Volume 2: Tab 3, Customer, Energy and Demand Forecast Report

Q. Volume 2, Tab 3, page 7 of 8.

a) Please report what percent of Newfoundland Power's customers have electric baseboard heating.

b) What percent of these customers does Newfoundland Power forecast converting into heat pumps by the end of 2026?

c) Please explain the impact of heat pump conversions from electric baseboard heating on energy sales forecast and peak demand.

A. a) As of December 31, 2023, 74% of Newfoundland Power's domestic customers use electricity for heating, which is predominantly electric baseboard heating.[1] As of the same date, 54% of general service customers use electricity for heating.

b) Newfoundland Power estimates that approximately 35% of domestic all-electric customers will have a heat pump installed by 2026.[2]

c) The installation of a heat pump typically supplements an existing space heating source and provides a reduction in energy usage due to the better space heating efficiency provided by the heat pump. The forecast of heat pump installations supplementing electric heat provides a reduction in both the forecast of energy sales and peak demand, which is consistent with the results of the Heat Pump Load Study, provided as Attachment A.

Table 1 provides the reduction in the forecast energy sales due to domestic heat pump installation supplementing existing electric heat.[3]

Table 1:
Heat Pump Impact on Energy Sales and Demand

Year	GWh	Peak MW
2024	(15)	(3.6)
2025	(15)	(3.6)
2026	(7)	(1.5)

[1] For example, based on the 2022 takeCHARGE marketing survey, 71% of domestic service customers reported having electric baseboard heaters.

[2] Based on the 2022 takeCHARGE marketing survey, 28% of domestic service customers reported having a heat pump. In Newfoundland Power's view, heat pump information up to 2022 is generally reflective of heat pump installations in all-electric households. The Company forecasts annual average increases in heat pumps in all-electric households of approximately 2% per year. For comparison, 17% and 24% of domestic customers reported having a heat pump in 2020 and 2021, respectively. This indicates annual growth of 7% and 4% in 2021 and 2022, respectively.

[3] The sales forecast also accounts for conversions from oil to electric heating, which can include heat pumps. These conversions provide an increase in the forecast of energy sales and peak demand. See the response to Request for Information PUB-NP-097.

Heat Pump Load Study

Newfoundland Power

HEAT PUMP LOAD STUDY – FOURTH WINTER SAVINGS

Final Report

February 14, 2024

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This report presents the results of the fourth winter of the Heat Pump Load Study conducted for Newfoundland Power. The study was continued for a fourth winter since previous periods did not include very cold conditions typical of grid peak and prevented from drawing definitive conclusions on the grid-level impact of DHPs during peak conditions. Colder temperatures were observed during the 2022-23 winter, especially during the month of February 2023.This report therefore focuses on peak demand savings and is based on four months of winter data, between December 2022 and March 2023.

The methodological approach remained consistent to that described in the previous Annual Results presented in 2021.[1] Additional participants were recruited to the study since the 2021 analysis to maintain an acceptable sample size. Therefore, the results presented herein differ in part due to the different composition of the treatment and control groups. This report presents the results of Climate Zone 2 only, which includes the area around St. John's.[2]

[1] Econoler (2021). Heat Pump Load Study – Annual Results, Report prepared for Newfoundland Power, p. 45.
[2] Due to the difficulty of obtaining a representative control group in Climate Zone 1 (the central and western parts of Newfoundland), this climate zone was excluded from the study.

1 Validation of Control and Treatment Groups

Econoler first validated the control and treatment groups based on available participants. This validation was performed separately for December-January and February-March since most new participants were added at the end of January 2023. Table 1 lists the number of available participants per month.

Table 1: Number of Available Participants

Month	Control – Whole-house	Treatment – Whole-house	Treatment - DHP[3]
December 2022	34	48	48
January 2023	34	49	49
February 2023	42	55	52
March 2023	41	53	52

The results were generally similar for the two periods; hence, Table 2 below only presents the results for February-March, which is the period of greater interest since it includes most of the peak condition data.

