VERSCHUREN CENTRE
For Sustainability in Energy and the Environment

February 14th, 2020

Nova Scotia Power – IRP Team
Nicole Godboot, Lia MacDonald, Mila Milojevic, Brendan Matheson, Linda Lefler

Via email

Re: Comments regarding initial IRP Assumptions

Thank you for the opportunity to participate in the Integrated Resources Plan engagement session. In response to the Assumptions provided on January 21, 2020 and February 3, 2020, we offer the following comments, questions and suggestions:

1. **Energy Storage**

The Verschuren Centre engaged industry partners for updated capital cost and O&M cost of Lithium Ion Battery systems. The data are broken down by size, to help facilitate a more granular substation-level perspective, as discussed in more detail later in this letter.

	2019	
	CapEx ($/kW)	**Fixed O&M ($/kW-yr)**
Residential Li-Ion Battery (3hr) (scalable to any size)	$3000	$100
Li-Ion Battery (1hr) (1 – 10MW)	$700	$18
Li-Ion Battery (1hr) (10 – 100MW)	$500	$13
Li-Ion Battery (2hr) (1 – 10MW)	$1100	$21
Li-Ion Battery (2hr) (10 – 100MW)	$900	$17
Li-Ion Battery (4hr) (1 – 10MW)	$1900	$25
Li-Ion Battery (4hr) (10 – 100MW)	$1700	$21

We are also interested to learn more detail regarding how energy storage will be considered in the Plexos model. Energy storage systems can provide multiple value streams including: energy; capacity; ancillary services such as frequency regulation, operating and spinning reserves; demand response; load following and other benefits enabling increased efficiencies of existing grid assets. Much of the value of energy storage comes from its ability to respond extremely quickly with no ramp rates and provide flexibility as both a load and a generator. For example, a 100MW energy storage facility can act as both 100MW of generation and 100MW of load, providing a total of 200MW of flexibility to the grid. It is important that the model consider all potential value streams for energy storage systems, and how they can be stacked; to most accurately determine the lowest cost solution for ratepayers. This importance has been confirmed by FERC through the passing of Rule 841 requiring fair market access for energy storage resources (over 100kW) in RTO jurisdictions. Please provide more detail regarding how the various value streams of energy storage will be accounted for in Plexos.

2. Electrification

We think it is critically important that this Integrated Resource Plan consider an appropriate amount of electrification. There is a significant body of research that suggests that electrification will be the most cost effective pathway to zero emissions. It is reasonable to suggest, therefore, that electrification will be the most cost effective pathway for Nova Scotia to achieve the targets of the Sustainable Development Goals Act.

The Verschuren Centre has calculated the 2017 total final energy requirement in Nova Scotia to be 4.7TWh for transportation and 9.6TWh for fossil fuel based space heating.

Many major economies are planning to ban the sale of internal combustion engines within the next 5 to 20 years. Therefore, it would be reasonable to assume that by 2050, 80-100% of transportation will be either directly electric, or powered through an electric fuel cell or other electricity derived source.

For space heating, heat pump technology is already cost competitive compared to most alternatives, and technologies are only improving over time. Therefore, electrification of space heating of 80%-100% by 2050 would also be reasonable. It is also important to note that the coefficient of performance of heat pumps will reduce the final impact of the space heating energy on the grid significantly. Space heating loads are also aligned with current electricity demand peaks, and therefore, electrification of space heating presents significant capacity concerns as well.

3. Distribution

On its own merits, it is clear that this IRP should take into account substation level capacity considerations. The electrification suggestions above will only accelerate this need. Recent locational studies filed with the UARB show a list of 34 heavily loaded substations transformers that are near or over their capacity. (M07815 – 2018 Locational Pilot Update – Table 1, Page 5). Some of these substations have associated transmission restraints as well.

