CLEAN ENERGY CANADA

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Re: Clean Fuel Standard: Discussion Paper (February 2017) – Comments on Design Framework

Clean Energy Canada is a climate and clean energy think tank within the Centre for Dialogue at Simon Fraser University. We work to accelerate our nation's transition to clean and renewable energy systems by telling the story of the global shift to clean and low-carbon energy sources. We conduct original research, host dialogues and aim to inspire and inform policy leadership.

Introduction

Last year, Clean Energy Canada applauded[1] the federal government's Pan-Canadian Framework for Clean Growth and Climate Change. We see the framework as essential to meet Canada's greenhouse gas targets and necessary for Canada to compete in the growing, global clean economy.

The Clean Fuel Standard is a critical part of the framework, and Clean Energy Canada fully supports its development and implementation. It has the potential to reduce emissions by 30 Mt CO_2eq beyond existing measures, including other policies in the Pan-Canadian Framework, and expand the market for low-carbon fuels like electricity, biofuels and hydrogen. There remain design questions, however, as outlined in *Clean Fuel Standard: Discussion Paper*[2].

To help address these questions, Clean Energy Canada contracted Navius Research to model several scenarios showing how the Clean Fuel Standard could be designed and the implications for greenhouse gas reductions and technology deployment. We will share the full study once complete later in May. However, the draft results provide insight on several of the questions in the discussion paper. A brief summary of the approach follows and the appendix contains a more detailed outline of our approach.

The modelling contains three scenarios that offer a range of results based on different designs of the Clean Fuel Standard. Clean Energy Canada is not recommending Environment and Climate Change Canada adopt any particular scenario—rather the scenarios help to illustrate the impact of different design options. The three scenarios are:

1. **Reference Scenario:** The reference scenario includes all major provincial and federal policies in the Pan-Canadian Framework. This includes all provinces meeting the federal carbon price framework, coal phase-out, vehicle energy efficiency requirements, and provincial and

[1] Smith, Merran (2016) *Statement to premiers on Canada's clean growth plan.* http://cleanenergycanada.org/statement-to-premiers-on-canadas-clean-growth-plan/
[2] Environment and Climate Change Canada (2017) *Clean Fuel Standard: Discussion Paper*

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federal renewable and low-carbon fuel standards. Reductions from the Clean Fuel Standard in the partitioned and non-partitioned scenarios are therefore incremental to these policies.

2. **Partitioned Scenario:** A transportation-focused Clean Fuel Standard that requires a 15% reduction in greenhouse gas intensity in the transportation sector from 2010 levels by 2030. This essentially applies B.C.'s low-carbon fuel standard across Canada. Any remaining emissions reductions to meet the 30 Mt CO_2eq target come from the building and industrial sector.

3. **Not-Partitioned Scenario:** In the non-partitioned scenario, all fuel supplies in buildings, industry and transport compete to provide the lowest-cost reduction. This is facilitated by unlimited credit trading between and among fuel types. Total reductions must hit 30 Mt CO_2eq by 2030 relative to a 2030 reference case.

The results shared in this submission are preliminary, and we intend to refine this research during the development of the Clean Fuel Standard.

Recommendations and Comments

The submission uses these results to support the following comments:

1. The reduction target is achievable
2. The Clean Fuel Standard should be based on multiple objectives
3. Partition the transportation sector
4. Broad coverage allows for multiple reduction pathways
5. Ensure that credits are administratively simple to generate, even for non-regulated parties that would opt in
6. The standard should include cost-containment mechanisms
7. Align complimentary policies
8. Ensure transparency, accountability, regular updates and reporting
9. Use sustainability criteria

Each topic area identifies which question in the discussion paper is being addressed.

1. The reduction target is achievable

The Clean Fuel Standard is achievable because there are several feasible pathways to meet it at affordable costs. Depending on the policy design, emission reductions of 30 Mt CO_2eq is possible in the industrial and building sectors, the transportation sector or some combination thereof. Each sector also has multiple fuel options to comply with the standard. Further, these reductions can occur at credit costs at or below those in jurisdictions that already have functioning clean fuel standards with little evidence of increased fuel costs.

Transportation (Q1, Q9, Q10, Q12)

A 30 Mt CO_2eq drop in emissions in the transportation sector is also achievable. The requisite technologies and fuel pathways exist and, the costs are modest. We applied B.C.'s low-carbon fuel standard target nationally which requires that the lifecycle fuel intensity of gasoline and diesel decline by 15% by 2030 relative to a 2010 baseline.

In terms of energy, 2,070 PJ per year in 2030, equivalent to 13% of gasoline and diesel use today, is replaced with a mix of renewable diesel (58%), ethanol (25%) electricity (10%), biodiesel (3%) and natural gas (3%). The model includes only renewable diesel from canola; however, this supply could come from other feedstocks or processes including co-processing at refineries. All of these fuels can be produced with available and commercial technology.

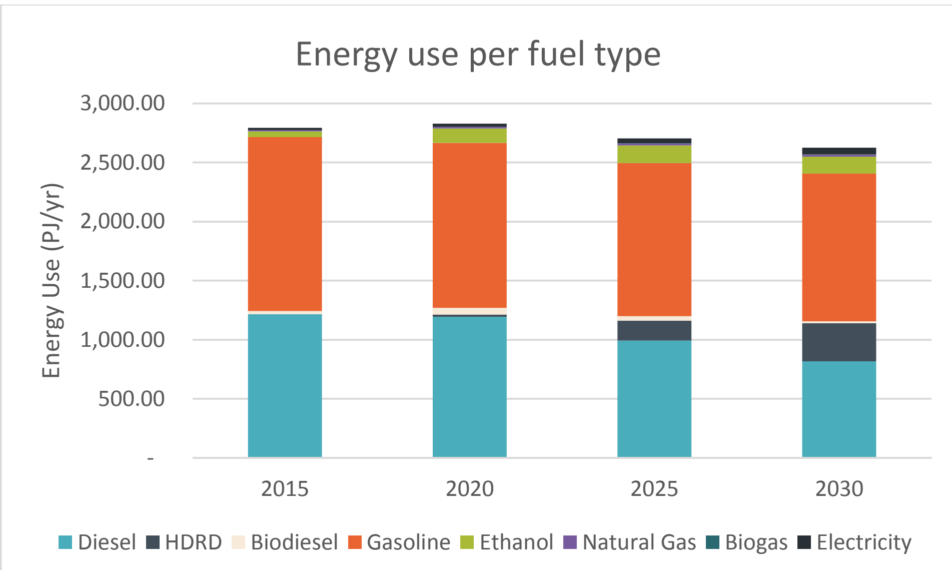

Figure 1: Energy use per fuel in the transportation sector in the partitioned scenario

