CANADIAN ENERGY RESEARCH INSTITUTE

Study No. 178
March 2019

CANADIAN ENERGY RESEARCH INSTITUTE

ECONOMIC AND GREENHOUSE GAS EMISSIONS IMPACTS OF ALTERNATIVE TRANSPORTATION SCENARIOS FOR CANADIAN CITIES

Executive Summary

Transportation is an energy service that is essential for the functioning of social and economic systems. Fuels consumed for transportation — mostly gasoline and diesel — are almost exclusively derived from fossil energy sources. As such the transportation sector is a significant contributor to anthropogenic greenhouse gas (GHG) emissions. At 25% of total emissions, the transportation sector is the second largest contributor to Canada's GHG emissions. The vehicles being a large stock of dispersed GHG emitters and the fact that the demand for transportation is growing in proportion to population growth have made the transportation sector a challenging sector to reduce GHG emissions.

While transportation emissions are from dispersed vehicles, most of the GHG emissions from transportation, particularly those from passenger transportation is concentrated in urban centers. This has led many cities around the world, including several in Canada, to explore alternative options to reduce GHG emissions from transportation. These options include fuel and vehicle technology switching, improving vehicle fuel economy, changing operating practices, and reducing transportation demand through urban planning. This study developed an analysis to provide energy, economic and GHG emissions implications of alternative solutions to reduce fuel demand and emissions for passenger and freight transportation in Calgary, Ottawa, Halifax, and Yellowknife.

A key difference in this study in comparison to others related to transportation is the focus on energy systems. We consider the impacts on the oil supply, electricity supply, and distribution networks. Table E.1 lists the total transportation energy demand for urban passenger and freight transportation in each of the four cities. We find that all options have the potential to reduce transportation fuel demand and by doing so, reduce GHG emissions.

- Urban densification can potentially reduce the overall energy consumption by about 1-2% in 2020, 2-5% by 2030, and 4-8% by 2050, depending on the city.

- Overall fuel economy improvement in conventional passenger vehicle stock – mostly gasoline-fueled – under the Stringent CAFE[1] scenario can achieve up to approximately 21% fuel demand reduction in all four cities except Yellowknife. In Yellowknife, the fuel demand reduction potential under the Stringent CAFE scenario is up to 10%.

- Under the Alternative Vehicles scenario, the vehicle stock transitions to one dominated by battery-powered electric vehicles (BEVs) for private vehicles and public transit vehicles and one dominated by fuel cell electric vehicles (FCEVs) for urban freight vehicles. This reduces transportation fuel consumption by up to 40-46% by 2050 depending on the city. The overall primary energy consumption and GHG emissions under this scenario depend on overall efficiency and GHG intensity of the electricity system. Total electrical energy

[1] Corporate Average Fuel Efficiency

demanded by BEV passenger vehicle fleets in respective cities would increase by less than 5% in Calgary, 6% in Halifax, 2% in Ottawa, and 3% in Yellowknife. However, the peak demand impact can be as high as a 25% increase.

- Use of Fuel Cell Electric Vehicles, fueled by hydrogen from electricity or natural gas, has the advantage of higher range and lower refuelling times that are important for freight vehicles. The analysis showed high-efficiency gains due to FCEV adaptation. The FCEV-based freight vehicles (0.8 megajoule [MJ]/tonne-km) in the freight sector reduces the fuel usage by at least half compared to the reference case (1.7 MJ/tonne-km).

Table E.1: Total Transportation Energy Demand by Scenario and City, 2020-2050

City	Year	Total Transportation Energy Demand (TJ)				Relative Energy Reduction (% of BAU)		
		BAU	Urban Densification	Alternative Vehicles	Stringent CAFE	Urban Densification	Alternative Vehicles	Stringent CAFE
Calgary	2020	39,635	38,780	39,631	39,635	2%	0%	0%
	2030	40,406	38,354	38,955	35,849	5%	4%	11%
	2040	42,389	40,158	31,737	34,401	5%	25%	19%
	2050	45,576	43,267	27,299	36,119	5%	40%	21%
Halifax	2020	5,718	5,632	5,717	5,718	1%	0%	0%
	2030	5,652	5,426	5,463	5,023	4%	3%	11%
	2040	6,176	5,833	4,671	5,009	6%	24%	19%
	2050	7,087	6,596	4,263	5,596	7%	40%	21%
Ottawa	2020	23,678	23,276	23,675	23,685	2%	0%	0%
	2030	22,550	21,557	21,738	19,841	4%	4%	12%
	2040	23,297	21,857	17,248	18,977	6%	26%	19%
	2050	25,088	23,188	14,618	20,016	8%	42%	20%
Yellowknife	2020	168	168	168	168	0%	0%	0%
	2030	160	156	155	152	2%	3%	5%
	2040	162	157	119	148	3%	27%	9%
	2050	169	162	92	151	4%	46%	10%

