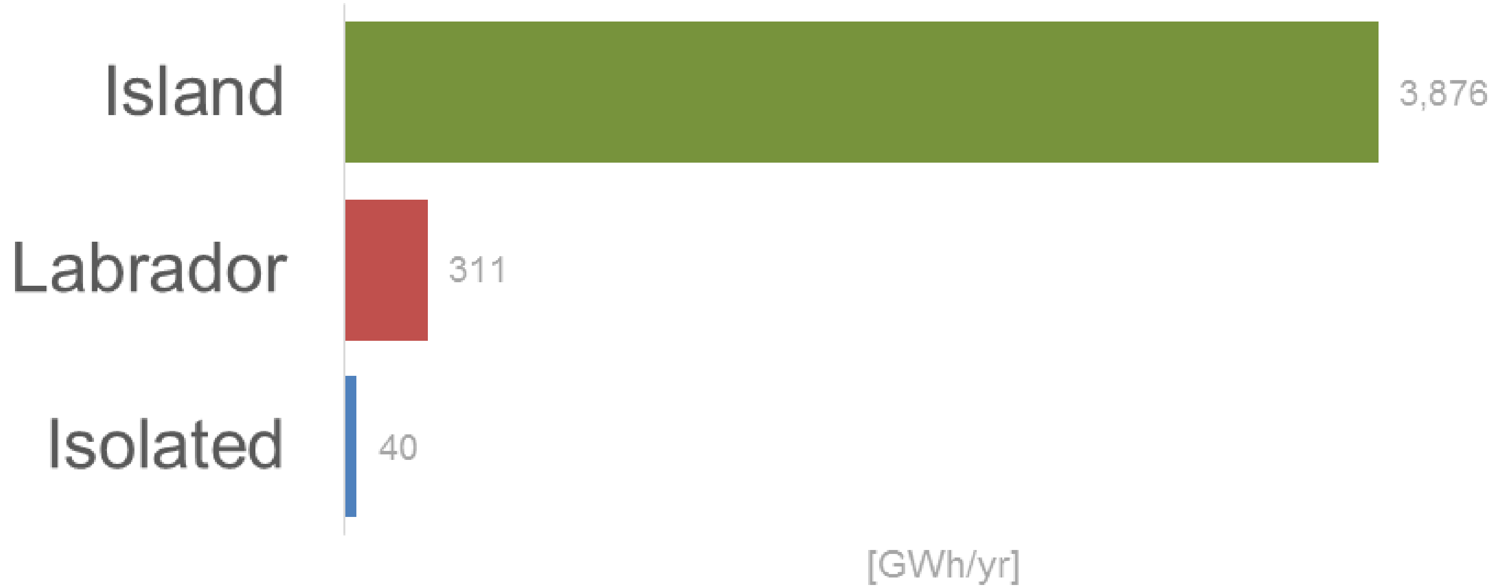
- "Upper" = Very Best Possible Case
- "Lower" = Business as Usual

2

Overview of the Residential technology results to date

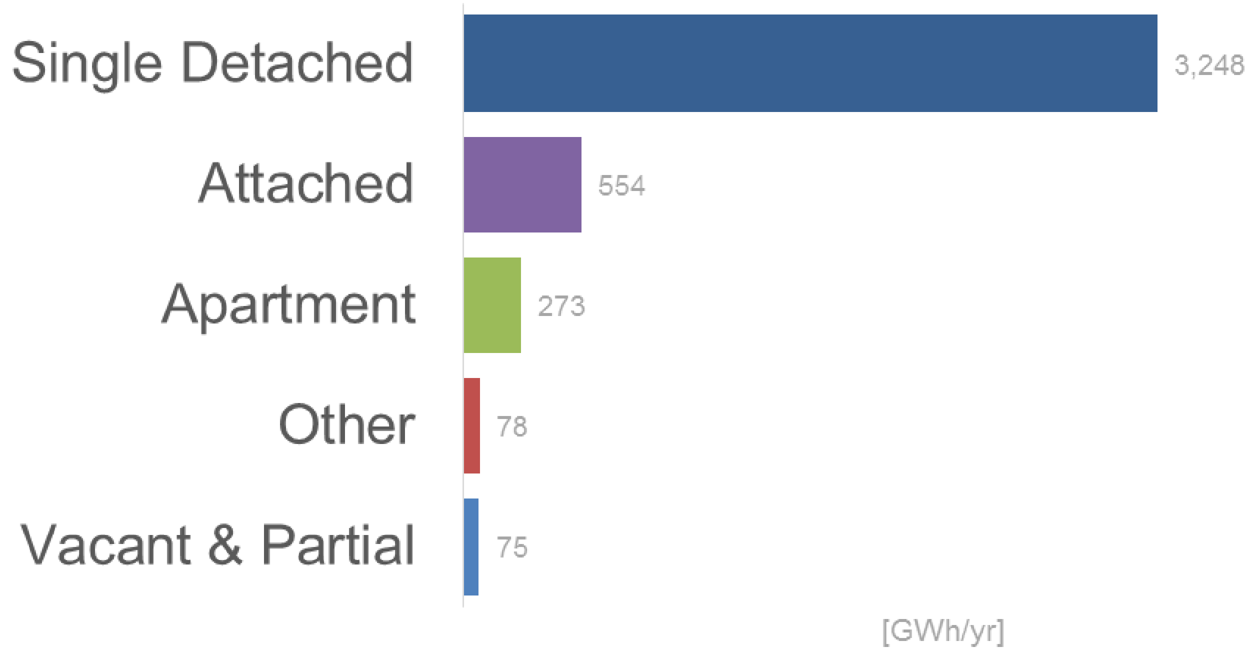
Segmentation

Region



Segmentation

Dwelling Type

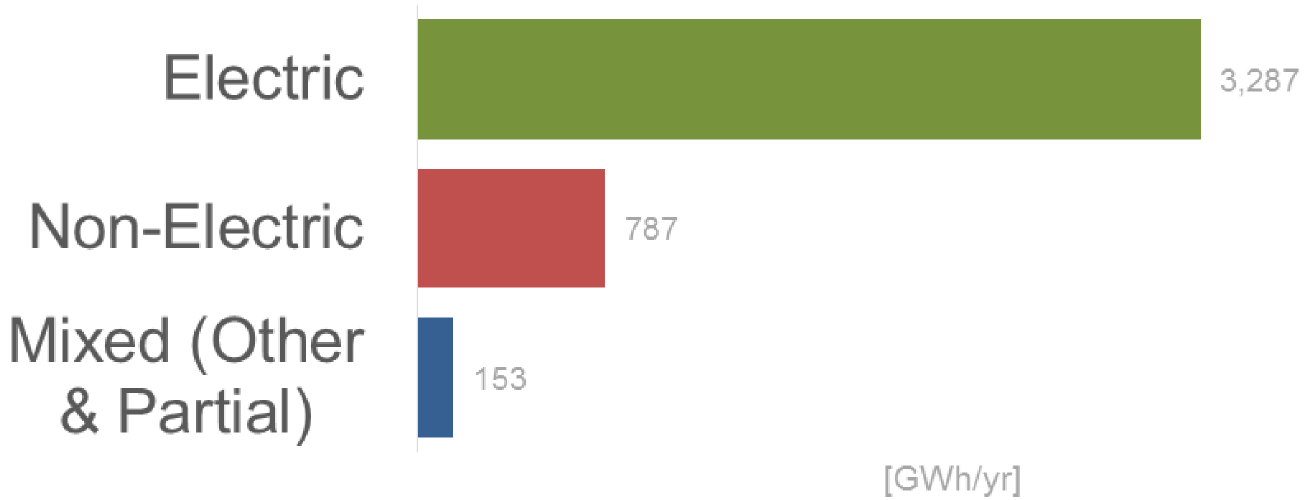


Segmentation

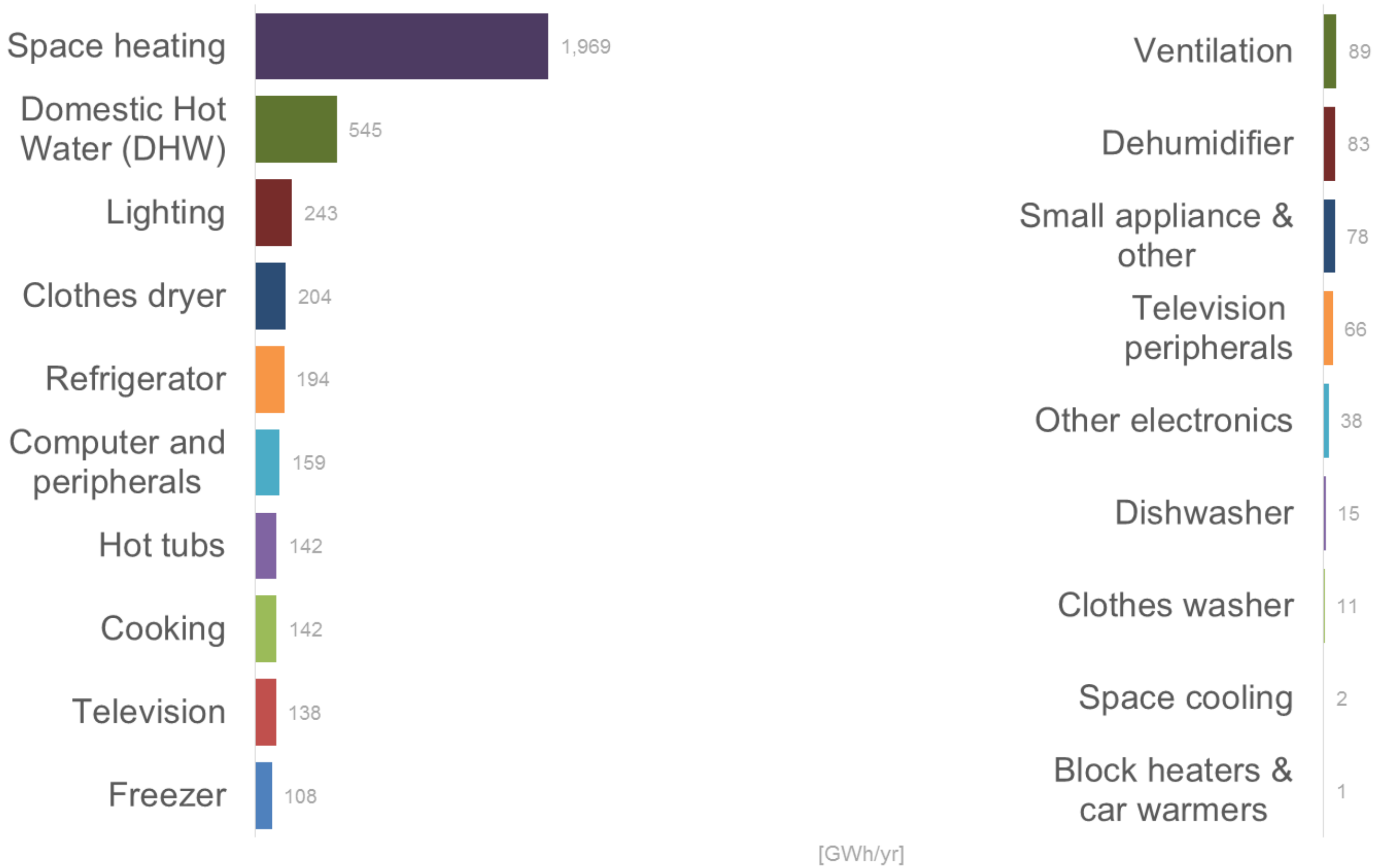
Vintage (2014)

Segmentation

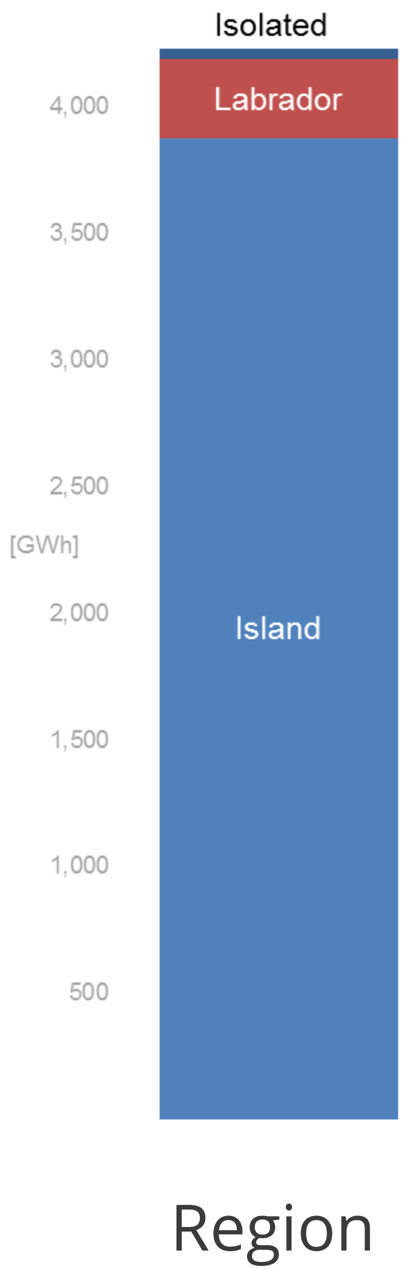
Primary Heating Type



End Uses

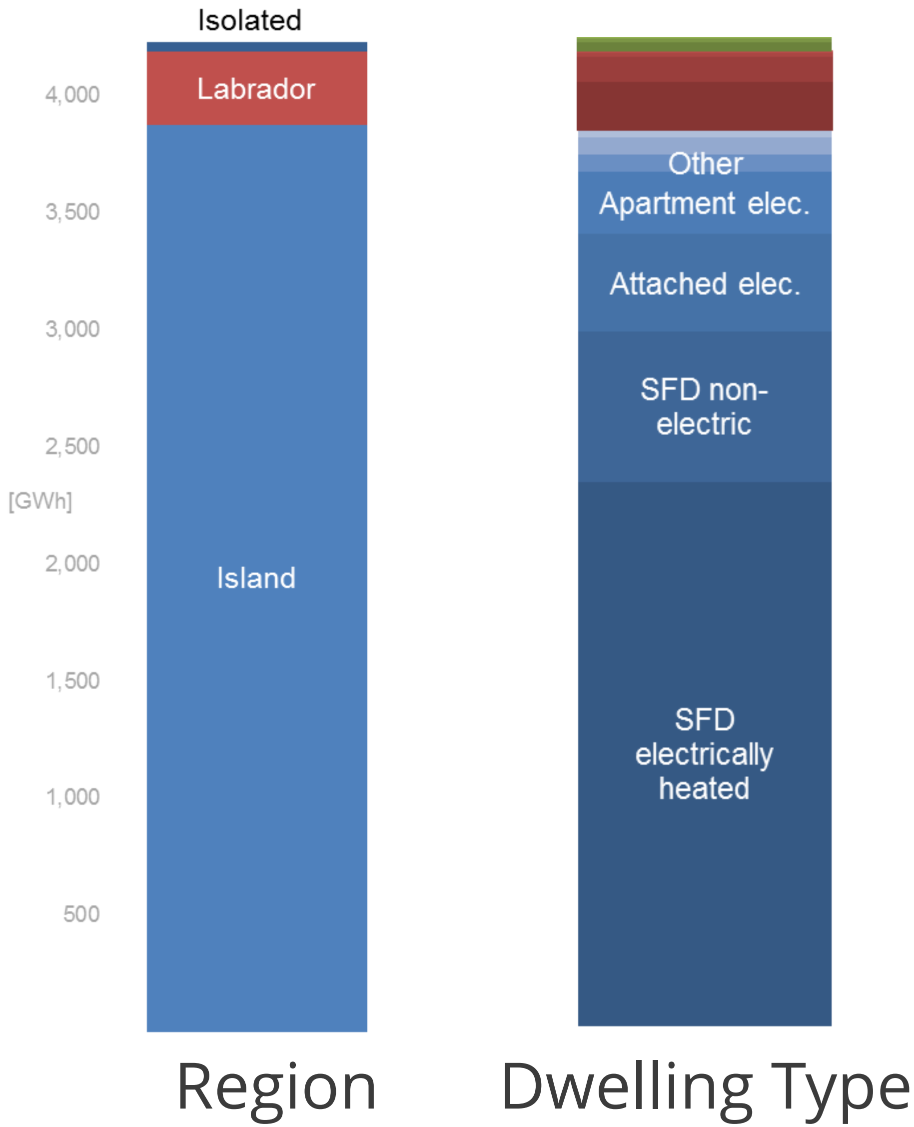

Space heating
1,969
Domestic Hot Water (DHW)
545
Lighting
243
Clothes dryer
204
Refrigerator
194
Computer and peripherals
159
Hot tubs
142
Cooking
142
Television
138
Freezer
108
Ventilation
89
Dehumidifier
83
Small appliance & other
78
Television peripherals
66
Other electronics
38
Dishwasher
15
Clothes washer
11
Space cooling
2
Block heaters & car warmers
1
[GWh/yr]

2014 Base Year

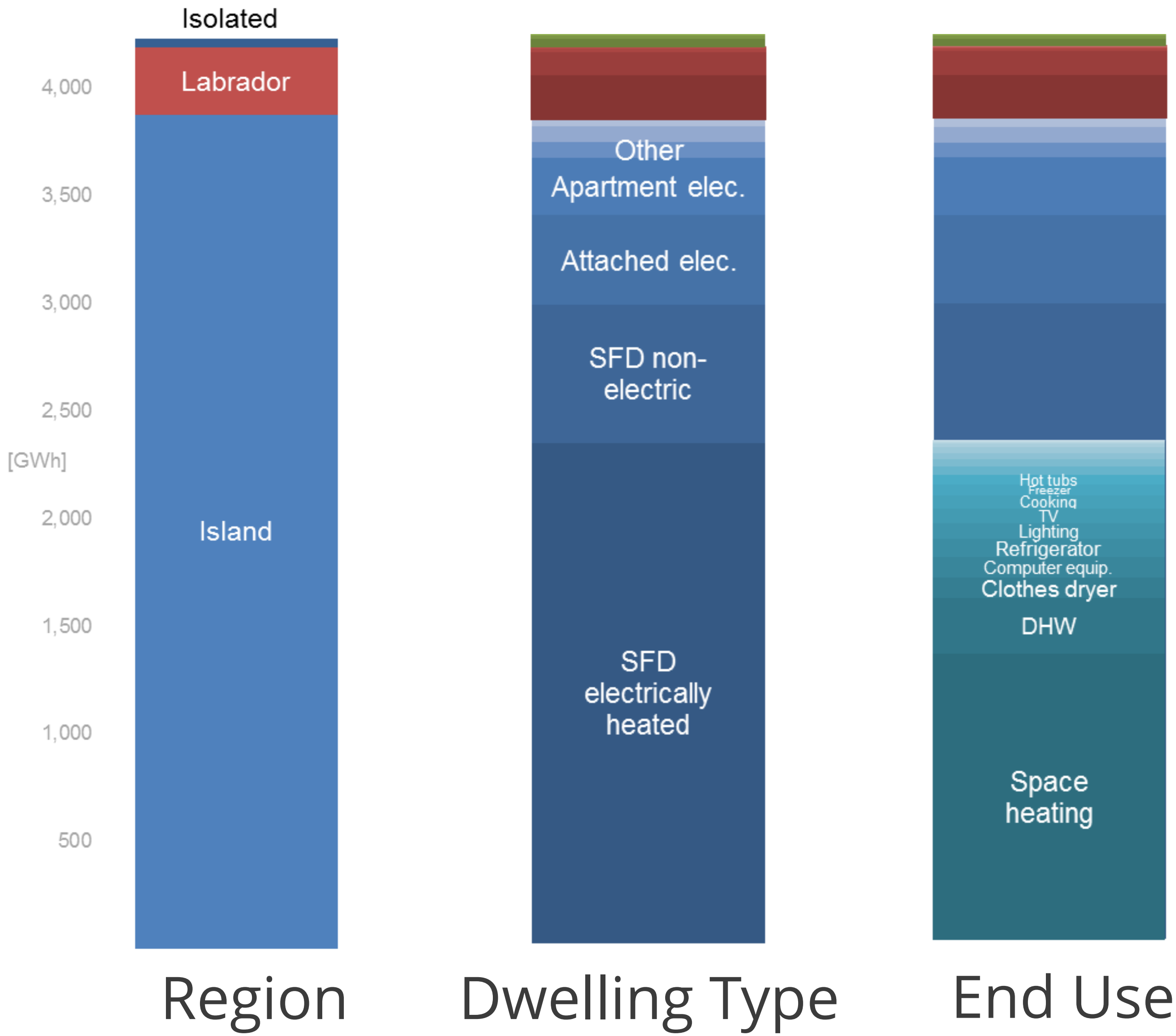


Total electricity sold to residential customers by region for 2014

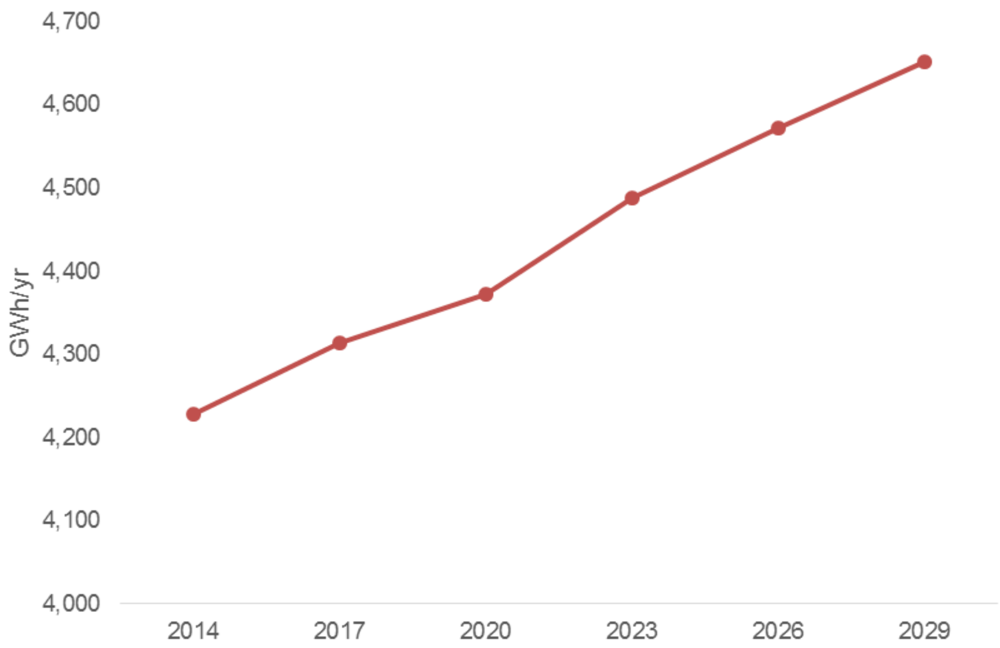
2014 Base Year



2014 Calibrated Base Year



Reference Case – The Foundation



- Growth forecasts for new construction (electrically heated and non-electrically heated) are 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	

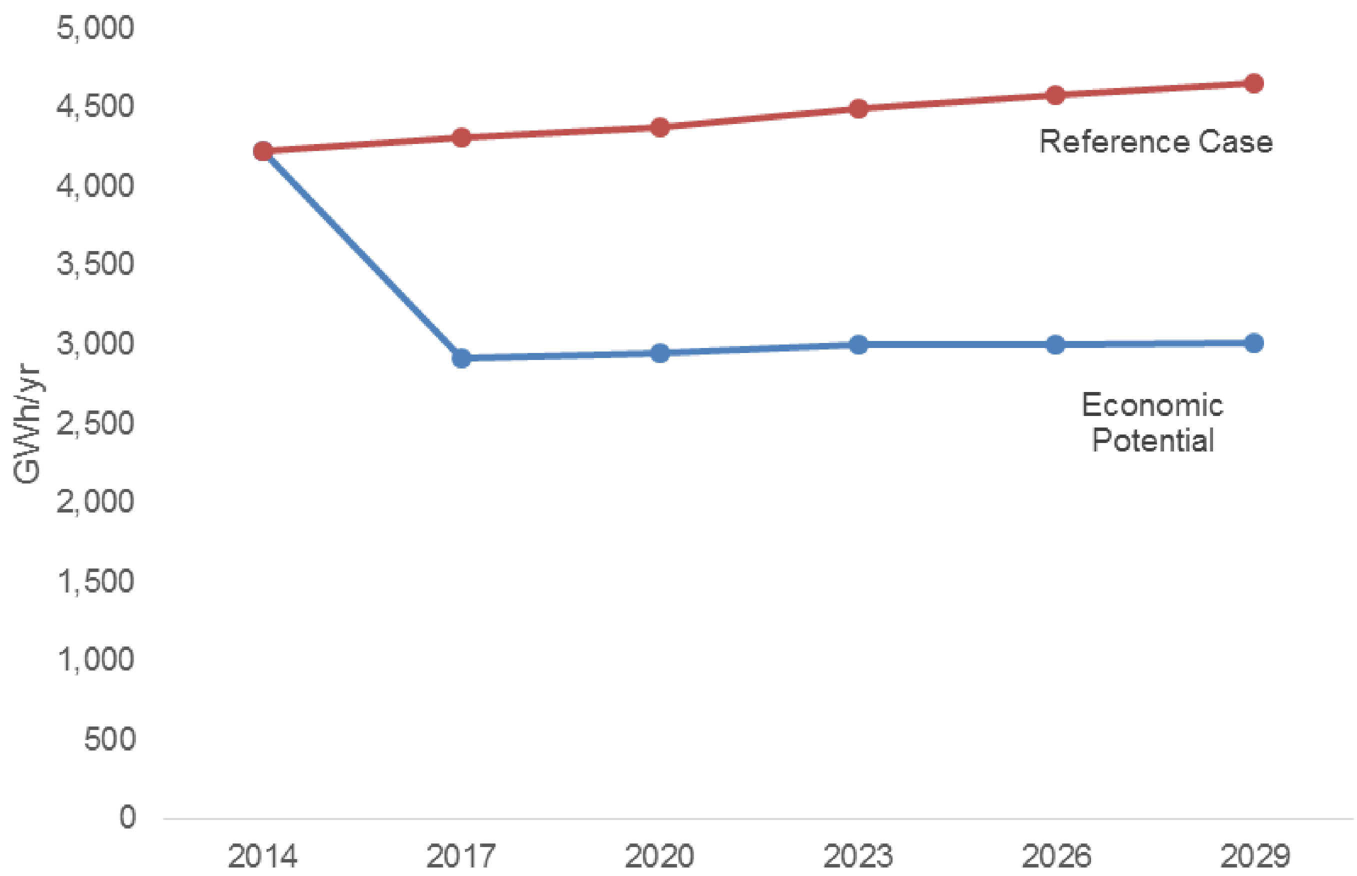
The Results – the Big Picture

- Nearly 70 out of 80 measures passed the screen in at least some dwelling types and regions
- Overall potential is 35% of projected 2029 consumption
- Interaction between internal electricity uses and the home heating system are high:
  - Reducing lighting by 100 kWh would increase electric heating by 60 kWh in the Island region, and by 70 kWh in the Labrador region
  - This makes measures that save internal electricity without reducing space heating less attractive economically
  - These measures also have no effect on peak demand in an electrically heated house, because their savings during the coldest hours of the year are offset by the baseboards working harder

