Electrifying Transportation

Impacts on GHGs, Electricity and Oil Demand in Alberta


Laura Beattie
Mechanical Engineering


Rachel Ho
Civil Engineering


Natalie Piegza
Electrical Engineering


Colin Rintoul
Natural Sciences


Osman Yaseen
Chemical Engineering

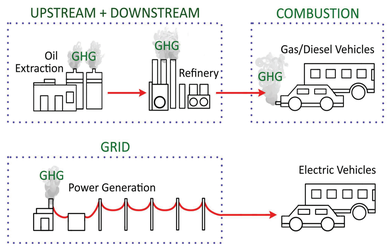
Correspondence:
lkbeatti@ucalgary.ca

INTRODUCTION

Vehicle electrification has been proposed as a strategy to reduce the greenhouse gas (GHG) emissions of personal vehicles, and other vehicles not used for heavy freight transport. In Alberta, emissions from such vehicles account for about 16 Mt CO_2/yr [1].

This study created a scenario model for the rapid adoption of electric vehicles in Alberta, to assess possible impacts on:

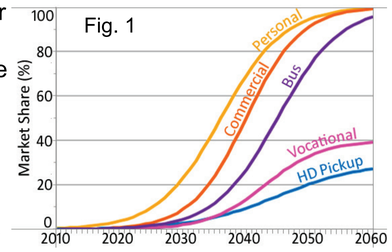
- ❑ **GHG emissions,**
- ❑ **Oil demand,**
- ❑ **Electricity demand.**



METHODS

Assumptions for Alternative (Electrification) Scenario

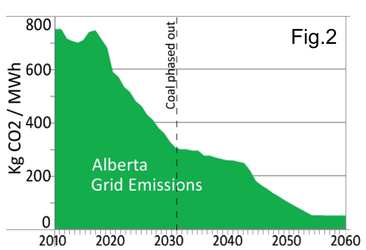
1. Market shares for new electric vehicle by vehicle type based upon our predictions (Fig 1):



2. Market turnover rates (% of stock per year) for Bus (**11%**), Commercial (**10%**), Personal (**9%**), Vocational (**13%**) and HD pickup (**12%**). [2]

3. Other Assumptions:
   - ✓ Vehicle number same as reference scenario
   - ✓ Deployment rate of electric vehicles penetrates market shares of all fuel types proportionally;
   - ✓ Improved operating efficiency (MJ/100 KM) of electric vehicles over internal combustion are similar for each vehicle type;
   - ✓ Well-to-wheel emissions is 128% of tank-to-wheel emissions for non-electric vehicles [3]

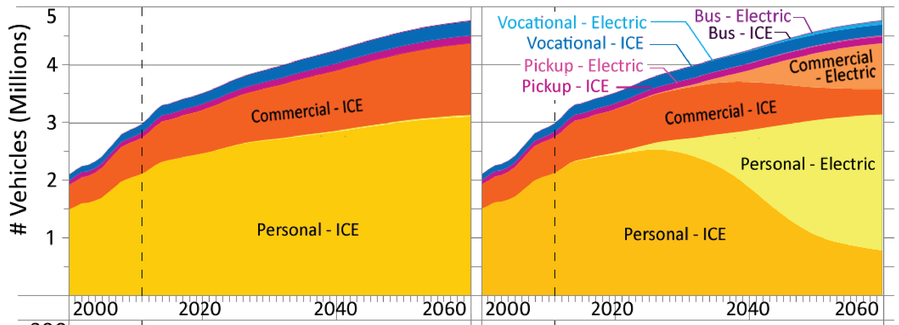
4. GHG intensity of Pubic Grid as per Fig. 2. [4] (Assumes coal replaced by NGCC by 2030, then nuclear replaces CC at end of life).



