Name: Rob Botterell

Organization: PVLA and PVEA

Date: October 02, 2017

Subject: Question 20: Impact of Electric Vehicles on Load Forecast

Good Afternoon Commission Secretary Patrick Wruck,

Please find attached our Phase 2 submission on Question 20 from Peace Valley Landowner Association and Peace Valley Environment Association expert Robert McCullough.

Please let me know if there is any other information you require or any questions you may have.

Thank you for your assistance in this regard. I can be reached at [redacted]

Rob Botterell

MCCULLOUGH RESEARCH

ROBERT F. MCCULLOUGH, JR.
PRINCIPAL

Date: October 2, 2017

To: British Columbia Utilities Commission

From: Robert McCullough

Subject: Question 20: Impact of Electric Vehicles on Load Forecast

British Columbia Hydro has predicted that electric vehicles will constitute a significant proportion of electricity demand within the coming years. It is argued that the forecast increase in demand due to electric vehicles will help to offset or mitigate any forecast reduced load from, for example, industrial customers. However, there is no evidence that this will be the case.

BC Hydro has seemingly failed to realize that the lengthy refueling times for electric vehicles will tend to move the load into off-peak hours. As noted below, this is a very different view than held elsewhere in the industry. This will reduce – or even eliminate – the need for new capacity to serve this emerging technology.

In their August 30, 2017 submission to the BCUC, British Columbia Hydro predicted the following forecast for electric vehicles:

Table H-1 EV Load, Number of Electric Vehicles, and Market Share

Fiscal Year	EV Energy[1] Sales (GWh)	EV Peak Demand[1] (MW)	Total Number of Projected EVs	Market Share Percentage of Total Vehicles[2] %
F2018	20	6	8,211	0.3
F2019	28	9	11,171	0.4
F2020	38	12	15,007	0.5
F2026	323	101	125,114	3.6
F2030	856	299	299,258	8.1
F2036	1,770	648	578,268	14.5

Notes:
1. The EV load above does not include system losses and are before rate impacts as the values arethe raw projections from BC Hydro's in house energy and peak EV models.
2 For fiscal 2018 the estimate of the total number vehicles in BC is about 3.1 million cars and at the end of the forecast the estimate based on driving population growth is about 4 million cars

Figure 1:British Columbia Hydro's predictions for electric car sales and power consumption in BC.[1]

[1] British Columbia Hydro. BCUC site-c inquiry submission. Appendix H Page 19.

By 2026, they project that over 125,000 electric vehicles will be on the road, adding 100 megawatts to peak demand.

According to a study published in the Electrical Power Systems Research journal electric vehicles are rarely charged during peak hours.[2]