Collectively, these fuels reduce lifecycle emissions by 29 Mt CO_2eq by 2030 relative to a 2030 reference baseline. However, all low-carbon fuels in the transportation system, not just those that are incremental to the 2030 reference scenario, will be eligible to generate credits in the Clean Fuel Standard. Once all the low-carbon fuels are included the Clean Fuel Standard will have to account for 52 Mt CO_2eq of reductions relative to a 2010 baseline to achieve a 15% reduction in lifecycle greenhouse gas intensity in 2030.

For the most part, these reductions align with the energy share of the fuels with two important exceptions. Electricity accounts for 29% of emissions avoided, while only accounting for 10% of low-carbon fuel energy. The fuels relatively low-carbon intensity and the high efficiency of electric motors compared to combustion engines accounts for this difference. Ethanol accounts for only 13% of emission reductions, while accounting for 25% of low-carbon fuel energy. This is because ethanol production and distribution still generates greenhouse gas emissions.

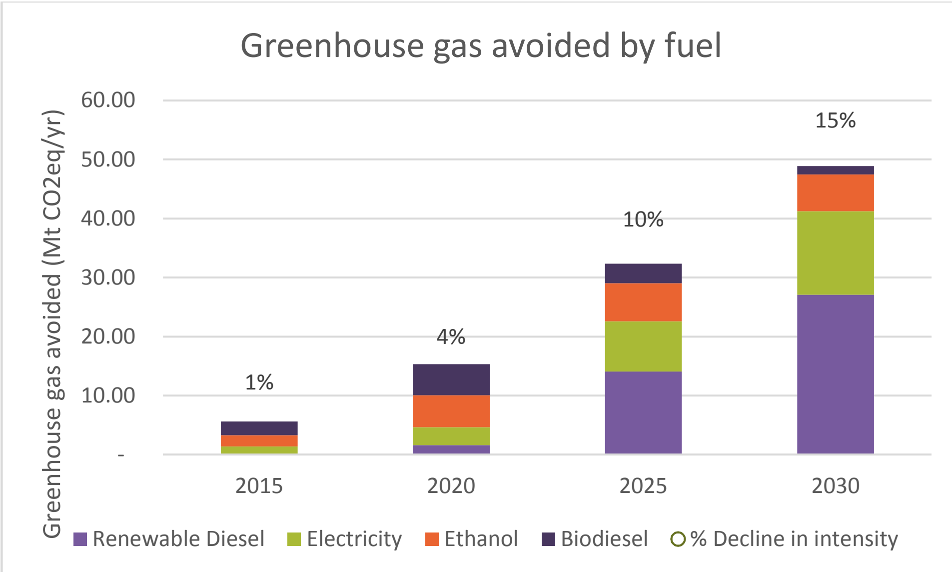

Figure 2: Greenhouse gases avoided by fuel in the partition scenario

Our analysis does not include a supply review, however. Of the fuels mentioned above, renewable diesel, ethanol and biodiesel demand require the closest attention because all grow quickly; renewable diesel volumes would expand considerably from near-zero in 2015 to 8.9 billion litres per year (L/yr) in 2030, and ethanol demand would more than double from 2.2 billion L/yr in 2015 to 6.3 billion L/yr in 2030. Biodiesel would also have to expand quickly to more than double existing supply from 0.7 to 1.6 billion L/yr. However, overall biodiesel use remains below 5% blending, so while it expands quickly, there remains room to expand more with the existing vehicle fleet. Electricity supply is of less concern since electricity demand for transportation would represent just 3% of Canada's current generation at its peak in 2030. Put another way, that's less than a 0.3% increase per year in required electricity generation.

From a vehicle technology perspective, the results do not require major advances in vehicle technology or changes in the fleet beyond the reference scenario. Specifically:

- Our ethanol estimates assume no more than 15% ethanol content in gasoline. This aligns with the Environmental Protection Agencies 2012 approval that 15% ethanol is acceptable for vehicle models that are from 2001 or later. [3]
- Renewable diesel is chemically similar to diesel and so can be mixed with existing diesel. In our modelling we assume a maximum of 40% blending.[4]
- Under existing provincial and federal policy electric vehicles sales, including plug-in hybrids and full-electric vehicles, are already on the right trajectory to contribute to compliance we model here. In the reference scenario, electric vehicles including plug-in hybrids and full electric vehicles are expected to reach 3.6% of all light-duty vehicles on the road in 2030.

[3] Environmental Protection Agency (2015) *Final Rule: Regulation to Mitigate the Mis-fueling of vehicles and engines with gasoline containing greater than ten volume percent ethanol and modifications to the reformulated and conventional gasoline programs.* https://www.epa.gov/gasoline-standards/final-rule-regulation-mitigate-misfueling-vehicles-and-engines-gasoline

[4] BC Ministry of Energy and Mines, 2014, Fuel Backgrounder to the 2014 RLCFRR Consultation

A national fuel standard using B.C.'s trajectory, as described here, would see credit prices start at $180 per tonne and then decline to $120 per tonne by 2030.[5] B.C. already has a credit price at this point, and the transportation fuel system remains fully functional and there is little evidence of increased costs at the pump. In theory, even if all the costs were passed onto the consumer still relying on gasoline or diesel, the cost would be close to $0.04 a litre of gasoline.

Building and Industry (Q14, Q15, Q19, Q20, Q22, Q23)

In the non-partitioned scenario, the policy drives emission reductions in oil and gas, heavy industry, buildings, electricity generation[6] and mining sectors. Of these five sectors oil and gas, heavy industry and buildings represent 85% of avoided emissions. Collectively 25 Mt CO_2eq are avoided per year by 2030. Figure 3 summarizes these results.

