Impact of Electric Vehicles and Electric Off-road Equipment on Air Quality in Canada

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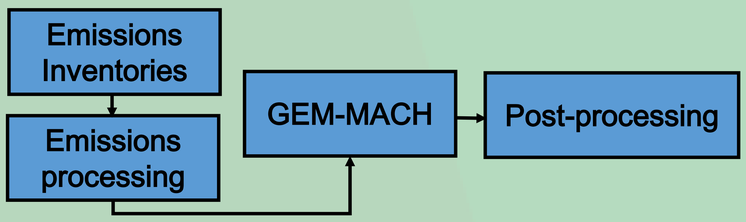
Introduction

The government of Canada is giving rebates to incentivize the purchase of Electric Vehicles (EVs). Certain provinces (BC, ON, QC) also offer subsidies for the purchase of an EV. Many off-road equipment also have an electric equivalent.

Objective: Performing a quantitative analysis regarding the impact of electric vehicles and electric off-road equipment on the air quality in Canada using Environment and Climate Change Canada (ECCC) Air Quality Policy-Issue Response Section's (REQA's) air quality modelling platform.

Methodology

1. The 2015 Emissions inventories were modified for the following scenarios:
   - **Scenario 1**: 10% of Light Duty Vehicles (LDV) EVs in BC, ON, QC + 5% of LDV were replaced by EVs in the other Canadian provinces (excluding territories)
   - **Scenario 2**: 20% of certain off-road equipment, such as gardening equipment, golf carts, chainsaws, etc. became electric across Canada
   - **Scenario 3**: 10% of LDV EVs in BC, ON, QC + 20% of certain off-road equipment became electric across Canada
2. Emissions inventories were processed with the Sparse Matrix Operator Kernel Emissions modelling system (SMOKE) v3.7 to produce chemical transport model-ready emissions files
3. Air quality model GEM-MACH (Global Environmental Multiscale - Modelling Air quality and Chemistry) was run at a 10 km resolution over North America with a 2017 meteorology
4. GEM-MACH results are processed to produce pollutant metrics of interest



Emissions

Table 1 – Number of EVs per province: modeled vs. current

Province	Number LDV	% EVs	Number EVs	Current number EVs
NL	354,811	5	17,741	48
PE	77,723	5	3,886	34
NS	588,807	5	29,440	240
NB	533,082	5	26,654	186
MB	771,944	5	38,597	402
SK	794,478	5	39,724	208
AB	3,074,733	5	153,737	2,269
BC	2,859,463	10	285,946	19,893
ON	7,866,332	10	786,633	35,271
QC	5,086,519	10	508,652	52,556
Total	**22,007,892**	**—**	**1,891,010**	**111,107**

EVs were allocated to urban areas, and seem to be well allocated according to the map of populated cities. Off-road emissions appear to be mostly allocated in or near urban areas:

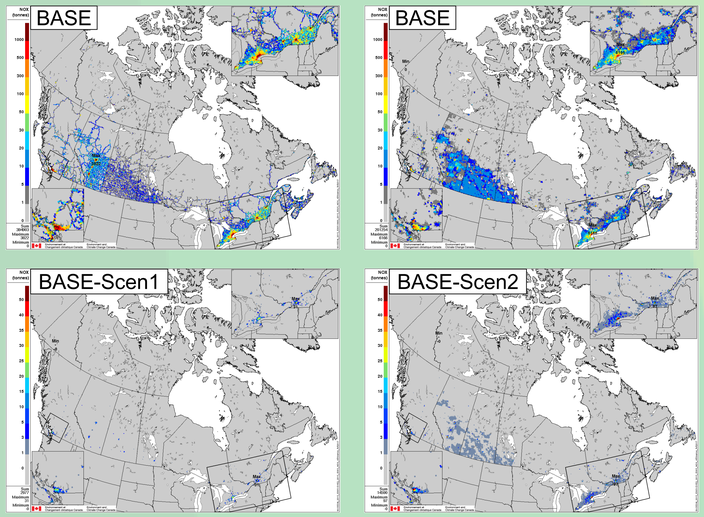


Figure 1: 2015 NO_X gridded emissions showing the base case, the differences between the base case and the scenarios, and a map of the largest cities in Canada for emissions allocation comparison purposes

Post-Processing Results

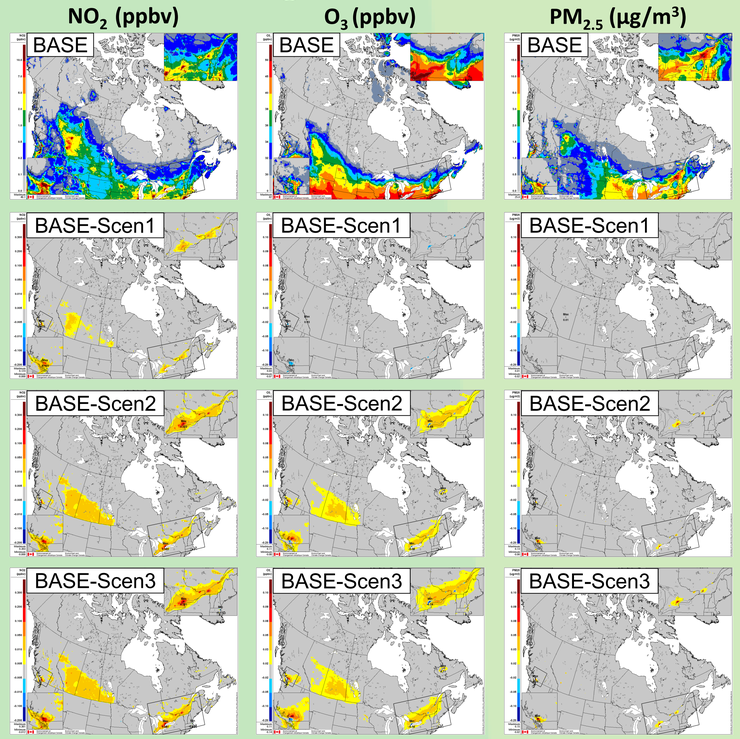


Figure 2: Annual NO_2 average, annual daily max 8h O_3 average, and annual $PM_{2.5}$ average concentrations for the base case and differences between the base case and the scenarios

Conclusion

- The replacement of fuel-based off-road equipment by electric versions showed higher concentration reductions than EVs.
- Nearly 2 million EVs showed little air quality improvements.
- All scenarios showed slight O_3 concentration increases.
- Little PM2.5 reductions due to tire wear and brake wear.
- Proper allocation of EVs in urban areas across Canada.

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