Memorandum

TO: NOVA SCOTIA UTILITY AND REVIEW BOARD (NSUARB)

FROM: DAVID WHITE

DATE: JULY 29, 2022

RE: EVIDENCE RE THE NSPI 2022 LOAD FORECAST (M10569)

Introduction

For many years Nova Scotia Power, Inc. (NSPI) has filed a load forecast report, and Synapse has been reviewing them. These reports have changed considerably over time. The *2022 Load Forecast Report* [1] represents substantial improvements in an expository sense by providing additional information. However, the 2022 forecast predictions are significantly above those of recent years.

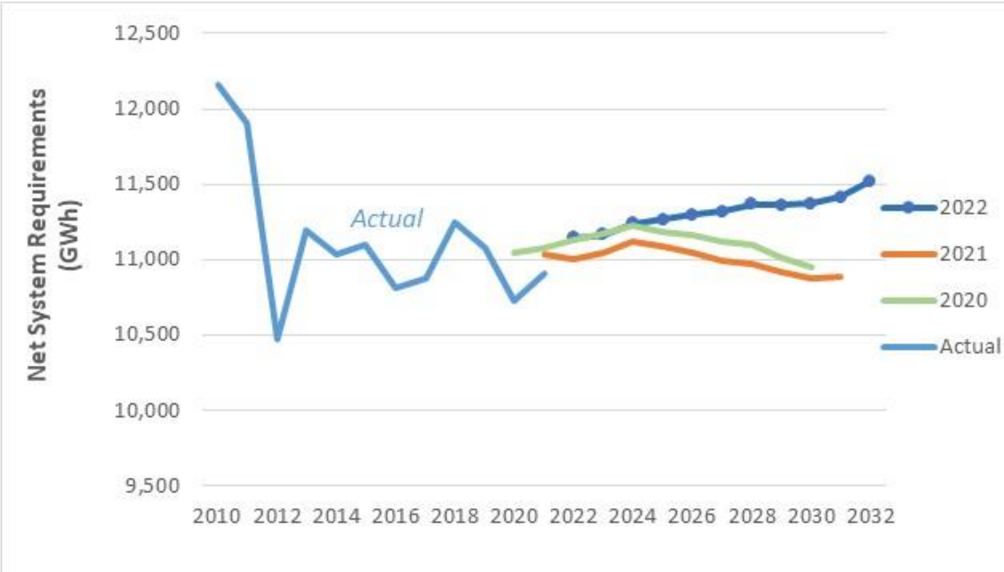
We note that the final forecast results consist of three discrete elements. The first is the Statistically Adjusted End-Use (SAE) model forecast which determines customer intensity. The second is the Demand Side Management (DSM) adjustments which are applied to the SAE forecast values. Thirdly, NSPI applies other factors to reflect customer growth and specific program adjustments. We will discuss all these factors in this evidence

Forecast Comparisons

First, we look at how this forecast compares with recent ones. Figure 1 below shows both the actual historical energy requirements and recent forecasts, including this one, that include DSM effects. Energy loads have declined substantially since 2010 as industries have closed in the province. Actual loads since 2013 have been relatively flat. Recent forecasts have predicted modest declines in future loads varying from -4.3 percent to -0.9 percent over their respective forecast periods. The current energy forecast has an overall increase of 3.4 percent. The big changes are the increases after 2024 associated with increased electrification.

[1] Nova Scotia Power, Inc. *2022 Load Forecast Report*, April 29, 2022.

Figure 1. Net system requirements

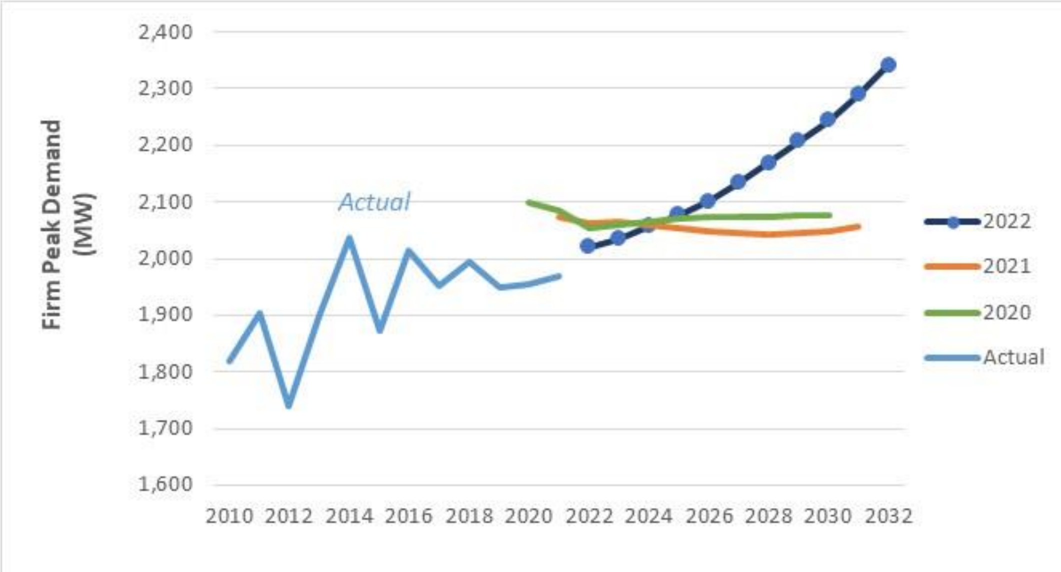


Source: Synapse from NSPI Figure C1.

The historical trend for firm peak demand shows a general increase, as shown in Figure 2. The recent previous forecasts predicted little future change, either up or down. However, the current forecast predicts a substantial increase of 16 percent over the forecast period. This is a drastic increase from the recent historical years (2018–2020) to 2021, the first forecast year, that seems incongruous. We note that part of the difference between the actual and forecast values are associated with weather normalization of the peak load, which we will discuss later.

The 2022 peak forecast shows an increase of 15.9 percent over its forecast period (2022–2032) whereas the previous three forecasts showed changes ranging from -0.3 to -1.1 percent. There are a number of reasons for this change, basically having to do with increased electrification of heating loads (discussed later).

