Some less-discussed externalities of contemporary electric vehicle mania in Canada

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1. Introduction

It is generally recognized that private use of internal-combustion motor vehicles is a very significant source of emission of greenhouse gases (GHG) in developed economies. In North America and western Europe, gasoline-powered vehicles are the most common means of private-use transportation. During the past decade, electric vehicles (EV) have been promoted widely as the superior zero-pollution approach. Some of the notable technical problems encountered in the EV include the weight, capacity and durability of battery for energy storage. As reflected in the steady decline in the offered price of EV in the consumer market, considerable technical advances have been achieved to resolve these technical issues in recent years. However, the more fundamental problem of power availability for charging EV batteries has largely been ignored. It is generally assumed that "unlimited" supply of electric power would be available. Primary source of electric power is notably variable from region to region. For example, in France, most of the electricity is generated by nuclear fission reactors. In contrast, virtually all the electricity generated in Norway is from hydroelectric dams. In Canada, variation is substantial. In the province of Quebec, hydroelectric predominates, whereas in the province of Nova Scotia, thermal coal-fired generators are the principal source of electricity [32,34]. It is thus apparent that the widespread adoption of the EV strategy and its impact on the net GHG emission would be very different for example Quebec and Nova Scotia. Several power supply studies under prevailing situation in the European Union have suggested that there would be no significant shortage of power supply if an EV strategy was implemented to the level of 20–25% of present number of conventional motor vehicles (see, for example, [16,41]).

The many Life Cycle Analysis studies conducted on the EV have generally concluded to be positive on a site-specific basis. In particular, one of the key LCA determinants is the ways and means of sourcing incremental and new supply of electricity for the charging of EV batteries (see, for example, [21,26,52], Aquirre et al. [1] have concluded that battery EV are more energy efficient and less polluting than conventional gasoline vehicles, on the basis of assigned GHG emission factors for specific California gasoline formulation and mix of electricity. After all, an electric motor of an EV can operate at the efficiency of 80–90% [55–57]. In contrast, a typical internal-combustion gasoline engine would operate at
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Canada) was selected to illustrate the problematical issues of power
powered with electric vehicles. British Columbia (a province of
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data published by the US Environmental Protection
45,53,61].

2. Methods

Public-domain data published by various government agencies
were used in the present study. Analysis is greatly simplified
because gasoline sold in Canada is used almost entirely by private
automobiles. In contrast, diesel fuel is used sparingly by some
private automobiles and virtually all buses and trucks. The 2012
reference year was chosen because the availability of essential
public-domain data for analysis was complete.

The basic vehicle fuelling concept is illustrated in Fig. 1. Nissan
Versa (gasoline powered) and Nissan Leaf (electricity powered) of
2012 model year were selected as the private 5-passenger vehicles
for comparison purposes. It is assumed that recharging EV batteries
is made through conventional household (110-volt, 15-A) plug-in
outlets. The performance characteristics of both vehicles are
based on data published by the US Environmental Protection
Agency [55–57].

In order to demonstrate the impact of externalities of power
supply on GHG emission, and the fiscal consequences for govern-
ments, a model EV strategy was constructed. The basis of the model
is that power presently exported to the USA would be terminated
summarily and the now-available power would be used for
charging EV batteries. This approach circumvents the variable is-
issues of comparative economics of owning and running an EV
(versus a conventional gasoline powered vehicle) in view of vari-
able environment of low benchmark pricing of petroleum, and
uncertain continuing government subvention. Furthermore it is
assumed that the implementation of the model EV strategy is
unaffected by the steadily-converging parity in technical perfor-
ance of EVs and gasoline-powered vehicles. In other words, the
reduction of GHG emission in the passenger vehicle sector has
priority over prevailing less-attractive comparative economics of
owning and operating an EV, in the absence of any substantial new
market intervention by governments.

It is recognized that as the conversion of (grid) electricity to
energy stored in EV batteries become more efficient, the assigned
allocation of electricity could “fuel” more EV, which might subse-
quently result in greater displacement of gasoline-powered vehi-
cles, to a certain extent.

Life cycle analysis (LCA) is outside the scope of the present pa-
per. LCA of electric vehicle technologies has been discussed
extensive elsewhere for more than 2 decades (see for example
[2,40,43,45,53,61].

3. Results and discussion

3.1. Gasoline consumption

In Canada, the consumption of gasoline is generally limited to
motor vehicles with less than 4000 kg gross vehicle weight. Larger
motor vehicles such as trucks and buses are nearly always powered
by diesel fuel.

Table 1 shows the population trend as related to number of
vehicles registered and consequent sale of gasoline. In comparison,
the city of Vancouver, with about 13% of the British Columbia
provincial population, has 24% of the registered vehicles in this
class,1 in 2012.

3.2. EV power demand

In the example case of Nissan Leaf all-electric vehicle, there has
been a notable improvement in “fuel economy” as reflected with
availability of improved batteries. In the 2012 model, the EPA rating
was 34 per 100 miles (~21 KWh/100 km) and in the 2015 model
year, the rating has decreased to 30 KWh/100 miles (~19 KWh/
100 km). Table 2 shows that the improvement in fuel economy of
comparative gasoline-powered Nissan Versa was interestingly
similar between 2012 and 2015.

It is uncertain if substantial progress could be achieved in the
application of energy to the wheel. Some the technical limitations
include minimum friction required for traction and driving

2 Energy efficiency denotes the conversion of energy in fuel into net power
applied to the wheels of a motor vehicle.

3 The numerical difference between “passenger vehicles registered” as described
in the 2014 Transportation Panel Survey [65] and “motor vehicles <4000 kg gross
vehicle weight) registered” is considered to be relatively minor for the purpose of
the present analysis.
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