Table 2: Summary of Group Characteristics

Characteristic	Average Value for Control Group	Average Value for Treatment Group	Is the Difference Statistically Significant at 90% Confidence?	Potential Impact on Savings Estimation
Number of Occupants per Household	2.90	2.76	No	Overestimation
Year of House Construction	1984	1989	No	Overestimation
Floor Area (ft²)	1,513	1,614	No	Underestimation
Usage of Woodstove	3/40[4] using more than once a month	2/53 using more than once a month	No	Underestimation
Occupancy Pattern	2/42 leaving on weekends	7/55 leaving on weekends	No	Overestimation

None of the differences between the two groups is statistically significant, although there are more participants in the treatment group who leave on weekends. A disproportionate portion of control participants who did leave their house on weekends in the previous sample was removed because they installed a heat pump. It is important to note that the column indicating the potential impact on savings estimation describes tendencies (based on an understanding of the impact of each metric – for instance, older houses tend to consume more electricity). It is not possible to say with certainty how much each small, non-statistically significant difference impacted the overall results. Since none of the differences were statistically significant and the available sample was already small, Econoler elected not to exclude any participants as part of the control and treatment group validation.

[3] The number of participants for which metering data is available is sometimes different for whole-house and DHP. This occurred when one of the two meters had connectivity issues and was discarded, but the other meter remained functional.
[4] The denominators do not match the number of available meters because a few participants did not answer all questions.

2 Savings Results

This section presents the peak demand savings that are specific to the top 20 hours during which grid demand was the highest as well as the energy savings for the period between December 2022 and March 2023.

2.1 Peak Demand Savings

To determine which days and hours should be considered as meeting peak conditions, Econoler used the grid-level hourly demand data provided by Newfoundland Power for the period of December 2022 through the end of March 2023.[5]

Econoler considered two definitions for the peak period: The top 20 and the top 10 highest demand hours of the 2020 winter. Using only the 10 highest demand hours yields results that are closest to the absolute peak conditions sustained by the grid but allowed for fewer data points. The top 20 hours and their corresponding maximum grid demand and weather conditions for St. John's are listed in Table 3. Many of the highest grid demand values occurred on February 4, 2023; the system peak on that date was the largest peak ever experienced in the province.

Table 3: Top 20 Hours of Grid Peak Demand

Date/Time	Time	Maximum Grid Demand (MW)	St. John's	
			Temperature (°C)	Wind Chill (°C)
February 4, 2023	5:00 PM	1,499.1	-14.9	-28.3
February 27, 2023	7:00 AM	1,489.0	-15.6	-24.9
February 24, 2023	8:00 AM	1,479.7	-15.9	-26.7
February 27, 2023	8:00 AM	1,479.5	-14.5	-24.0
February 4, 2023	4:00 PM	1,479.0	-14.6	-28.9
February 24, 2023	9:00 AM	1,472.2	-15.7	-27.0
February 4, 2023	6:00 PM	1,469.0	-15.1	-27.8
February 24, 2023	7:00 AM	1,468.9	-16.3	-27.0
February 28, 2023	7:00 AM	1,462.2	-16.1	-23.6
February 4, 2023	7:00 PM	1,457.5	-15.3	-27.5
February 27, 2023	6:00 AM	1,456.7	-15.8	-26.4
February 24, 2023	10:00 AM	1,442.3	-15.2	-26.3
February 4, 2023	8:00 PM	1,441.9	-14.5	-27.0
February 28, 2023	8:00 AM	1,441.2	-12.4	-21.1
March 1, 2023	7:00 AM	1,429.6	-11.8	-21.7
March 1, 2023	8:00 AM	1,427.9	-11.4	-21.2
February 28, 2023	6:00 AM	1,426.8	-15.4	-22.8
February 4, 2023	3:00 PM	1,424.1	-14	-27.0
February 4, 2023	12:00 PM	1,419.0	-13	-26.3
February 25, 2023	9:00 AM	1415.7	-13.9	-24.1

[5] The grid-level demand data correspond to the total of Newfoundland Power's production and purchases from Newfoundland and Labrador Hydro.

Table 4 presents the savings achieved during the highest peak hours along with DHP consumption during those hours.