Figure 2. Firm peak demand



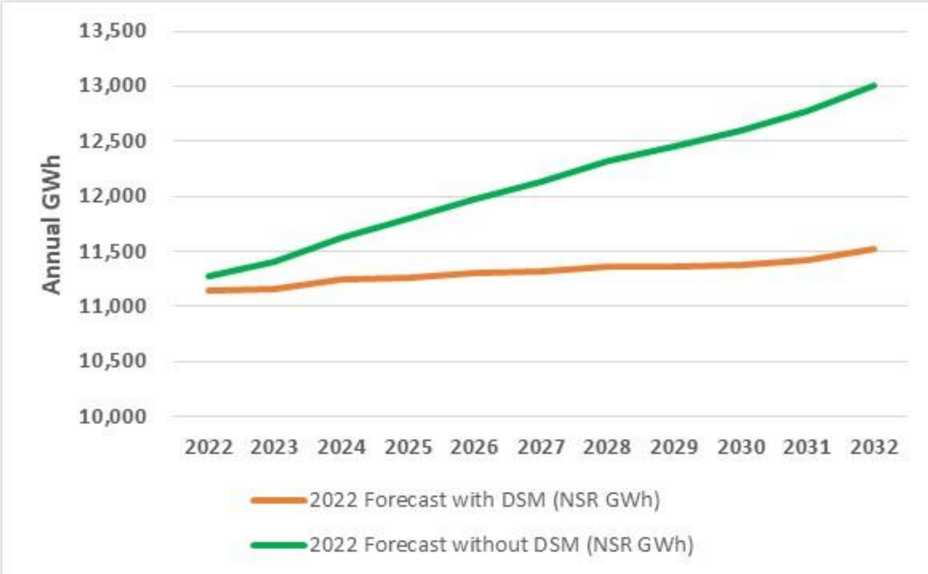
Source: Synapse from NSPI Figure C3.

DSM Overview

In previous years, NSPI provided energy and peak loads with and without DSM effects in its Appendix A, but now NSPI provides that information separately. In the current report it is given in Figure 36: Annual Forecast of DSM Savings. We used that information to illustrate below what the energy forecast would have been without DSM effects.

The following figure shows that without DSM savings the energy requirements would increase by 15.4 percent over the forecast period, but DSM programs reduce that increase to a more modest 3.4 percent. These results are consistent with the previous forecast report. Overall, DSM is playing a major role in limiting the energy growth.

Figure 3. Energy forecast comparison with and without DSM

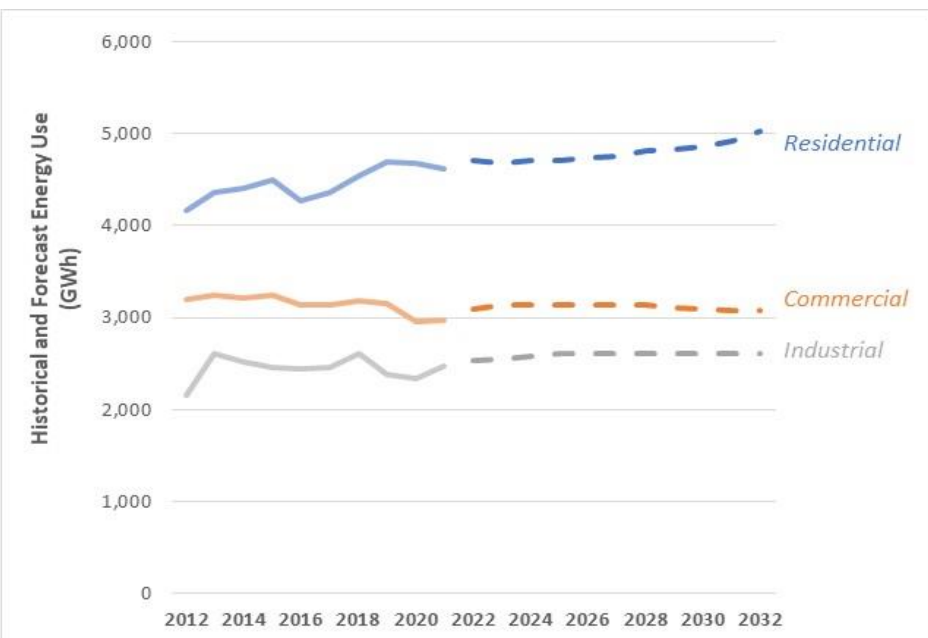


Source: Synapse from NSPI load forecast filings—using DSM savings from Figure 36.

Sector Overview

The following figure shows the historical and forecast energy use by sector. Overall, the residential load (representing around 40 percent of the total load) is growing slightly, the commercial forecast is relatively flat, and the industrial load increases a little.

Figure 4. Energy historical and forecast by sector



Source: Synapse from NSPI load forecast filings—based on Table A1 of the load forecast report. Solid lines represent historical values and dashed lines represent forecasted values.

The following table summarizes the forecast components by sector. The residential sector is the largest one and shows the largest increase. Commercial customers show a slight decline. The industrial sector represents only about one-quarter of the load but has a positive growth rate. Municipal customers are a very small portion of the requirements. Overall losses are about 6 percent and can be attributed on a roughly proportional basis to the loads.

Table 1. Sector energy forecasts including DSM effects

Sector	2020 Fraction	2022–2032 Change
Residential	45%	+6.62%
Commercial	30%	-0.58%
Industrial	25%	+2.44%
Total	**100%**	**+3.44%**

Source: Synapse from NSPI load forecast report.

In general, the forecast seems reasonable, but there are significant increases in the energy and peak requirements from the previous forecast. These increases need to be explored and understood. In recent years energy and peak loads have been relatively flat, but now increases are predicted which have numerous implications. The primary driving factors appear to be increased electrification and population and economic growth.