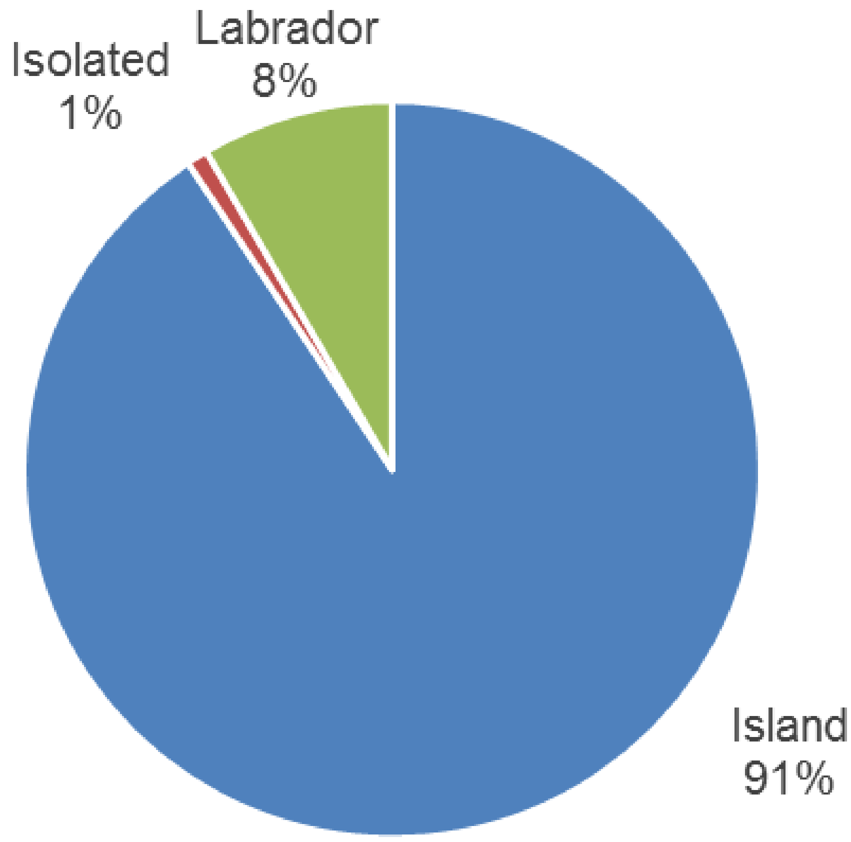
The Results – the Big Picture

- Most measures pass in Isolated, comparatively few in Labrador, and many drop out of contention in Island after the avoided costs decrease in 2018
- Heat pumps show considerable potential for energy savings (but no demand reductions)
- If the heating system is a heat pump, on average it becomes twice as efficient as electric resistance
  - 100 kWh lighting savings adds less than 40 kWh to heating
  - Lighting, appliance, and electronics paybacks would improve
- Changes expected in the NL electrical system: Muskrat Falls, Labrador-Island Link

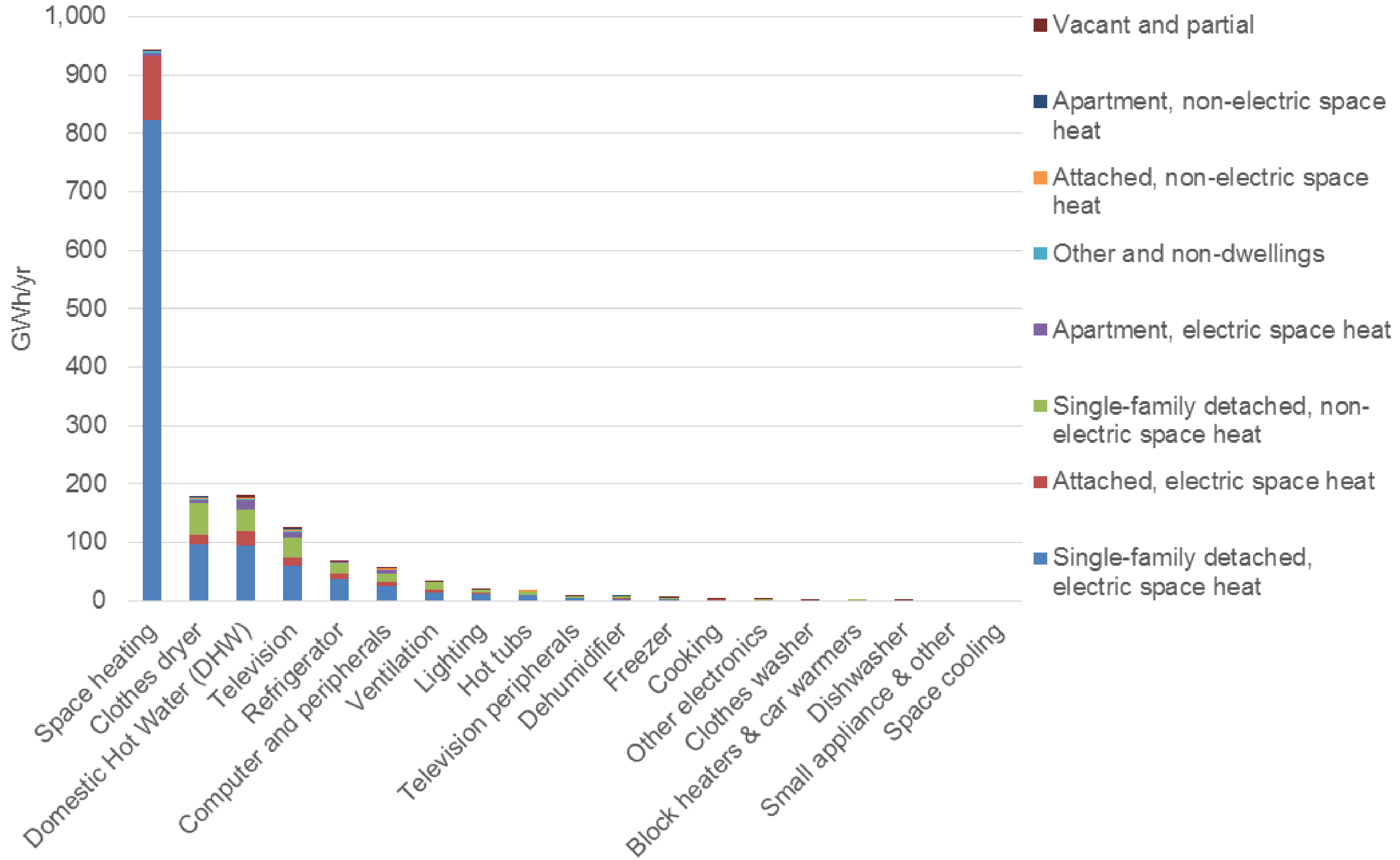
Overall results – 2 scenarios



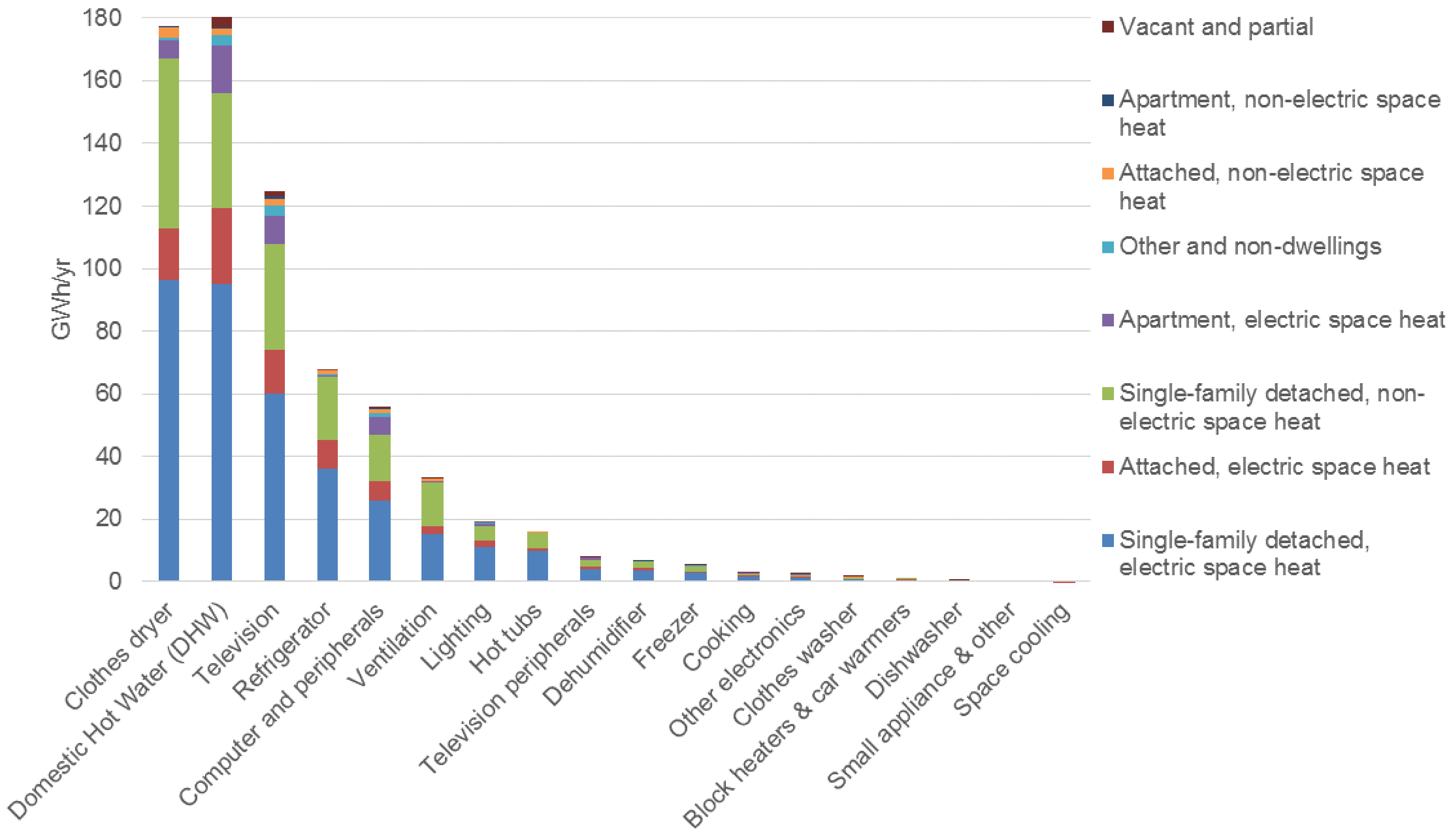
Overall Results-Distribution of Savings



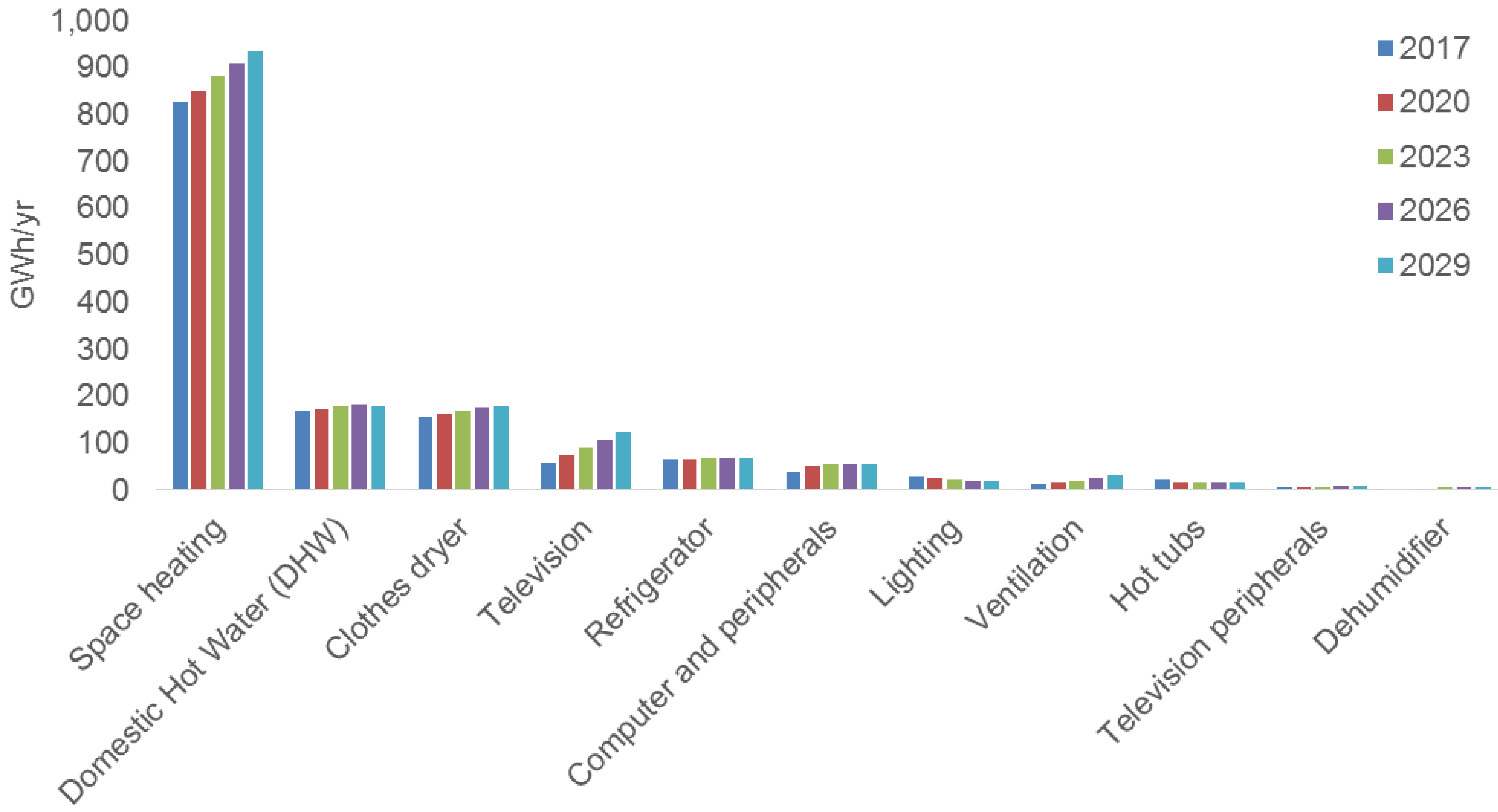
Results in 2029 – Economic Potential



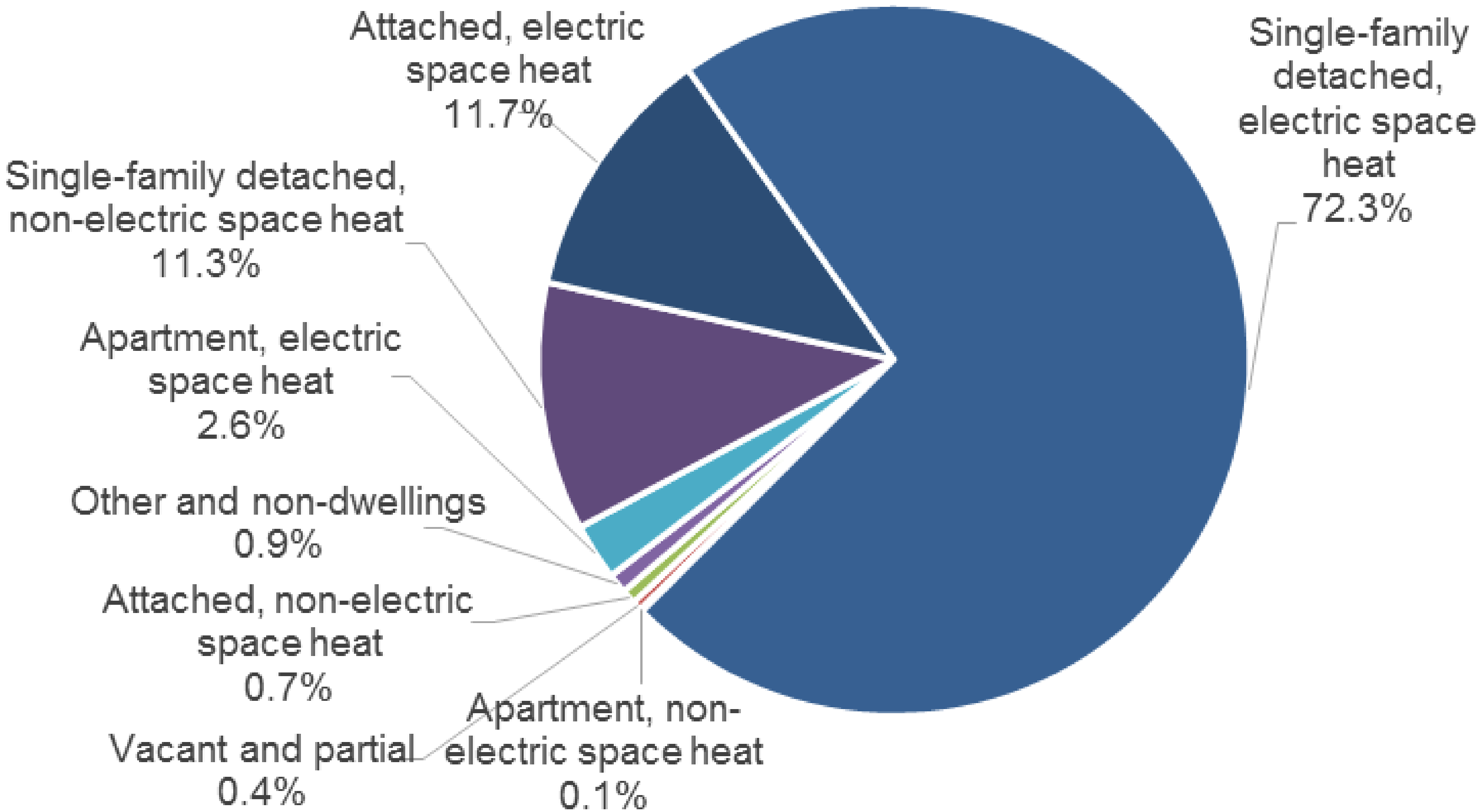
Results in 2029 – Economic Potential (Heating Removed)



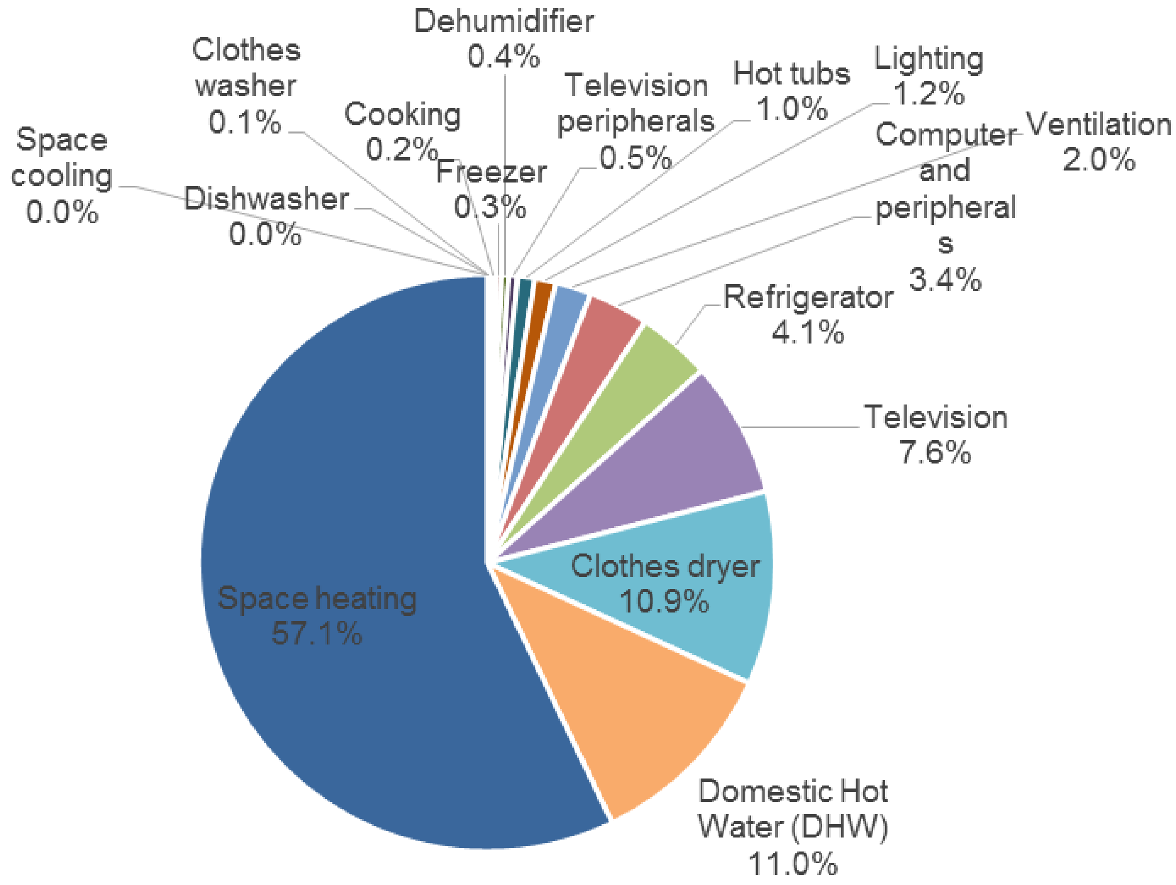
Economic Potential by End Use and Milestone Year



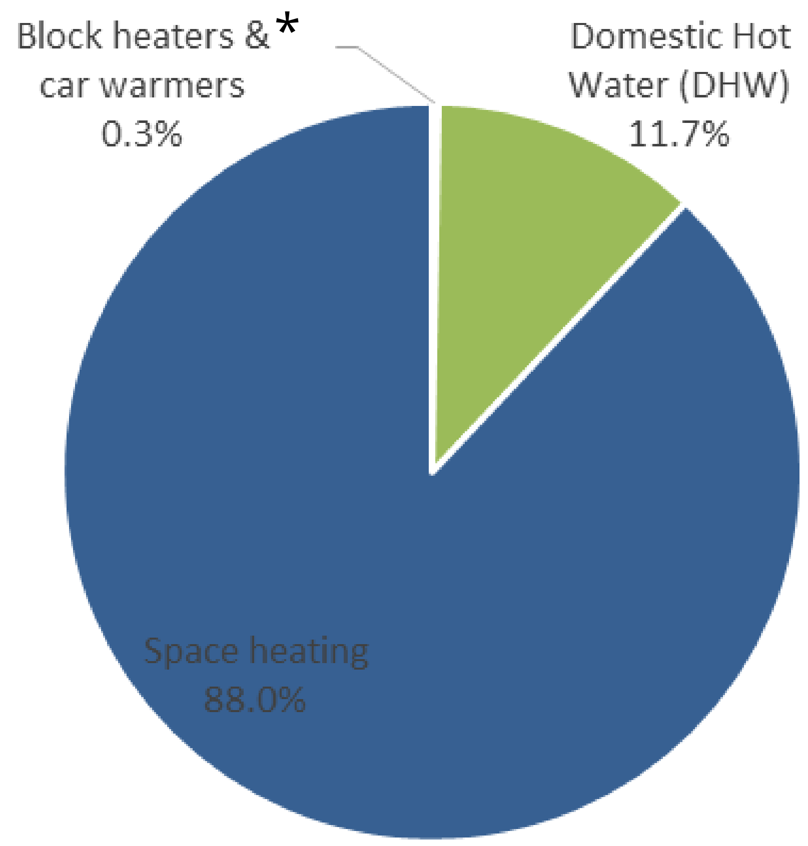
Economic Potential by Dwelling Type - 2029