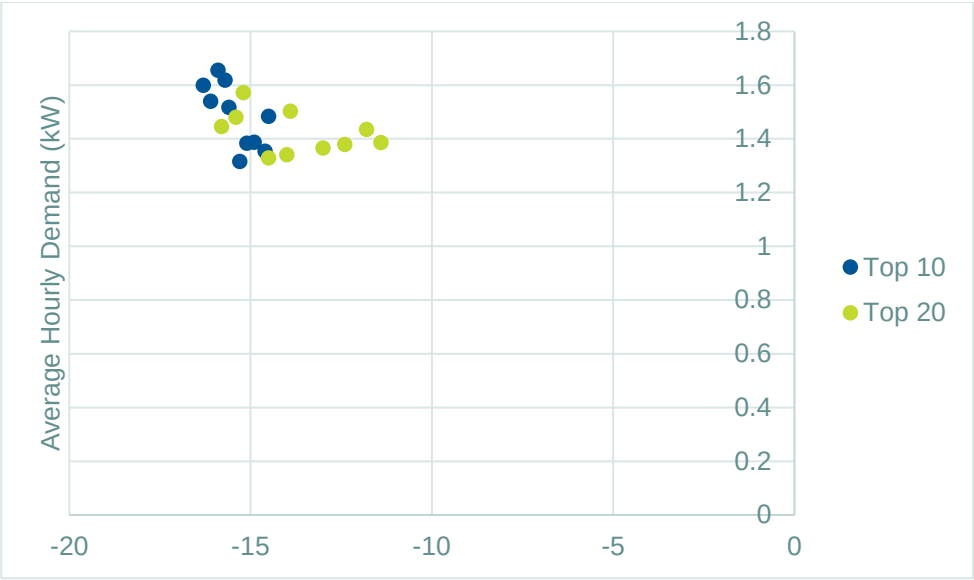
Table 4: Demand Consumption and Demand Savings During Top 10 and Top 20 Peak Hours

Top Hours	Whole-house Average Consumption (kW)		Savings (kW)	Savings (%)	DHP Consumption (kW)
	Control Group	Treatment Group			
Top 10 Peak Hours	6.23	5.78	0.45 ± 0.28	7.2%	1.49
Top 20 Peak Hours	6.04	5.60	0.44 ± 0.19	7.2%	1.46

For both top 10 and top 20 hours, statistically significant savings are observed, which indicates that heat pumps continue to generate savings in peak conditions. The relative savings in percentage is extremely close to the average energy savings achieved throughout the winter, as presented in the following subsection. In absolute terms, the average savings of about 450 W are higher than the savings observed for all winter hours, which are approximately 275 W.

Figure 1 below illustrates the relationship between the average hourly demand of DHPs and the outside air temperature; the objective of this graph is to determine if heat pumps continue to operate under peak conditions. The top 10 data points are in blue and the top 20 data points in green to differentiate between their highest peak conditions.

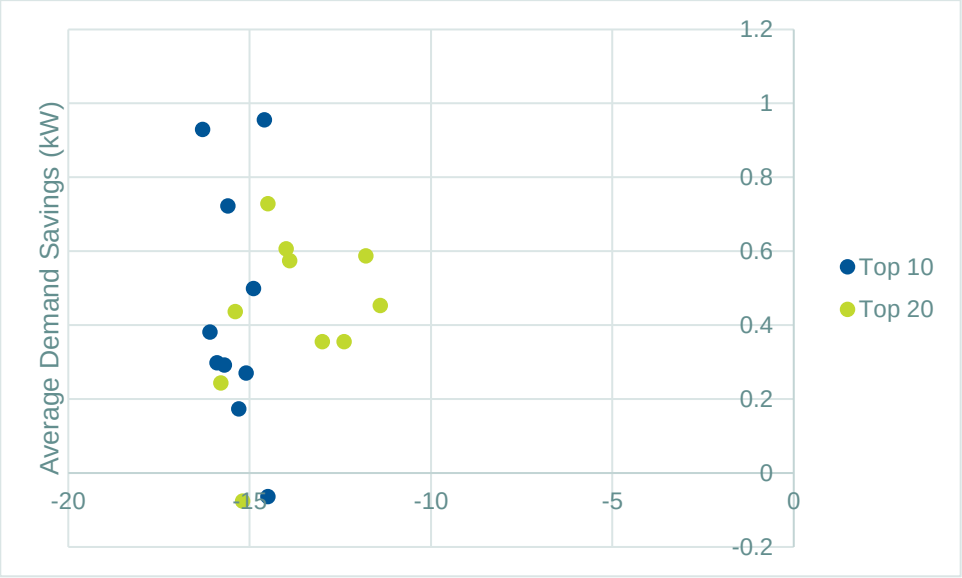
Figure 1: DHP Demand as a Function of Outside Temperature During Top 20 Peak Hours



The maximum hourly demand is reached approximately at the coldest temperature, with no sign of a decrease that could indicate the heat pump has stopped operating.