We will look at specific forecast components to note where there are questions and possible improvements. We will look at each sector in sequence and discuss the following issues:

1. What are the components and drivers for the changes?
2. Are the effects of DSM programs properly represented?

Recommendations from the Previous Forecast Review

The Synapse Evidence regarding the 2021 forecast and the resulting Board Order list several recommendations for improving the forecast.[2]

For the 2022 forecast we recommended NSPI do the following:

- Prior to developing a new forecast, have a formal stakeholders' meeting with an agenda and advance materials discussing the issues and any planned forecast changes or enhancements. Discuss specifically the issues raised in the most recent Board order.
- Explore more fully technologies to control peak space heating and water heating loads.
- Explore whether battery storage and solar/battery storage combinations could modify the peak loads.
- Provide updates on the water heating load control project in the 2022 load forecast report, including estimates of the impact of hot water heater device control initiatives on system peak demand.
- Include preliminary results of the Smart Grid Nova Scotia (SGNS) project in the next load forecast report, and include more information and learnings from the Smart Grid Nova Scotia program the next load forecast.
- Reevaluate and update COVID-19 pandemic impacts on commercial sales in the next forecast.
- Monitor DSM program savings and, if they increase above historical levels, then consider adjusting upwards the adjustment factors made to NSPI's SAE model to reflect greater levels of future savings.
- Consider the issue of what the design day temperature should be going forward in an era of global warming. This is an issue that has come up in other locations and NSPI should devote more attention to this matter in future load forecasts.

We support these ongoing efforts and will discuss some of them in the appropriate sections below. We especially note the importance of the heat pump and water heater end-uses for the residential sector.

[2] Page 22 of the Synapse 2021 Evidence.

Energy Forecast

In Table 1, we saw the sectorial components of the Nova Scotia load. Here, we will review each of them in sequence, going in the same order as in the forecast report.

Major Inputs and Regression Models

In addition to end-use technology changes and numbers of customers, the forecast is influenced by several economic and environmental drivers. The economic and employment data is from the latest Conference Board of Canada (CBoC) 20-year forecast. This is the only long-term forecast available for the province. Other forecasts for the short term provided in the response to NSUARB IR-3 indicate the CBoC values for 2021–2023 are generally consistent with the various bank forecasts available. However, there is greater uncertainty in any longer-term forecast, and sensitivity analyses are useful for looking at this issue.

The residential model previously used retail sales and household income as the economic drivers. In this forecast NSPI used new construction and household compensation instead. Household compensation increases by 7.3 percent in real terms over the forecast period. New construction increases the number of new customers by about 6.1 percent over this period. The regression statistics as reported in NSPI's Appendix B are respectable, although other models with different input variables could have been investigated more fully. In terms of the impacts as reported in Appendix B, the change in average energy use for existing customers increased by 1.3 percent over the forecast period. New customers increased the total residential load by 4.9 percent.[3] The choice of drivers seems reasonable but should be reviewed every year.

The residential statistical model includes a binary variable to represent the effects of COVID-19. NSPI gave that variable a value of 1.0 for 2020. It was reduced to 0.5 in October 2020 and finally reduced to 0.16 in September 2022 and then stays at that level.[4] The net effect is to increase the residential load by 54 GWh for 2023 and beyond.[5] The future value chosen for that variable appears somewhat arbitrary. Although the choice is reasonable at the present time, the COVID-19 variable should be reevaluated going forward.

The handling of DSM effects is discussed in a later section of this Evidence.

For the commercial (General Services) models, NSPI continues to use non-manufacturing gross domestic product and non-manufacturing employment. In the industrial sector, NSPI used manufacturing gross domestic product and manufacturing employment. A longer regression timescale was used for the industrial models as that produces better statistics. We consider these to be reasonable choices.

[3] 2022 Load Forecast Report (LF Report), Appendix B. page 5.

[4] Load Forecast Report, Appendix B, p.2.

[5] Load Forecast Report, p.59.

The use of the widely available CBoC forecast is a reasonable choice given the need for general consistency within Canada as a whole. We note however the inherent uncertainty of all economic forecasts and also that the future may diverge significantly from the forecast.

The forecast now gives more consideration to long-term weather trends. NSPI analyzed the trend in heating degree days (HDD) and cooling degree days (CDD) over time, considering the effects of climate change. As one might expect, there has been a decline in HDD and an increase in CDD. The HDD trend used for this forecast was -17.245 HDD/year, a little more than the -16.743 number used in the 2021 forecast. The CDD trend was +1.36 CDD/year compared to +1.37 used last year. NSPI now incorporates these trends into the forecasts. This change represents an acknowledgement of climate reality and is a definite step forward. This data should be analyzed and updated on a regular basis.

NSPI investigated the use of more weather station data from other parts of the province. However, this seems to have a very minimal effect on the forecast results (ranging from -0.03 to +0.04 percent).[6] Thus this was not incorporated in the current forecast. This might be worth investigating more in the future but based on the very minimal differences does not seem to be a very high priority.

Residential Sector

The residential sector represents about 45 percent of the total customer load. The residential forecast (which includes the effects of DSM programs) increases by 6.6 percent over the forecast period. Without DSM programs, the increase would be roughly twice as much.

NSPI changed the economic drivers in this forecast to New Construction and Household Compensation from a 50/50 mix of retail sales and household income in the previous year. New construction affects the new customer growth which produces a 4.9 percent increase in the residential load over the forecast period and is a significant growth driver. Household compensation basically affects the load of existing customers which is factored with other drivers in the existing customer calculations which increases by 1.3 percent over the forecast.[7]

The residential forecast is based on an SAE model designed to capture the nature of the sector's uses. NSPI's report discusses key future load drivers (heat pumps, water heaters, electric vehicles, and PV generation) separately and explicitly.

We will discuss the Residential SAE model in some detail here to better understand the drivers behind the forecast. The key output of the SAE model is the average customer use. This is the weighted sum of XHeat, XCool and XOther plus a few other terms such as historical DSM savings, a Covid term, and some binary terms for specific months.[8]

[6] Load Forecast Report, Figure 14.

[7] Load Forecast Report, Appendix B, p.5.

[8] Load Forecast Report, Appendix B, pp.1-7.