RESULTS

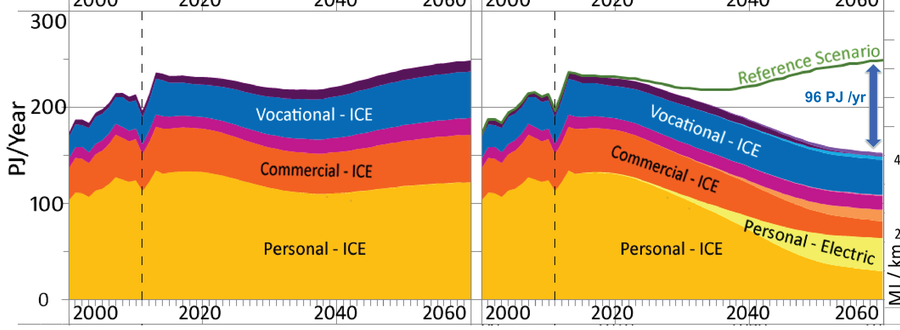
Reference **Alternative**

A. Total Vehicle Stock



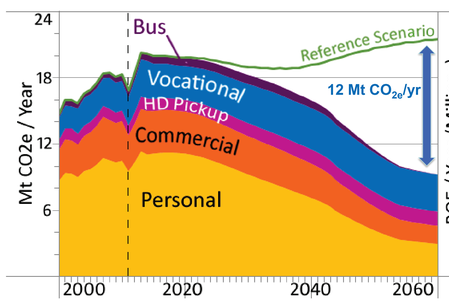
By 2060, electric vehicles are projected to be **68%** of total vehicle stock, or 3.2 million vehicles, as opposed to **0.5%** in our reference scenario.

B. Energy Used



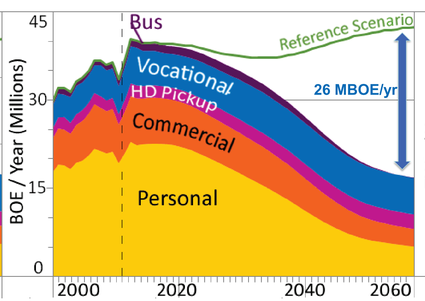
This **-39%**, or **96 PJ** per year energy reduction is a result of the higher efficiency of an electric engine.

C. GHG Emissions



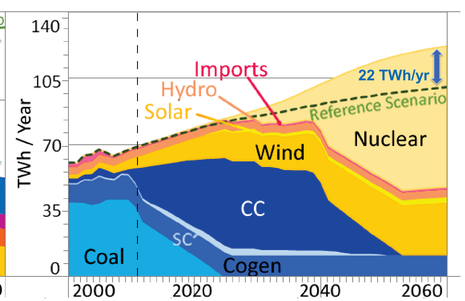
By 2060, there will be a total reduction of **12 Mt CO_2e** per year, **-57%** of GHG emissions from these vehicle classes as compared to our reference scenario.

D. Oil Demand



By 2060, there will be a reduction of **26 MBOE** per year, **-61%** of oil demand for these vehicle classes as compared to our reference scenario.

E. Electrical Grid



By 2060, an increased electricity demand of **+22 TWh** per year, or **+22%** from the reference scenario.

DISCUSSION

By 2060, **68%** of the total vehicle stock in Alberta were projected to be electric vehicles in the Alternative Scenario. The overall energy use and GHG emissions by vehicles in Alberta decreased by **61%** and **57%** respectively since:

- ❑ Electric vehicles are approximately 3 times more energy efficient than gasoline engines
- ❑ Future electricity generation was assumed to continue to decarbonize (Figure 2).

To fuel these vehicles, demand for grid power was projected to increase by **22%.** With smart charging techniques, where flexible loads charge at night, this demand could be shifted to off peak hours, and there would be minimal demand for additional generation capacity [5].

With the exception of buses, available literature for heavy duty and vocational vehicles in North America were very limited. Most case studies focused on concept vehicles and prototypes, as opposed to large scale, mass-manufactured fleets [6].

CONCLUSIONS

The electrification rates modelled here will be in line with the shift in energy systems that will be required for Canada to meet its future energy reduction targets.

The reduction in energy consumed by vehicles will lead to cleaner energy systems in Alberta, reduced greenhouse gas emissions, reduced oil demand, and a cleaner electrical grid.

The electrification rate of vehicles will not only be driven by the reduction in energy intensity, but also by overcoming barriers, such as, technological innovation, technological competition, development of pilot programs and social acceptance.

The implementation of more government policies – tax rebates, environmental policies, funding for R&D and a higher carbon price would drive a faster adoption of electric vehicles.

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