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Request IR-1:

Reference: NS Power 2022 Load Forecast, page 15, lines 3-8.

"As part of the 2020 IRP Action Plan, NS Power has worked with third party consultant E3 to develop forecasts for space heating and EV uptake that will allow the province to meet stated emissions goals and EV sales targets over the next 20 years. This work uses stock rollover models to assess uptake required under scenarios that meet these goals, without assuming any specific change to regulations or incentives, though both are possible in the timeframe of the current 10-year load forecast."

(a) Please provide all inputs and outputs of E3's stock rollover models in their original form.

(b) Please provide final copies of all E3 deliverables provided to NS Power related to the electrification work with all formulae intact. This may include but is not limited to E3's stock rollover model, model inputs and outputs, reports and presentations.

Response IR-1:

(a-b) Please refer to NSUARB IR-2. Please also refer to Synapse IR-42 for the output data from E3. E3 also provided a presentation which is included in Appendix E of the Report.

Request IR-2:

(a) Please describe all electrification research/pilots/programs NS Power is currently planning and/or carrying out.

(b) Please provide all applicable project schedules, studies and/or reports that have been developed for activities listed in response to part (a) of this IR.

Response IR-2:

(a)

(i) Residential Customer Programs: NS Power currently supports electrification in the residential sector through the heating solutions program, with a focus on customers that heat their home using non-electric sources. The program includes education on electric-based technologies including heat pumps, water heaters and electric thermal storage. The program also includes a network of over one hundred contractors across the province and offers on-bill financing for eligible customers.

(ii) Commercial Customer Engagement: NS Power supports customers in commercial rate classes on electrification opportunities. The commercial program includes heating ventilation and air conditioning (HVAC) electrification programs with partner contractors to support the adoption of efficient, electric-based solutions. The program also conducts and supports industry studies which identify building decarbonization initiatives through electrification, engagement with Key Accounts to identify opportunities to save money and reduce emissions, highlight technologies to electrify facilities, and the promotion of electrification rebates and funding programs to offset capital investment.

(iii) Smart Grid Nova Scotia (M10176): A four-year pilot program focused on studying the effects posed by distributed energy resource (DER) penetration on the electrical

system and the opportunity to partner with customers to unlock new value offered by DERs. While DER penetration is expected to continue growing in the province, sharing the value offered by DERs with customers can make electric-based solutions even more accessible while mitigating potential challenges including an increase to peak demand.

(iv) Transportation Electrification: In addition to electric vehicle (EV) pilots included in the Smart Grid Nova Scotia Program (M10176), NS Power is supporting the transition to electric mobility through various initiatives. The Company's existing charging station network is closely studied to understand usage and impact to the electrical system, and data is shared with various stakeholders to help inform future public charging infrastructure requirements. Support is being provided to municipal initiatives including Halifax Regional Municipality's Electric Vehicle Strategy (Municipal Electric Vehicle Strategy - November 4/21 Environment and Sustainability Standing Committee | Halifax.ca) and Halifax Transit's Electric Bus Proposal (Electric Bus Proposal | Halifax). NS Power is expanding its own fleet of EVs and supporting charging infrastructure, which now includes sixteen total EVs, and is supporting commercial customers across the province as they transition their fleets to electric.

(v) Electrification Strategy: NS Power is developing an Electrification Strategy as part of its ongoing IRP Action Plan. This work is being conducted in partnership with Energy + Environmental Economics (E3) and incorporates five tasks, as described in NS Power's IRP Action Plan Update. The IRP Action Plan Update also provided an overview of findings from the jurisdictional scan task. Electrification load impacts from this work were incorporated into the 2022 Load Forecast Report, as discussed in the report and at the accompanying stakeholder workshop. Completion of this work is now targeted for Q3 2022.

(b)

(i) Residential Customer Programs: Please refer to materials filed with the NSUARB in M0931.

(ii) Commercial Customer Engagement: Please refer to case studies at Energy Solutions For Your Business| Nova Scotia Power (nspower.ca)

(iii) Smart Grid Nova Scotia: Please refer to the materials and project reports filed with the NSUARB in (M09985).

(iv) Transportation Electrification: Pleaser refer to Electric Vehicles| Nova Scotia Power (nspower.ca)

(v) Electrification Strategy: Please refer to the update on Electrification strategy development contained within the IRP Action Plan Update, April 2022[1], pages 24-28.

