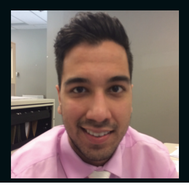
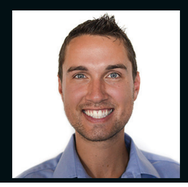
Natural Gas in Freight Transportation in Canada

Implications for GHG Emissions and Oil & Gas Markets

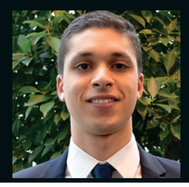
Jacqueline Smith
BSc Civil Engineering



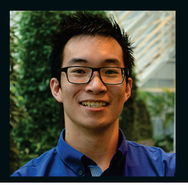
Sahil Sharma
BSc Civil Engineering



Steven Stosky
BSc Mechanical Engineering



Ahmed Moussa
BSc Chemical Engineering



Eric Lim
BSc Chemical Engineering

Correspondence:
e.lim@outlook.com

INTRODUCTION

- Highway is the dominant freight transportation mode across Canada and between Canada and the US. Diesel is the primary fuel source for the industry.
- Compared to diesel, natural gas (**NG**) has several benefits:
  - $0.40 cheaper at the pump (energy equivalence basis) [1]
  - Better fuel economy [2]
  - Fewer tank-to-wheel (**TTW**) GHG emissions [3]
- The analysis compares the total energy use and associated greenhouse gas (**GHG**) emissions of a reference scenario to an alternative scenario (accelerated transition of diesel to NG vehicles)
- The high carbon intensities of fuel produced from oil sands and shale gas are considered [4] [5].
- This analysis may be used by the freight industry and policy makers to determine the value of a fuel shift.

METHODS

Our model is driven by three different catalysts that affect the diesel to NG vehicle transition rate. These catalysts are:

1. Government mandating that a certain percentage of freight vehicles must be NG driven
2. Government subsidizes the capital cost of freight vehicles
3. The ratio of NG cost versus diesel cost changes over time

From this, a "**most probable**" transition rate has been generated [6]. In our analysis we've assumed a fuel efficiency of 9.77 MJ/km for NG and 11.41 MJ/km for diesel (Figure 1) [3]. In determining the life cycle analysis of the fuels, we've assumed the most GHG-intensive extraction methods. The result is a NG engine in which emissions are about 67% CO_2e/km of their diesel counterparts (Figure 2) [4].

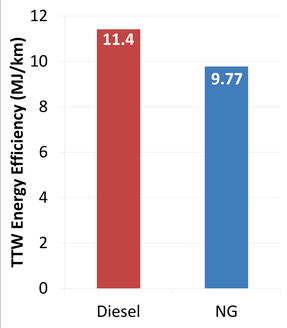


Figure 1. TTW energy conversion efficiency of diesel and NG.

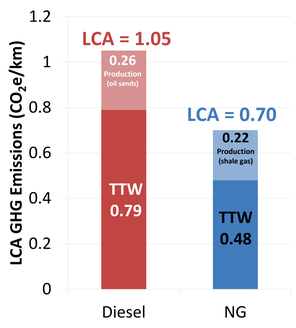


Figure 2. LCA breakdown of diesel and NG.

RESULTS

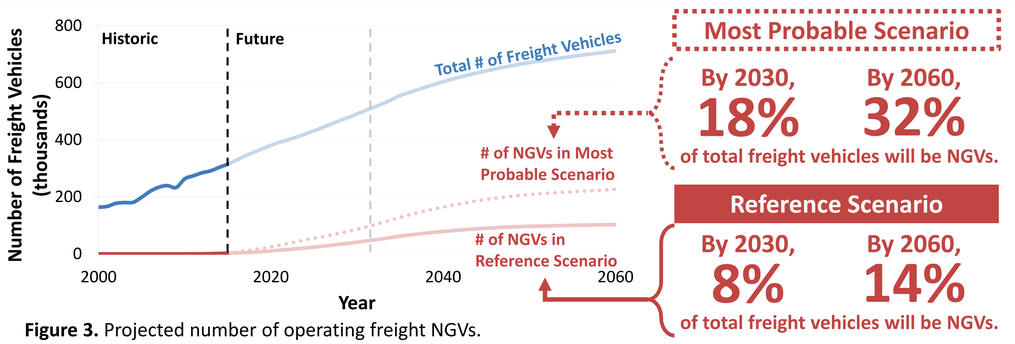


Figure 3. Projected number of operating freight NGVs.