The **XHeat** variable is the product of the HeatUse and HeatIndex terms. *HeatUse* represents (a) heating degree days, (b) household income, (c) household size, and (d) energy price. *HeatIndex* represents (a) heating saturation, (b) equipment efficiency, (c) building shell integrity, and (d) building size. The major change drivers for XHeat are electric (resistance) heat, heat pumps, and secondary heat. The net change over the forecast period is -.09 percent.[9]

The **XCool** variable is the product of the CoolUse and CoolIndex terms. *CoolUse* represents (a) cooling degree days, (b) household income, (c) household size and (d) energy price. *CoolIndex* represents (a) cooling saturation, (b) equipment efficiency, (c) building shell integrity, and (d) building size. The major change driver for XCool is heat pump cooling. The net effect is to increase XCool by 71.8 percent

The **XOther** variable is the product of the OtherUse and OtherIndex terms. *OtherUse* represents (a) seasonal use pattern, (b) household income, (c) household size, and (d) energy price. *OtherIndex* represents (a) other appliance saturation and (b) efficiency trends. The primary change drivers for XOther are water heat (increased electric heater saturation), reductions in lighting use, and miscellaneous. The net effect is to increase XOther by 1.5 percent.

From this one can see that there are many factors driving the SAE model regressions and it is difficult to untangle all the effects. However, Appendix B of the Report does provide a rough summary of the overall effects of the major terms on the average use. For the residential average use, 42 percent is associated with heating, 2 percent with cooling, and 56 percent with other uses. Over the forecast period, XHeat results in a 0.4 percent reduction, XCool a 1.6 percent increase, and XOther a 0.9 percent increase. The overall increase in average use is 1.3 percent.

But this is only the first step, NSPI applies additional adjustments to the SAE results to account for (1) new customers, (2) electric vehicles, (3) solar, (4) renewable to retail (RTR) markets, and (5) future DSM savings.

To represent these various effects, we reproduce here a table from Page 5 of Appendix B. The first column shows the SAE regression model results, and the other columns reflect various adjustments to the forecast.

[9] Load Forecast Report, Appendix B, pp.6-7.

Table 2. Residential load: post regression (GWh)

	Existing Customer Average Use from Regression Model (kWh/year)	New Cust. Load	EVs	Solar	RTR	Res DSM Adjustment	Res Sales	Total Res DSM (at the meter)	DSM captured by end-uses
2022	9,748	56	12	(31)	0	(26)	4,717	(50)	(24)
2032	9,872	287	510	(176)	(3)	(349)	5,029	(684)	(335)
Change to load	1.3%	4.9%	10.5%	-3.1%	-0.1%	-6.8%	6.6%		

Note: Res Sales = Existing Customer Load + New Customer Load + EV Load + Solar Load + RTR + DSM.

Source: NSPI load forecast report Appendix B.

Heat pumps

The heat pump section of the report discusses replacement of both fossil and electric resistance heating by heat pumps in existing buildings.[10] As discussed above, these are inputs to the XHeat and XCool model variables. The report handles new customers separately. The end-use model uses a heat pump saturation of 35 percent in 2022, which then increases to 66 percent in 2032. The actual saturation achieved by 2032 is uncertain. In terms of effects on the forecast, the results are probably minimal. The reason for this is that over a third of the installations replace resistance heating which results in a net savings that offsets the increased usage resulting from replacing fossil systems. This is shown in the residential XHeat variable discussed above which shows a 1.5 percent decline over the forecast period. The big change in the model is for cooling; this is represented by the XCool variable which increases by 78 percent. The residential average load decreases by 0.4 percent because of heating changes but increases by 1.6 percent because of cooling. And the SAE model, average residential load increases by a total of 1.3 percent. [11]

In the near term, about 16,000 heat pump installations are expected per year. The prediction is that roughly 65 percent of these are for non-electric heating customers and roughly 35 percent are for electric heating customers. Replacing fossil heating increases the electrical loads, while replacing resistance heating reduces it. What needs further clarification is the mode of these new heat pump installations. For example, whether the new installation is the sole heating source, or whether some existing fossil heating systems remain in place.

There is some uncertainty as to the overall energy and peak effects of increased HP usage, as indicated in Figure 23 of NSPI's report. The E3 analysis indicates significantly greater peak effects. This should be evaluated more closely in future years using AMI data.

[10] Load Forecast Report, pp.35-40.

[11] Load Forecast Report, Appendix B, p.5.

We ask NSPI to more fully investigate the peak load effects of heat pumps in future forecasts.

Water heaters

For water heaters, the forecast predicts that a portion of the customers who convert fossil heating systems to heat pumps will also convert to electric water heaters.[12] Based on Figure 25, the electric water heater saturation will increase from 68 to 82 percent, which implies that about 40 percent of the current non-electric water heating customers will convert to electric water heaters by 2032. This is a fairly substantial increase and should be carefully monitored as this is a significant energy and peak load growth driver.

The net effects are not given in the report. However, inspecting the XOTHER table on page 7 in Appendix B seems to indicate a 4.3 percent increase in water heating usage.

We recommend consideration of heat-pump-based hot water heating.

NSPI notes that a pilot project is being finalized with E1 to investigate demand response for water heaters.

We ask that NSPI provide updates on the water heating load control project in the next load forecast report, including estimates of the impact of hot water heater device control initiatives on system peak demand.[13]

Electric vehicles

Electric vehicles represent another load growth area, but one with a great deal of uncertainty. This forecast has electric vehicles making up 12.5 percent of the vehicle stock (~96,000) vehicles by 2032.[14] That would represent an energy load of 510 GWh with peak load impacts ranging from 89 to 131 MW. (This is a substantial increase from the previous forecast with 9 percent in 2031, entailing an energy load of 195 GWh and peak load impacts ranging from 39 to 83 MW.) In 2032, electric vehicles represent 4.4 percent of the energy load and 3.8 to 5.6 percent of the peak load.[15] This prediction is based on meeting stated public goals and may not actually be achieved. We also understand that there currently are some supply chain problems. But then again electric vehicles could become very popular and exceed these levels, as has been the case with residential heat pumps.

[12] Id, p. 41

[13] Demand Response is discussed further in section 10,0 of the forecast report and will be commented on later.

[14] Id, Figure 28.

[15] Id, Figure 58.

Time of charging is also an important peak load issue, and programs need to be implemented to reduce on-peak charging as the electric vehicle penetration increases. NSPI notes that its SGNS project is testing options for direct utility control of charging, to shift electric vehicle charging to off-peak times.[16]

We ask that more complete results of the SGNS project regarding electric vehicle impacts be included in the next load forecast report.