Economic Potential by End Use - 2029

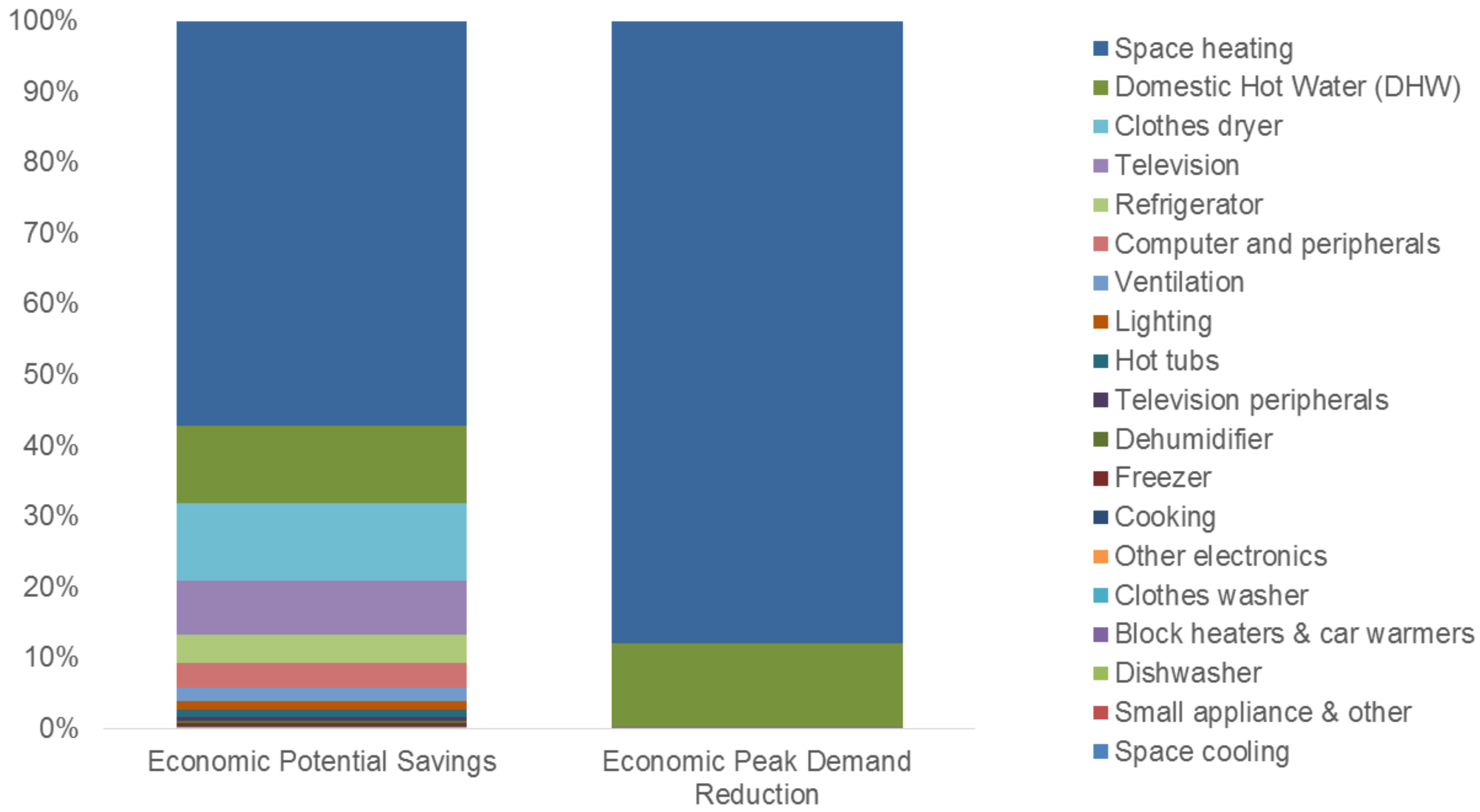


Peak Demand Reduction by End Use – 2029

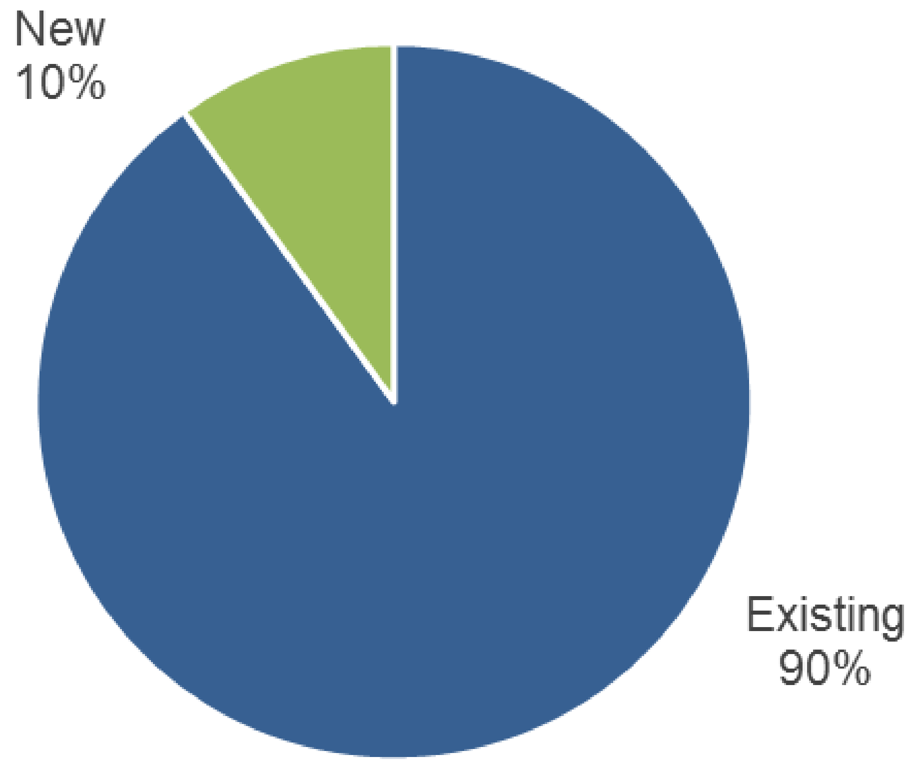


* Measure applies to Labrador only.

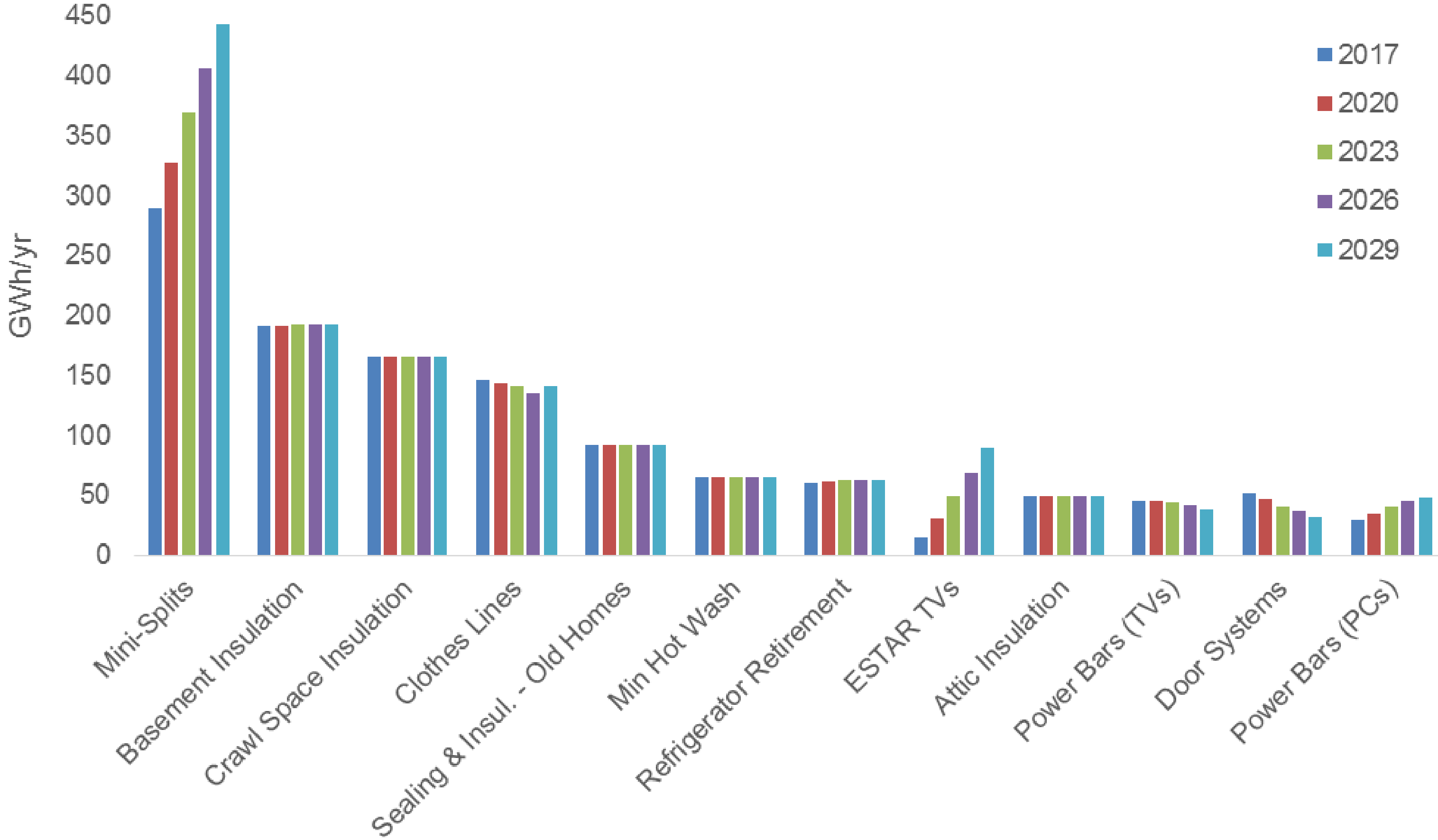
Comparison of Electric Energy & Peak Demand Savings



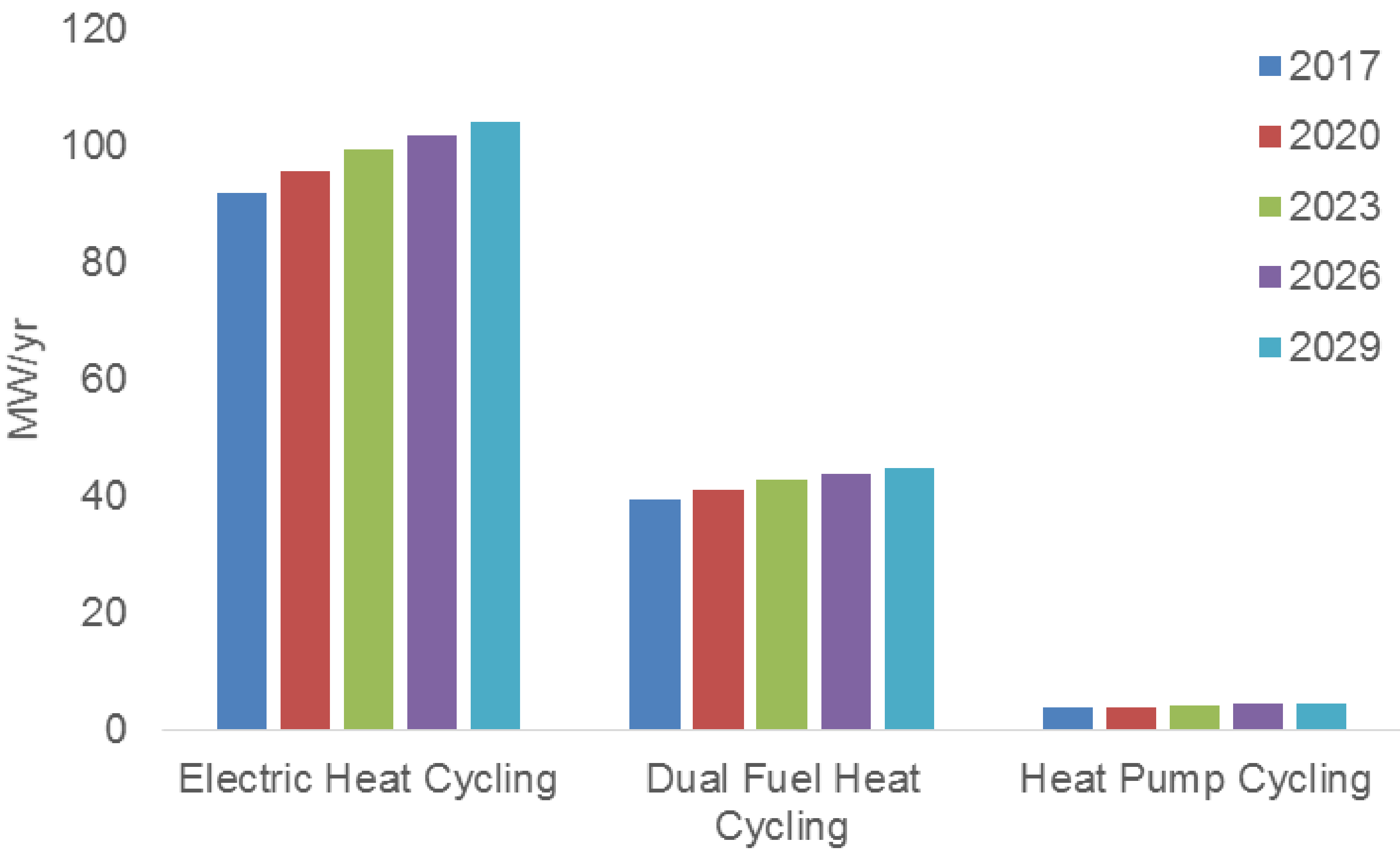
Economic Potential by Vintage - 2029



Economic Potential by Measure & Year



Peak Demand Reduction by Measure



3

Discussion of Residential Opportunities

Today's Discussion

High Level Market Characterization

- 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
- Several different end uses
- Some for existing dwellings, some for new construction
- Different stages of market adoption
- **A set of conversations that are as different from each other as possible!**

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

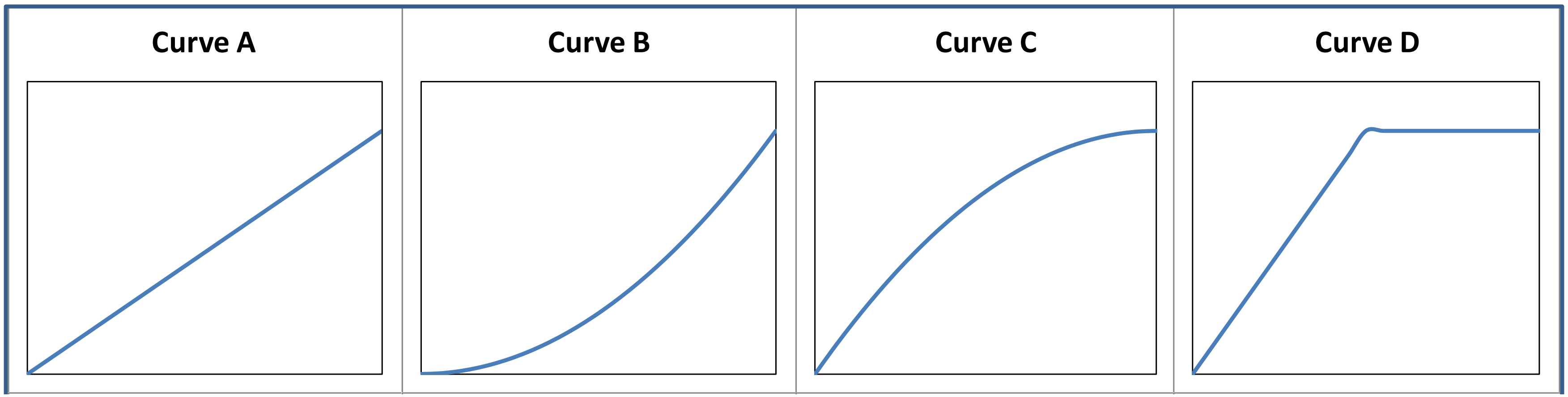
Achievable Potential - Definition

- 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



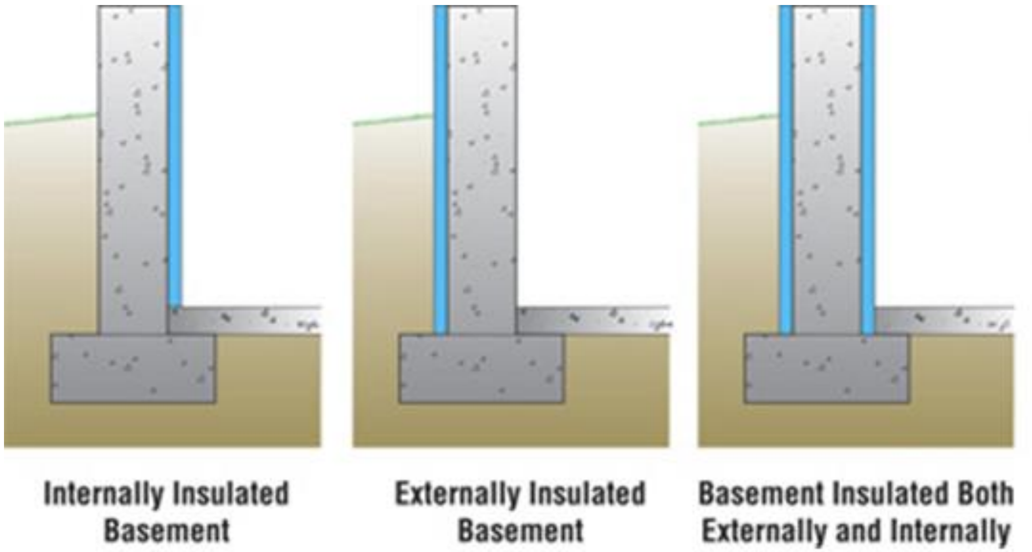
Opportunities for Today's Workshop

	Primary End Use	Percent of 2029 Economic Potential Savings
Basement Insulation	Space Heating	12%
Ductless Mini-Split Heat Pumps	Space Heating	27%
High-Performance New Construction	Space Heating	0.03%
Heat Cycling	Space Heating - Demand	88%
Electric Thermal Storgage	Space Heating - Demand	0%
Air Sealing	Space Heating	1.1%
Low-Flow Water Fixtures	Domestic Hot Water	4%
Behavioral Measures (Top 3)	Clothes Dryers	16%

Residential Opportunity 1:

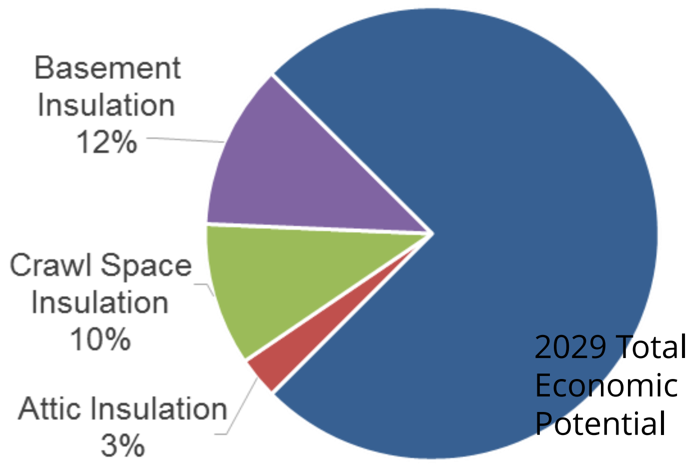
Basement Insulation

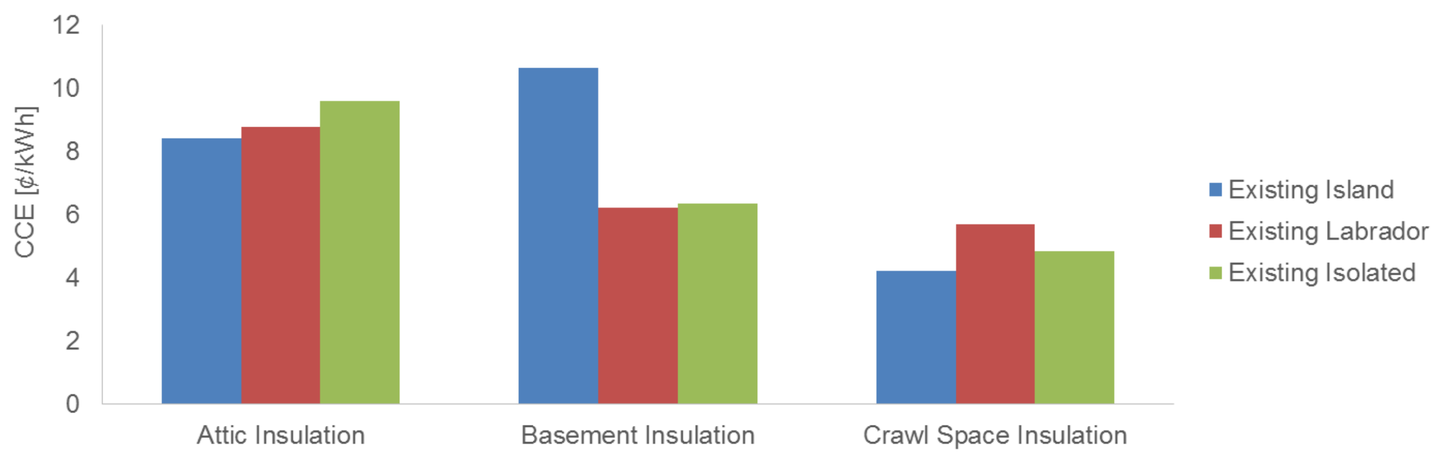
Increasing the basement foundation wall insulation of existing homes to **R-18**.



Residential Opportunity 1:
Basement Insulation
Comparison with Other Insulation Measures

	2029 Economic Potential Savings [GWh]	Passes Economic Test in Regions
Wall Insulation	0	None
Attic Insulation	49	All
Basement Insulation	193	All
Crawl Space Insulation	166	All





Residential Opportunity 1:

Basement Insulation

Assumptions

Focus Dwelling Type	Detached
Focus Region	Island Interconnected
Typical Application:	
Cost	$ 2,300
Basis	Full
Useful life	length of study
Savings:	
Space heating	25%
Space cooling	small increase in usage
Ventilation	8%

Residential Opportunity 1:

Basement Insulation

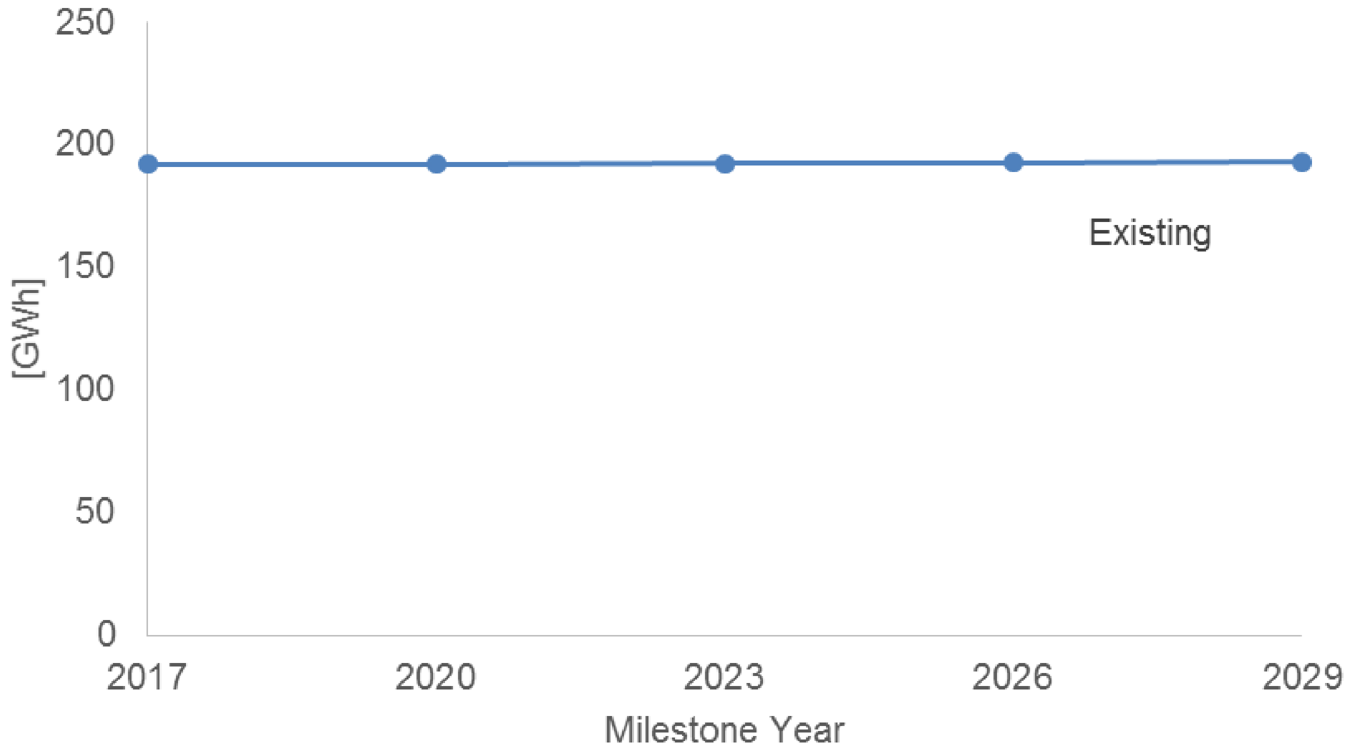
Economic Indicators

Simple Payback (SFD - Island)	5.7 years
Average CCE (¢/kWh):	
Island	11.5
Labrador	6.2
Isolated	10.1
Basis	Full cost
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	102,000
Principal region	Island Interconnected

Residential Opportunity 1:

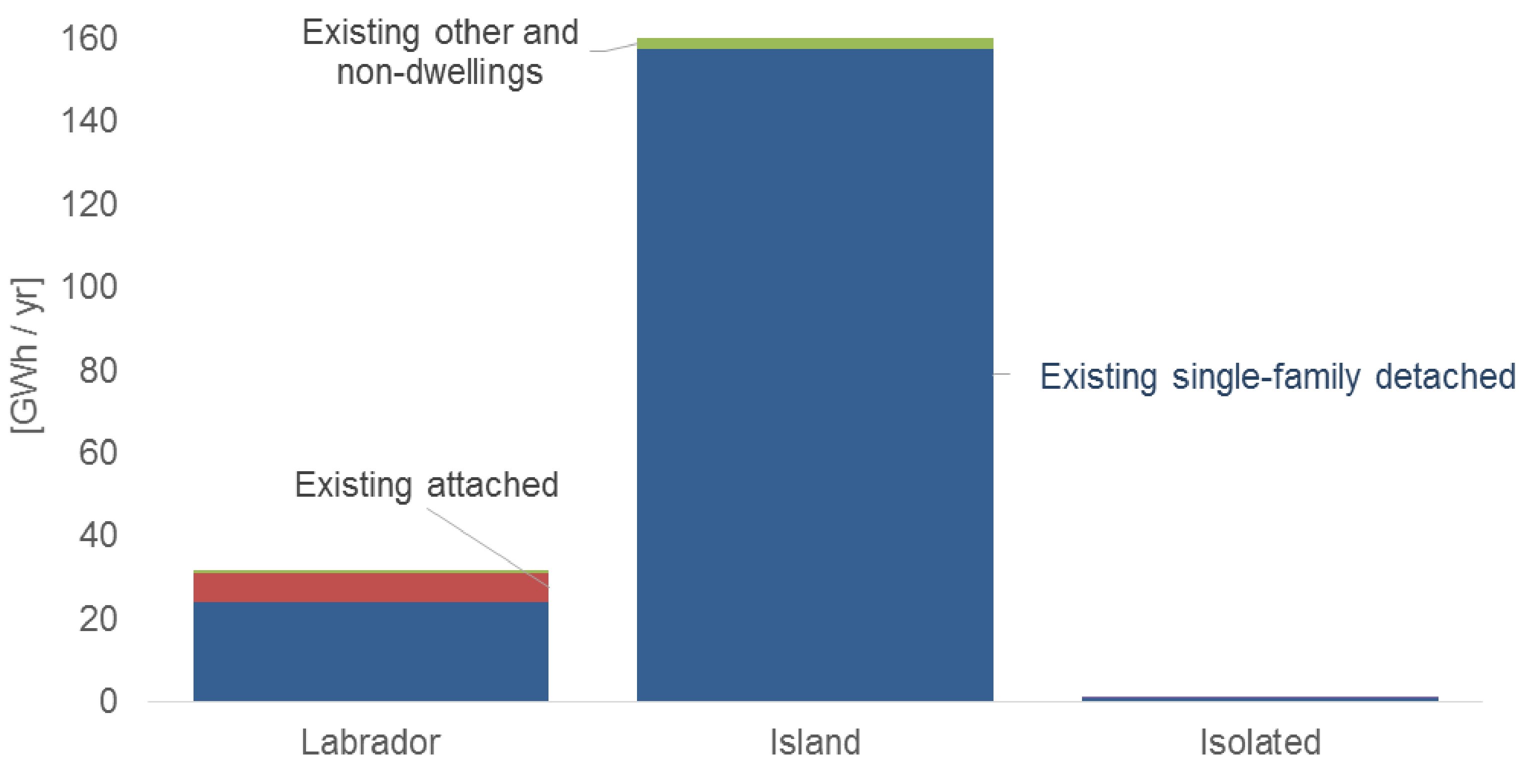
Basement Insulation

Growth of Economic Potential



Residential Opportunity 1:
Basement Insulation

2029 Economic Potential Breakdown



Residential Opportunity 2:

Ductless Mini-Split Systems

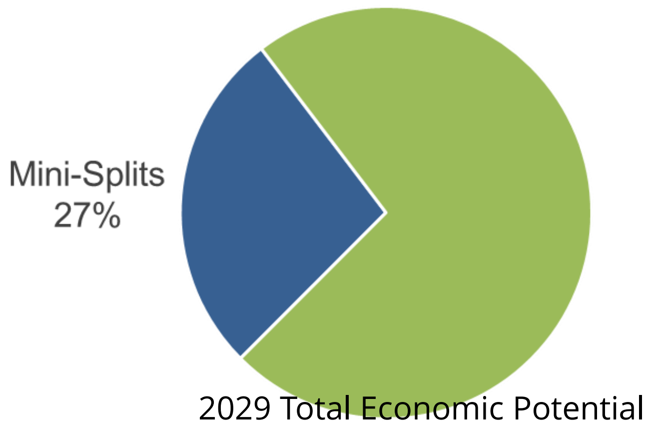
Upgrading a dwelling heated with **electric baseboards** to one with a **ductless mini-split heat pump system** that supplies heat to the most-used portion of the house (about 60% of the total floor area)

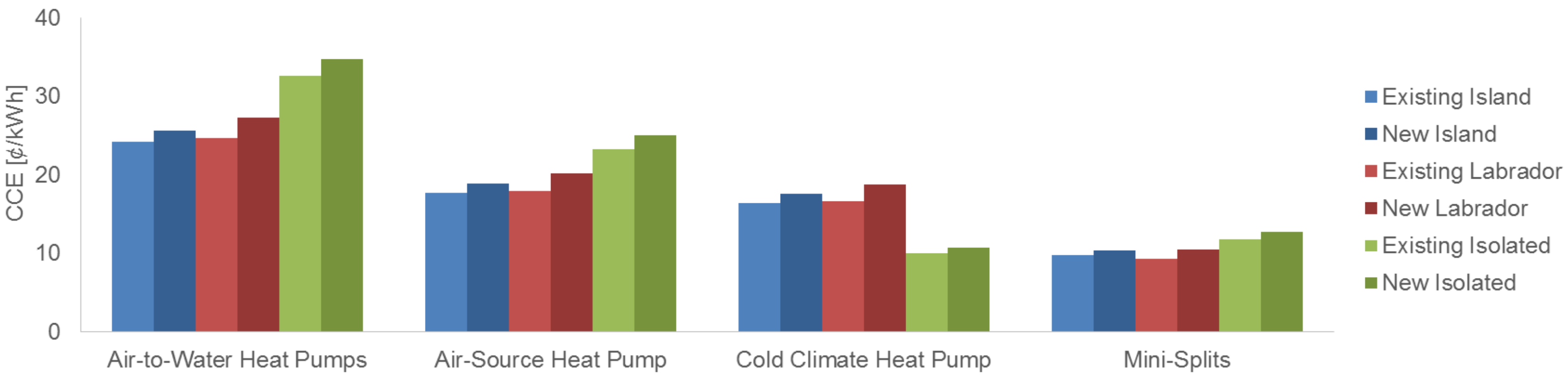
Residential Opportunity 2:

Ductless Mini-Split Systems

Comparison with Other Heating Measures

	2029 Economic Potential Savings [GWh]	Passes Economic Test in Regions
Air-to-Water Heat Pumps	0	None
Air-Source Heat Pump	0.178	Isolated only
Cold Climate Heat Pump	0.072	Isolated only
Mini-Splits	444	All





Residential Opportunity 2:

Ductless Mini-Split Systems

Assumptions

Focus Dwelling Type	Detached
Focus Region	Island Interconnected
Typical Application:	
Cost	$ 3,500
Basis	Full
Useful life	15 years
Savings:	
Space heating	35%
Space cooling	small increase in usage

Residential Opportunity 2:

Ductless Mini-Split Systems

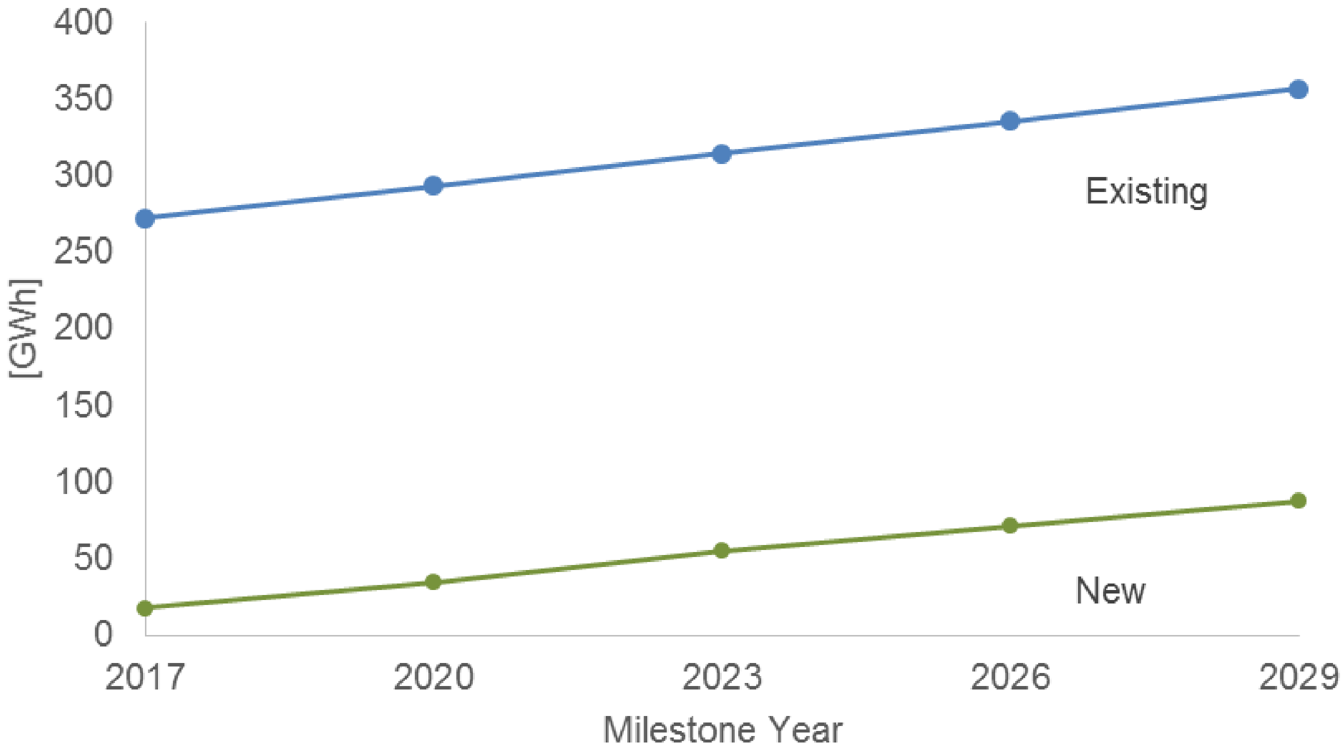
Economic Indicators

Simple Payback (SFD - Island)	6.4 years
Average CCE (¢/kWh):	
Island	9.8
Labrador	9.3
Isolated	11.8
Basis	Full cost*
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	130,000
Region	Island Interconnected
	* Labrador is incremental.

Residential Opportunity 2:

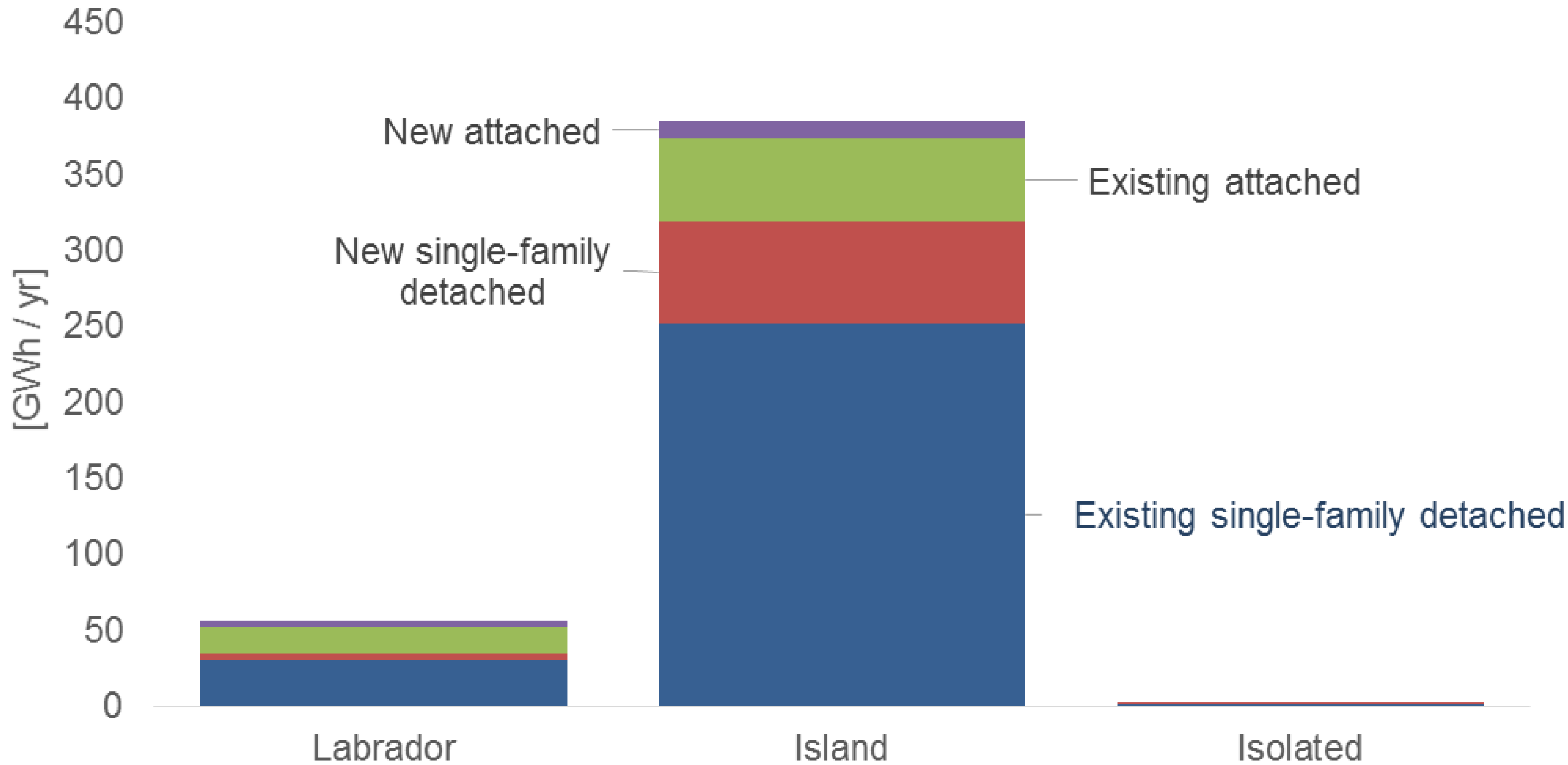
Ductless Mini-Split Systems

Growth of Economic Potential



Residential Opportunity 2:
Ductless Mini-Split Systems

2029 Economic Potential Breakdown



Residential Opportunity 3:

High-Performance New Construction

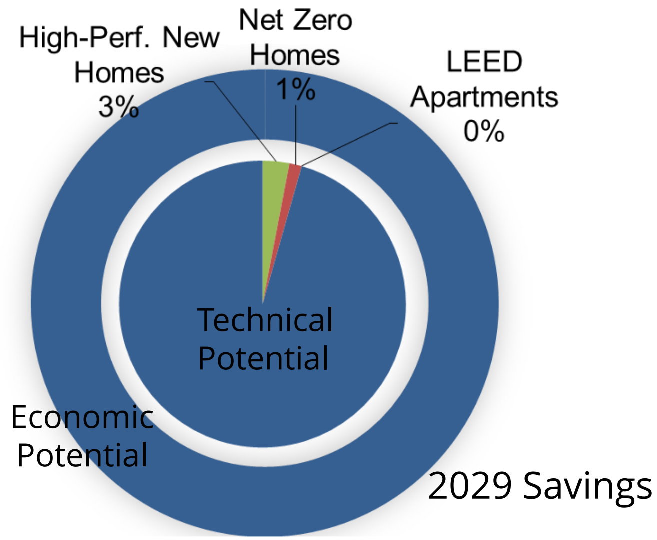
Building a new home to **EnerGuide for Houses (EGH) rating of 80**.

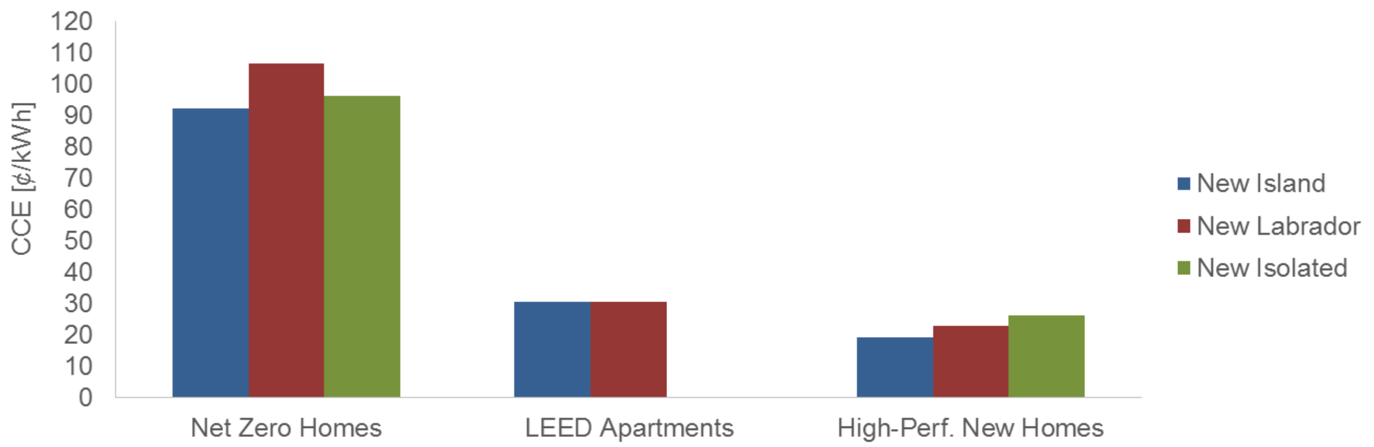
Measure includes **Energy Star**® and **R2000**, which requires a minimum air tightness level of 1.5 ACH@50Pa and installation of a heat recovery ventilator.

Residential Opportunity 3:
High-Performance New Construction

Comparison with Other New Construction Measures

	2029 Technical Potential Savings [MW]	2029 Economic Potential Savings [MW]	Passes Economic Test in Regions
Net Zero Homes	22797	0	None
LEED Apartments	3241	0	None
High-Perf. New Homes	49237	565	Isolated only





Residential Opportunity 3:

High-Performance New Construction

Assumptions

Focus Dwelling Type	Detached
Focus Region	Isolated (Diesel)
Typical Application:	
Cost	$ 5,800
Useful life	[length of study]
Savings:	
HVAC, lighting and DHW	17%

Residential Opportunity 3:

High-Performance New Construction

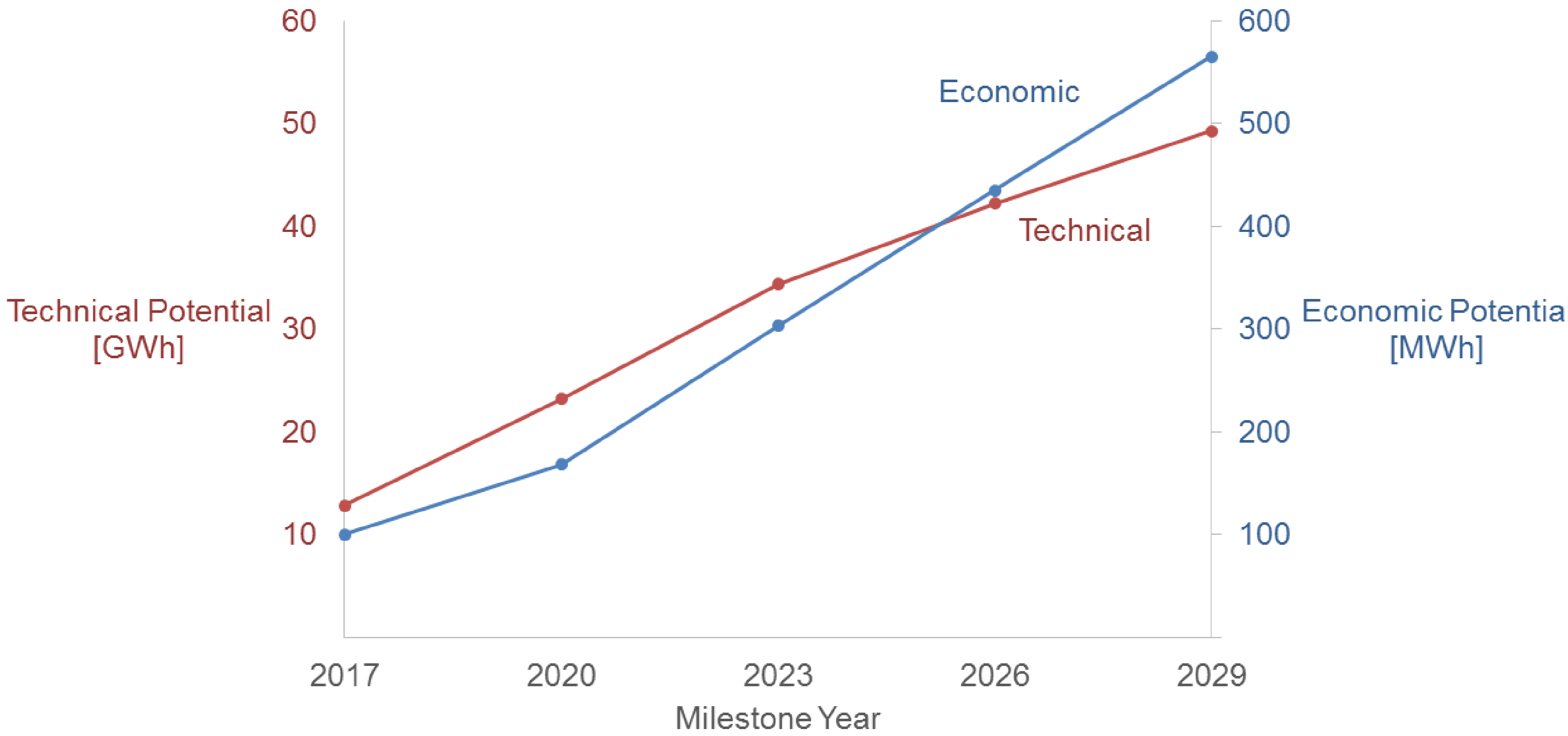
Economic Indicators

Simple Payback (SFD - Island)	17.2 years
Average CCE (¢/kWh):	
Island	24.0
Labrador	22.8
Isolated	46.0
Basis	Full cost
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	547
Principal region	Isolated (Diesel)

Residential Opportunity 3:

High-Performance New Construction

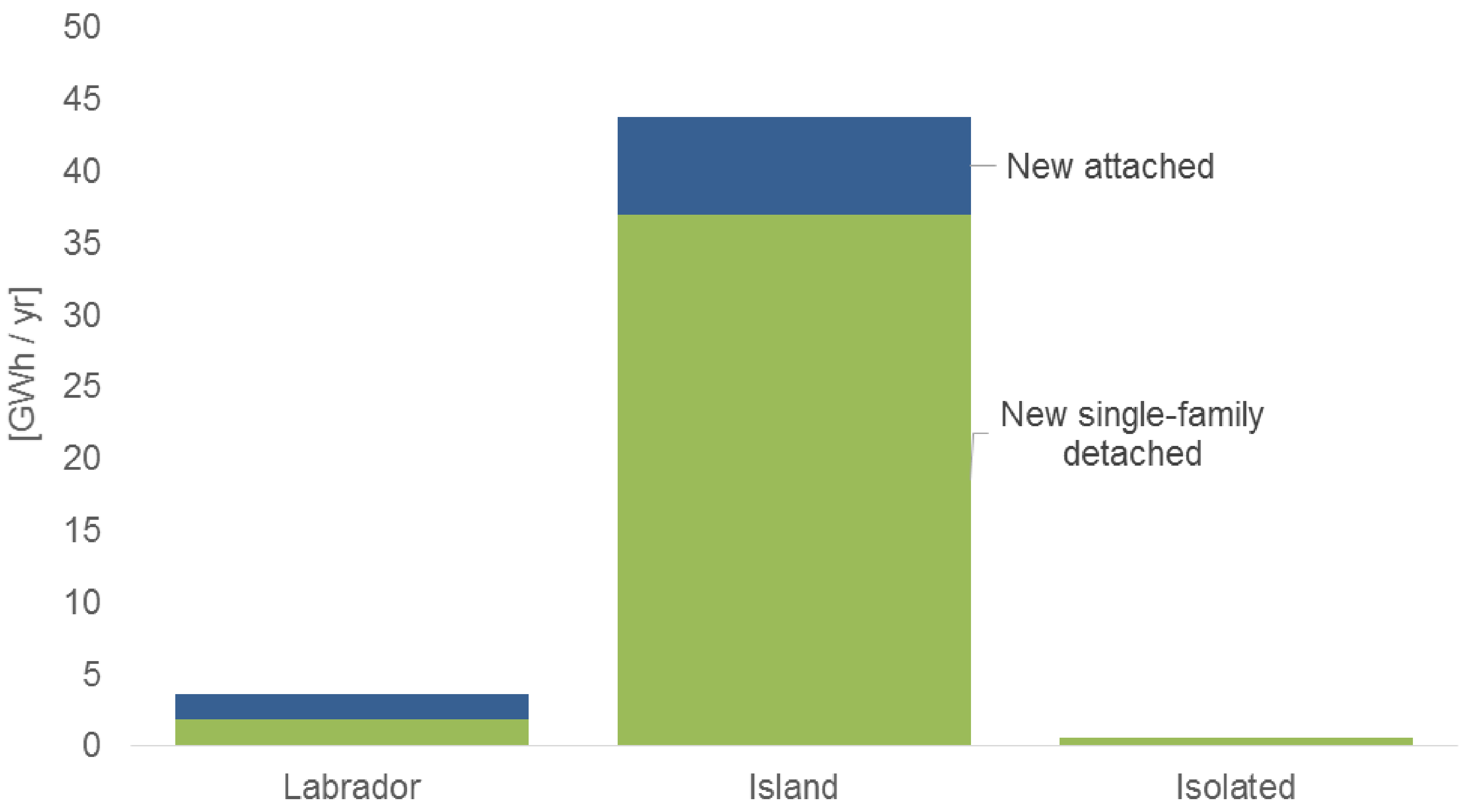
Growth of Technical and
Economic (Isolated only) Potential Savings



Residential Opportunity 3:

High-Performance New Construction

2029 Technical Potential Breakdown



Residential Opportunity 4:

Heat Cycling

Adding a load management device on an electric baseboard, furnace or heat pump to **cycle the heater on and off** during times of peak demand. Homes have a secondary heat source for “Dual Fuel” cycling.

Residential Opportunity 4:

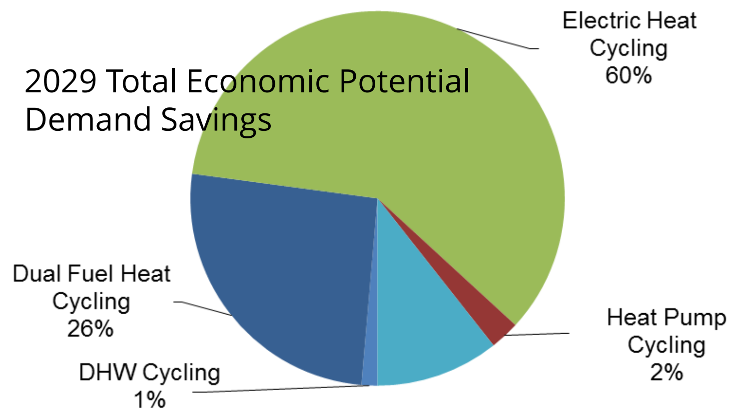
Heat Cycling

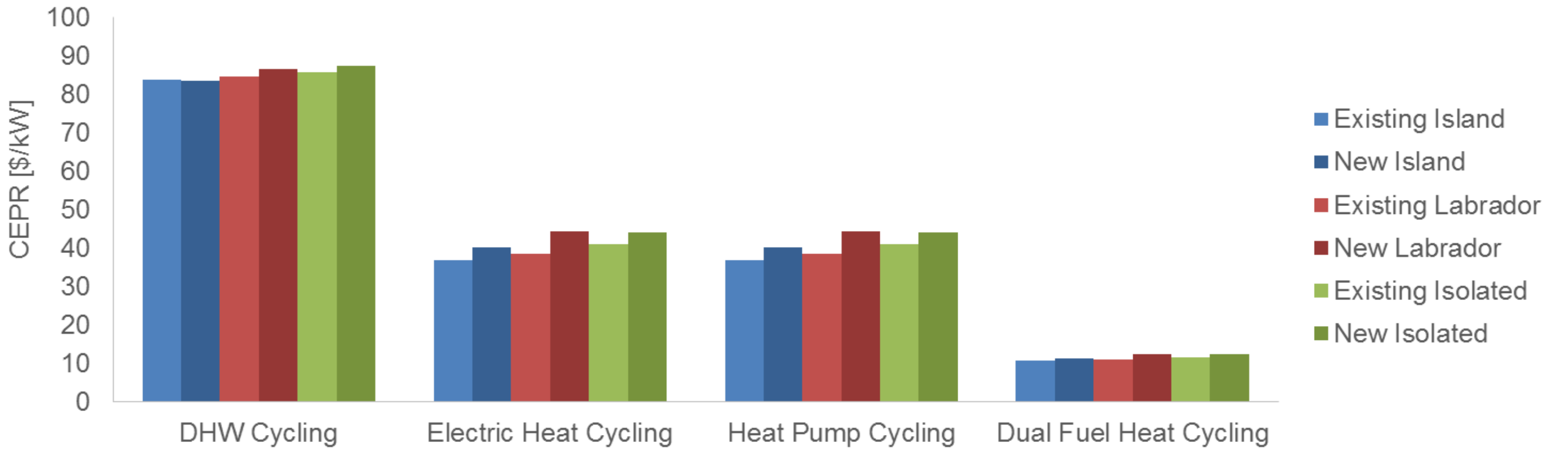
Comparison with Other Cycling Demand Measures

* Assumptions for DHW cycling measure have been updated since the workshop. Originally presented numbers are shown here.