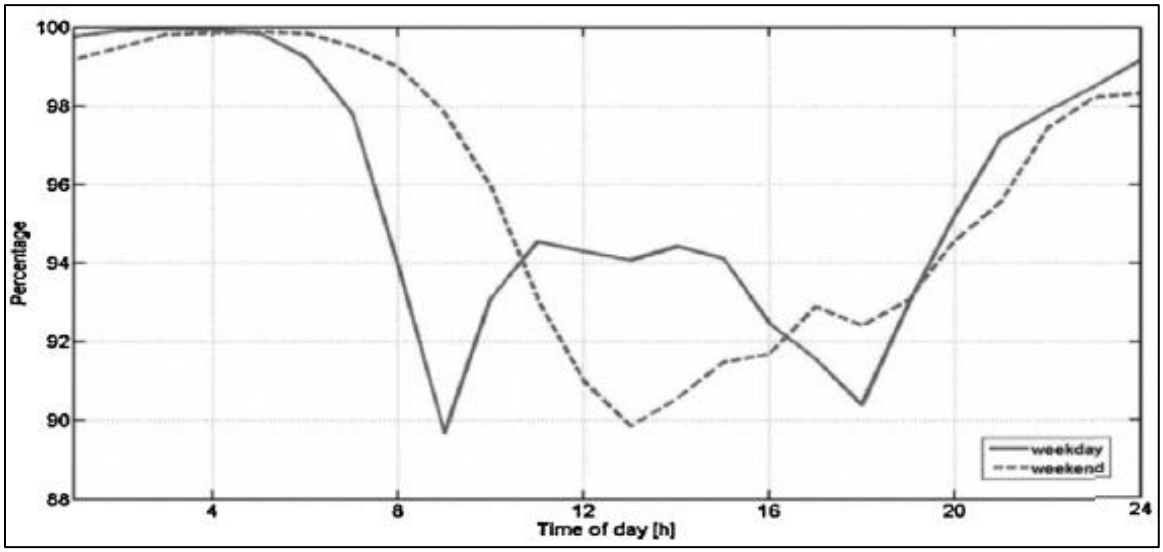

Figure 2: Percentage of cars parked at certain times of day.[3]

As we might expect, cars are most likely to be driven during the day, which implies that an electrical vehicle will be less likely to be charged during those hours.

The Electrical Power Systems Research article also generated a simulation showing the electricity demanded by 1,000 plug-in electric vehicles.

[2] Electric Power Systems Research. Probabilistic estimation of plug-in electric vehicles charging load profile. March 2015
[3] Ibid., Page 5.

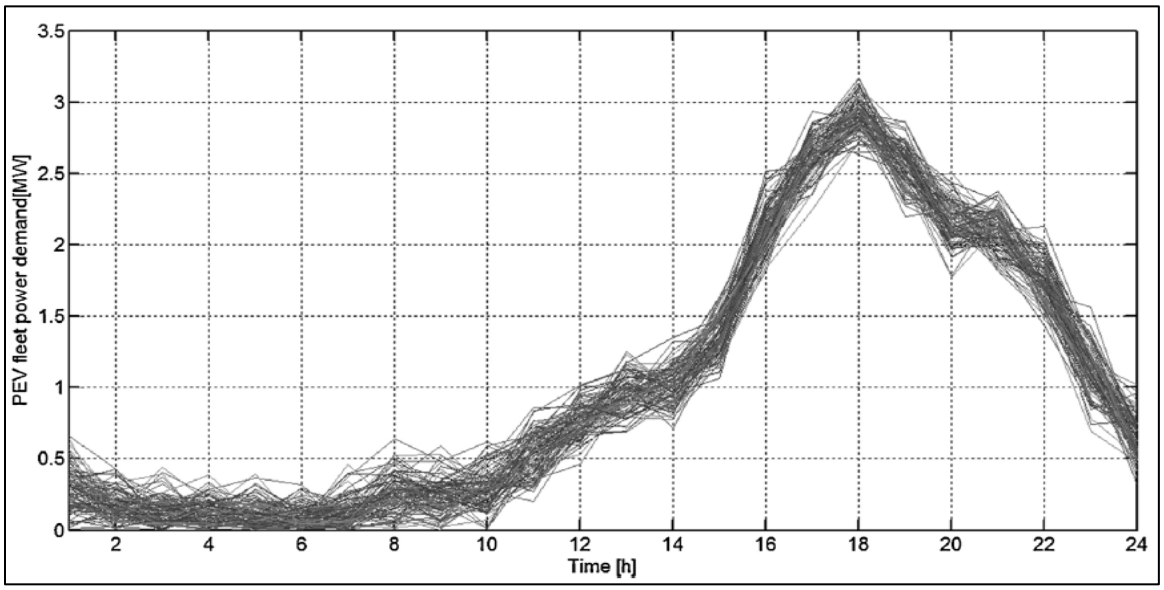

Figure 3: Numeric simulation of uncontrolled domestic power demanded by 1,000 electric vehicles at a given time of day.[4]

The state of California's Fact Sheet clearly states the impact is going to be off-park:

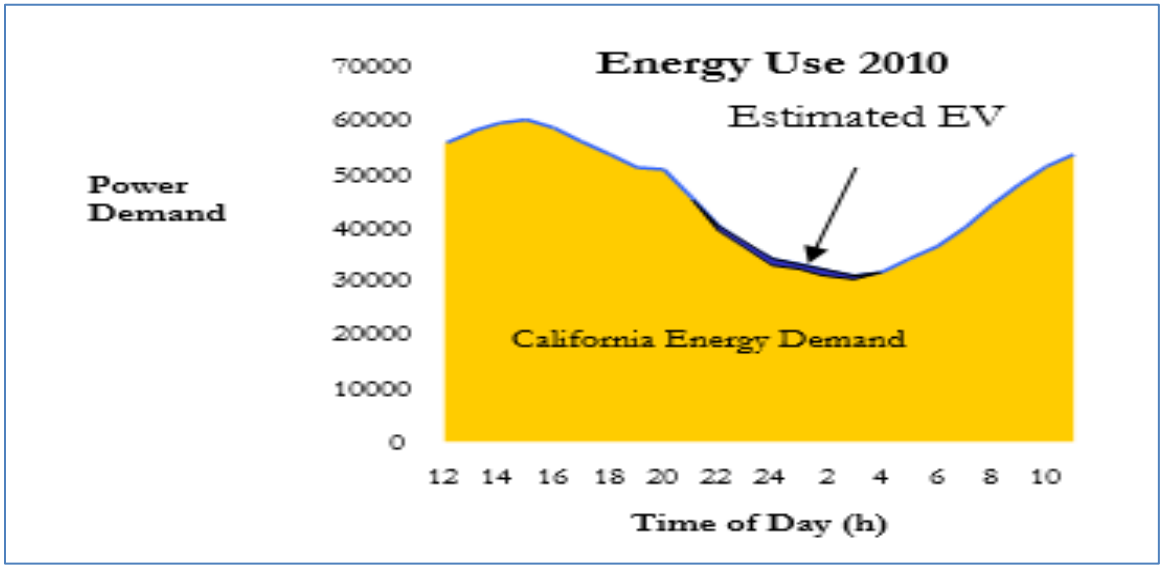

Figure 4: California power consumption (in MW) at different portions of the day. The predicted time of EV charging is highlighted.[5]

[4] Ibid. page 5
[5] Electric Vehicles and Energy Use, California Air Resources Board, September 29. 2017, page 2.

California's forecast indicate that the peak recharging hours will complement existing load patterns – not increase peak demand.

Recharging behavior will be easily modified with time-of-use pricing. New York, for example, has already recommended a program to incentivize electric vehicle owners to charge during off peak hours:

> Based on the research and analysis conducted for this project the recommendations are that New York utilities and the New York Public Service Commission (PSC) pursue a series of pilot offerings to incentivize off-peak PEV charging using both whole-house TOU rates and off-peak charging rebate programs (each PEV owner should be able to choose which program to participate in).[6]

If British Columbia implements a similar program, then electric vehicles will have a manageable impact on the grid. In other words, the majority of load increase forecast by British Columbia Hydro will not increase the need for system capacity.

Additionally, the batteries in electric vehicles can actually improve the grid's dispatchability for more intermittent sources of power. Wind, for example, can use the large amount of reliable energy storage present in the many thousands of electric vehicles.[7] A properly designed time-of-use tariff for electric vehicles can easily be used to trigger on-demand charging during off-peak hours. Logically, a form of water heater tariff would work well – delaying off-peak recharging when wind generations falls and restarting when the wind turbines resume generating.

[6] Electricity Pricing Strategies to Reduce Grid Impacts from Plug-in Electric Vehicle Charging in New York State , Brian Jones, June 2015, Page S-1.

[7] Electricity Storage and Plug-In Vehicles, Energy Storage Association, http://energystorage.org/energy-storage/technology-applications/electricity-storage-and-plug-vehicles.