Solar generation (PV)

Solar generation can either be small-scale at the customer level, or a larger utility scale. The load forecast considers the customer-level impacts. Currently the number of installations is small but is projected to increase about ten-fold over the forecast period. Because of the timing of the system peak, NSPI predicts no effect for the future peak load but predicts a net reduction of 205 GWh (2.5 percent) in the combined residential and commercial energy load.[17]

Solar-plus-battery

The report discusses solar/battery storage combinations but does not expect them to have much effect on future loads.[18] However, some possible impacts based on preliminary results from the SGNS project are presented in Figure 30 of NSPI's report. With a high penetration of battery systems, the peak impacts could be substantial and are worth exploring, especially if they can reduce the need for new peaking resource investments.

We ask that more complete results of the SGNS project regarding battery storage be included in the next load forecast report. We further request that NSPI investigate more fully the use of electric vehicle batteries, especially for peak management.

New customers

The final piece of the residential forecast are the new customers discussed in Section 5.0. This is based on new construction, which is expected to decline over the forecast period.[19] Overall, new customers represent the second source of the residential load increase, after electric vehicles, and are expected to add 282 GWh (6.0 percent) to the 2032 residential load.[20]

Other

NSPI integrated the heat pump and hot water end-uses into the intensity calculations and regression model results rather than treating them separately. However, Figure 41 of the report does provide some

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[16] Id, p. 44

[17] Id, pp. 45-47.

[18] Id, pp. 39-41.

[19] Id, Figure 17.

[20] Id, Figure 40.

illustrative contributions. Heat pump heating load increases by 471 GWh and cooling load increases by 70 GWh for a total of 541 GWh. However, baseboard heat decreases by 549 GWh. Thus, they are roughly equivalent. However, heat pumps displace some fossil fuel heating and thus there are additional unreported savings there.

We find the reconciliation of the residential model changes on pages 5-7 of Appendix B to be very helpful in understanding the forecast model behavior. Especially interesting is the 1.3 percent increase in the load associated with existing customers and a 4.9 percent increase associated with new customers. Most striking however is the 10.5 percent increase associated with electric vehicles.

The current SAE model formulations appear reasonable, but the choice of the key drivers should be reevaluated for each forecast.

Commercial Sector

The commercial sector represents 30 percent of the customer load. The commercial forecast (as shown in Table 1 of this evidence) decreases by 0.58 percent over the forecast period. In the 2021 forecast, it decreased by 2.6 percent. In the 2020 forecast, the decrease was 4.2 percent.

The commercial sector consists of three subsectors: Small General Service, General Service, and Large General Service. In 2022, the Small General Service group represented 10 percent of the commercial load, the General Service group represented 75 percent, and the Large General Service group represented 15 percent.

Our comments focus on the General Service (also called Medium) group which represents three-quarters of the commercial load. We reviewed the statistical models in Appendix B and found them satisfactory. The current report has also provided specifics of the various factors affecting the changes in sales, which we replicate below. The total change between 2022 and 2032 is a decrease of 3.7 percent. The DSM program reductions are about twice the anticipated increases.

We also raise a point about the appropriateness of the commercial electrification programs. We ask NSPI to provide further information about their relative benefits and costs.

Table 3. General demand sales drivers from 2022 to 2032

Category	2031 Change
Average Model Use Contributions	+2.0%
Electrification	+2.4%
Solar	-0.8%
DSM[21]	-7.3%
Total Change	**-3.7%**

Source: Load Forecast Report, Appendix B p. 17.

We also found the comparisons of the 2031 versus the 2021 regression values for the Small General Service sector on page 12 of Appendix B helpful in understanding the forecast model behavior.

NSPI states that the COVID-19 pandemic had some impact on commercial sales, but those sales are expected to rebound in 2022. No Covid variables are included in the commercial regression models. Results to date indicate that 2022 commercial sales are in line with those of 2019.[22] This will need to be reevaluated and updated in the next forecast.

Large general sales are expected to increase by about 50 GWh driven primarily by hospital expansions. This represents a change from the 2021 forecast, which was essentially flat.

[21] Note that the reported DSM impacts are in addition to DSM effects embedded in the SAE model itself. Therefore, the actual savings from DSM programs are significantly greater.

[22] Id, p. 65.

Industrial Sector

The industrial sector represents 25 percent of the customer load. The industrial forecast (shown in Table 1) increases by 2.4 percent over the forecast period. In the 2021 forecast, this was 3.9 percent. In the 2020 forecast, the increase was 5.4 percent. Most of the change is associated with current and potential new large customers which is lumpy by nature and thus subject to a fair amount of uncertainty.

The industrial forecast is based on statistical models and customer surveys. There are three subsectors to the industrial customers: (1) Small, (2) Medium, and (3) Other (primarily large). The Small sector is expected to grow at 0.7 percent annually, driven by economic growth. The Medium sector is expected to grow at 0.1 percent annually, driven by economic activity. The Large (also called Other) category represents about 70 percent of the industrial load and has an annual 0.3 percent rate of increase. The change in this category is based on customer surveys and new customer inquiries. Thus, the methodology is different than for the other sectors and should be considered as an informed estimate rather than a calculation.

We note too that the survey of the Large General Service customers appears to have achieved a reasonable coverage for this report, with 23 responses to the survey. NSPI also indicates that several expansion projects and new customers are likely to occur in the next several years. That is the primary reason for the overall increase in the energy sales up to 2024.

This forecast assumes the continuation of current major customers throughout the forecast period. Major changes in those operations represent an uncertainty in the industrial load.

As with the commercial sector, the pandemic has had an impact on the industrial sector in that the 2019 and 2021 loads were roughly 135 GWh (5 percent) below those of 2018. The current forecast predicts a recovery, but the loads are slightly below the previous ones.

Table 4. Industrial loads with DSM (GWh)

Category	2022	Fraction	2032	Change	% Change
Small	311	12%	333	22	5.9%
Medium	480	19%	485	5	2.3%
Large	1,751	69%	1,823	72	4.1%
Total	**2,542**	**100%**	**2,641**	**98**	**3.9%**

Source: Synapse IR-1 response, Figures 47-50 and Table A1 from the forecast report.