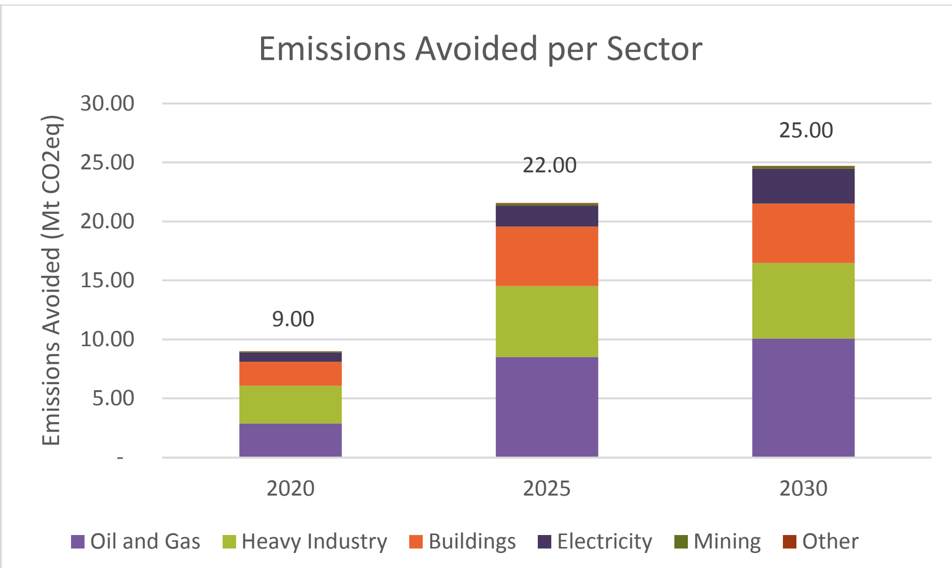

Figure 3: Emission reductions per sector for the non-partitioned scenario

These reductions imply a credit price rising from $50 per tonne in 2020 to $85 per tonne in 2030. This credit price is the marginal cost to meet the intensity target, and so the average cost to consumers, assuming the cost is passed on directly, would be much lower. In 2030, the actual cost to consumers would be at most $0.6 per gigajoule (GJ) of natural gas, equivalent to an extra $6 per month on household heating bills[7]. In addition, our model is conservative because it does not include electricity in the building and industrial sector as a pathway to meet the standard (this is a limitation of the model, rather than a desired outcome), and there are many other technology and fuel pathways that are not in the model. Homes and businesses can also mitigate this cost increase through energy efficiency upgrades and switching to different heating sources than natural gas.

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[5] The cost decline is primarily driven by increases in oil prices over the study period. We use the National Energy Boards price forecast which as oil rising to $90 per barrel in 2030. However, lower cost alternative fuels also mitigate price increases. Combined these forces counteract the increased stringency of the policy.

[6] These reductions are above and beyond the coal phase out and are most likely from carbon capture and storage on natural gas generating facilities and a small percentage of renewable natural gas in the natural gas stream.

[7] This estimate based on average natural gas use per household in Alberta, the province with the highest percentage of households using natural gas and the most natural gas used per average household in Canada of households that use natural gas. It also assumes no increase in energy efficiency for homes over the next 13 years. In other words, the most expensive case.

Switching to renewable natural gas, switching from higher carbon intensity to lower carbon intensity fuels and carbon capture and storage all contribute to sector reductions. As we refine our work further we will provide estimated greenhouse gas reductions per fuel type.

The examples above show two extremes: one where the Clean Fuel Standard reduces emissions only in the building and industrial sector, and one where reductions occur primarily in the transportation sector. Both show that the 30 Mt CO_2eq reduction target is achievable with existing technologies and fuel pathways in the building, industrial and transportation sector.

2. The Clean Fuel Standard should be based on multiple objectives (Q39)

The design of the Clean Fuel Standard should support the objectives of the policy. From our perspective, the Clean Fuel Standard should have two primary objectives:

1. Reduce lifecycle emissions by 30 Mt CO_2eq incremental to existing provincial and federal policy commitments by 2030
2. Support low-carbon fuel innovation and technology deployment in all sectors

Objective 1 – Reduce lifecycle emission by 30 Mt CO_2eq incremental to Pan-Canadian Framework

Our understanding of Environment and Climate Change Canada Clean Fuel Standard objective is to reduce lifecycle greenhouse gas emissions by 30 Mt CO_2eq relative to policies in place as of November, 2016. We've opted to model the Clean Fuel Standard to achieve a 30 Mt CO_2eq reduction incremental to federal and provincial policies in the Pan-Canadian Framework. If Environment and Climate Change Canada adopted a similar approach this would allow the Clean Fuel Standard to make a greater contribution towards Canada's 2030 target and help close the 44 Mt CO_2eq gap. Our modelling shows this greater level of ambition is affordable and technically feasible.

Objective 2 – Support low-carbon fuel innovation and technology deployment

We encourage Environment and Climate Change Canada to adopt a low-carbon fuel innovation and technology deployment objective. Meeting the kind of emission reduction objectives articulated in Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy[8] requires deployment of cleaner fuels in the transportation and building sectors beyond 2030. For example, according to *Pathways to deep decarbonization in Canada,* in order for Canada to meet a 2050 reduction target (80% below 2005 levels by 2050) average, biofuel blending would need to be more than 20% by 2030 with electricity representing 16% of transport energy.[9] In the industrial sector, biomass, electricity and carbon capture and storage would all need to be scaled up to hit 2050 targets.[10] This will require not only broad deployment of commercial technologies but also development of new technologies in all sectors. As we've illustrated above a non-partitioned policy will likely lead to few changes in the transportation sector, limiting the development and deployment of technologies in that sector and making it more difficult to achieve longer-term targets.

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[8] Government of Canada (2016) Canada's Mid-Century Long-Term Low-Greenhouse Gas Development Strategy. http://unfccc.int/files/focus/long-term_strategies/application/pdf/canadas_mid-century_long-term_strategy.pdf
[9] Bataille, C et al. (2015) *Pathways to deep decarbonization in Canada*. SDSN - IDDRI
[10] IBID

Each sector has unique barriers to innovation and technology deployment, and thus the Clean Fuel Standard should be designed to encourage innovation and deployment in each sector.