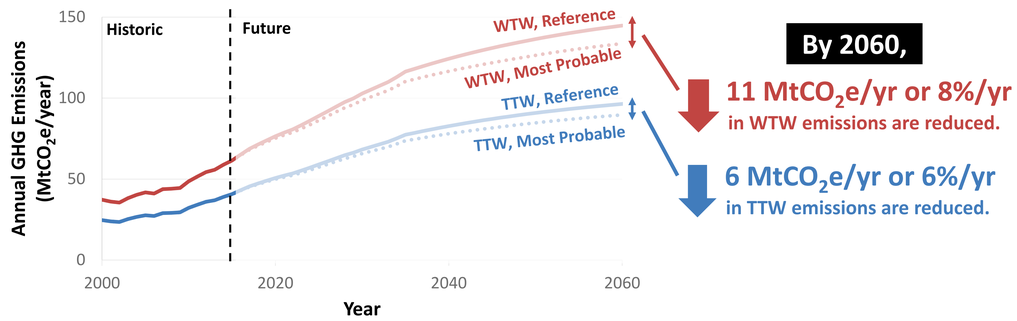


Figure 4. Projected annual GHG emissions of WTW and TTW LCAs.

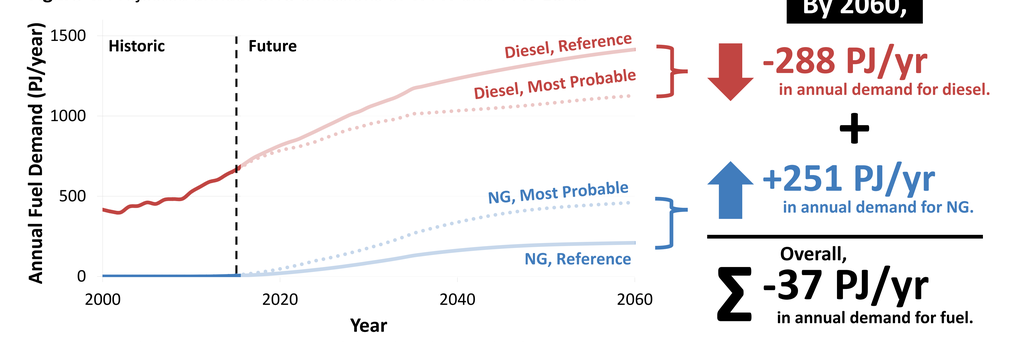


Figure 5. Fuel demand comparison of diesel and NG in both scenarios.

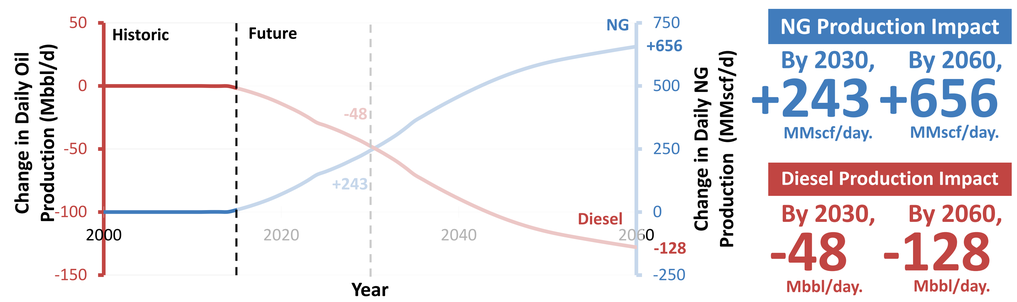


Figure 6. Annual impact on oil and gas markets based on daily production rates.

DISCUSSION / CONCLUSION

The analysis suggests that by implementing the most probable scenario, by 2060:

- Up to 6 $MtCO_2e$ could be reduced annually from a TTW perspective
- Up to 11 $MtCO_2e$ could be saved annually from a well-to-wheels (**WTW**) perspective, assuming shale gas and oil sands are the dominant sources used to produce fuel, and current technologies and associated emission contributors (i.e., methane leakage) persist
- The transition results in an overall energy demand change where by 2060:
  - Approximately 128 Mbbl oil/day via the diesel market are displaced
  - Approximately 656 MMscf/day to the gas market are required
  - If the alternative scenario is implemented, gas overtakes oil in terms of the market share of transportation fuel supply in the year 2031

Over time, there are both economic and environmental benefits that would be realized in a fuel transition, however prior to this occurring, up-front regulation and/or incentives will likely be required, as the price-tag on a new NG semi is around $100,000 more than that on a diesel semi [7].

Limitations to this study include:

- Consideration of future extraction technologies which could reduce production-related emissions and effectively change the well-to-tank (**WTT**) (and therefore WTW) emissions used in the study
- Consideration of varied impacts based on diesel grades
- Conversion of non-turnover fleet vehicles from diesel to NG engines
- Actual knowledge how the NG:diesel cost ratio will change and affect consumer decisions
- Real cost of infrastructure upgrades along transportation corridors to facilitate NG refueling
- GHG emissions related to infrastructure upgrades
- Changes in NO_x and SO_2 emissions are not considered
- Application of a federal fuel tax at the pump (presently, NG is exempt [8])
- Industry lobbying and/or political support that could affect decisions
- Impact of a fuel shift to/by other sectors of the transportation industry; this analysis is only one aspect of an extremely complex system

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