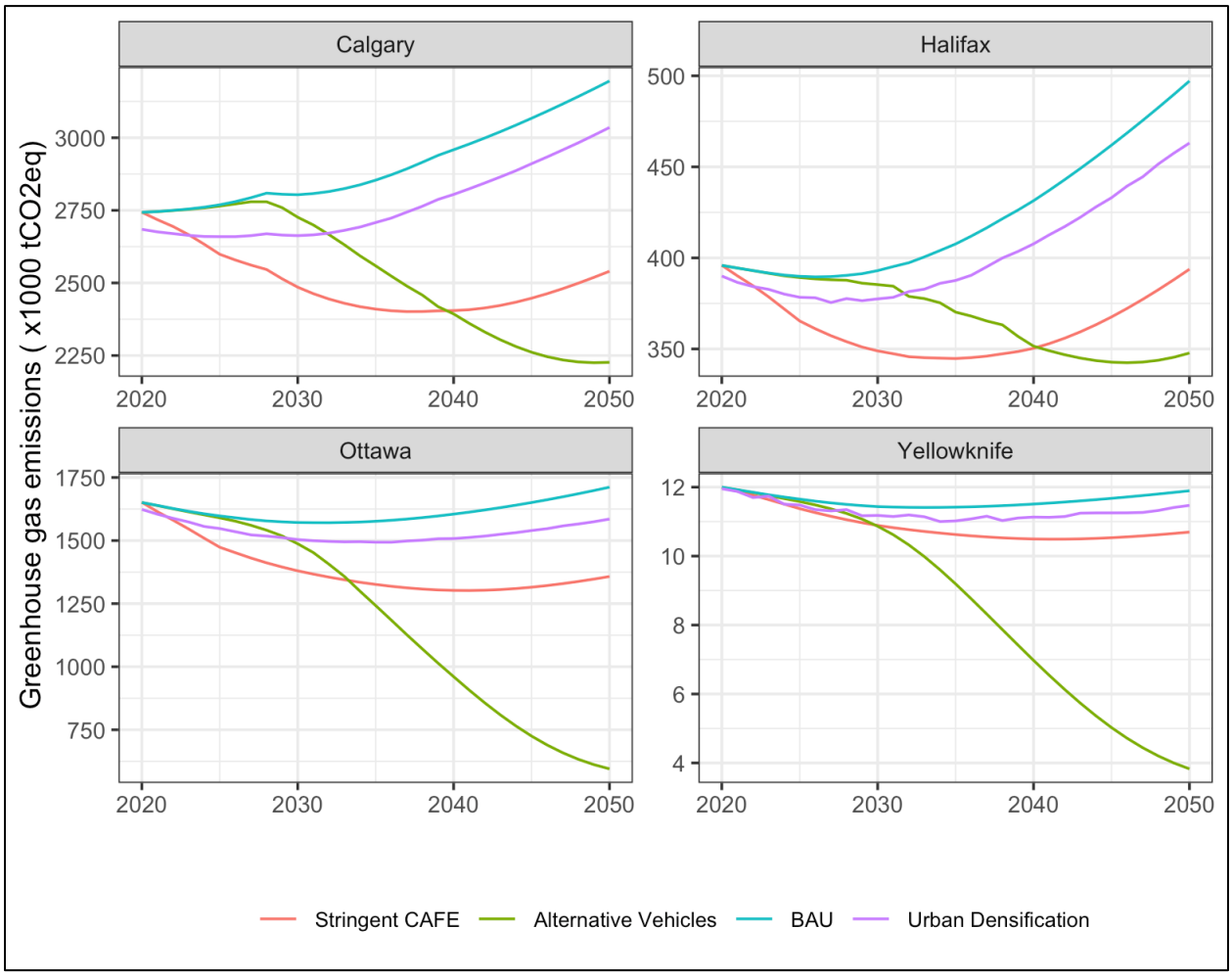
Note: Fuel magnitudes are indicated using their equivalent thermal energy in terajoules (TJ). For comparison, 1 TJ ≈ 30,000 litres of gasoline; ≈ 26,000 litres of diesel; ≈ 278 MWh of electricity

Figure E.1 depicts the overall GHG emissions under each of the scenarios. Compared to the BAU, all three alternative transportation scenarios we assessed deliver GHG emissions reduction. The exact amount depends on the city and scenario.

In all four cities, the GHG emissions reduction potential under the Urban Densification scenario is about 5% in all years compared to the BAU. The Stringent CAFE scenario sees emissions reduction potential of up to 20% in all periods. GHG emissions reduction potential under the

Alternative Vehicles scenario is gradual and varies by city. In Ottawa and Yellowknife, the reduction potential is 60% by 2050. In Calgary and Halifax, the reduction potential in 2050 is about 30%. Lower emissions reduction potential in Calgary and Halifax is due to the difference in GHG intensity of the generation system that satisfies the BEV electricity demand.

Figure E.1: GHG Emissions from Urban Passenger and Freight Transportation by Scenario and City, 2020-2050



Source: CERI

The macroeconomic impact assessment shows that the decline in gasoline sales under Alternative Vehicles scenario leads to a notable decline in provincial GDP and jobs. However, there are also gains due to higher electricity investment and sales.

The urban transportation systems we utilize today are a result of several decades of technical evolution, infrastructure developments, and public as well as private investments. Making changes to such a complex system requires challenging and integrated technical and policy solutions from the business community and government.