Both California and B.C. set objectives of accelerating clean technology deployment for their transportation sectors when adopting clean fuel standards. California's Low-Carbon Fuel Standard's goal is to reduce the greenhouse gas intensity of fuels by 10% but also to transform and diversify the fuel pool and reduce petroleum dependency.[11] Similarly, B.C.'s Renewable and Low Carbon Fuel Requirements Regulation aims to reduce the province's reliance on non-renewable fuels, help reduce the environmental impact of transportation fuels and contribute to a low-carbon economy[12].

Of course, Canada's clean fuel standard policy should also be designed in such a way as to minimize compliance costs while achieving objectives 1 and 2 above.

3. Partition the transportation sector *(Response to Q7, Q8, Q29, Q35)*

To send the strongest possible signal for low-carbon innovation in transportation, the transportation sector should be "partitioned" (separated) from other covered sectors. The Government of Canada should achieve this by setting transportation-specific targets and restricting credit trading for obligated parties in transportation to others within the transportation sector. This approach would help incent technology innovation and deployment that would not otherwise occur, align the standard with existing policies outside and inside Canada, and allow Canada to apply lessons from other jurisdictions.

Incent technology deployment

Without transportation-specific targets and restricted credit trading, there are likely to be few emission reductions in the transportation sector even if the 30 Mt CO_2eq reduction target is achieved overall. Based on our analysis, emission reductions to the target level are likely to be less expensive in the industry and building sectors, and so without a partition, nearly all emission reductions occur in those sectors.

While this may be desirable from a cost effectiveness perspective, a non-partitioned policy risks stunting the deployment of low-carbon fuels and technologies in the transportation sector, which in our view is one of the principle objectives of the policy. Technologies and processes will take time to deploy and several analysis have demonstrated will be necessary to achieve a 2050 target[13]. Figure 4 and Figure 5 show the differences in greenhouse gas reductions with and without a partition.

[11] California Air Resources Board (2016) *Low Carbon Fuel Standard*. https://www.arb.ca.gov/fuels/lcfs/background/basics.htm

[12] Government of British Columbia (2017) *Renewable & Low Carbon Fuel Requirements Regulation*. http://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels. Accessed March, 7th, 2017.

[13] Bataille, C et al. (2015) *Pathways to deep decarbonization in Canada*. SDSN – IDDRI, The Canadian Academy of Engineering (2016) Canada's Challenge & Opportunity: Transformations for major reductions in GHG emissions. https://www.cae-acg.ca/wp-content/uploads/2013/04/3_TEFP_Final-Report_160425.pdf, International Energy Association (2016) *World Energy Outlook*.

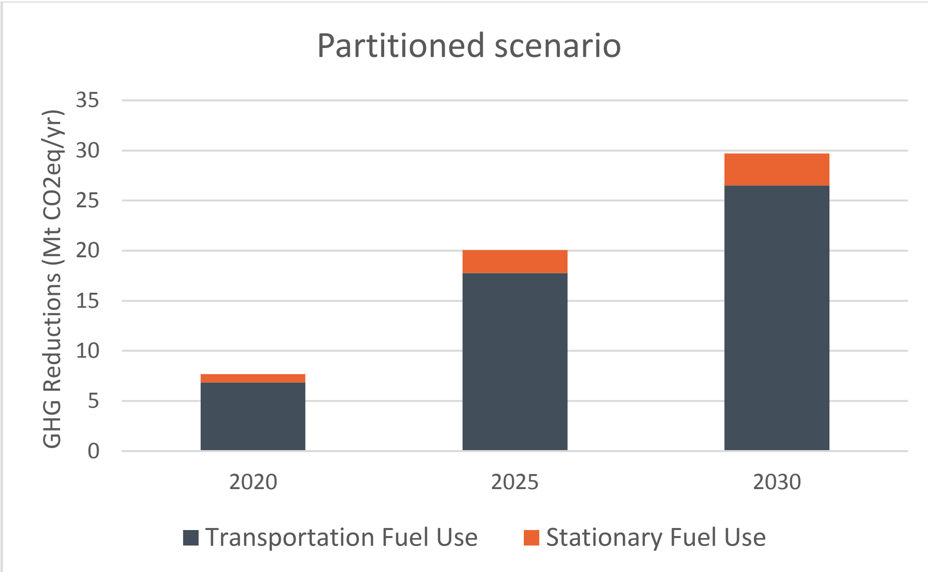

Figure 4: Greenhouse gas reductions in transportation and stationary fuel use for the partitioned scenario

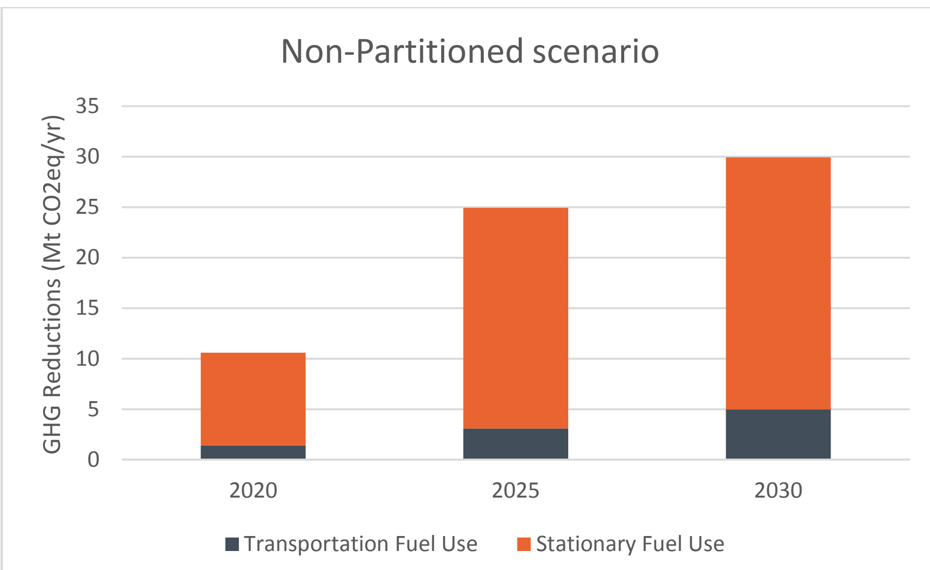

Figure 5: Greenhouse gas reductions in transportation and stationary fuel use for the non-partitioned scenario

In the partitioned scenario renewable diesel, ethanol and to a lesser extent electricity become important transportation fuels because of the partition. Figure 1 and Figure 2 in the previous section show the specific fuel pathways that generate the emission reductions in Figure 5.