It is not clear in the report how much of the commercial and industrial demand savings presented in Figure 36 are contained in the industrial forecast. We ask NSPI to clarify the DSM effects for each sector.

Commercial and Industrial Electrification

The effects of commercial and industrial electrification are presented in Figure 34 of the report. The energy impacts range from 31 GWh in 2022 up to 136 GWh in 2032. However, it levels off in 2027. It would seem more likely that electrification impacts would continue to increase.

We ask NSPI to further investigate the commercial and industrial electrification impacts after 2027.

The Municipal Sector

The municipal sector represents a minimal 0.6 percent of the customer load. Six municipal electric utilities have purchased power from NSPI and include residential, commercial, and industrial users. Four of these utilities have elected to obtain 100 percent of their energy from other sources. This is the cause of the drop in municipal sales from 146 GWh in 2019 to 68 GWh in 2020. NSPI continues to provide backup power, so those utilities' needs are included in the peak load requirements. The remaining municipal utilities' energy needs are expected to be supplied by NSPI throughout the forecast period.

Energy Forecast and DSM Effects

Future DSM savings used in this forecast are presented in Figure 36 of the report.[23] The forecast total annual DSM savings correspond to about 1.6 percent of the residential plus commercial load. The DSM adjustments to the SAE forecast are about half as much as the full DSM savings. This is because the SAE model already includes the effects of some of those savings in its statistical equations, which are based on historical data and trends.

The residential statistical model includes the variable *AvgEESavings* to capture E1's past reported savings. This is used to adjust the future E1 DSM savings included in the forecast. This year the coefficient for this was -0.512 compared to the larger one of -0.587 last year. The year-by-year adjustments are shown in Figure 36 of the Report and are roughly 30 GWh per year.

For the commercial/industrial adjustments, a factor of -0.38 is used. NSPI produced this using the combined commercial and industrial model described on pages 25-26 of Appendix B. This is a bit lower than the value of -0.437 used last year which reduces the adjustment since it implies that more DSM is now being captured in the regression model. It does seem a little odd though that the coefficient is so different than in the previous forecast with a change of only one year of data. This suggests a less than robust methodology.

We'd like further explanation from NSPI about why the C/I adjustment varies so much from what was used last year.

[23] Note that there is an error in the C/I adjustment that overstates the value in Figure 36 of the Report. NSPI corrected this error in its response to Synapse IR-15 (e.g., for the 2032 CI adjustment the Report table shows 28.2 while the correct value should be 20.9).

The actual commercial DSM adjustments are included in Appendix B (pages 12 & 17). For the small general load, it varies from a reduction of 2 GWH in 2022 to 24 GWH in 2032. For the medium general load, it goes from 17 to 187 GWh, or 7.9 percent of the load in 2032. No explicit adjustments are indicated for other customers.

The adjustments discussed in the forecast report appear reasonable to us.[24] Since these factors are statistically derived, the values could vary by +/- 20 percent, but this should be considered as yet another uncertainty in the forecast. Overall, we feel that this type of approach and the proposed magnitudes of the adjustments are appropriate for this forecast.

However, if DSM program savings are increased above historical levels, then the adjustment factors probably should be adjusted upward to reflect greater levels of incremental savings.

[24] Id, pp. 40-41.

Peak Forecast

As shown in Figures 2 and 3 of the load forecast report, the system peak (including DSM effects) increases substantially in this forecast. For a direct comparison, the 2031 firm demand in this forecast is 233 MW (11 percent) greater than that of the previous forecast. And there is a further 53 MW increase from 2031 to 2032.

Figure 58 in the report (reproduced below) shows the effects of various components on the future peak load. Basically, the peak is first modeled statistically using historical data and economic and demographic projections to produce a Modeled Peak, and then NSPI applies various adjustments to arrive at the System Peak.

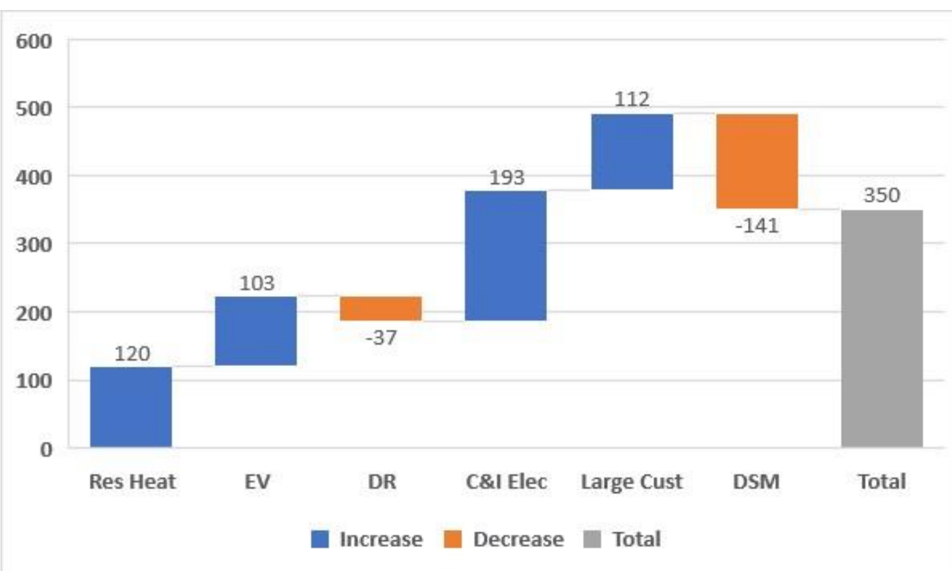
Table 5. Peak contribution components

	Modeled Peak (MW)	Res Heat Peak (MW)	EV (MW)	DR (MW)	C&I Elect. (MW)	Large Cust. (MW)	DSM (MW)	Firm Peak (MW)	Inter. Cust. (MW)	System Peak (MW)
2022	1,920	7	3	-0	10	99	-18	2021	144	2,165
2032	1,993	120	103	-37	193	112	-141	2342	152	2,532
2032 (no EV mitigation)	1,993	120	152	-37	193	112	-141	2392	152	2,581

Source: Figure 58 of the Load Forecast Report.