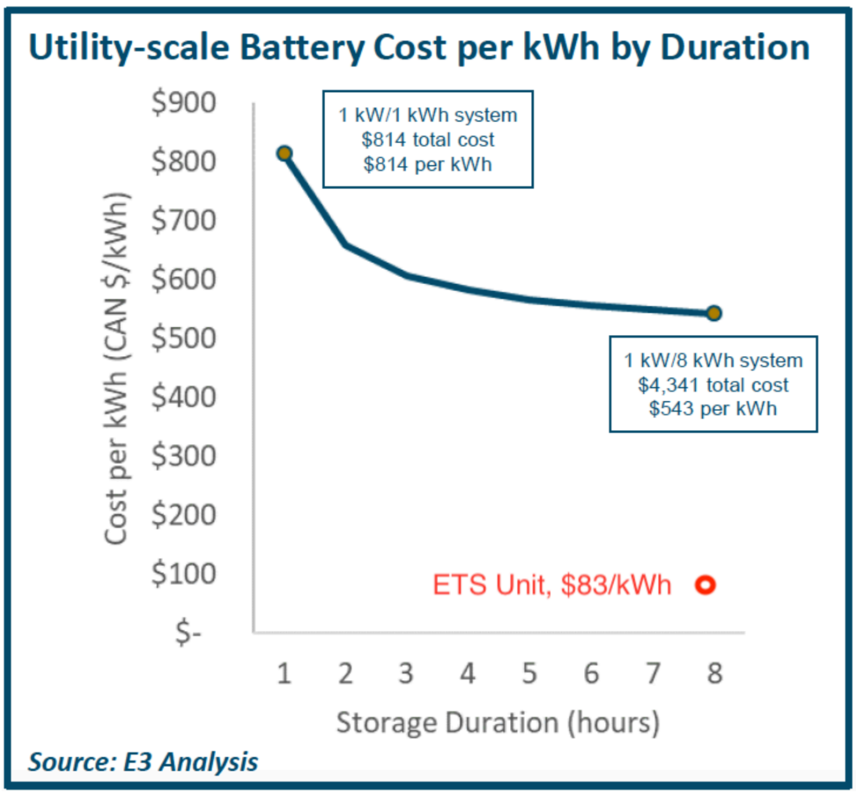
Most of the transportation and space heating electrification will take place at the end of the line, and therefore, place additional load on this fleet of already heavily loaded substations.

To facilitate this analysis, a suite of distribution scale energy and capacity assumptions should be considered (1-10MW). We have provided data points for lithium battery and thermal storage, and inputs from the wind and solar industries should be sought as well.

4. Thermal Storage

As noted in our August 2019 letter to NS Power as part of the pre-IRP engagement, and subsequent meeting, The Verschuren Centre is suggesting that thermal energy storage be given closer consideration in the IRP. Broadly speaking, thermal energy storage includes any technology that has the potential to store heat or cold onsite behind the meter, to offset future heating and cooling needs. Considering that peak demand on the NS Power grid is highly aligned with space heating, and that electric space heating demands are likely to grow significantly over the next 20-30 years, it makes it clear that there is significant value in having flexibility in that demand.

Thermal storage technologies are very cost completive with other sources of capacity (~$520/kW), and even more competitive compared per kWh (~$83/kWh). A typical ETS unit, upon which this pricing is based, can provide 12+ hours of storage. In simple terms, the materials used to provide thermal storage; brick, water, salt, concrete, etc; are all inexpensive and durable long term. See the following graphic comparing the ETS cost per kwh versus the Utilities Scale battery cost data from E3's pre-IRP documentation.



Based on this data, we feel that thermal storage should be considered separately from other forms of energy storage and demand control in the IRP model. Thermal storage does not have all the abilities of other electrical storage technologies, but it also has more potential, and higher ELCC, than other demand control technologies.

It should also be noted that thermal energy storage could be the best solution for balancing wind energy, as both wind energy and space heating needs are generally aligned during the year. See figure below.