[1] IRP Action Plan Update Jan 2022 - April Update (nspower.ca)

Request IR-3:

(a) Is it NS Power's position that cost-effectiveness testing is appropriate to apply to all ratepayer funded electrification pilots and programs? Please provide the basis for your position.

Response IR-3:

NS Power is developing an electrification strategy that is aligned with the 2020 IRP Action Plan as well as the NS provincial objective of economy-wide decarbonization. NS Power is reviewing policies and incentives implemented in other jurisdictions to assist in electrifying and decarbonizing energy use in the heating and transportation sectors. NS Power has not determined its position on electrification cost effectiveness testing at this time.

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Request IR-4:

Reference: NS Power 2022 Load Forecast, page 15, lines 3-8.

"As part of the 2020 IRP Action Plan, NS Power has worked with third party consultant E3 to develop forecasts for space heating and EV uptake that will allow the province to meet stated emissions goals and EV sales targets over the next 20 years. This work uses stock rollover models to assess uptake required under scenarios that meet these goals, without assuming any specific changes to regulator or incentives, though both are possible in the timeframe of the current 10-year load forecast."

(a) Is it NS Power's position that the Nova Scotia energy market is fully aligned with the Federal Zero-Emission Vehicle (ZEV) mandate for 2030 as proposed, as well as the Province of Nova Scotia Environmental Goals and Climate Change Reduction Act?

(b) Does NS Power anticipate the market is likely to follow the trajectories as modelled by E3 without any additional interventions?

(c) If the answer to (a) is no; is there a significant risk that electrification will not follow the modelled trajectory? If yes, please provide specific details on how NS Power intends to mitigate this risk.

(d) If additional market interventions are viewed as necessary, what process will NS Power follow to determine:

(i) the level of ratepayer intervention required; and

(ii) whether such intervention is beneficial to ratepayers?

Response IR-4:

(a) NS Power has not undertaken an energy market-wide analysis to determine alignment relative to the goals of the Environmental Goals and Climate Change Reduction Act (EGCCRA).

(b) As described in the Report, the trajectories modeled were designed to meet the end state (e.g. 2050 economy-wide net zero) and in some cases interim goals that are prescribed by environmental legislation and policy, while accounting for equipment lifetimes and targeting a smoothed transition to reduce pressure in any given year on limited resources such as equipment supply chains and installers.

(c) NS Power intends to work with partners to enable electrification programs in support of provincial and federal decarbonization targets. The trajectories modeled are forecasts, and changes in technology, policy, and economic inputs could impact the pace of electrification.

(d) The process by which NS Power will consider such measures has not yet been determined.

Request IR-5:

Reference: NS Power 2022 Load Forecast, page 36, Figure 20.

(a) Please confirm whether there are heating options other than heat pumps which also provide an electrification trajectory in Nova Scotia. If no, please explain. If yes, please provide details of these options including provision of all data and analysis supporting this position.

(b) What factors are responsible for the decreasing share of wood and electric resistance shares, as modelled by E3 as part of this analysis? Are these changes expected to be fully market driven?

(c) What role will other heating systems technologies have in meeting net zero objectives? Please list all that apply as well as their anticipated impact.

Response IR-5:

(a) The forecast assumes that heat pumps will be the technology used to provide the space heating electrification necessary to contributed to the achievement of carbon emission reduction targets. Other electric heating sources (such as electric baseboards and electric thermal storage) were not considered by E3 as they are less efficient than heat pumps.

(b) The model is not based on economic uptake. It is based on the changes required in the space heating sector to meet emission reduction targets.

(c) Other heating system technologies are not included in this model as heat pumps have greater efficiency than resistive heating and can be widely deployed.

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Request IR-6:

Reference: NS Power 2022 Load Forecast, page 36, Figure 20.

Please provide the current shares of residential heat pump stocks by the following categories:

(i) Ductless Heat Pumps;

(ii) Central Air-to-Air;

(iii) Central Air-to-Water; and

(iv) Ground Source.

Response IR-6:

Available data does not distinguish between heat pump types, but it is assumed the majority are ductless with some central air to air.

Request IR-7:

Reference: NS Power 2022 Load Forecast, page 80, lines 27-30

"DR forecasts continue to use an effective load carrying capacity (ELCC) of 48 percent to account for the fact that the full nameplate capacity will not be available at all times, and this value will be reassessed as more information is gathered through the implementation of DR programs".