To show this more visually, we have created the following waterfall graph showing both the increases and decreases. The net effect of these adjustments is to increase the modeled peak by 350 MW.

Figure 5. Peak contribution adjustments to 2032 (with EV mitigation)



Source: Figure 58 of the Load Forecast Report.

Note that the largest contributor to the peak growth is commercial and industrial electrification. This is followed by residential heating, which is associated with increased electrification of this end-use. The electrification of vehicles (identified as EV) is also a major growth factor that can be mitigated with time-of-charge controls. We also wonder if more can be done with demand response.

The interruptible load representing primarily large industrial customers is projected to increase modestly from 144 MW in 2022 to 152 MW in 2032. Increasing this would help moderate the peak.

We ask NSPI to investigate what can be done with time-of-use rates and other measures to mitigate the peak load increases for all these components, especially for the commercial and industrial sectors.

Electric vehicles are a substantial contributor to peak growth. We would like to see a more complete evaluation of the options to control this growth in the next forecast.

We note that the load forecast report's Figure 54 shows that demand response is not increased after 2026, although we also understand that NSPI is developing larger demand response programs as part of the IRP Action Plan.

Please include explicitly the effects of the additional demand response measures, including those after 2026 that are included in the IRP Action Plan in the next forecast.

We note that the peak normalization in this report has resolved the apparent leap from historical to forecast values in the previous forecast. The adjustments listed in Figure 59 appear reasonable. We also acknowledge the increase in the design day temperature from -15.0 to -13.7 C, as was previously recommended.

The end-use contributions to the peak shares are shown in Figure 61 for the residential sector and in Figure 62 for the commercial sector. Our understanding is that these contributions are in the Modeled Peak values shown previously.

In the NSPI response to E1 IR-9, it was stated that it was assumed that heat pumps lock out at -7 degrees Celsius.[25] That seems to imply that heap pumps are operating as resistance heaters at peak load conditions. However as indicated in the graph provided in that response, some heat pumps have a COP above 1.0 at that temperature.

We ask NSPI to further investigate and clarify the performance of heat pumps during peak load conditions.

The response to E1 IR-9 also states that "Yes, NS Power views Electric Thermal Storage (ETS) as an effective backup for Air-Source 16 Heat Pump systems when ETS is sized appropriately to carry the heating load."

[25] NSPI Response E1 IR-9 page 3.

We ask NSPI to quantify how electric thermal storage could moderate the peak load.

For the residential sector, space heating decreases from 64.1 to 60.3 percent of peak load. This represents in part a change from resistance heating to heat pumps. Water heating, however, increases from 8.0 to 9.8 percent, representing primarily a switch from fossil fuels. We roughly estimate that water heating contributes about 110 MW to the 2032 peak load but ask NSPI to compute a more precise number.

Water heating has potential for load control measures which NSPI should fully investigate to manage peak load growth.

Cooking is the third-largest contributor. The new technology of induction cooking is more efficient than current stoves and its possible effects considered.

Induction cooking is a new technology that should be evaluated for its effects on energy and peak loads.

For the commercial sector, the heat end-use showed the greatest increase from 32.0 to 49.1 percent of the peak. Deeper investigation of this seems indicated.

We ask NSPI to evaluate commercial heat use more fully as to what is driving it and how the peak impacts could be moderated.

The analysis of the forecast accuracy in Appendix C shows that the recent peak forecasts have been substantially above the actual peaks.

We ask that NSPI review its peak forecasting methodology in light of these discrepancies and evaluate what factors (e.g., DSM, heat pumps, weather) account for the gap.

Overall, the peak forecast seems plausible, although some aspects need refinement. There should be more discussion of the underlying factors causing peak growth (and decline).

We also note that further refinements of the peak forecast methodology to use class-specific information are underway. We look forward to seeing further refinements of the peak model in future reports.

Peak Demand Research

The exploration of using interval data to understand peak at the class level should better inform future forecasts. This effort should continue. We await the see the results from further use of AMI data.

Sensitivity Analysis

The forecast report (in Section 10 and Appendix D) presents sensitivity analyses that help to understand potential future load variations.

The energy load sensitivity considered weather and economic impact variations. Details can be found in Appendix D and generally appear plausible, with temperature being the greatest near-term uncertainty and the economic uncertainty dominating by 2032.

The peak load sensitivity used a set of weather and economic drivers. As expected, the peak is most sensitive to the peak temperature and has a greater relative range than energy. However, no relative sensitivity for the 2032 peak is included in Appendix D as there is for energy in Figure D7.

We ask that NSPI provide a 2032 peak sensitivity analysis similar to what was done for energy in Appendix D.

Figure D8 shows additional potential impacts, although there is little explanation of the assumptions behind these values.

We ask that NSPI provide more information about the assumptions and the calculations behind the values in Figure D8.

In general, the sensitivity analyses appear reasonable and provide some insight into the forecast uncertainty.

All of the sensitivities are basically statistical. It might be informative to also do some what-if analyses. This could look at policy options, for example, proactive utilization of TOU/CPP to attack peak increases.

We recommend that there be future sensitivity analyses based upon thoughtful/critical examination of realistic but aggressive proactive actions to mitigate projected peak increases using newly available technology.

The forecast also includes a comparison with some of the 2020 IRP scenarios in Figure 69. The current forecast for 2031 is much more solidly within the ranges represented by the IRP electrification scenarios than was the previous one. This indicates a greater consistency between the forecast and the IRP analysis and addresses an issue raised in our previous evidence.

NSPI Response to Previous Synapse Recommendations

Our report from last year included several recommendations and NSPI has moved to address most of them. For the record, we have attached NSPI's replies to Synapse IR-43 and acknowledge its responsiveness. While there are still some issues to consider, this forecast represents a further improvement over the previous one.

In our 2021 report we made some recommendations that were included in the Board encouragements:

- Evaluate the input variables in the residential model and test over a period of time if alternative inputs make the residential model more robust, considering the following:
- Given the recent population growth and housing shortage in Nova Scotia, re-evaluate the use of housing completions for the near term;
- Given the dependence of income on the retail sales variable, the retail sales variable should be re-evaluated, particularly in the near-term given forecast supply-chain issues;
- Re-evaluate the use of the Total Provincial Disposable Income variable as it may be biased by outliers;
- Testing if Median Household Income provides a more accurate indicator of the level of income in the province is encouraged; and
- Consider incorporating household size and age of household residents to determine if a better understanding of demand on the load by time of day is achieved.