VERSCHUREN CENTRE
For Sustainability in Energy and the Environment

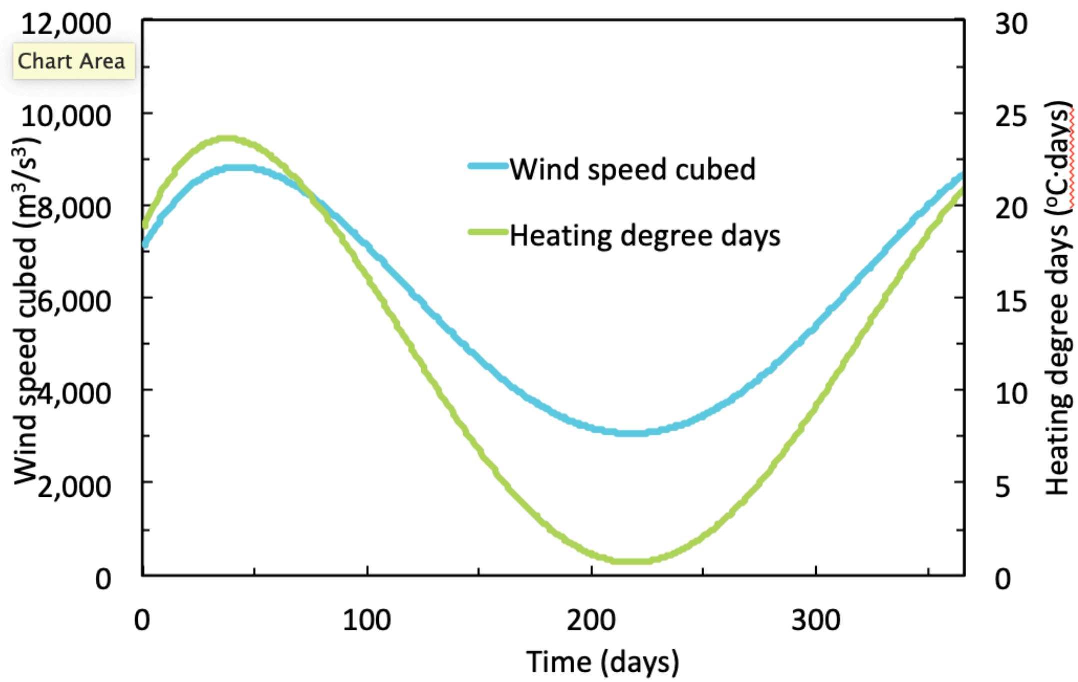
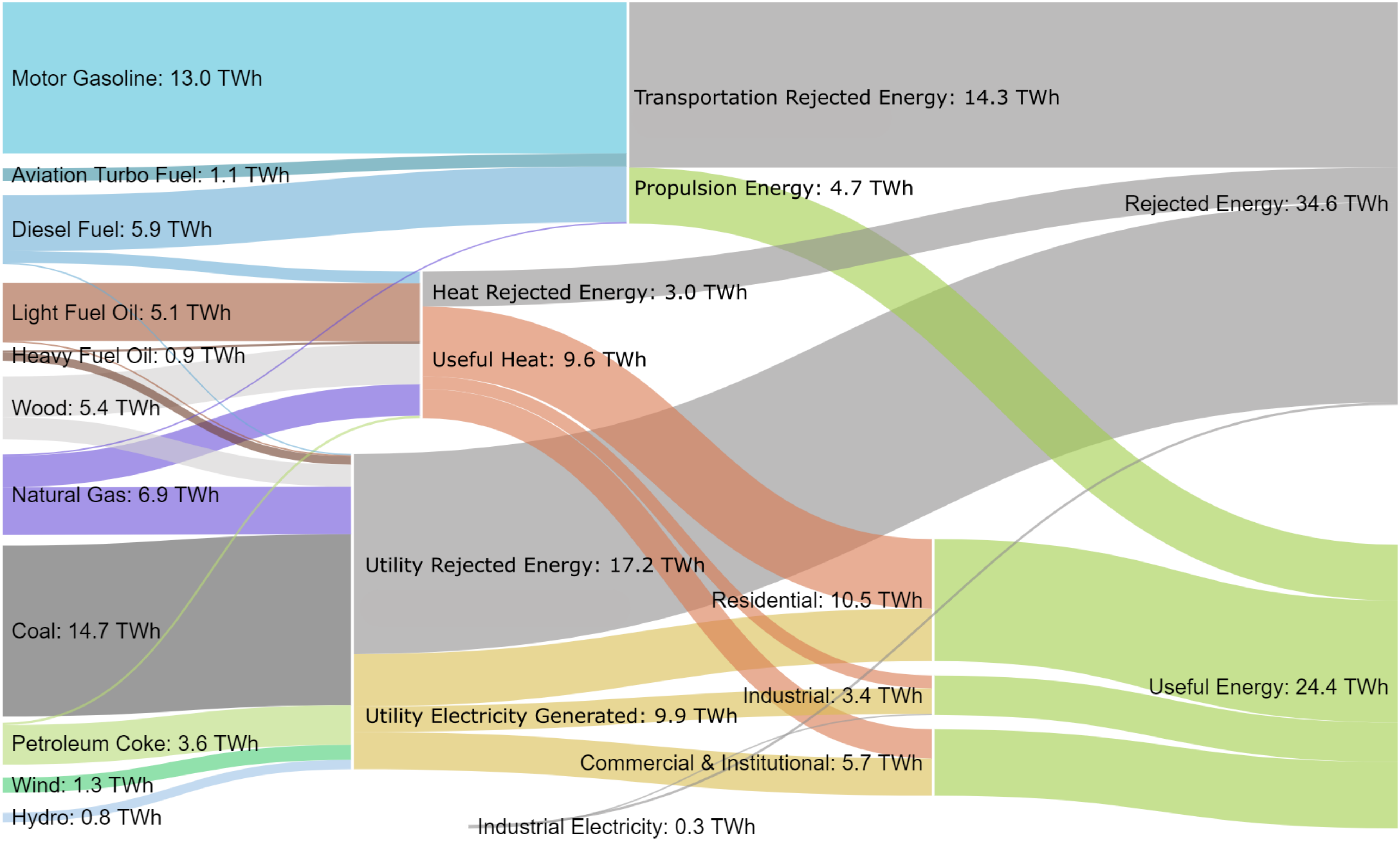