Figure 2 below depicts the correlation between outside temperature and demand savings.

Figure 2: Demand Savings as a Function of Outside Temperature During Top 20 Peak Hours



The graph is very scattered and shows no clear correlation between temperature and savings. However, savings are generally positive with only two data points below zero. The margins of error on these individual data points are quite large, which might explain the negative savings.

In conclusion, the results presented in this section demonstrate continued savings in peak demand during the cold 2022-2023 winter season, which included temperatures below -15°C.

2.2 Energy Savings

While the focus of the fourth winter analysis was to determine if DHPs achieved demand savings under grid peak conditions, an analysis of energy savings was also performed.

Table 5 below summarizes the energy savings calculations per month as well as monthly DHP energy consumption. For comparison purposes, the results for the same months from the previous annual study are presented at the end of the table in italics.

Table 5: Normalized Monthly Energy Consumption and Savings

Month	Whole-house Energy Consumption (kWh)		Energy Savings (kWh)	Relative Energy Savings	Relative Peak Demand Savings	Energy Consumption of DHPs (kWh)
	Control Group	Treatment Group				
December 2022	2,709	2,473	236 ± 124	8.7%	7.2%	540
January 2023	2,897	2,686	210 ± 170	7.3%		655
February 2023	2,624	2,444	180 ± 137	6.9%		700
March 2023	2,579	2,401	178 ± 138	6.9%		574
Previous Annual Study						
December 2020	*2,916*	*2,442*	*474*	*16.3%*	*14.5%*	*553*
January 2020	*3,094*	*2,720*	*374*	*12.1%*		*661*
February 2020	*2,921*	*2,458*	*463*	*15.9%*		*632*
March 2020	*2,858*	*2,426*	*433*	*15.1%*		*579*

The first thing to note is that monthly savings are statistically significant for all four months with savings varying between 178 kWh and 236 kWh. These savings represent between 6.9% and 8.7% of the total electricity consumption of the control group. The relative energy savings are of the same magnitude as the peak demand savings for both the 2022-2023 and the previous annual study.

The savings measured during the 2022-23 winter appear to be lower than in the previous study both in absolute and relative terms. The whole-house and DHP consumption of the treatment group are essentially the same for each month when comparing the 2022-2023 results to 2020 results. What explains the reduction in savings is the decrease of about 8% to 10% in the whole-house energy consumption of the control group each month. The initial assumption was that there must have been participants in the control group that installed a heat pump since they started participating in the study. However, this was verified at the end of the study through a survey conducted by Ecofitt – 33 of the 42 control participants with valid data in February 2023 were reached, and eight of them had a heat pump installed. It is possible that a few of the remaining nine control participants that were not reached through the survey had a DHP installed, but a few missed DHPs would likely not substantially change the result. For instance, the eight identified control participants with newly installed DHPs consumed on average 7.5% less than the control participants who did not install a heat pump, a number very similar to the monthly savings for the entire treatment group.

Econoler also screened participants to identify any potential outliers with very high or low consumption and found none. In conclusion, the most probable cause for the lower consumption of the control group is the new composition of that group. The margin of error on the control group consumption is around 200 kWh; therefore, it is possible that the real value is higher than the measured value for this fourth winter.

In Econoler's opinion, this additional analysis does not contradict the result of the previous 2021 Annual Report, which yielded savings of 12% to 16% of total electricity consumption for months between December and March. Those results had been confirmed through a pre and post billing analysis, which demonstrated yearly savings of over 16% and reinforced the validity of the estimated savings. Econoler does not recommend updating these figures in light of the analysis conducted for a portion of the fourth year, which are not believed to be more accurate for energy savings than the prior study.

2475, Laurier boul., Suite 250
Quebec City, QC G1T 1C4 Canada
Tel.: 418-692-2592 | Fax: 418-692-4899

econoler.com

ECONOLER