	2029 Economic Potential Savings [MW]	Passes Economic Test in Regions
DHW Cycling	2.4	Isolated and Labrador
Electric Heat Cycling	104	All
Heat Pump Cycling	4.4	All
Dual Fuel Heat Cycling	45	All

2029 Total Economic Potential Demand Savings





Residential Opportunity 4:

Heat Cycling

Assumptions

Focus Dwelling Type	Detached
Focus Region	Island Interconnected
Typical Application:	
Cost	$ 200
Useful life	10 years
Savings: Heating	(tiers are program choice)
Duel Fuel	90%
Electric Heat	25%
Heat Pump	25%

Residential Opportunity 4:

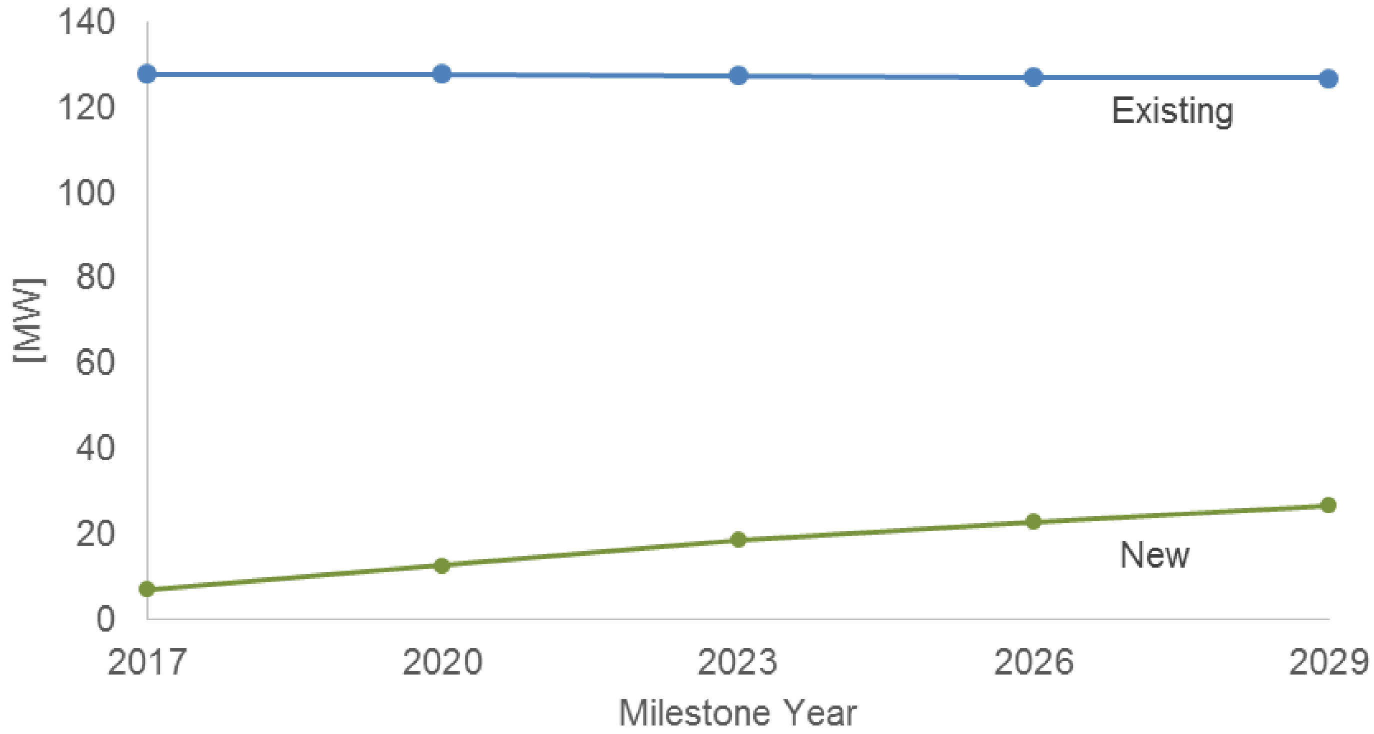
Heat Cycling

Economic Indicators

Simple Payback (SFD - Island)		N/A
Average CEPR ($/kW):		
Island	$	43
Labrador	$	39
Isolated	$	72
Basis		Full cost
Eligibility Timeline		Immediate
Eligible participants:		
Number of dwellings by 2029*		188,000
Principal region		Island Interconnected

* all heat cycling measures

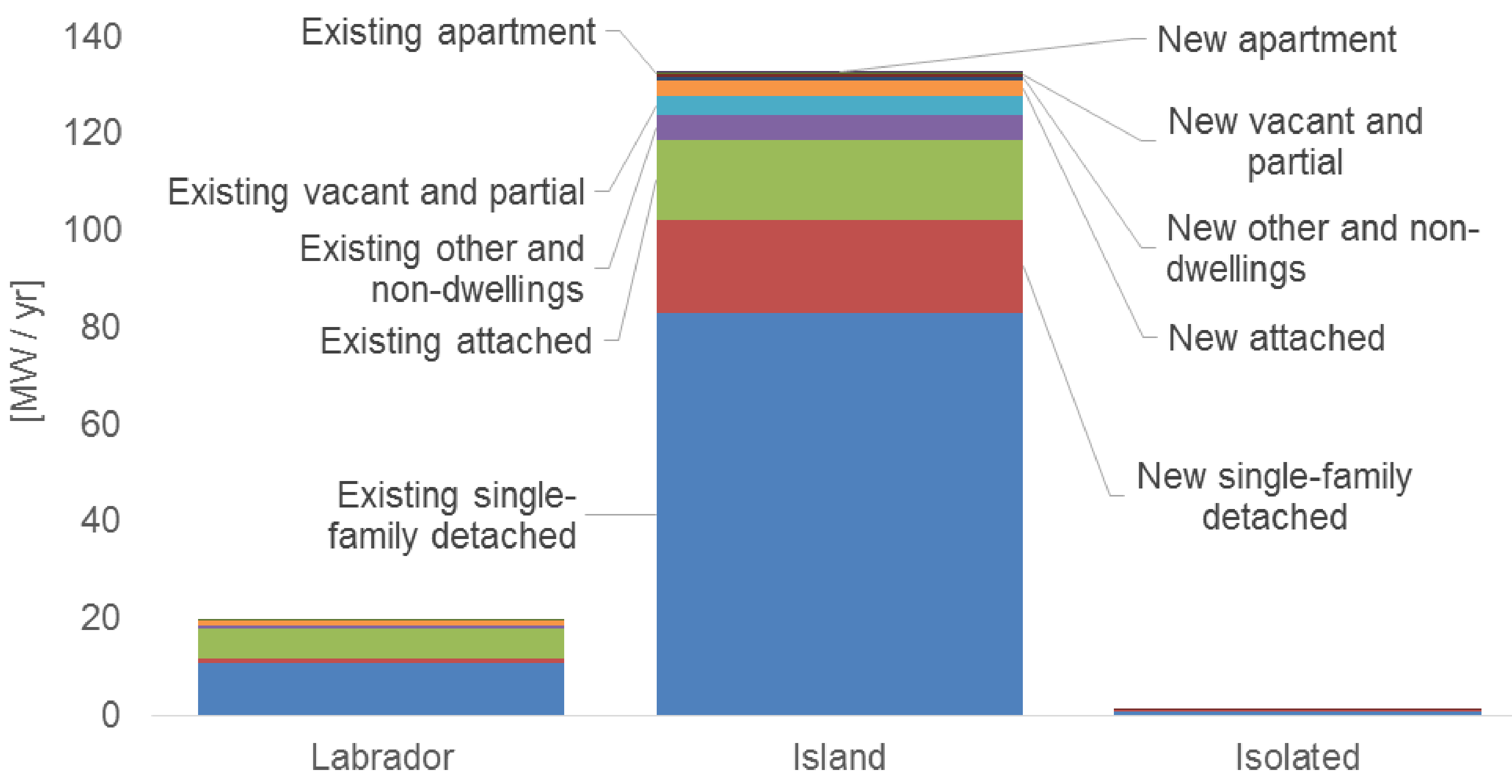
Residential Opportunity 4:
Heat Cycling
Growth of Economic Potential Savings



Residential Opportunity 4:

Heat Cycling

2029 Economic Potential Breakdown

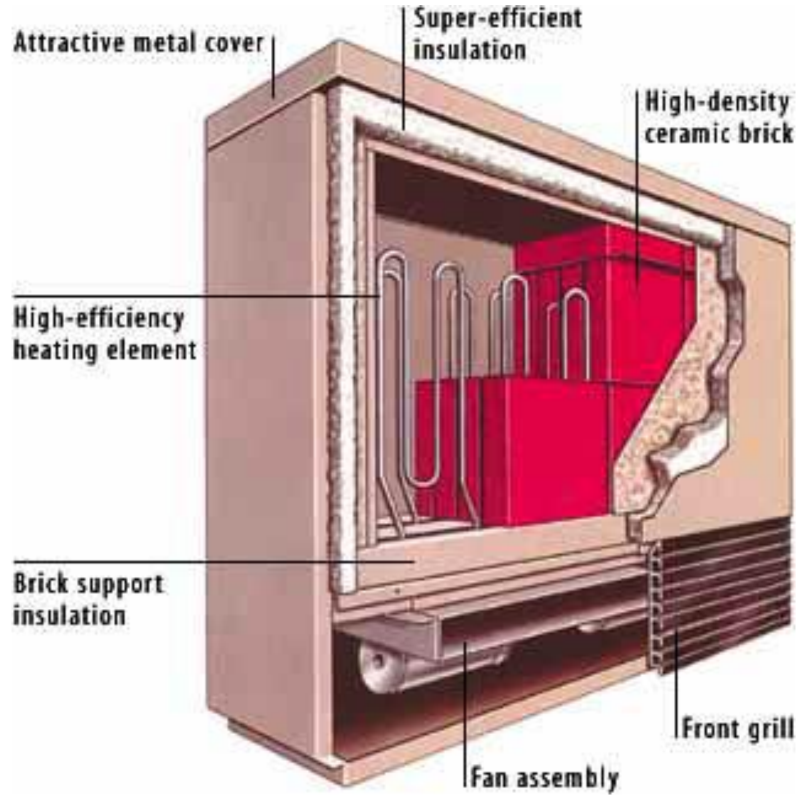


Residential Opportunity 5:

Electric Thermal Storage

For homes with **central heating**, replacing an electric furnace with a unit with **thermal storage** capability.

For homes with **baseboard heating**, replacing baseboards or with **two unit heaters with thermal storage** in the principal living areas (approximately **60%** of total area).

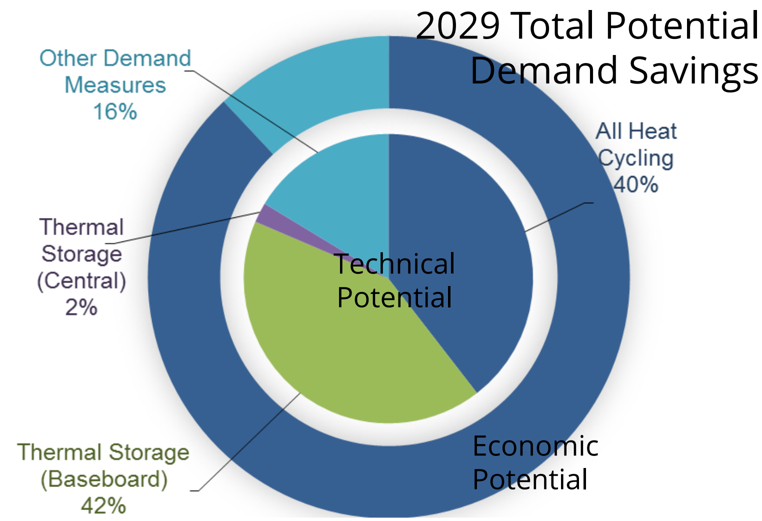


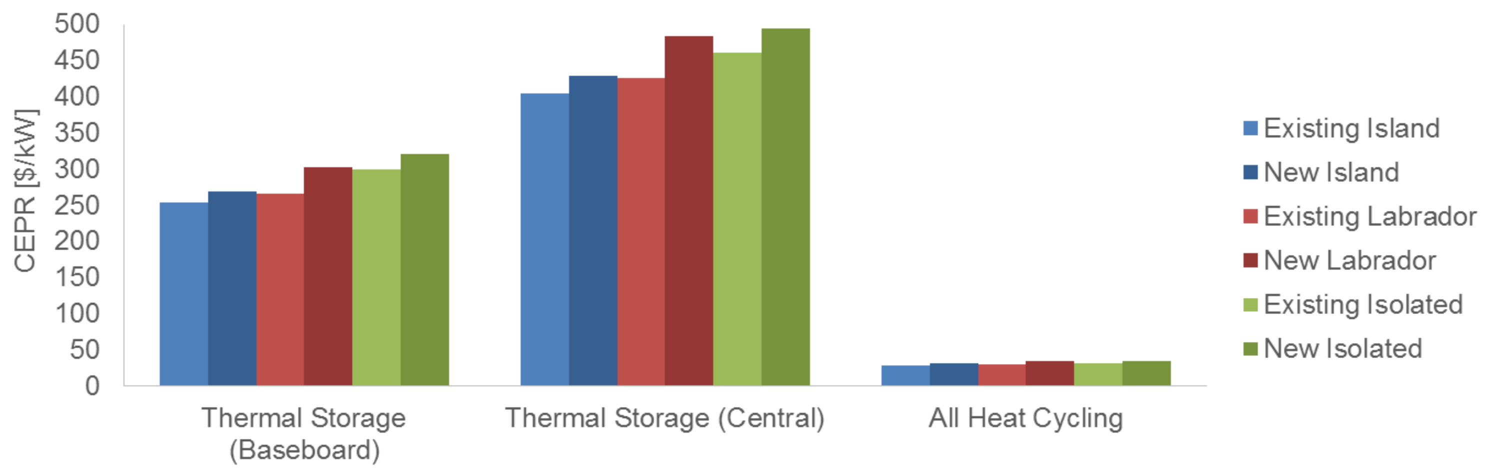
Residential Opportunity 5:

Electric Thermal Storage

Comparison with Other Heating Demand Measures

	2029 Technical Potential Savings [MW]	2029 Economic Potential Savings [MW]
Thermal Storage (Baseboard)	289	0
Thermal Storage (Central)	15	0
All Heat Cycling	272	153





Residential Opportunity 5:

Electric Thermal Storage

Assumptions

Focus Dwelling Type		Detached
Focus Region		Island Interconnected
Typical Application:		
Cost:		
Unit heaters (2)	$	5,000
Central heating	$	11,500
Useful life		15 years
Savings: Space heating		
Unit heaters (2)		56%
Central heating		85%

Residential Opportunity 5:

Electric Thermal Storage

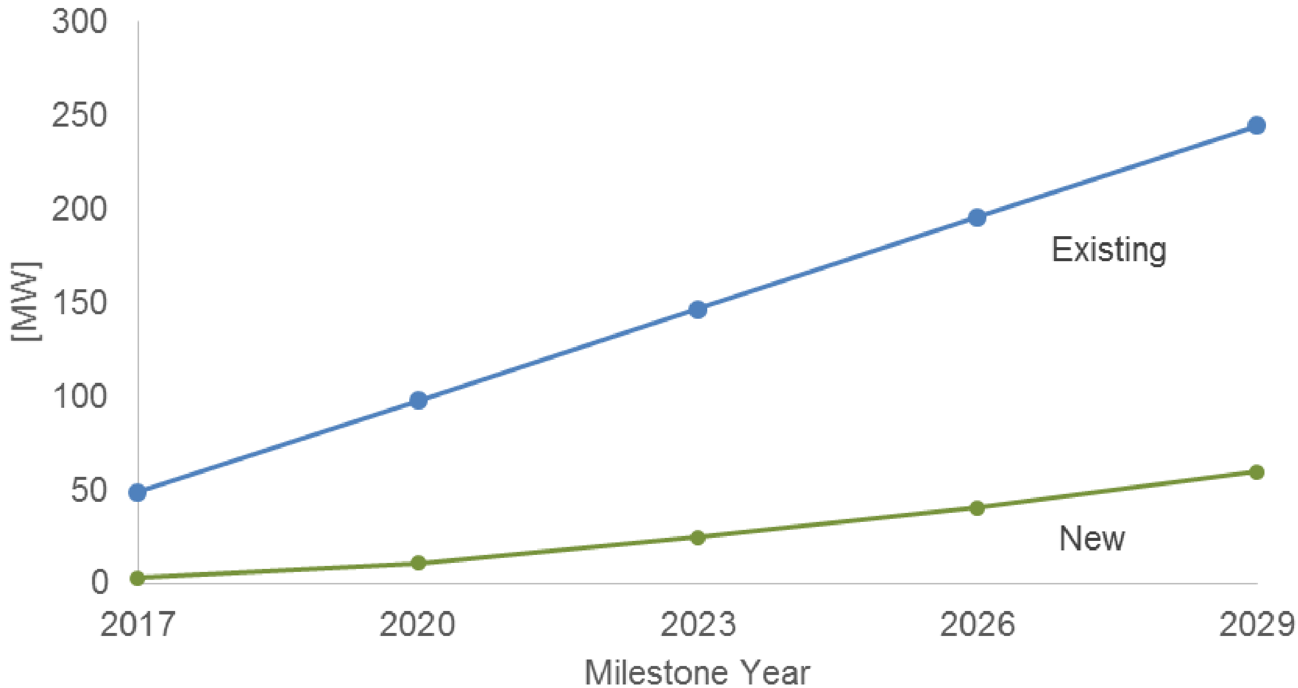
Economic Indicators

Simple Payback (SFD - Island)	N/A
Average CEPR ($/kW):	
Unit heaters (2)	$ 285
Central heating	$ 450
Basis	N/A
Eligibility Timeline	N/A
Eligible participants:	
Number of dwellings by 2029	0

Residential Opportunity 5:

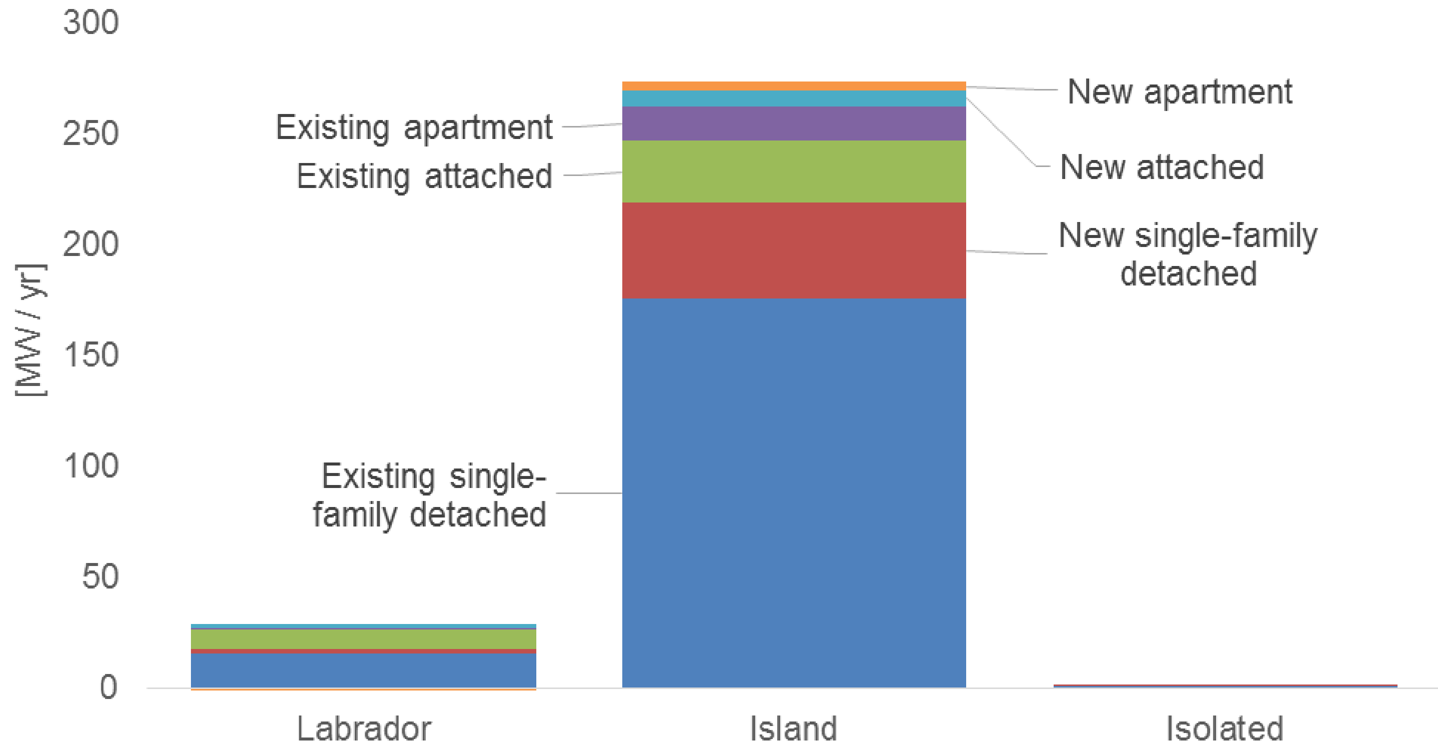
Electric Thermal Storage

Growth of Technical Potential Savings



Residential Opportunity 5:
Electric Thermal Storage

2029 Technical Potential Breakdown



Residential Opportunity 6:

Air Sealing

Homeowner air sealing: improving home air tightness by **15-20%**

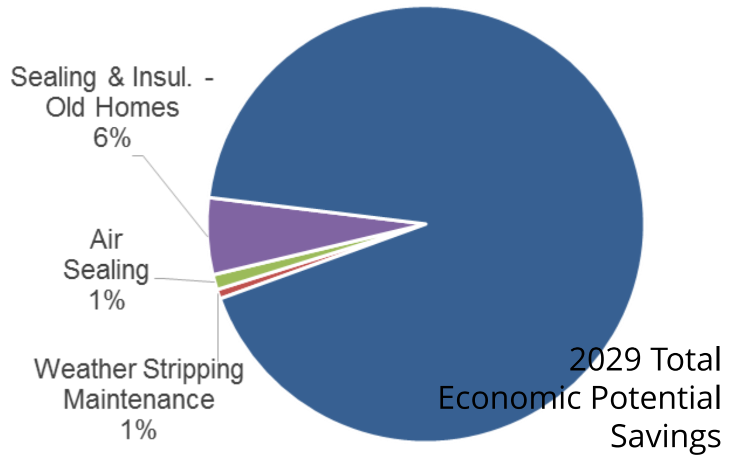
Professional air sealing: improving home air tightness by **30%**

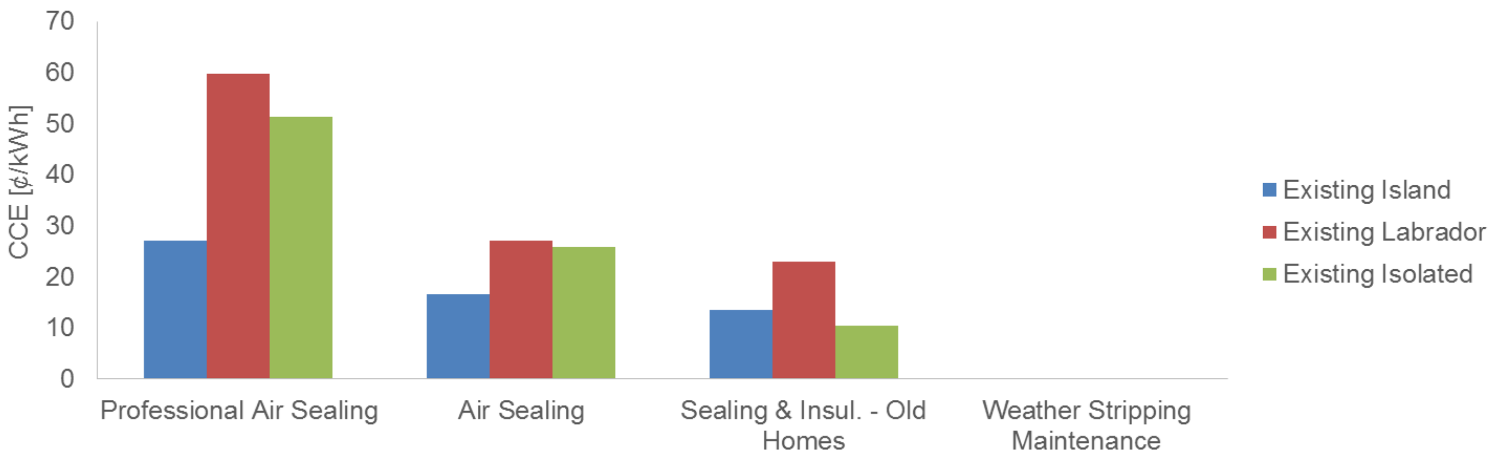
Residential Opportunity 6:

Air Sealing

Comparison Between Sealing Measures

	2029 Economic Potential Savings [GWh]	Passes Economic Test in Regions
Professional Air Sealing	0	None
Air Sealing	18.4	Island and Isolated only
Sealing & Insul. - Old Homes	92.8	Island and Isolated only
Weather Stripping Maintenance	11.5	All





Residential Opportunity 6:

Air Sealing

Assumptions

Focus Dwelling Type		Detached
Focus Region		Island Interconnected
Typical Application:		
Cost:		
Homeowner sealing	$	200
Professional sealing	$	1,800
Sealing & attic insulation	$	3,000
Useful life:		
Homeowner sealing		15 years
Professional sealing		length of study
Savings: Heating & Ventilation		
Homeowner sealing		2.3%
Professional sealing		4.7%

Residential Opportunity 6:

Air Sealing

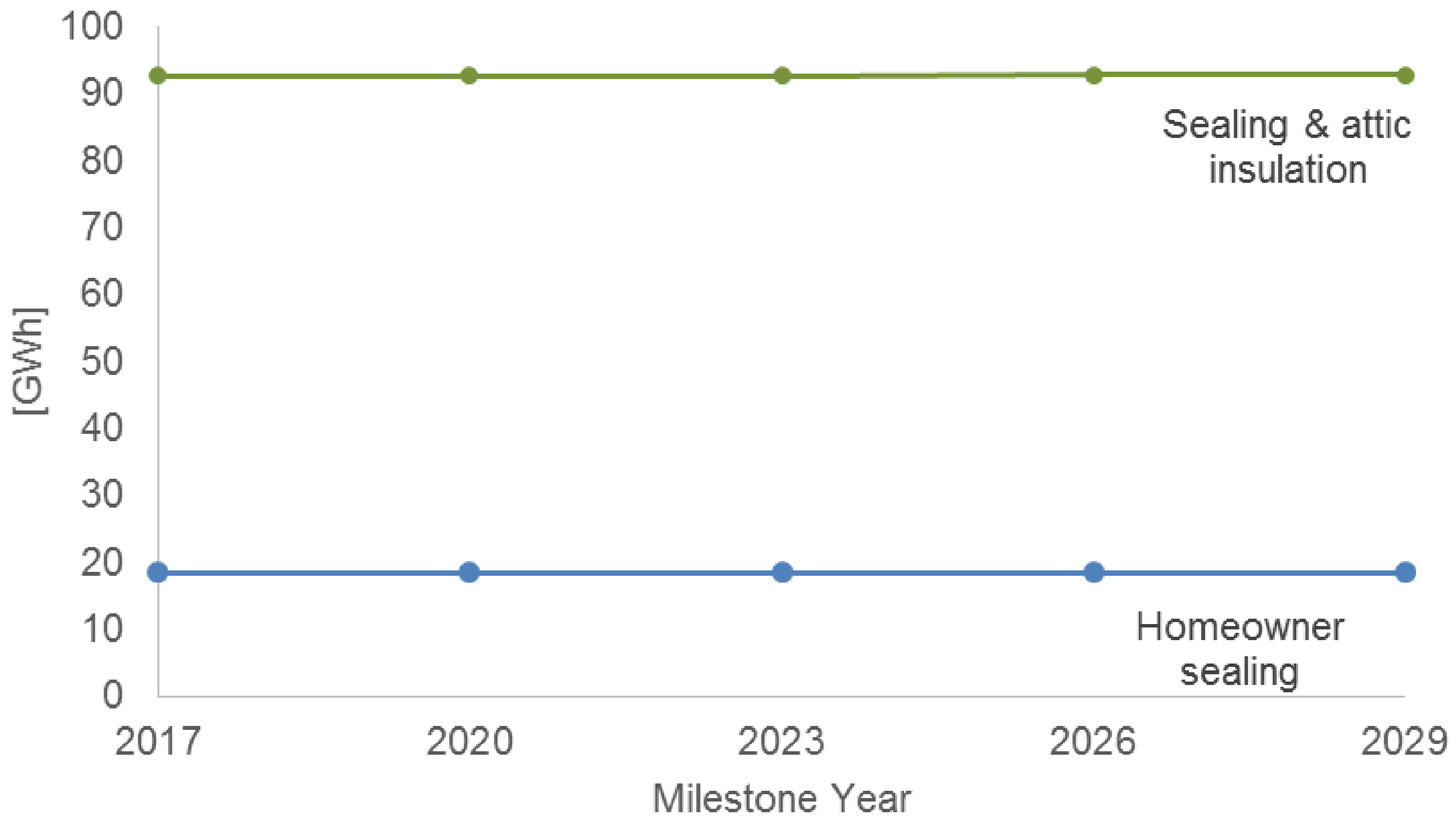
Homeowner Sealing Economic Indicators

Simple Payback (SFD - Island)	11 years
Average CCE (¢/kWh):	
Island	17
Labrador	27
Isolated	26
Basis	Full cost
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	113,855
Principal region	Island Interconnected

Residential Opportunity 6:

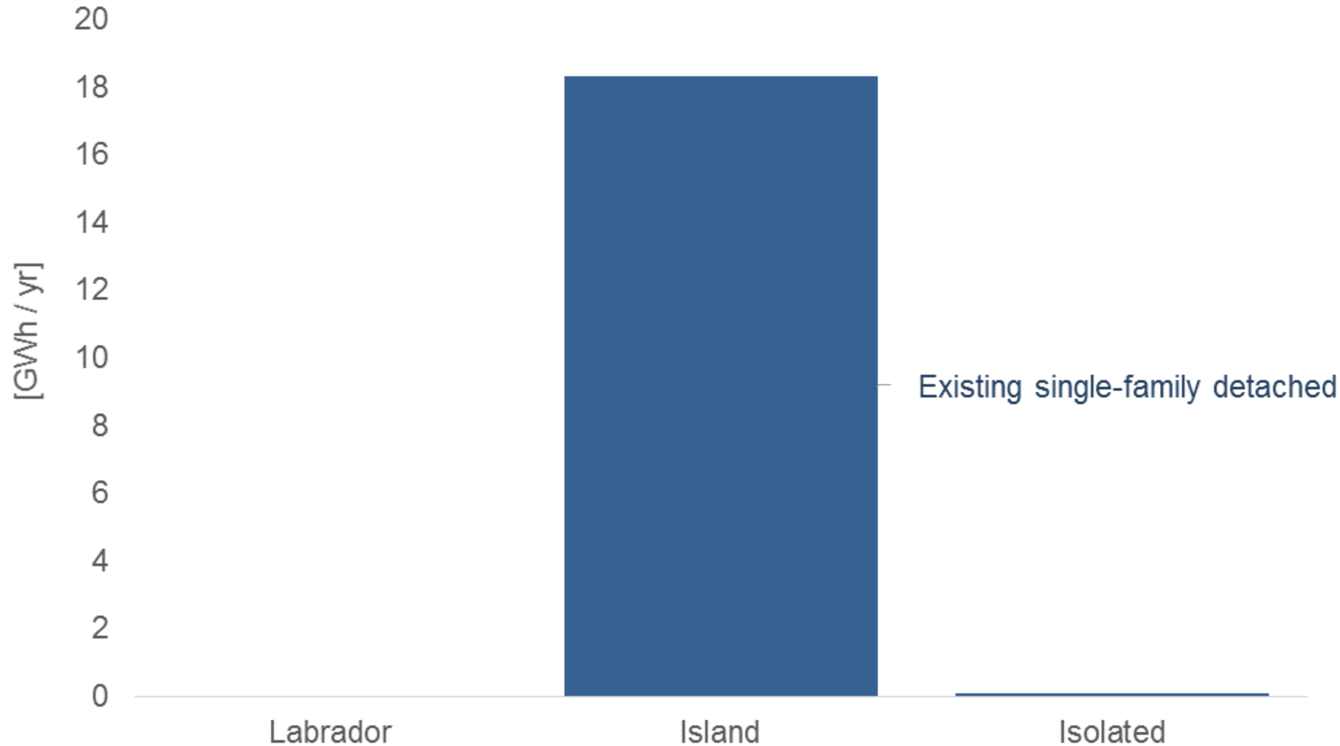
Air Sealing

Growth of Economic Potential Savings



Residential Opportunity 6:
Air Sealing

Homeowner Sealing: 2029 Economic Potential Savings Breakdown



Residential Opportunity 7:

Low-Flow Water Fixtures

Installing a low-flow washroom **faucet** with a 1.5 GPM (5.7 LPM) flow rate.

Installing a 1.5 GPM (5.7 LPM) **aerator** on a kitchen faucet.

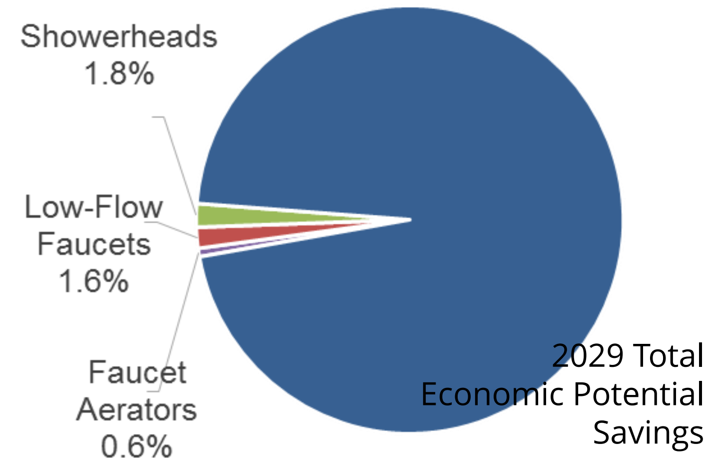
Installing an ultra low-flow **showerhead** with a 1.25 GPM (4.75 LPM) flow rate.

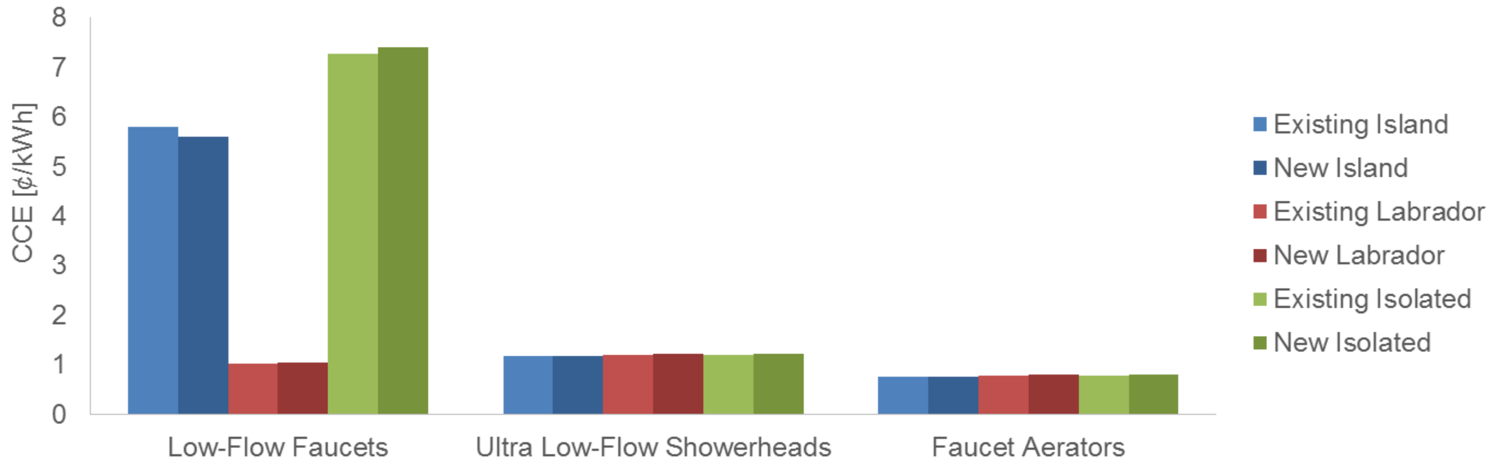
Residential Opportunity 7:

Low-Flow Water Fixtures

Comparison Between Low-Flow Measures

	2029 Economic Potential Savings [GWh]	Passes Economic Test in Regions
Low-Flow Faucets	25.9	All
Ultra Low-Flow Showerheads	29.0	Incremental in Labrador
Faucet Aerators	10.3	All





Residential Opportunity 7:

Low-Flow Water Fixtures

Assumptions

Focus Dwelling Type		All
Focus Region		All
Typical Application:		
Cost		
Showerheads	$	29
Faucets	$	45
Aerators	$	7.50
Basis		Full/Incremental
Useful life		20 years
Savings: DHW		
Showerheads		10%
Faucets		6%
Aerators		6%

Residential Opportunity 7:

Low-Flow Water Fixtures

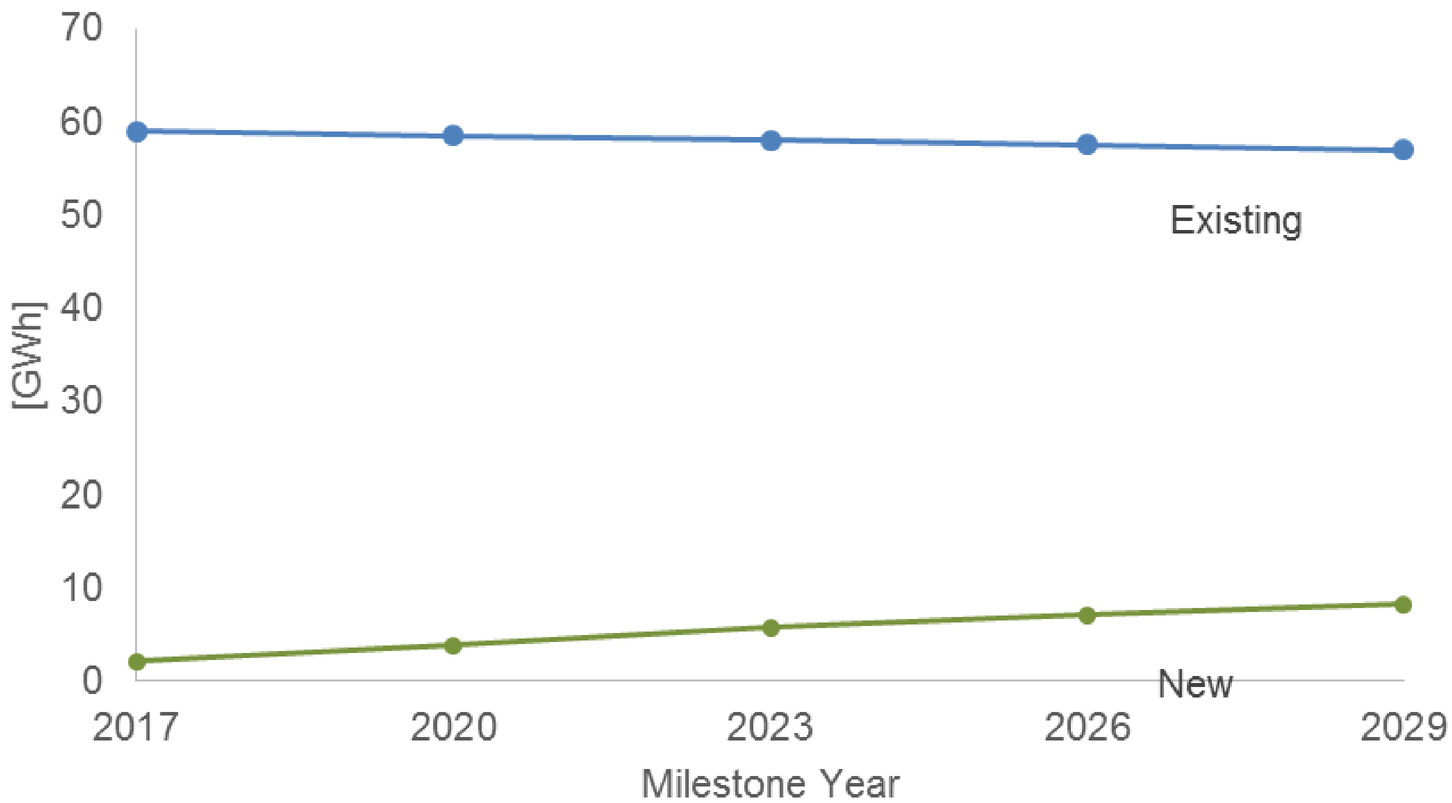
Economic Indicators

Simple Payback:	
Showerheads	1.3 years
Faucets	5.3 years
Aerators	7 months
Average CCE (¢/kWh):	
Showerheads	1.20
Faucets	4.69
Aerators	0.78
Basis	Full/Incremental
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	138,100
Principal region	Island and Isolated

Residential Opportunity 7:

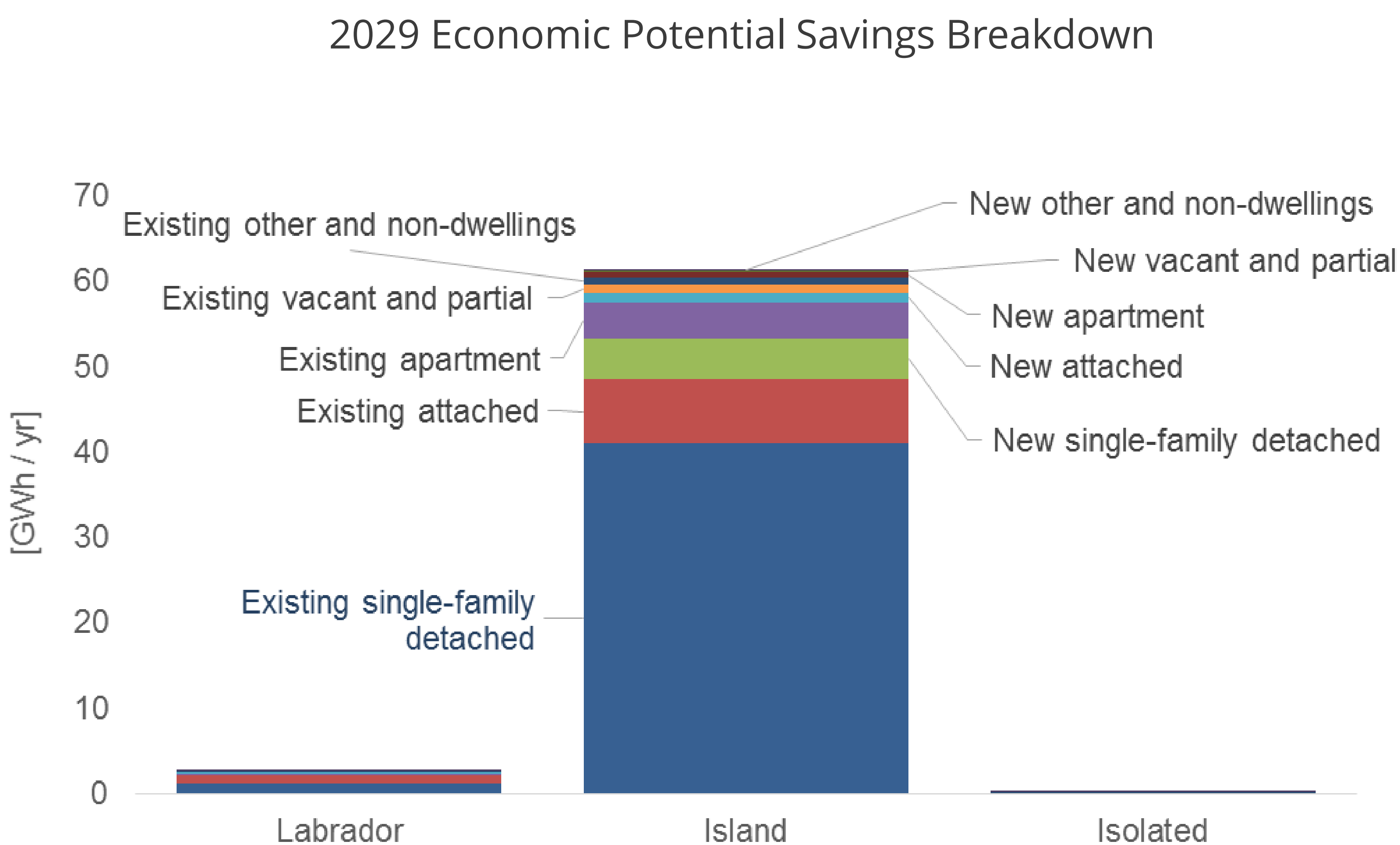
Low-Flow Water Fixtures

Growth of Economic Potential Savings



Residential Opportunity 7:

Low-Flow Water Fixtures



Residential Opportunity 8:

Behavioral Measures

Top three behavioral measures:

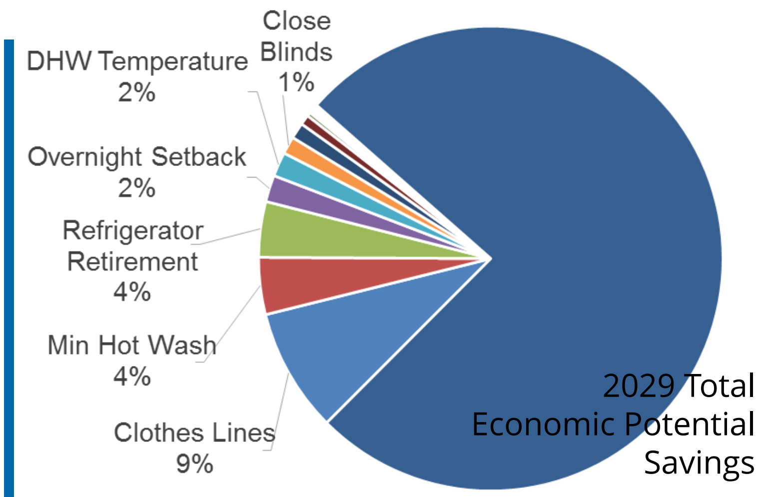
1. Clotheslines
2. Minimize hot and warm clothes wash
3. Second refrigerator retirement

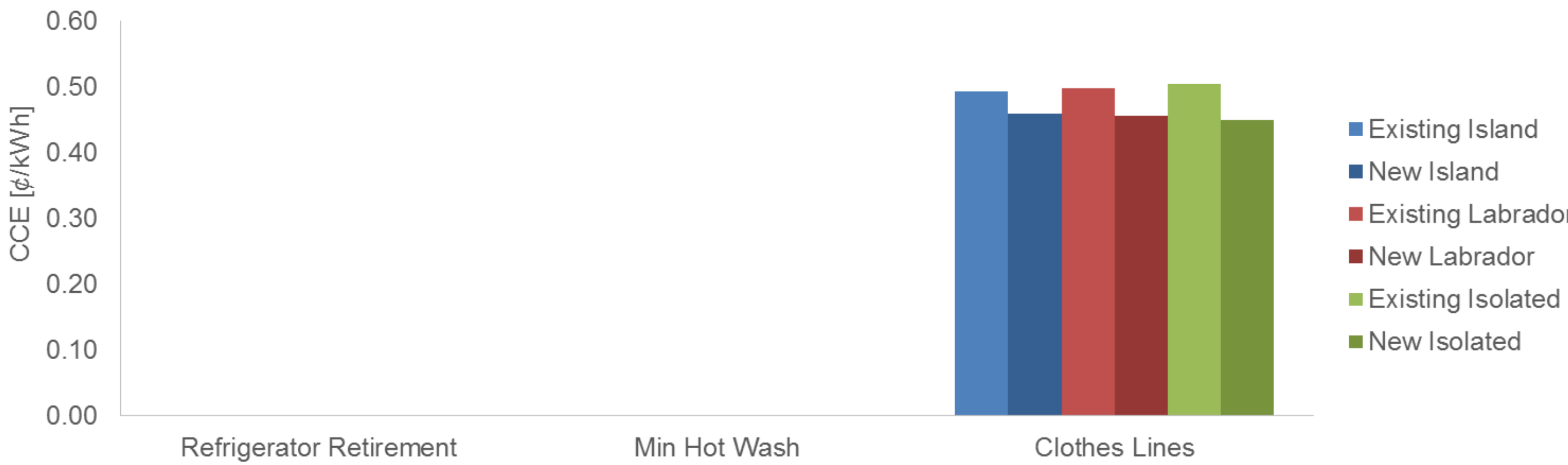
Residential Opportunity 8:

Behavioral Measures

Comparison Between Behavioral Measures

	2029 Economic Potential Savings [GWh]
Refrigerator Retirement	63.3
Min Hot Wash	64.9
Clothes Lines	140.9





Residential Opportunity 8:

Behavioral Measures

Assumptions (Combined)

Cost	(near) free
Useful life	1 year
Savings:	
Clothes dryer	61%
Refrigerator	30%
Domestic Hot Water (DHW)	16%
Other electronics	4.9%
Space heating	3.4%
Freezer	1.4%
Ventilation	1.3%
Television	1.3%
Lighting	0.1%

* Percentages of the pre-measure end use consumption.