These results are similar to compliance with the existing low-carbon fuel standards in California and B.C. In both jurisdictions ethanol, biodiesel, renewable diesel and electricity have accounted for the majority of emission reductions to date.[14]

[14] California Air Resources Board (2016) *Data Dashboard.* https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm & Ministry of Energy and Mines (2017) *Renewable and Low Carbon Fuel Requirements Regulation Summary: 2010-2015.* http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/transportation/renewable-low-carbon-fuels/rlcf-007-2015.pdf

Align with existing standards

If the transportation sector is partitioned than the Clean Fuel Standard would be similar to low-carbon fuel standards in B.C., California, Oregon and Ontario's proposed modern renewable fuel standard. Thus, in the Canadian context partitioning would align the federal standard with Ontario's modern renewable fuel standard and B.C.'s low-carbon fuel standard.

Over time, partitioning would also allow for potential credit trading with other low-carbon fuel standard jurisdictions like California and Oregon. In theory, linking systems would help reduce compliance costs, although we haven't modelled this outcome. With no partition, the policies would likely be too different to allow for credit trading.

Applying lessons from other jurisdictions

Another benefit of partitioning is that Canada can learn from the jurisdictions that have already implemented the Clean Fuel Standard. For example, both California and B.C. now have considerable experience developing and maintaining life-cycle intensity values and credit trading systems. Both have also developed reporting systems for regulated parties and public reporting on the effectiveness of their standards. Regulated parties have learned how to report and meet each standard.

For other sectors (Response to Q37)

We support the government in pursuing intensity reductions for buildings, industry and transport starting in 2020 and would prefer the standard be implemented for all sectors at this date. However, should building and industrial sectors be phased in on a slower timeline any phase-in of compliance obligations must be shown to be compatible with achieving the 30 Mt CO_2eq target in 2030.

4. Broad coverage allows for multiple reduction pathways (General comment on "Scope," section 4.)

While we recommend partitioning, we do support the federal government's decision to set fuel greenhouse gas intensity targets for the buildings, industry and transportation sectors. This sends a signal to all fossil fuel producers and users in Canada that greenhouse gas intensity of Canada's fuel supply must decline year over year.

To meet the objectives outlined above, these intensity targets should be sufficient to meet the overall 30 Mt CO_2eq target while also driving emission reductions within each sector. This approach would ensure innovation and technology deployment in each sector that most likely would not have occurred otherwise and create economic opportunity.

The modelling results here show that a 30 Mt CO_2eq target could be met in the transportation sector by reducing the emissions intensity by 15% from a 2010 baseline by 2030. Overall lifecycle intensity for transportation and stationary fuels for the partitioned and non-partitioned sectors are summarized below. We are not recommending these specific reduction targets, rather these are the reduction targets necessary to achieve 30 Mt CO_2eq reductions for transportation and stationary fuels.

Table 1: Lifecycle greenhouse gas intensity declines for transportation and stationary fuels in both scenarios

	2015	2020	2025	2030
Partitioned scenario – transportation fuels (g CO2eq/MJ)	89.0	86.2	81.4	76.6
Partitioned scenario – transportation fuels (% reduction relative to 2010)	-1.3%	-4.3%	-9.7%	-15.0%
Non-partitioned scenario – stationary fuels (g CO2eq/MJ)	55.6	54.8	52.6	51.9
Non-partitioned scenario – stationary fuels (% reduction relative to 2010)	-1.4%	-2.7%	-6.7%	-7.9%

5. Ensure that credits are administratively simple to generate, even for non-regulated parties that would opt in

The Clean Fuel Standard should be designed so that regulated parties can generate credits without undue administrative complexity from new fuel pathways such as electricity, biofuels and hydrogen, and improvements within traditional fossil fuel supply chains. Credit generation should be accessible to both large and small organizations.

Below we provide some specific examples based on experience in B.C. and California and on the results, as well as results of our modelling work.

Electricity (Response to Q9, Q14, Q19)

The Clean Fuel Standard can be designed to allow for third parties (e.g. gas stations, charging companies, utilities or EV manufacturers) to sell electricity for vehicle charging and gain credits that can be used against a company's compliance obligations. California included this approach in the 2015 re-adoption of its Low Carbon Fuel Standard.[15] Regardless of the approach the electricity use must be transparent, verifiable, avoid double counting and be based on rigorous data collection. Attaining these objectives is possible if regulators draw on existing electric vehicle analytics, charging station data and estimates for home charging.

Monetizing these credits could be a powerful incentive to encourage electrification. For example, every electric vehicle on the road in Ontario represents $410 per year in potential credit revenue under a Clean Fuel Standard, assuming a credit value of $170 per tonne of CO_{2eq} (similar to the credit price in B.C. today[16]). Electric vehicle manufacturers could use this credit to reduce electric vehicle costs. Charging companies could use it to expand charging infrastructure and utilities could use it to reduce electricity rates for EV charging. All these approaches would increase electric vehicle sales.

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[15] California Air Resources Board (2015) *Low Carbon Fuel Standard*. https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf

[16] Credit price from Government of British Columbia (2017) Credit Transfer Activity Dec. 31st, 2016. http://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels. Assumes GHG intensity of gasoline of 84.26 gCO2eq/MJ, electricity grid intensity of 80 gCO2eq/kwh. For an electric vehicle using 3,600 kwh per year, driving of total 19,200km with an energy efficiency ratio of 3, relative to a gasoline vehicle. The value of a credit per kwh of electricity is equal to the difference of GHG intensity multiplied by the energy efficiency ratio for electric vehicle.