(a) Is the load forecast intended to estimate how much demand response (DR) capacity is available during the system peak (highest single hourly average demand in a year)? If no, please explain the reason for such limitations.

(b) E1's proposed 2023-2025 DSM Plan DR program considers the average available capacity during system peak (modelled as 5-8 pm, December through February), and has considered factors such as the intermittency of resources (load factors), opt-out rates, and the limited nature of demand response resources. By applying an ELCC of 48% has NS Power underrepresented the value of demand response resources? If no, please explain.

(c) Please describe how NS Power determines when to use an ELCC factor.

(d) Please describe in what contexts it is appropriate to apply an ELCC factor to DR, and when is it not appropriate.

(e) If NS Power believes it is appropriate to apply an ELCC to DR in the load forecast, should an ELCC be applied to other time limited demand-side resources such as the large industrial interruptible rider and EV managed charging? If not, please explain.

Response IR-7:

(a) The Load Forecast is estimating annual system firm peak, incorporating an estimate of the reliability contribution of Demand Response (DR) programs based on the Planning Reserve Margin and Capacity Value Study[1] completed for the 2020 Integrated Resource Plan (IRP). Firm peak is an input used for capacity resource planning and this value is carried into studies and reports such as the IRP and NS Power's annual 10-year System Outlook.

(b) No, the application of the Effective Load Carrying Capability does not lead to underrepresenting the contribution of DR programs. ELCC assessment is industry best practice for determining the capacity value of dispatch limited resources (both demand side and supply side) for reliability planning purposes when applied to nameplate values. NS Power's approach of applying the calculated ELCC to DR was discussed with EfficiencyOne and other stakeholders as part of the 2020 IRP process. NS Power's ELCC estimates for specific DR programs will be refined as programs are developed and better data is available.

(c) NS Power applies an ELCC factor to dispatch-limited resources when conducting long-term capacity expansion modeling. This is done to ensure that resource portfolio development reflects resource capabilities appropriately in calculations of supply adequacy.

(d) If the use of a particular DR resource is constrained to a relatively short duration per call, or if there is a limitation on the number of calls in a given period of time (e.g. per month or per year), the application of an ELCC factor is warranted. This ELCC factor is calculated via reliability modeling, as described in NS Power's Planning Reserve Margin and Capacity Value Study. As the available number of calls and duration of call increase,

[1] Exhibit N-9 M08929,NS Power IRP Appendices A-N, page 111of1348, March 11, 2020

the ELCC increases as well reflecting the increased capacity value of more flexible DR programs relative to inflexible programs.

(e) An ELCC factor is not required for the large industrial rider. NS Power has the capability via real time telemetry and control and/or interruption notifications and penalties to curtail customers on the interruptible rider, and, as such, has assurance of immediate (i.e. 10 minutes notice) capacity reduction capability. NS Power's Control Centre has the capability to ensure interruptible customers are not contributing to peak demand during emergency conditions, over long durations if necessary. Finally, the nature of curtailing interruptible customers is different from Demand Response, as residential customers may have periods of inelastic response during certain conditions (e.g. the eventual requirement for water or space heating). The program design of potential EV managed charging will determine what ELCC factor, if any, is applied for resource planning purposes.

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Request IR-8:

Reference: NS Power 2022 Load Forecast, page 37, lines 4-6 and page 38, Figure 22.

"E3 saturation estimates had a lower starting point than the NS Power models, so the NS Power series was adjusted to meet the E3 series by around 2040 as shown in Figure 22, resulting in a slightly lower trajectory."

Figure 22 indicates that NS Power's model estimates commercial electric heating share in 2021 to be ~52%, while E3's model estimates the share to be ~27%. This is a significant variance, particularly in the near-term.

(a) Please describe the specific assumptions and/or modelling approaches that are causing this significant difference in results.

(b) What is the best estimate of current commercial electric heating share? Please provide this estimate by the following type of heat pump:

(i) Ductless Heat Pumps

(ii) Central Air-to-Air

(iii) Central Air-to-Water

(iv) Ground Source

(c) Why have the models not been calibrated to produce similar results?

Response IR-8:

(a) Please refer to NSUARB IR-9 for a description of the difference in the forecasts.