Residential Opportunity 8:

Behavioral Measures

Eligible Participants

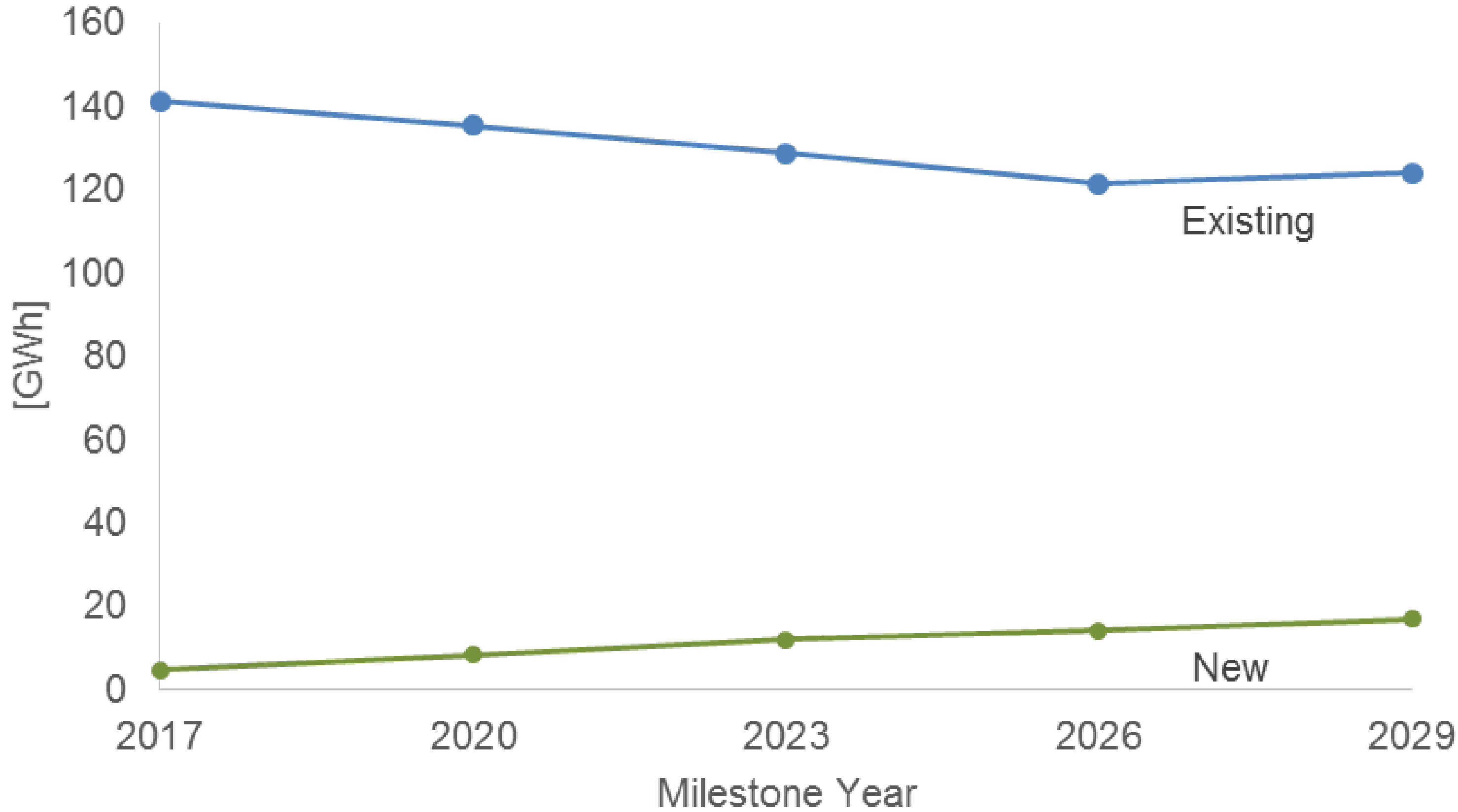
Eligible Dwellings by 2029:	
Clothes Lines	108,145
Minimum Hot Wash	86,874
Refrigerator Retirement	158,325

All types of dwellings, all regions.

Residential Opportunity 8:

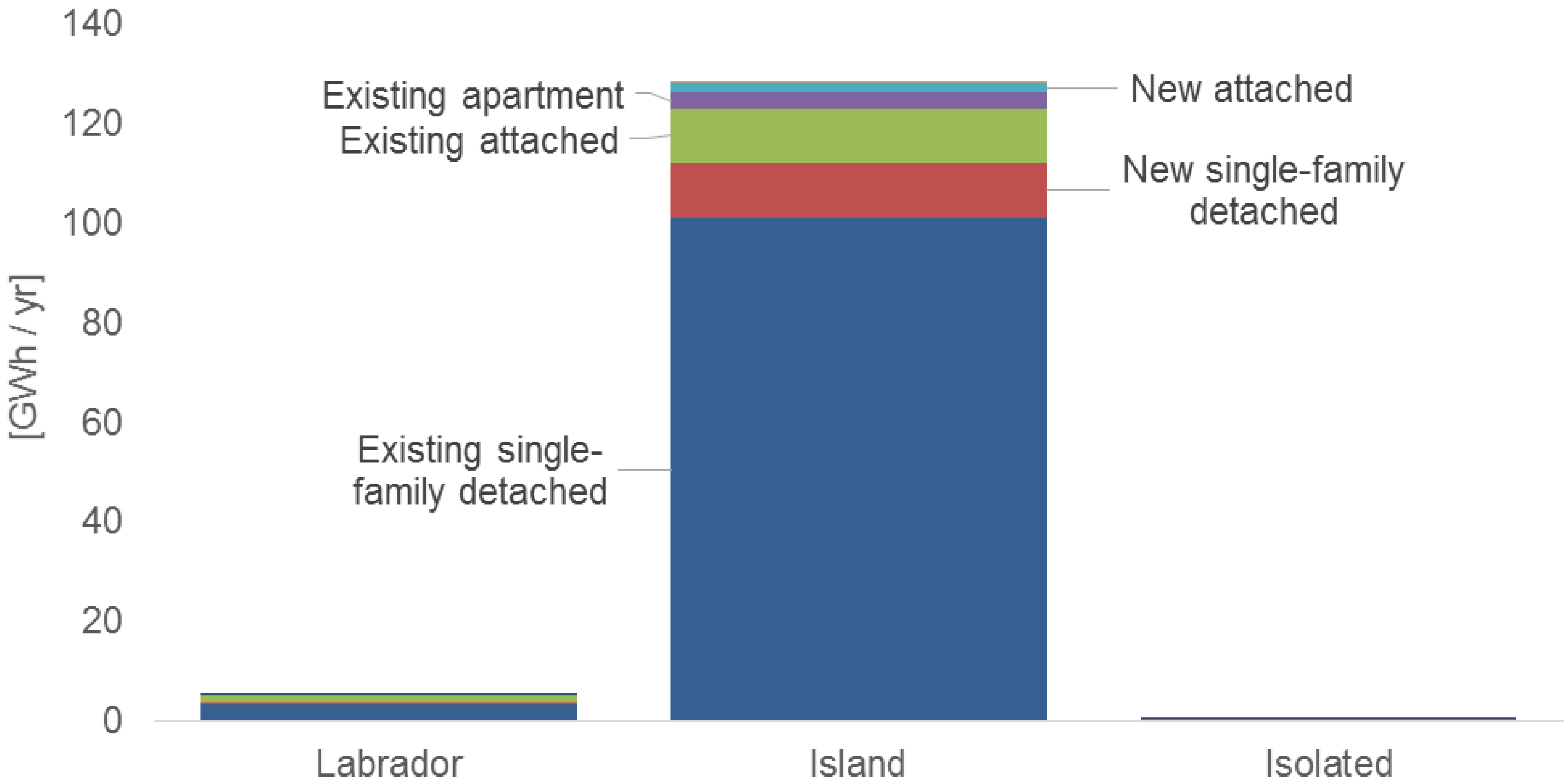
Behavioral Measures: Clotheslines

Growth of Economic Potential Savings



Residential Opportunity 8: Behavioral Measures: Clotheslines

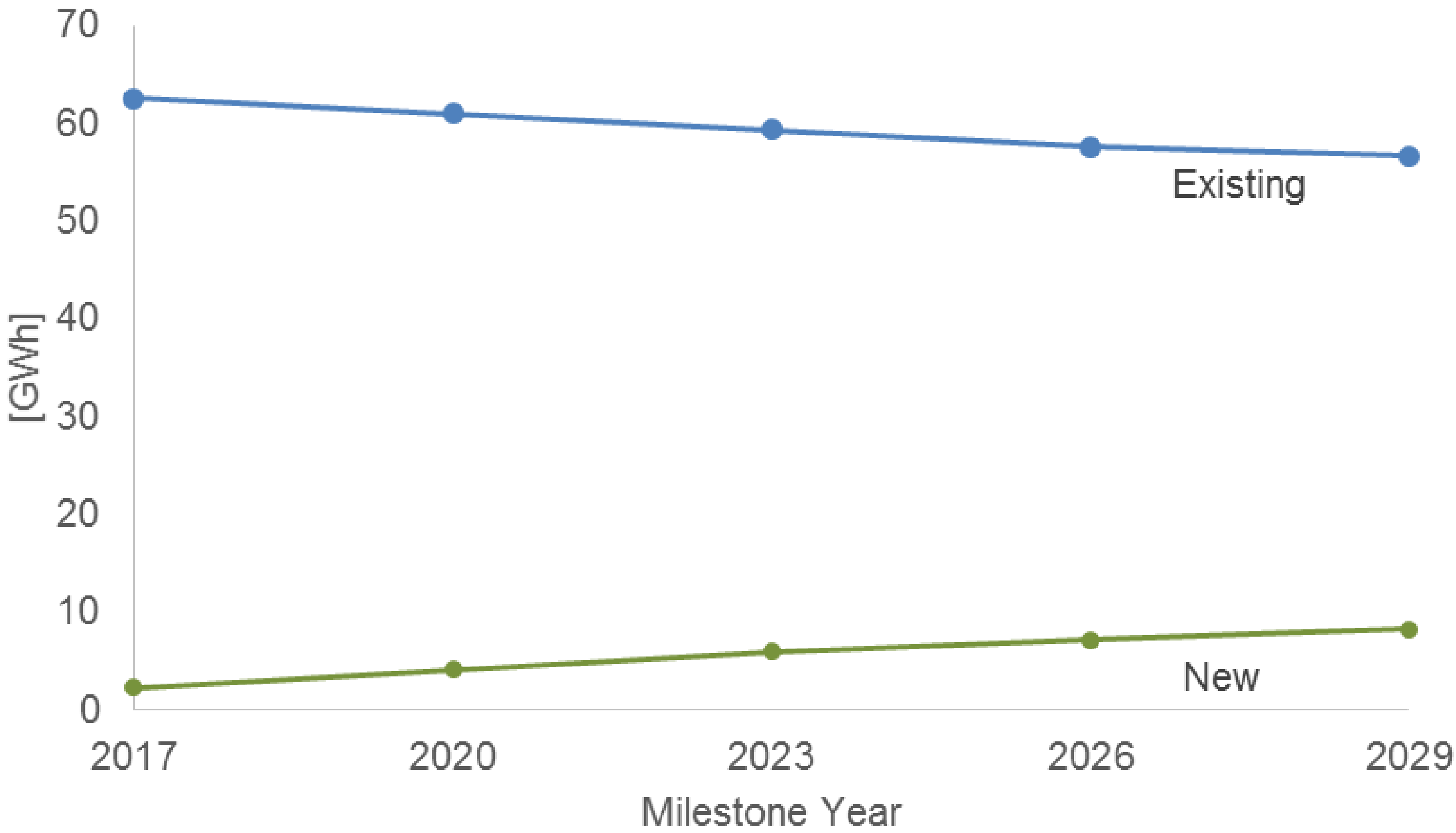
2029 Economic Potential Savings Breakdown



Residential Opportunity 8:

Behavioral Measures: Minimize Hot Washes

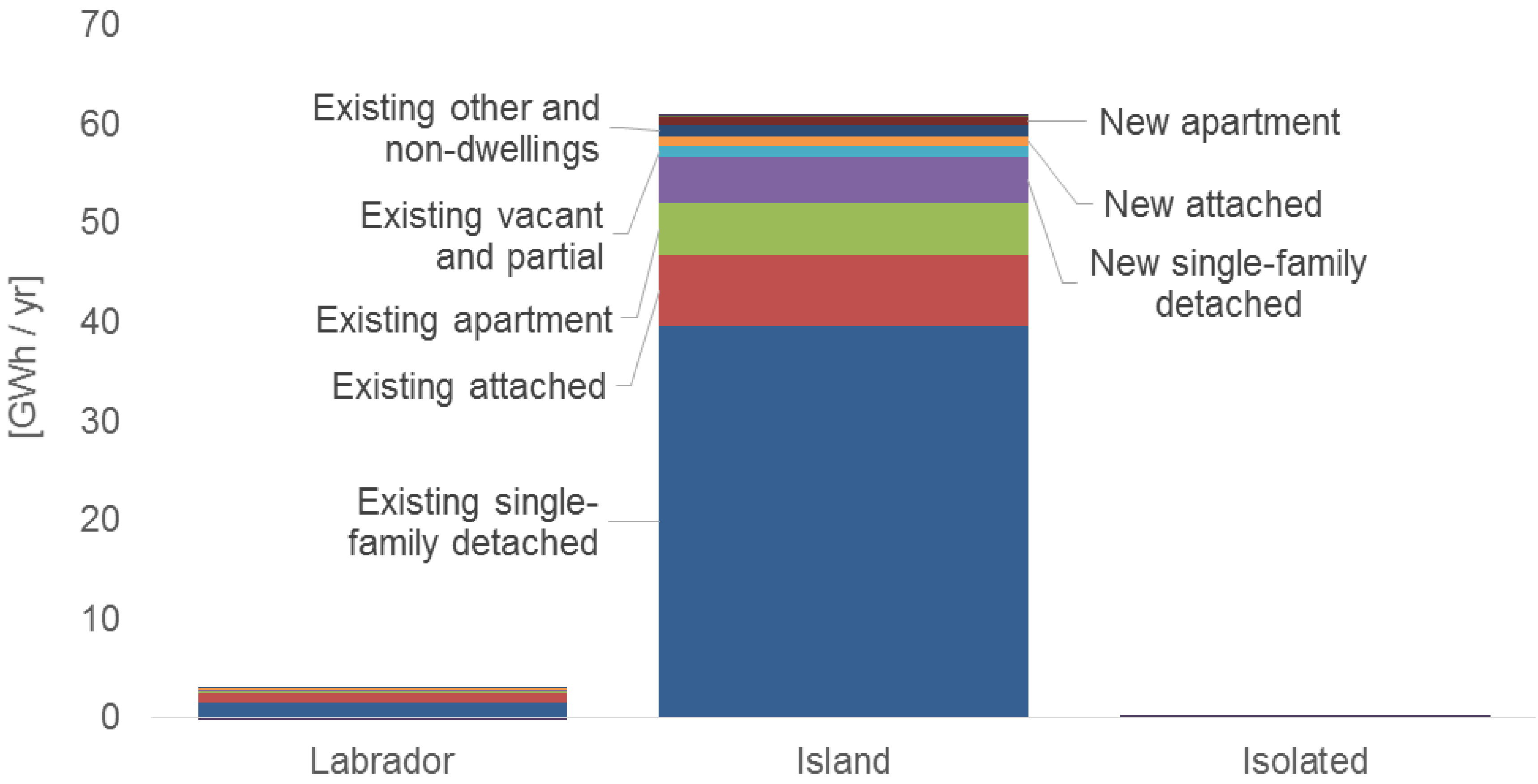
Growth of Economic Potential Savings



Residential Opportunity 8:

Behavioral Measures: Minimize Hot Washes

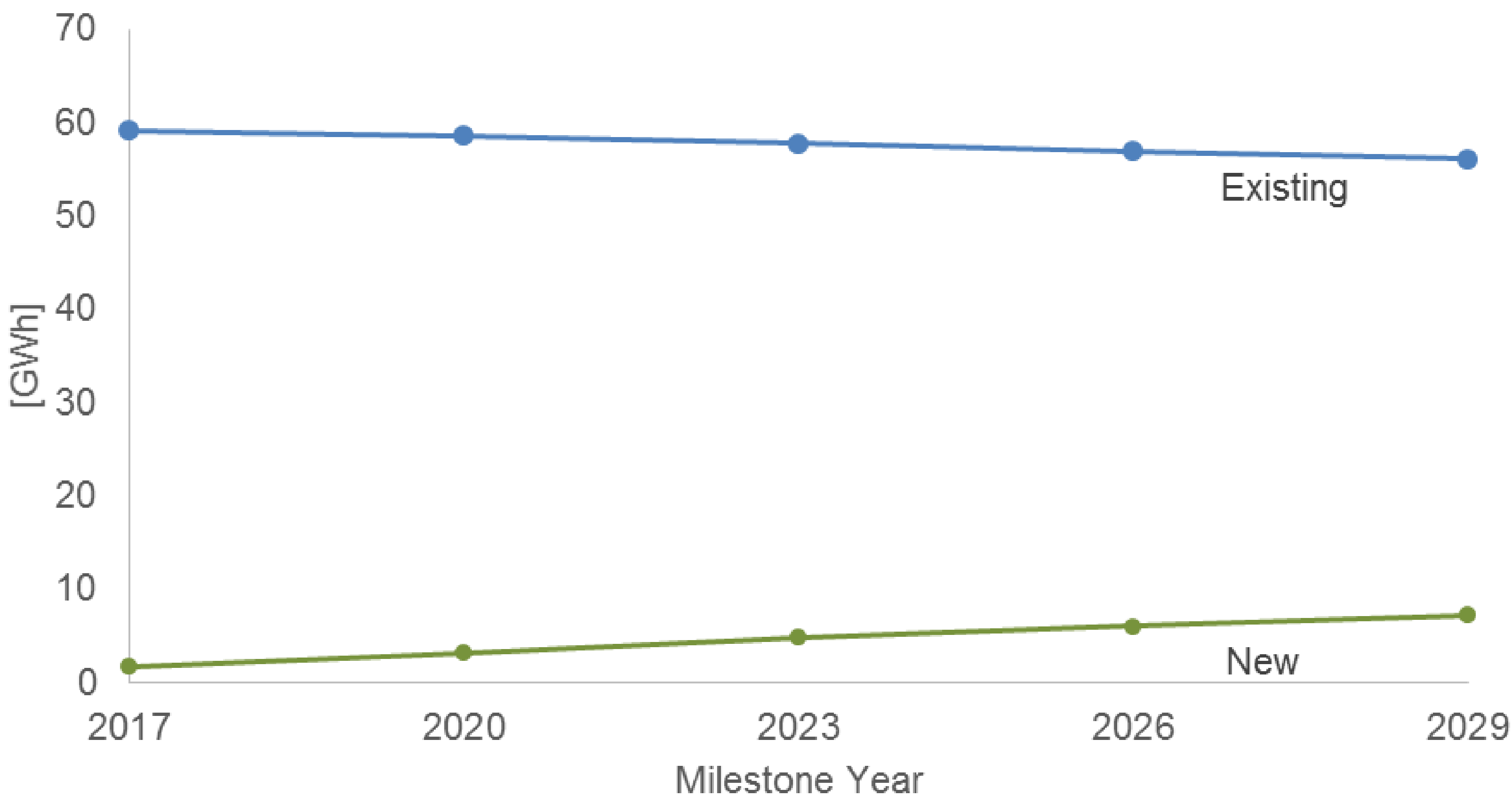
2029 Economic Potential Savings Breakdown



Residential Opportunity 8:

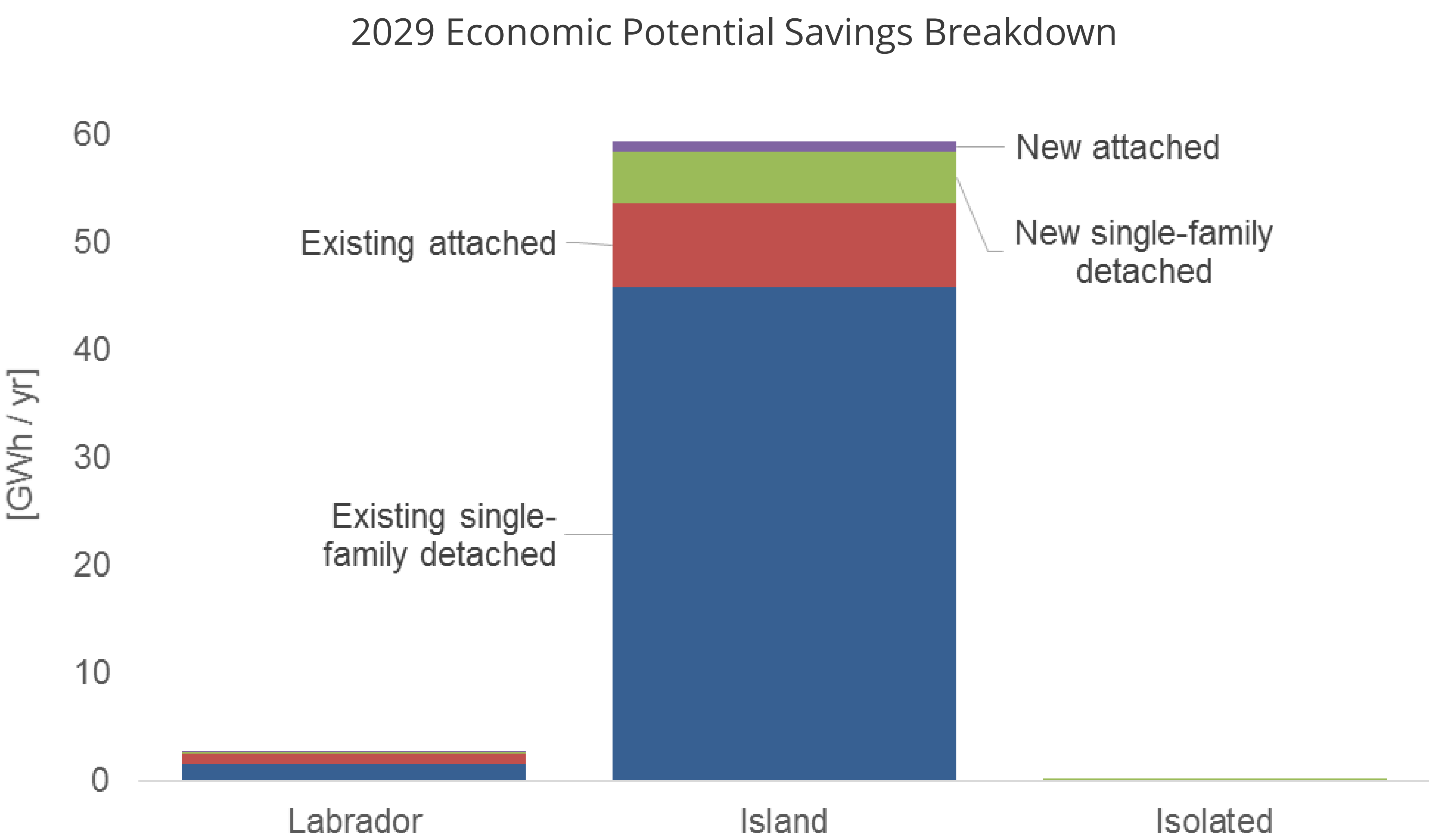
Behavioral Measures: Refrigerator Retirement

Growth of Economic Potential Savings



Residential Opportunity 8:

Behavioral Measures: Refrigerator Retirement



Residential Opportunity 9:

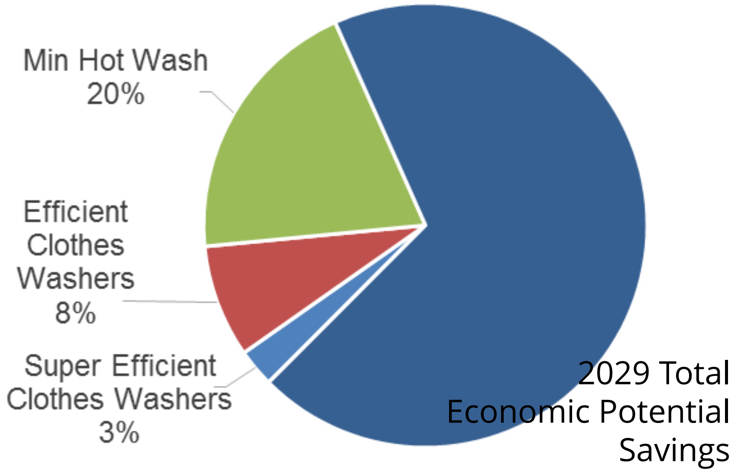
High-Efficiency Clothes Washers

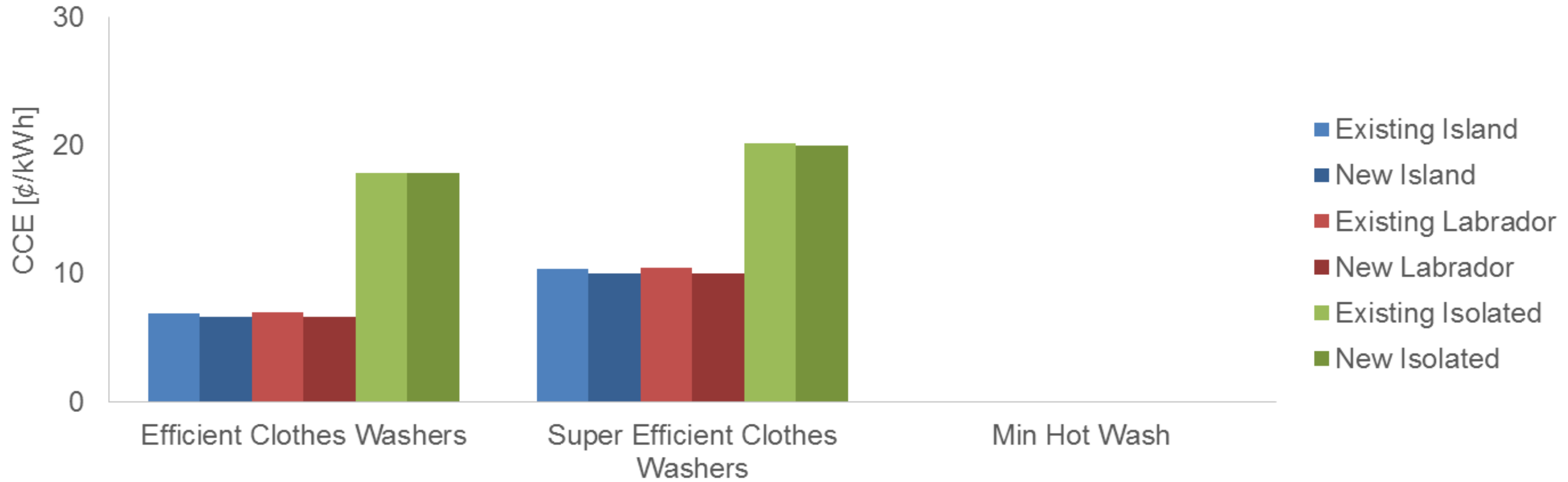
Installing a **CEE Tier III clothes washer**, which must meet targets for using less water and mechanical energy. Includes both top- and front-loading models.

Residential Opportunity 9:
High-Efficiency Clothes Washers

Comparison Between Clothes Washing Measures

	2029 Economic Potential Savings [GWh]	Passes Economic Test in Regions
Efficient Clothes Washers	134	Full in some Isolated
Super Efficient Clothes Washers	45	Full in some Isolated
Min Hot Wash	325	All





Residential Opportunity 9:

High-Efficiency Clothes Washers

Assumptions

Focus Dwelling Type		Detached
Focus Region		Island Interconnected
Typical Application:		
Cost	$	1,100
Basis		Incremental*
Useful life		12 years
Savings:		
Clothes Washers		48%
Clothes Dryers		48%
DHW		58%

* Full in some Isolated dwellings.