Our modelling shows that if this credit is not monetized in the ways discussed above then the Clean Fuel Standard, even if partitioned, does little to incent transport electrification. The next iteration of our modelling will estimate the potential impact on electric vehicle uptake.

In addition, the regulation should be designed to offer as much detail on the carbon intensity of an electricity grid as possible. Given the variations in electricity generation in Canada, a national value for electricity generation carbon intensity would be inappropriate. Provincial or regional carbon intensity values for electricity, updated annually, would allow for more accurate greenhouse gas accounting and incent clean technology adoption in the regions with the highest potential benefit.

Pathways for the oil and gas sector

Individual oil producers and refiners could prove their fuel carries a lower emission intensity than the industry average—and receive credits against their compliance obligations. This kind of credit generation should be limited to specific and significant improvements such as carbon capture and storage or integrating renewable energy, two credit generation options that California has allowed.[17] B.C. does not currently provide credit for these types of actions.

6. The standard should include cost-containment mechanisms (Q29, Q30, Q31 and Q32)

The regulation should be designed to minimize costs—while achieving the two objectives mentioned earlier—and maintaining affordability for Canadians. Credit trading and a maximum credit price (or some other mechanism that creates a price ceiling like a clearance market) can help to achieve this objective.

Credit trading system

Credit trading systems help mitigate the costs of compliance on any one business while also providing incentives for innovation and commercial deployment of low-carbon fuels. Both California and B.C. use credit trading systems in their Clean Fuel Standards. However, the only credits available for trading should be those generated within each sector. For example, credits used to comply with intensity reduction targets for the transportation sector should only come from the transportation sector. Credits generated in other sectors or from cap-and-trade programs, offsets or other credits generated outside the regulation should not be included.

Price ceiling

As discussed earlier, costs can be further mitigated by regulating a maximum credit price, a clearance market or a combination of both. Both options help contain costs associated with the regulation.

A $250 per tonne CO_{2eq} maximum credit price, indexed to inflation, would both protect Canadians from unexpected costs to comply with the regulation while also maintaining a strong incentive to deploy and invest in low-carbon technologies. A $250-per-credit ceiling price translates to a *maximum* cost of nine cents per litre of gasoline if all 30 Mt CO_2eq reductions occur in the transportation sector. Increases in gasoline price will be well below the maximum cost and likely below the calculated credit price because:

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[17] California Air Resources Board (2015) *Low Carbon Fuel Standard*. https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf

- This maximum price is well above our modelled maximum compliance cost of $180 per tonne CO_{2eq} and higher than the maximum credit price in California (C$160 per credit)[18] and the maximum credit price in B.C. (C$171 per credit).
- It is also unlikely that the full credit price would be passed onto Canadians in the transportation sector. For example, the Renewable and Low Carbon Fuel Requirements Regulation in B.C.[19] has not produced any detectable increase in pump prices. In California, the Low Carbon Fuel Standard—in combination with other transportation policies such as a Zero-Emission Vehicle Standard and vehicle efficiency requirements and incentives—is expected to provide a net financial benefit to citizens over time.[20]
- Companies will also have access to many reduction options that are lower than the maximum credit price and so should only pass on the average cost, which would be much lower.
- Canadians also have access to and will have more access to efficient vehicles, and vehicles that rely less on gasoline and diesel and so many will have the ability to avoid these cost increases.

Figure 6 summarizes the maximum cost increase per litre of gasoline with the price ceiling and calculated credit price. As discussed, costs per litre will most likely fall below the "calculated credit price line" and only for those who continue to rely on gasoline vehicles.

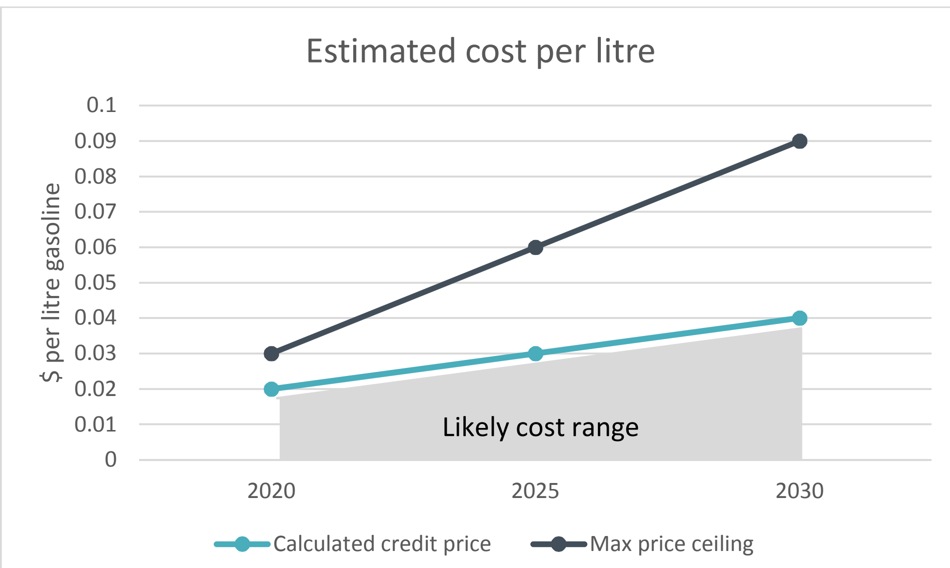

Figure 6: Maximum cost increase per litre of gasoline for the partition scenario

7. Align complementary policies (Q33 & Q35)

The Clean Fuel Standard complements pricing and should be aligned with other complementary policies to remove barriers to adopting low-carbon fuels and reduce regulatory overlap when possible. Some examples are provided below, but these are not exhaustive.

[18] California Air Resources Board (2016) *Data Dashboard.* https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm
[19] Wolinetz, Michael (2015) Examining the Renewable and Low-Carbon Fuel Regulation Requirement in the Context of Refinery Net-Revenues. http://www.naviusresearch.com/wp-content/uploads/2016/05/Refining_Margins_-and_the_BC_Clean_Fuel_Regulation_Navius.pdf
[20] ICF International (2016) Consumer Impacts of Low-Carbon Transportation Policies. http://consumersunion.org/wp-content/uploads/2016/03/Consumer-Impacts-of-Low-Carbon-Transportation-Policies-Report.pdf

- **Clean Fuel Standard as a complementary policy:** Reducing emissions in the transportation sector requires a mix of cleaner fuels, cleaner vehicle technologies and alternatives to driving such as transit, biking and shorter commutes. A mix of approaches that already exist in Canada such as carbon pricing, vehicle efficiency regulations, transit investment and urban planning are critical to reducing emissions, but they do little to incent lower-carbon transportation fuels. The Clean Fuel Standard fills that gap and so is complementary to carbon pricing and other policy tools.