We found NSPI to be responsive to these recommendations and are attaching those responses to Synapse IR-43 to this report. We also note that some changes are being delayed to the 2023 forecast.

Questions and Recommendations

In this Evidence we ask for further clarifications and make several recommendations:

- We ask NSPI to more fully investigate the peak load effects of heat pumps in future forecasts (p.11).
- We recommend consideration of heat pump-based hot water heating (p.11).
- We ask that NSPI provide updates on the water heating load control project in the next load forecast report, including estimates of the impact of hot water heater device control initiatives on system peak demand (p. 11).
- We ask that more complete results of the SGNS project regarding electric vehicle impacts be included in the next load forecast report. We also ask that NSPI investigate more fully the use of electric vehicle batteries, especially for peak management. (p.12).
- We ask that more complete results of the SGNS project regarding battery storage be included in the next load forecast report (p.12).
- We also raise a point about the appropriateness of the commercial electrification programs. We ask NSPI to provide further information about their relative benefits and costs (p.14).
- It is not clear in the report how much of the commercial and industrial demand savings presented in Figure 36 are contained in the industrial forecast. We ask NSPI to clarify the DSM effects for each sector (p.15).
- We'd like further explanation from NSPI about why the commercial and industrial adjustment varies so much from what was used last year (p.16).
- Electric vehicles are a substantial contributor to peak growth. We would like to see a more complete evaluation of the options to control this growth in the next forecast (p.19).
- We ask NSPI to investigate what can be done with time-of-use rates and other measures to mitigate the peak load increases for all these components, especially for the commercial and industrial sectors (p.19).
- Please include explicitly the effects of the additional DR measures, including those after 2026, that are included in the IRP Action Plan in the next forecast (p.19).
- We ask NSPI to quantify how electric thermal storage could moderate the peak load (p.20).
- Water heating has potential for load control measures which NSPI should fully investigate to manage peak load growth (p.20).

- Induction cooking is a new technology that should be evaluated for its effects on energy and peak loads (p.20).
- We ask NSPI to evaluate commercial heat use more fully as to what is driving it and how the peak impacts could be moderated (p.20).
- We ask that NSPI review its peak forecasting methodology in light of these discrepancies and evaluate what factors (e.g., DSM, heat pumps, weather) account for the gap (p.20).
- We ask that NSPI provide a 2032 peak sensitivity analysis similar to what was done for energy in Appendix D (p.21).
- We ask that NSPI provide more information about the assumptions and the calculations behind the values in Figure D8 (p.21).
- We recommend that there be future sensitivity analyses based upon thoughtful/critical examination of realistic but aggressive proactive actions to mitigate projected peak increases using newly available technology (p.21).

We support NSPI's ongoing efforts to improve the transparency and accuracy of the load forecast. There is still more to do; but overall, this report is very well done and better explains the underlying factors driving the forecast.

Attachment 1 – NSPI Response to Synapse IR-43

Request IR-43:

General Modeling Improvements – The Board Decision of October 27, 2021 makes several recommendations (p 5-6):

i) ***The intervenors recommended that NS Power re-evaluate the use of a low design temperate (sic) in future forecasts, to which NS Power agreed. The Board, therefore, directs NS Power to evaluate peak causing conditions and a peak forecast based on historic peak temperatures (such as a 1-in-2) in its future load forecasts, as well as add trends in peak weather in the 2022 Load Forecast Report.***

ii) ***NS Power agreed with the CA's recommendation on weather normalizing and presenting a more accurate approach to estimating the impact of incremental cold on loads. Therefore, the Board directs NS Power to evaluate improvements to the weather normalization estimate and examine the impact of incremental cold on loads in the temperate ranges where peak loads occur. These updates to the forecast are to be provided in future load forecast reports, preferably in the 2022 Report, but if not possible then in the 2023 Report.***

iii) ***The SBA suggested that NS Power include forecast accuracy for the system peak in addition to the energy and firm peak presented in the Load Forecast Report. NS Power is directed to incorporate this into future load forecast reports.***

iv) ***The CA stated that it is more common to use load-weighted averages of temperatures from multiple weather stations in a load forecast, and cited NS Power's planning reserve margin study that used weather station data from three different areas of the province. NS Power agreed to add more weather station data to future load forecasts, but stated that Halifax is the major load centre of the province, followed by Sydney and the remainder of the load is dispersed throughout the more rural areas of the province. NS Power suggested that increasing the data may increase the complexity of the model without improving accuracy. However, given the ranges in weather event occurrences throughout the province, the Board***

directs NS Power to incorporate more weather station data into future load forecasts using a load weighted approach.

v) NS Power's rebuttal was agreeable with many of the recommendations by intervenors. However, in response to intervenors' request for more information on the Smart Grid Nova Scotia and Water Heating Demand Response projects, NS Power stated that the results are preliminary, although they also stated that the results are incorporated into the load forecast when possible.

vi) ***The Company also indicated that it provides semi-annual reporting to the Board and stakeholders on the Smart Grid and the Demand Response projects, therefore, further reporting is not necessary. However, the Board directs NS Power to report the results from the Smart Grid and Water Heating Demand Response projects, as it relates to the impacts that these pilot projects have on load, in the 2022 Load Forecast.***

(a) Please indicate how this forecast responds, or does not respond, to each of these recommendations.

(b) Please indicate how future reports will incorporate these recommendations.

Response IR-43:

(a) (i) Please refer to sections 4.2 and 10 of the Report.

(ii) This will be addressed in the 2023 load forecast.

(iii) The information is included in Appendix C.

(iv) Please refer to section 4.2 for the energy model. The peak model will be addressed in the 2023 load forecast.

(v-vi) Available information on these projects has been included in sections 4.4 and 10 of the Report.

(b) Peak weather normalization will be updated in the 2023 load forecast, as will the analysis of a weighted weather input to the peak forecast. Any available updates from the Smart Grid or Water Heating Demand Response will also be incorporated in the 2023 load forecast.