Residential Opportunity 9:

High-Efficiency Clothes Washers

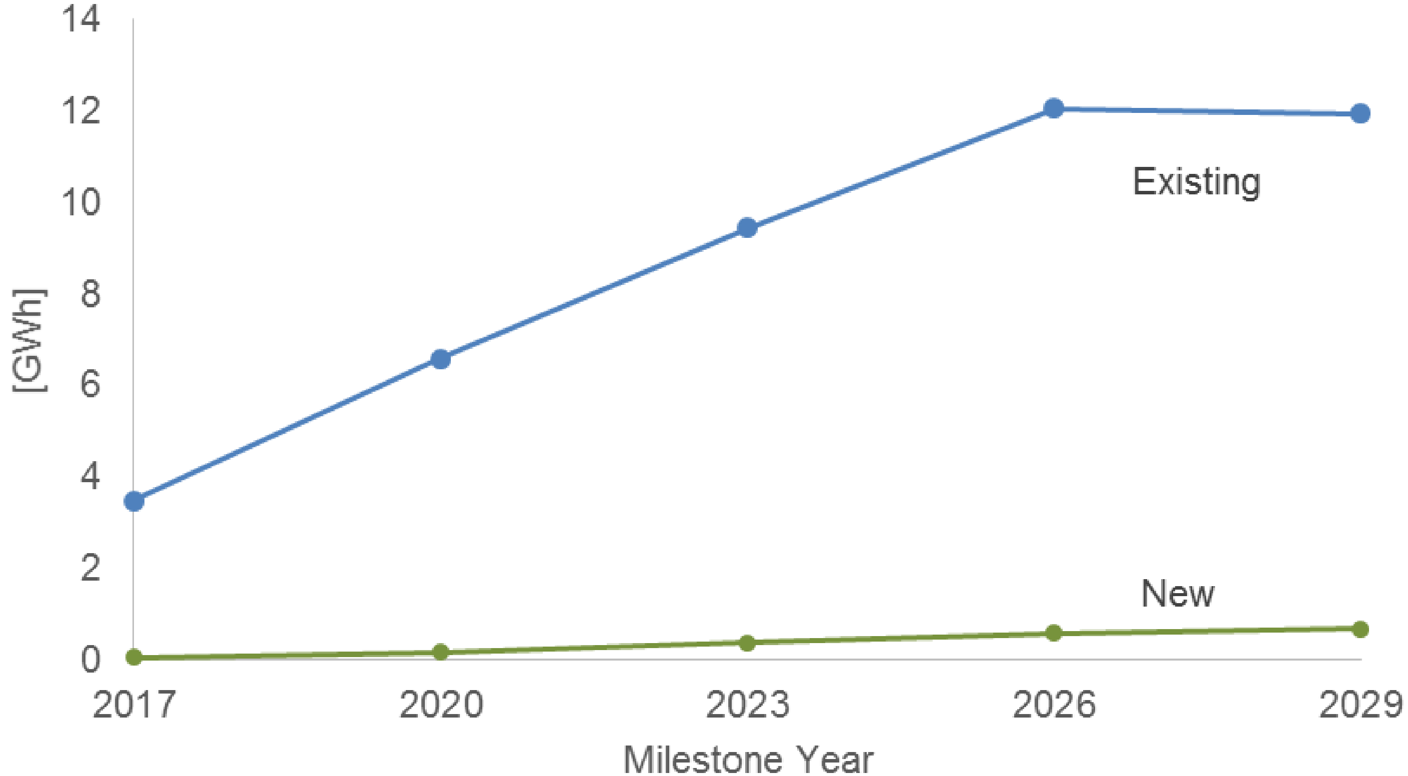
Economic Indicators

Simple Payback (SFD - Island)	6.6 years
Average CCE (¢/kWh):	
Island	12.0
Labrador	10.4
Isolated	21.7
Basis	Incremental*
Eligibility Timeline	Immediate
Eligible participants:	
Number of dwellings by 2029	175,542
Principal region	Island Interconnected
	* Full in some Isolated dwellings.

Residential Opportunity 9:

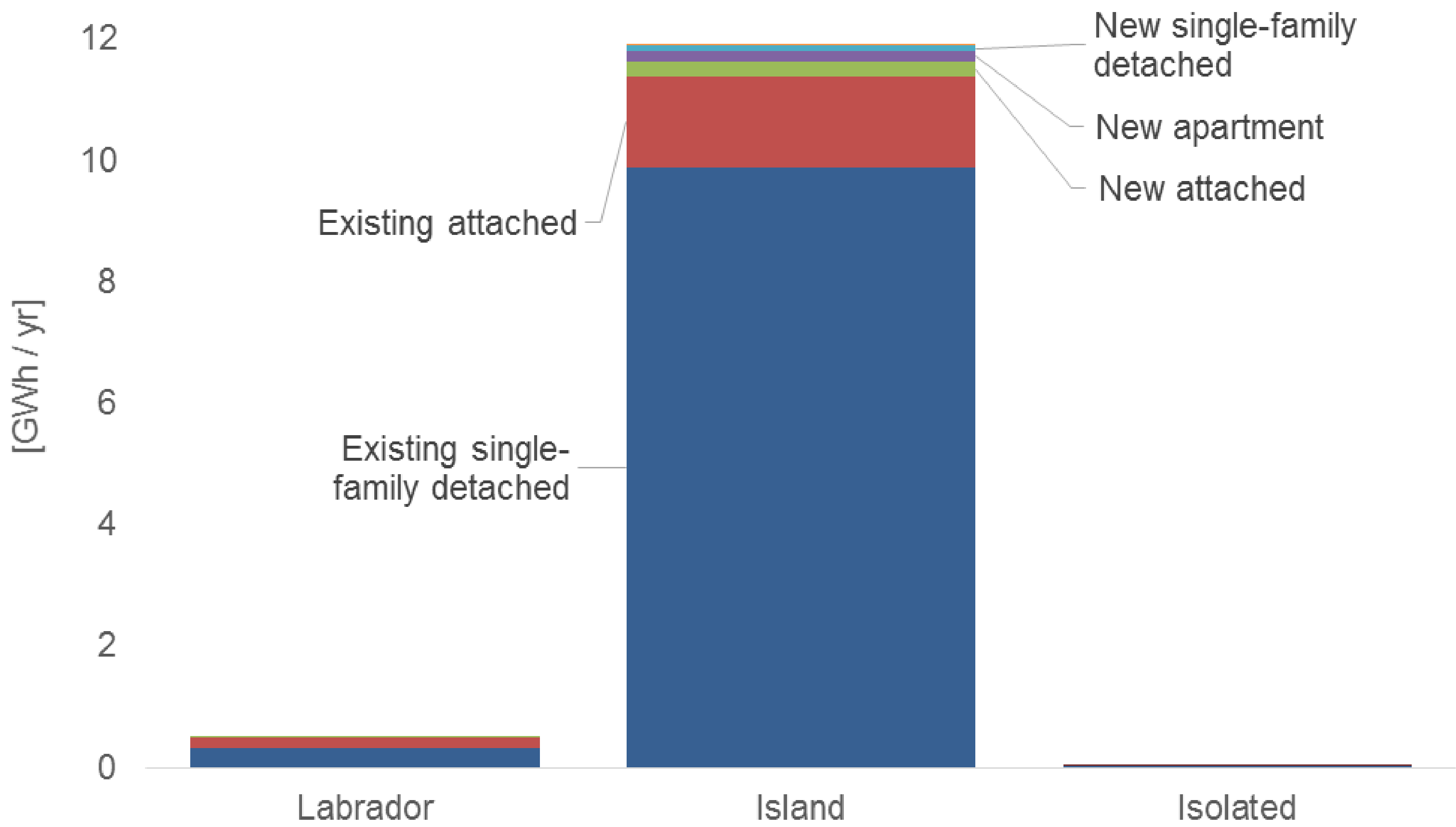
High-Efficiency Clothes Washers

Growth of Economic Potential Savings



Residential Opportunity 9:
High-Efficiency Clothes Washers

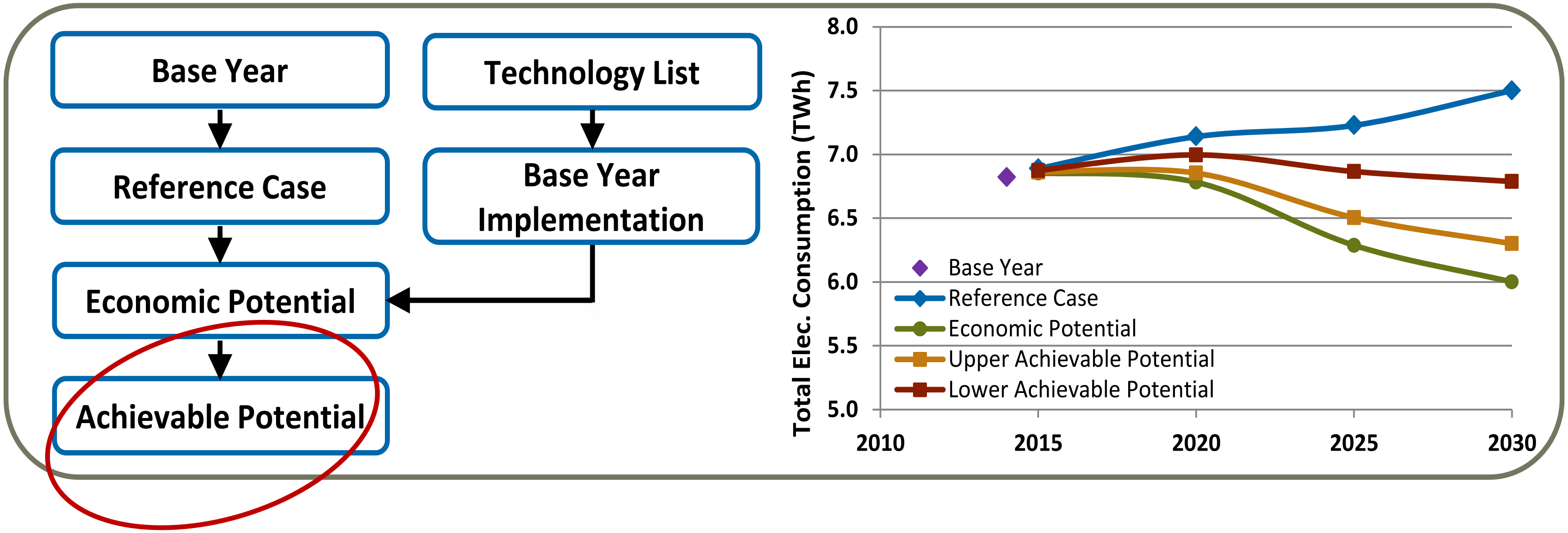
2029 Economic Potential Savings Breakdown



4

Wrap Up & Next Steps

Next Steps


Base Year
Technology List
Reference Case
Base Year Implementation
Economic Potential
Achievable Potential
Total Elec. Consumption (TWh)
8.0
7.5
7.0
6.5
6.0
5.5
5.0
2010
2015
2020
2025
2030
Base Year
Reference Case
Economic Potential
Upper Achievable Potential
Lower Achievable Potential

Appendix H Background-Section 9: Achievable Workshop Measure Worksheets

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R1: Basement Insulation

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (c/kWh)	5.9		
Simple Payback (years)	5.7		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	88,583	88,583	
Dwellings Affected (Per Year)	29,528	5,906	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		25%	Past results: 5-10%; curve A
Aggressive Marketing		35%	Past results: 25-50%; curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		22,146	
Aggressive Marketing		31,004	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments (up/down units)			lower; because the basement is all finished
Labrador			lower
Isolated			lower
Other Envelope Measures:			
Crawl Space Insulation			similar
Attic Insulation			higher
Wall Insulation			lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			high
Primary Incentive Target (User, Channel Member, Both)			
Sensitivity to Direct Program Support (High, Medium, Low)			high
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			

Notes:
- finished basements: cost much more than $2300
- cost is a barrier
- practicalities and logistics of the project
- in public housing, requires entering the units
- resources to deal with the project are a major barrier
- program paid $400-450 on a typical project
- a lot of do-it-yourselfers in NL: leads to deferring the project
- more access to contractors in Avalon; fewer contractors elsewhere, so people do their own work
- seniors would have difficulty accessing contractors; population outside the Avalon is aging
- technique of doing the work is a barrier: making sure the job is done correctly
- people don't really know what the savings would be: they think because no one is in the basement it doesn't matter whether it is insulated down there
- education is a huge part of the picture
- risks: trigger other upgrades; if some other components don't meet code, water damage, etc., then you get into a lot of other work
- doing the job wrong and damaging the house; this risk is larger outside the Avalon
- city inspector can protect you: a permit will protect the homeowner
- if people don't have a ventilation system, this measure might make moisture problems worse
- having an energy audit done on the house before any kind of upgrade can explain where the best potential is: people would do more insulation and air sealing
- out of Avalon, many people use wood for much of their heating
- people on fixed income often can't live in much of their house, because they can't afford to heat it
- seniors are very reluctant to deal with the disruption of the project; also hard to find someone to help them through it, particularly outside the Avalon
- testimonials have very big impact
- efficiency upgrades are the best bang for your dollar: what kind of RRSP can give you 18% on your money??
- not a lot of home energy performance contractors: there have been such contractors in other regions
- opportunity to do this measure when houses change hands, when the basement is empty
- key players: home inspectors (when the home changes hands)
- split incentive between landlord and renters: especially if the renters pay the electric bill
- strategies: energy audits paid for by utility, simplify the execution of the project for the consumer (could utilities have contractors that do the work?), awareness is the first step, then education, then cost, then execution
- RenoMark: nationally recognized certification for renovation companies, provided by CHBA (renomark.ca)
- a preferred contractor route is a huge undertaking
- everything should be translated back to a monthly payment; make the cost flow positive from day one
- 40% of basements are finished; 34% are partly finished
- 45% of houses were built before 1980
- 35% is probably the upper achievable

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R2: Ductless Mini-Split Systems

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (¢/kWh)	7.8		
Simple Payback (years)	6.4		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	89,981	101,761	
Dwellings Affected (Per Year)	29,994	6,784	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		30%	Past results: 17%; Curve B
Aggressive Marketing		60%	Past results: 50%; Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		30,528	
Aggressive Marketing		61,057	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments			lower
New Homes			higher
Labrador			lower
Isolated			lower
Other Heat Pump Measures:			
Air-source Heat Pumps			lower
Cold Climate Heat Pumps			lower
Air-to-Water Heat Pumps			lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			low: more about financing
Primary Incentive Target (User, Channel Member, Both)			
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			financing, access, education

Notes:
- within 15 years, mini-splits are going to be much more important in the reference case
- cost of $3500 might be too low: people are installing multi-units to provide heating in the bedrooms, too. More like $6-8000. Most are therefore higher cost
- knowledge is a barrier
- price is a barrier
- availability of qualified installers
- financing
- range in quality: education of people to buy a unit that performs well at low ambient temperatures below -5C
- not getting proper heat loss calculations on the house, because the electrician is doing the estimate
- unit doesn't suit the house: designed for US
- customer with a wood stove found electric bills went out, because the unit was in defrost mode all the time
- aesthetics are a barrier
- strategies for program design: need to offer financing
- that's why NS is getting lots of uptake. No rebates there, but there is financing
- servicing
- HRAI certification
- Should require licensed installation, just like with an HRV
- Worse situation outside the Avalon, particularly in the Northern Peninsula and Labrador
- 80% in St. John's; less outside the Avalon
- sell it based on comfort (including AC benefit)
- need to make sure they are done properly, to avoid negative publicity

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R3: High Performance New Homes

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (¢/kWh)	17.7		
Simple Payback (years)	17.2		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	4,454	18,138	
Dwellings Affected (Cumulative)	2,974	12,111	
Dwellings Affected (Per Year)	991	807	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		65%	Adoption curve A
Aggressive Marketing		80%	Adoption curve A
BAU Marketing		7,872	
Aggressive Marketing		9,689	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			same
Labrador			lower
Isolated			lower
Other New Construction Measures:			
Net Zero Homes			lower
LEED Apartments			lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			incentives would be valuable
Primary Incentive Target (User, Channel Member, Both)			
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			non-energy benefits; labelling; codes and standards

Notes:
- to bring the performance of the houses from 77 to 80
- seems like the base case is too low, assuming people build to code
- on average outside the city, houses are not built to code
- can we push them beyond 80
- NS EnergySTAR is an 83; can't get to 83 in NL without a heat pump
- to get 80, you need rigid insulation on the outside, you need good insulation in the basement and attic, you need an HRV. As soon as we get a heat pump in the mix, you get beyond 80
- cost is the major barrier
- knowledge for consumers to want it
- perceived resale value: prospective buyers can't see these improvements
- hard to find builders willing to "push the envelope" because they haven't done it before
- potential partners: builders, certification on R2000 and EnerGuide through the assocation; consumers purchasing higher-end homes are more knowledgeable about these programs and are demanding them
- utilities could partner with the industry associations and jointly promote it
- consumer sees very long payback: sell it based on comfort; how do you monetize the value of it on resale, if they aren't going to stay in the house for 20 years
- payback of 17 years is not right, City of St. John's says more like 6 years
- work with government on labeling; could be either level of government
- subsidize certification and include it in the program

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R4: Heat Cycling

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CEPR ($/kW)	26.5		
Simple Payback (years)	n/a		Typically utility would pay for cycling equipment
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	100,055	112,411	
Dwellings Affected (Per Year)	33,352	7,494	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		0%	Participation rates for AC and DHW only
Aggressive Marketing		2%	Curve A
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		0	
Aggressive Marketing		2,248	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			same
Apartments			same
New Homes			same
Labrador			same
Isolated			same
Other Cycling Measures:			
Dual Fuel Cycling			much higher
Heat Pump Cycling			same
DHW Cycling			much higher
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			massive
Primary Incentive Target (User, Channel Member, Both)			user
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			couple with t-stat

Notes:
- comfort is the big barrier
- loss of control
- the utility would have to pay
- might only work in dual fuel situation
- politically difficult
- based on kW avoided cost, the utility can only afford maybe $10/hr per baseboard
- rebound from installing portable heaters

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R5: Electric Thermal Storage

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CEPR ($/kW)	185.2		
Simple Payback (years)	n/a		Depends on how rates are structured
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	12,977	76,050	
Dwellings Affected (Per Year)	4,326	5,070	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		0%	Very dependent on rate structure
Aggressive Marketing		1%	Would need time of use rates
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		0	
Aggressive Marketing		761	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			same
Apartments			same
New Homes			same
Labrador			same
Isolated			same
Other Cycling Measures:			
Central Thermal Storage			lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			massive
Primary Incentive Target (User, Channel Member, Both)			
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			

Notes:
- aesthetic issue is becoming less of a problem
- cost is a huge barrier
- no benefit to the customer - utility would need to pay in some way
- or introduce time of use rates
- risk in high performance houses where there is a lag; they could come on in the summer when it is cold at night
- without benefit to the customer, it's not clear that the utility could get any participation without paying for the whole installation

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR
R6: Air Sealing

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (c/kWh)	12.4		
Simple Payback (years)	11.1		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	113,487	113,487	
Dwellings Affected (Per Year)	37,829	7,566	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		20%	Past results: 3-10%; curve A
Aggressive Marketing		65%	Past results: 17-50%; curve A
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		22,697	
Aggressive Marketing		73,767	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments			lower
Labrador			same
Isolated			lower
Other Sealing Related Measures:			
Professional Air Sealing			lower; incentive probably couldn't be high enough
Air Sealing/Attic Insul. In Old Homes			lower
Weatherstripping Maintenance			same
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			not really about incentives
Primary Incentive Target (User, Channel Member, Both)			user
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			more need for education, maybe a kit, designated pı

Notes:
- an energy audit would help pinpoint the leakage areas
- otherwise the homeowner would be doing the "usual suspect" areas
- a lot of education to help homeowners know what to do and how to do it
- phyiscal ability to do the project
- confidence to do it yourself
- videos on the internet
- risks: injury, doing it wrong and getting no benefit (or making it worse)
- risk of making the house too tight if it doesn't have an HRV
- strategies: prepackage a kit and provide a video with it to tell people how to install them, and include a $20 rebate on top of it
- live demonstration with a blower door test would help give people a good idea of what to do
- energy audit might help to get a bundle of measures to pass
- could make a rebate on your mini-split contingent on getting an audit done, with a bundle of measures that go with that
- cost is not the main barrier
- awareness is a much bigger barrier
- the upper assumption is very contingent on the assumption of bundling

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR
R7: Low-Flow Water Fixtures

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (c/kWh)	1.1		(faucets = 6.4, aerators = 0.6)
Simple Payback (years)	1.0		(faucets = 6.1, aerators = 0.4)
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	76,734	84,179	
Dwellings Affected (Per Year)	25,578	5,612	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		5%	Past results: 70-80%; curve A
Aggressive Marketing		20%	Past results: 88-98%; curve A
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		4,209	
Aggressive Marketing		16,836	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments			lower
New homes			Higher: will be code within a few code cycles
Labrador			same
Isolated			lower
Other Sealing Related Measures:			
Faucets (washroom)			lower
Faucet Aerators (kitchen)			higher
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			not very
Primary Incentive Target (User, Channel Member, Both)			retailer
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			handing it out as a kit; or work with channel incentiv

Notes:
- not going to capture the people who want the rainwater showerheads and want to take out the flow restrictor
- standards are more restricted than they used to be. Not a lot of movement in the last five years
- not too many 1.25 showerheads available in the province at the moment
- some big box retailers are selling non-certified products
- Waterwise certification is 2.5 gpm and people are fooled
- no incentives not to use water in NL. Water usage is not metered.
- Gerald can't get the conditioner out of his hair when it's low flow
- lower flow causes the municipal pipes not to flow as well, but this is a bigger problem for the toilet
- perception from years ago that low-flow showerheads gave a poor shower; even though products have improved, that perception isn't completely gone
- most people don't switch until the showerhead breaks
- most faucets already have aerators
- people think "we don't pay for water" but people DO pay for hot water
- could you include these items in a kit (then does it end up in a drawer?)
- second program involved a direct install of the products in the kit
- gives you some control over the quality of the products
- if you have teenagers, a low-flow showerhead allows the last person up in the morning to still have a hot shower

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R8: Behaviour Measures

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (¢/kWh)	0.0		no capital cost
Simple Payback (years)	n/a		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	170,114	185,416	
Dwellings Affected (Cumulative)	79,471	86,619	(clothes line measure)
Dwellings Affected (Per Year)	26,490	5,775	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		0%	Nearly 30% already do this in NL.
Aggressive Marketing		10%	curve A
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		0	
Aggressive Marketing		8,662	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments			lower
New Homes			same
Labrador			same
Isolated			higher
Other Sealing Related Measures:			
Retire Second (old) Fridge		30-60%	Yukon retired over 500 in one year (17k customers)
Minimize Hot Water Wash	between clothes line and fri		43% maximum found in other studies
Others?			
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			
Primary Incentive Target (User, Channel Member, Both)			
Sensitivity to Direct Program Support (High, Medium, Low)			
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			

Notes:
- some subdivisions don't allow them
- covenants
- utilities don't want people attaching the other end of the clothesline to the utility pole
- umbrella style clothes lines are more space efficient
- indoor clothes lines use electric heat to dry the clothes, and you can get mold issues
- this is already a well-established cultural practice; not clear how many more people you'd get
- a lot of days in NL when the weather is not good for drying clothes
- no dryer sheet can replicate the smell of clothes hung on the line

- no incentive for clothes lines or minimizing hot water wash
- barriers to minimizing hot water wash? education; people are concerned about germs or dust mites
- people use hot water for bedsheets, but not so much for clothes
- NL water is very cold, so some hot water is always added even for the cold water wash.
- bundle the cold water wash with other water measures

- retirement of second fridge: NO!
- this program usually offers a way of getting a fridge out of your house and properly disposing of it
- very effective program in Yukon, BC, and Ontario
- utilities would like to work with the retailers, to get the retailers to talk about the program to haul away the old fridges
- there are some local service districts that have expertise to remove the refrigerant; Eastern Waste Management, for example
- take the fridge and give them a showerhead and a clothes line
- probably need an incentive for the fridge, but the main benefit is the help removing it
- appliance dealers might be able to participate in the program by doing the pickup
- can the "recycle culture" among the youth promote this in the next generation

NL ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R9: High Efficiency Clothes Washers

	NL		COMMENTS
	Island Interconnected		
	2017	2029	
MEASURE INFORMATION			
CCE (¢/kWh)	9.3		Energy Star is 6.2 ¢/kWh
Simple Payback (years)	6.6		Energy Star is 4.4 years
ECONOMIC POTENTIAL (number of washers)			
Total Number of Dwellings	170,114	185,416	
Washers Affected (Cumulative)	124,696	174,832	
Washers Affected (Per Year)	41,565	11,655	
PARTICIPATION RATES (%)			
BAU (Business As Usual)		10%	Past results: 50-65%; curve A
Aggressive Marketing		20%	Past results: 70-98%; curve A
ACHIEVABLE POTENTIAL (number of washers)			
BAU Marketing		17,483	
Aggressive Marketing		34,966	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			lower
Apartments			lower
New Homes			higher
Labrador			lower
Isolated			lower
Other Appliance Technologies:			
ENERGY STAR Refrigerators			lower
ENERGY STAR Freezers			slightly lower
ENERGY STAR Dishwashers			higher
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			high sensitivity to incentives
Primary Incentive Target (User, Channel Member, Both)			both
Sensitivity to Direct Program Support (High, Medium, Low)			medium to high
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			working with retailers

Notes:
- CEE Tier III is unfamiliar
- Retailers need to educate the customer about which models qualify
- cost is an issue
- utility have not referenced Energy Star or CEE; instead they offer a rebate on "qualifying models"
- there is a lot of product availability in the market - that may mean the rebate is too large - retailer in the room didn't think it was too large
- some retailers have really run with the program; others have been much more reluctant
- engaged retailers very much needed
- rebate is currently for the customer, not the dealer
- good retailers see it as a way to increase sales; others don't see that
- about 20% of the core appliance line qualifies
- people are looking for features and price, but the rebate does help convince people to choose the more efficient model
- our incremental cost might be too large
- the energy efficient washers tend to be better models overall
- education about the cost of a wash
- participation in the current program is still building
- the washer is one of the best performing products in the program

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