  The Clean Fuel Standard is a novel greenhouse gas reduction tool in the building and industrial sectors, but will likely drive outcomes similar to those in the transportation sector. Our research shows the Clean Fuel Standard would likely incent fuel switching from more polluting fuels to natural gas and increase the renewable content of natural gas. These types of changes are necessary to meet long-term targets as several studies have concluded.[21]

- **Align budget spending:** Federal investments like the Low-Carbon Economy Fund, the proposed Canada Infrastructure Bank, the Green Infrastructure Fund, support for the deployment of near commercial renewable energy technologies, and electric vehicle and hydrogen fueling stations should be clearly linked to supporting the Clean Fuel Standard. For example, electric vehicle charging stations will help accelerate electric vehicle deployment and in turn make it easier for regulated parties to comply with the regulation. The Low-Carbon Economy Fund and the relevant federal infrastructure funding commitments could support also support new biofuel projects like bio-crude and co-processing or new renewable natural gas facilities.

- **Consider phasing out national and provincial renewable fuel standards** (Q36)**:** Our modelling analysis suggest that the national The Clean Fuel Standard will incent low-carbon fuels above and beyond the current renewable fuel standard. The Clean Fuel Standard also evaluates and supports fuels on their greenhouse gas performance, something several renewable fuel standards fail to do. Federal and provincial renewable fuel standards could therefore be phased out over time once the Clean Fuel Standard is in place and functioning as intended.

- **Interactions with cap and trade and carbon taxes:** We view cap and trade or a carbon tax as complementary with the Clean Fuel Standard. Both provide incentives to industry and individuals to make decisions that reduce greenhouse gas emissions if well designed.

  However, jurisdictions will need to consider the interaction of the Clean Fuel Standard with credit prices under a cap-and-trade system and carbon tax rates necessary to drive reductions. In general, any policy aimed at reducing emissions under a cap-and-trade program will tend to decrease credit costs, as there will be less demand for credits. Estimates of California's Low Carbon Fuel Standard have found that credit prices could be up to 50% lower if the current Low Carbon Fuel Standard is strengthened compared to a scenario where its stringency is unchanged. This could have important implications on planned government revenue from the cap-and-trade system[22].

  In a carbon tax regime like B.C., a Clean Fuel Standard will likely be an additive cost to the carbon tax rate on fossil fuels, but may mitigate the level of increase of the carbon tax, and low-carbon fuels should be charged as fossil fuels at the pump. A stringent fuel standard helps reduce emissions and so governments in carbon tax jurisdictions may rely less on the carbon tax to meet targets. For example, Clean Energy Canada's policy mix to reduce

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[21] Bataille, C et al. (2015) *Pathways to deep decarbonization in Canada*. SDSN – IDDRI, The Canadian Academy of Engineering (2016) Canada's Challenge & Opportunity: Transformations for major reductions in GHG emissions. https://www.cae-acg.ca/wp-content/uploads/2013/04/3_TEFP_Final-Report_160425.pdf, International Energy Association (2016) *World Energy Outlook*.
[22] ICF (2017) *Post-2020 Carbon Constraints: Modeling Clean Fuel Standard and Cap-and-Trade.*

emission in British Columbia included a mix of strong regulations a maximum carbon price of \$80 per tonne CO_2eq.[23] Other studies require fewer regulations but a carbon tax rising well above \$80 per tonne CO_2eq.[24] Low-carbon fuels should also only be charged a carbon tax on the greenhouse gas emissions associated with the fuel, which is not done in B.C. right now.

8. Ensure transparency, accountability, regular updates and reporting (Q26, Q28)

Once implemented, the Clean Fuel Standard should publicly report compliance quarterly. This reporting should include all fuel volumes, feedstocks, carbon intensities, credit trading and greenhouse gas avoidance estimates per fuel type. This recommendation applies to fossil fuels and to other fuels used for compliance, such as electricity and hydrogen. Regulated parties could also be required to submit annual compliance reports to governments on they plan to meet the regulation.

This level of reporting is necessary to measure policy effectiveness and to inform changes to the policy. Compliance reporting for existing renewable fuel standards across Canada is generally poor and variable, leading to a diverse set of estimates on policy effectiveness and impact[25].

We also encourage the federal government to research pathways to achieve the standard, to evaluate the reported data, and to estimate the jobs and economic benefits of the standard. This research can help to guide future stages of the regulation.

The methodologies for assessing lifecycle carbon intensity pathways should be as robust and as transparent as possible, and be updated on a regular schedule as new science is validated. Carbon intensity estimates should also take into account any indirect land use change associated with fuel production based on assessment of Canadian specific data.

Because it is a Canada-specific model populated with Canadian data, we support using GHGenius for defining, maintaining and updating reduction pathways. It has also been used in Alberta and British Columbia to develop and maintain greenhouse gas intensity values per fuel and is also relatively transparent.

We also recommend that Environment and Climate Change Canada, along with other federal government partners, investigate and include indirect land use change estimates for all fuel pathways (i.e. not just for biofuels), provided these estimates are based on Canadian data and modified over time.

9. Use sustainability criteria

We support the concept that the regulation should include a broad range of sustainability criteria beyond carbon intensity for all fuels. *(Response to Q38.)*

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[23] Clean Energy Canada (2017) A Clean Economy and Jobs Plan for British Columbia. http://cleanenergycanada.org/work/a-clean-economy-and-jobs-plan-for-british-columbia/

[24] Climate Leadership Team (2015) Recommendations to government. https://engage.gov.bc.ca/app/uploads/sites/116/2015/11/CLT-recommendations-to-government_Final.pdf

[25] Moorhouse, J, Wolinetz, M. (2016) Biofuels in Canada: Tracking the progress in tackling greenhouse gas emissions from transportation fuels

Next steps

Thank you for the opportunity to comment on this important policy commitment. We support your efforts in developing the policy and look forward to further engagement. We would like to be involved in technical discussions and would welcome the opportunity to speak to our research.