(b) Available data does not distinguish between heat pump types. Overall electric heating saturation can be found in 2022 LFR Attachment 02 Small General Intensities and 2022 LFR Attachment 03 General Intensities, Shares tab.

(c) The trajectories have been calibrated to show similar increases over the forecast period.

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Request IR-9:

Reference: NS Power 2022 Load Forecast, page 39, lines 4-14.

"The capacity of heat pumps in the model is also assumed to decline as a function of COP which causes greater reliance upon backup electric resistance heating with lower efficiency during coldest hours increasing peak impacts."

(a) Please elaborate on the modelled performance of systems as Outside Air Temperatures decrease below – 15 °C.

(i) Are all types of heat pumps expected to have the same low-temperature behavior? If no, please describe any differences including design differences and specific limitations.

(ii) Is any contribution from heat pumps (as opposed to back-up) expected below -15 °C?

(iii) At what temperature(s) are heat pump coefficients of performance expected to reach 1.0?

(b) Please elaborate on any coincidence factor associated with the electric backup of heat pumps. Is any coincidence factor assumed for electric backup heating in the RESHAPE analysis?

(c) What penetration of electric resistance heating is assumed for backup of heat pumps in 2050?

(d) If the answer to (c) is less than 100%, what other types of back-up heating are expected to be in place for heat pumps in 2050, and what percent of the market are they expected to serve?

(e) Does NS Power view Electric Thermal Storage systems as effective backup to Air-Source Heat Pump systems? Please explain.

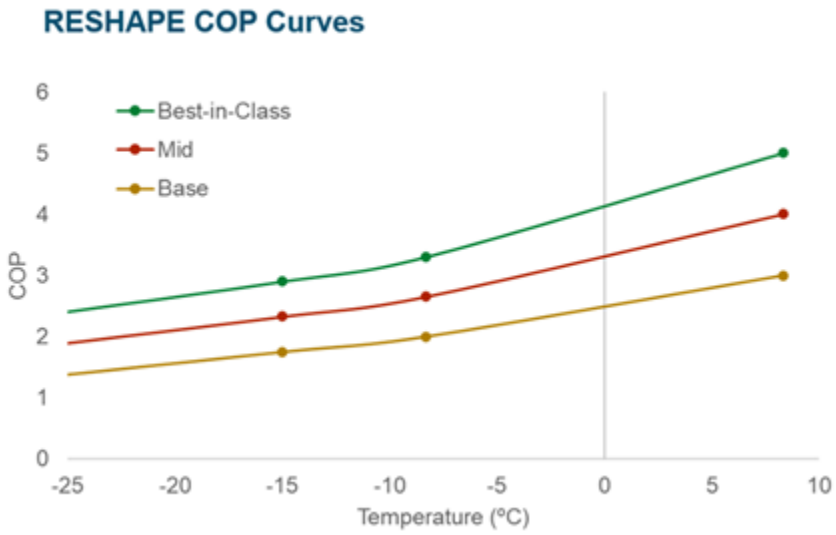
(f) Does NS Power view any other systems as creating effective backups? If so, please outline these systems.

(g) Does the RESHAPE modelling analysis include any changes to heating degree days or cooling degree days associated with climate change as part of the analysis of peak demand effects?

(h) Does the model consider the impact on heat pump efficiency due to the expected transition to low-Global Warming Potential (GWP) refrigerants in North America over the coming decade? If no, should it be considered? If yes, what low-GWP heat pump technologies have been modelled and when will they be assumed to be required in Nova Scotia?

Response IR-9:

(a) (i-iii) E3 modeled a mix of 30 percent Base efficiency, 40 percent Mid efficiency and 30 percent Best in Class heat pumps. The corresponding COPs are shown in the following graph:



All heat pumps are assumed to be sized to meet 93-95 percent hourly demand, and E3 assumed these heat pumps "lock out" below -7 degrees C and only the auxiliary heating source (electric resistance) serves the load below these temperatures. Modeling assumes no contribution from heat pumps below -7 degrees Celsius.

E3 models diversified load by capturing spatial and temporal variation in temperature and the housing stock. Each county in Nova Scotia was modeled with hourly historical temperature data sourced from approximately the geographic centroid of each county. Therefore, peak heating demand across the province reflects the fact that each county may not experience its coldest temperatures at the same time.

