Intelligence MEMOS

From: Stephen Holland, Erin Mansur and Andrew Yates

To: Canada's Energy Transition Leaders

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Re: **SHOULD ELECTRIC VEHICLES CHARGE DURING THE DAY?**

Effectively responding to climate change will likely require significant modification of the electricity grid through decarbonization and electrification.

Decarbonization of electricity generation requires shifting from fossil fuels to emission-free technologies such as wind, solar, and nuclear. Electrification requires converting fossil fuel using activities, such as transportation, to electricity instead.

Intuitively, electrification would seem to complicate decarbonization, because increasing electricity demand may make it harder to reduce reliance on fossil fuels. In our recent research paper, we analyze a model that accounts for the evolution of electricity generation technology in response to various public policies. Under certain circumstances, we find that electrification can actually facilitate decarbonization of the grid.

Our model is intuitive: If a given technology becomes cheaper to run, then more of that technology enters the market, and its share of total electricity generation increases, and vice versa. For example, a policy that reduces the costs of installing intermittent solar generation (such as a subsidy) would lead to entry of solar capacity but may cause exit of some substitute generation technologies (such as nuclear or combined cycle gas) and/or entry of complementary technologies (for example, peaking plants or battery storage.)

The effects of electrification policies can be surprising. Encouraging the purchase of electric vehicles increases demand for electricity, which leads to entry of new power generation. But the degree to which specific technologies enter depends crucially on the time of day the vehicles are charged.

Suppose at first that electric vehicles are charged at night. This increases the profitability of fossil fuel generation that can operate at night, increases entry of fossil fuels, and increases emissions. In this case, electrification complicates decarbonization.

Now suppose that electric vehicles are charged during the day. This increases the profitability of solar, induces entry of solar, and may even lead to a decrease in emissions. In this case, electrification facilitates decarbonization.

Of course, this result may simply be a theoretical possibility. To test its practical importance, we calibrated and simulated the model for the US electricity grid using hourly data on electricity demand and wind and solar availability for 13 regions. If the entire fleet of US light-duty vehicles is electrified and the vehicles are charged at night, then we calculate that total carbon emissions from electricity generation increase by about 27 percent.

If instead, the vehicles are charged during the day, then total carbon emissions decrease by about 7 percent, even though the demand for electricity increased significantly. In both cases, we also have the reduction in carbon emissions from removing the gasoline vehicles from the road. By charging during the day, we obtain this decrease in emissions and the decrease in emissions from electricity generation.

Our results suggest that carefully constructed policies that encourage electric vehicle owners to charge during the day may be beneficial in the US. Widespread electric vehicle adoption will require charging infrastructure for people who live in apartments and other high-density housing. Rather than, say, subsidizing charging infrastructure at these locations, policymakers may prefer to subsidize charging stations at workplaces and shopping centres instead.

While this analysis focuses on the US, the methodology can be easily applied to analyze electrification and decarbonization changes in other regions. Moreover, the specific policy recommendation about electric vehicle charging would likely hold in regions with a similar mix of generation costs and renewable availability.

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