Figure 2. Wind speed cubed and heating degree days for Environment and Climate Change Canada's weather station at Sydney Airport. Data were averaged from 2008 to 2017.

Thank you again for the opportunity to participate in this process, and we are happy to discuss any of the topics above in more detail with NSPI and E3.

Sincerely,

Daniel Roscoe, P.Eng
Lead – Renewable Energy
Verschuren Centre for Sustainability in Energy and the Environment


Motor Gasoline: 13.0 TWh
Aviation Turbo Fuel: 1.1 TWh
Diesel Fuel: 5.9 TWh
Light Fuel Oil: 5.1 TWh
Heavy Fuel Oil: 0.9 TWh
Wood: 5.4 TWh
Natural Gas: 6.9 TWh
Coal: 14.7 TWh
Petroleum Coke: 3.6 TWh
Wind: 1.3 TWh
Hydro: 0.8 TWh
Transportation Rejected Energy: 14.3 TWh
Propulsion Energy: 4.7 TWh
Heat Rejected Energy: 3.0 TWh
Useful Heat: 9.6 TWh
Utility Rejected Energy: 17.2 TWh
Utility Electricity Generated: 9.9 TWh
Industrial Electricity: 0.3 TWh
Residential: 10.5 TWh
Industrial: 3.4 TWh
Commercial & Institutional: 5.7 TWh
Rejected Energy: 34.6 TWh
Useful Energy: 24.4 TWh