(c-d) E3 assumes 100 percent penetration of electric resistance heat backup in 2050 for the 2022 Load Forecast.

(e) Yes, NS Power views Electric Thermal Storage (ETS) as an effective backup for Air-Source Heat Pump systems when ETS is sized appropriately to carry the heating load.

(f) NS Power views heat pumps paired with existing fossil fuel systems (serving as back-up) as effective alternatives to electric resistive backup sources, however NS Power is uncertain on the implication of these hybrid systems to achieving 2050 Net Zero targets.

(g) No, weather is assumed to be consistent over the forecast.

(h) No, those are not modeled, and the potential impact to the forecast is not known. It is unlikely this would have a significant impact on the forecast within the 10-year timeframe.

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Request IR-10:

Reference: NS Power 2022 Load Forecast, page 43, lines 12-13

"The peak impact assumes that 70 percent of charging is managed by NS Power (including smoothing through vehicle-grid integration) and 30 percent of charging is unmanaged."

(a) As part of its 2023-2025 DSM Plan, E1 has included EV managed charging in its demand response program. Does NS Power consider this as a possible way to achieve managed EV charging? Why or why not.

(b) Does NS Power consider a Critical Peak Pricing (CPP) rate structure as a possible way to achieve managed EV charging? Why or why not.

(c) How will NS Power ensure capacity savings from E1's EV charging offer is not double counted through both the managed charging inherent in the EV forecast, and the demand response programs that are subtracted from system peak?

Response IR-10:

(a) Programs that enable active control of electric vehicle demand are a possible way to achieve managed EV charging. NS Power would need additional details on the proposed demand response program to better understand the impact to peak demand.

(b) Rate structures such as CPP are a possible way to achieve managed EV charging when they are designed to incent shifting electricity use away from peak demand periods. The impact of rates structures, including CPP and Time Varying Pricing (TVP), are being studied through a pilot and will be compared against other managed charging approaches included in the Smart Grid Nova Scotia pilot project.

(c) NS Power will adjust the modeling of EV peak and energy impacts over time to account for E1 and other managed charging programs as they are rolled out, and as EV penetration increases leading to more actual data being available to inform load forecasting.

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Request IR-11:

Reference: NS Power 2022 Load Forecast, page 80, lines 19-21

"DR savings amounts are based on the demand reduction amounts included in the 2020 Integrated Resource Plan (IRP), which evaluated an aggregation of DR programs."

E1 has proposed a demand response program as part of the 2023-2025 DSM Plan. Has this updated demand response been incorporated into the 2022 Load Forecast in the same manner as energy efficiency from the 2023-2025 DSM Settlement Plan? If not, please explain why.

Response IR-11:

No, for the purposes of the forecast it was assumed that E1's proposed demand response measures are incorporated into the larger demand response program that is being developed as part of the IRP Action Plan.

Request IR-12:

Reference: NS Power 2022 Load Forecast, Appendix E, page 3 of 8.

"Measures are lower cost and commercially available to support economy-wide decarbonization"

(a) What are the electrification measures that NS Power is using for the quoted comparison above?

(b) What decarbonization measures are the electrification measures being compared to?

(c) Has NS Power analysed the costs and benefits of both the electrification and other decarbonization measures? If yes, please provide the values and sources for this information. If no, why not?

(d) Please provide an expanded description of the comparison being made by the quoted statement above.

Response IR-12:

(a-d) This statement refers to the findings of the *Canada's Net Zero Future* report from the Canadian Climate Institute (February 2021)[1]. Please refer to section 5.0 of that study for a discussion on technologies such as building and transportation electrification which are common to all net zero futures analyzed in the report. The report states:

> Many solutions - including improving energy efficiency, shifting to non-emitting electricity, adopting heat pumps and electric vehicles - will likely be part of Canada's net zero journey no matter which pathway is taken.

[1] Canadas-Net-Zero-Future_FINAL-2.pdf (climatechoices.ca)

> These "safe bets" will contribute a significant portion of the emissions reductions required to get Canada to its 2030 emissions target.[2]

This is consistent with findings in other economy-wide decarbonization analyses, including the Deep Decarbonization in Nova Scotia study that informed the 2020 Integrated Resource Plan (IRP). Please refer to NSUARB IR-07 for further discussion on this point.

[2] Canadas-Net-Zero-Future_FINAL-2.pdf (climatechoices.ca), page 4 of 132