Respectfully,

Jeremy Moorhouse, Senior Analyst
Clean Energy Canada

Appendix: Clean Fuel Standard Modelling Outline

Background

The Federal Government is developing a clean fuel standard (CFS) which aims to reduce greenhouse gas emissions from covered sectors by 30 $MTCO_{2eq}$ by 2030 and will incent creation of lower carbon fuel pathways, and drive technology and innovation. Clean Energy Canada has and will continue to participate in the federal government's engagement process. Clean Energy Canada has contracted Navius Research to help develop its recommendations and understand the likely compliance pathways for regulated parties.

This document outlines the purpose, scope and approach of the research.

Purpose

The purpose of this research is to understand:

- The impact of the CFS on energy consumption, GHG emissions, fuel prices and energy costs.
- The extent to which the CFS can achieve the stated GHG reduction target and with what technologies and fuels that might happen.
- The GHG emissions intensity targets that should be applied to each sector covered under the policy.
- The potential job impacts of the policy by province and sector.
- The impact of partitioning the CFS requirements between sectors (i.e. transportation, buildings, and industry).
- The complementary policies that could best support the CFS.

Scope

The research will be bounded by the scope outlined in Table 2: Scope of analysis.

Table 2: Scope of analysis

Element of the analysis	*Description*
Time horizon of the analysis	From 2015 to 2050, with results in five year time steps
Sectors and representative end-uses included in the model	Transportation, with a model of energy using technologies for light-duty road transport and heavy-duty road transport (scaled to represent total transportation energy consumption). **Buildings**, represented with a model of energy technologies that provide space heating. **Industry**, represented with a model of energy technologies that provide process heat.
Regions	Each province is represented separately.
Fuels	**Transportation**: Gasoline, diesel, electricity, natural gas, biogas, biodiesel, ethanol, renewable diesel, and as necessary hydrogen and renewable gasoline or other drop-in fuels. **Buildings and industry**: natural gas, petcoke, coal, oil, biogas and hydrogen and biogas, and hydrogen (as combustion fuel mixed with natural gas).
Policies scenarios	**Three policy scenarios that include:** • The CFS, with variation across scenarios in policy design (e.g. partitioning, compliance mechanisms, targeted GHG intensity) • Other North-American fuel policy, e.g. the Californian and BC fuel regulation, the Canadian and US renewable fuel standards and other provincial fuel mandates • Other major climate policies, e.g. carbon pricing, vehicle emissions standards, electricity sector policy (only in terms of how it affects exogenous assumptions about electricity GHG intensity).
Sensitivity scenarios	TBD depending on initial modelling results
Results	• Upstream and downstream GHG emissions • Energy consumption by fuel • Stocks of vehicle technologies • Fuel production by fuel and region • Investment in fuel production capacity by region and sector (e.g. capital expenditures for biofuel refineries) • Direct jobs in fuel production by region and sector (e.g. petroleum fuel vs. ethanol)

Approach

We plan to use two of Navius' in-house models, CIMS and OILTRANS. CIMS is a technology simulation model that incorporates detailed technologies, behavior and energy-demand technology adoption. OILTRANS is an equilibrium model for North American transportation models.

We will use these models to evaluate at a minimum three scenarios as follows:

1. **Reference Scenario:** The reference scenario includes all major provincial and federal policies in the Pan-Canadian Framework. This includes all provinces meeting the federal carbon price framework, coal phase-out, vehicle energy efficiency requirements, and provincial and federal renewable and low-carbon fuel standards. Reductions from the Clean Fuel Standard in the partitioned and non-partitioned scenarios are therefore incremental to these policies.
2. **Partitioned Scenario:** A transportation-focused Clean Fuel Standard that requires a 15% reduction in greenhouse gas intensity in the transportation sector from 2010 levels by 2030. This essentially applies B.C.'s low-carbon fuel standard across Canada. Any remaining emissions reductions to meet the 30 Mt CO_2eq target come from the building and industrial sector.
3. **Not-Partitioned Scenario:** In the non-partitioned scenario, all fuel supplies in buildings, industry and transport compete to provide the lowest-cost reduction. This is facilitated by unlimited credit trading between and among fuel types. Total reductions must hit 30 Mt CO_2eq by 2030.

We will supplement these scenarios with sensitivity analysis, which may include the following:

- **More rapid alternative-fuel vehicle adoption**: This analysis would explore the impact of faster than expected declines in battery technology and consumer acceptance of electric vehicles and other fuel types.

- **Constraints on biofuel blending**: This analysis would explore the impact of biofuel blending limits such as allowing or preventing newer vehicles from using 15% ethanol in newer vehicles.

- **Higher and lower prices for natural gas and oil:** This analysis would explore the impact of high and low natural gas and oil prices on outcomes of the CFS.

Timeline

We aim to have public results in May/June 2017

Additional Information:

The OILTRANS model is an equilibrium model of the North American market for transportation fuels from 2012 to 2050 (solved every five years). The model simulates the key agents most relevant to the North American fuel market and how the North American market adjusts under different policies (e.g., the low-carbon fuel standards), economic conditions (e.g., price for oil) and constraints (e.g., constraints on blending biofuels into gasoline or diesel). The model solves the price for every fuel, policy (some policies have "shadow prices" or implicit prices due to a regulation) and service such that the market arrives at an equilibrium (i.e., the supply for every good or service must be equal to demand).[26] This occurs at multiple fuel trading nodes and each Canadian province will be explicitly represented as one of these nodes in the proposed analysis.

OILTRANS is an "agent" based model. This means that the model simulates the behavior of specific agents within the market and distinguishes between the behaviors of different agents (e.g., fuel producers versus consumers). The key agents represented in the model are described Table 3. Note that the specific fuels listed in the table can be updated as necessary to provide an improved representation of the system in question. For example, we could add renewable gasoline if the market overview research indicates this fuel is potentially important for policy compliance during the timeframe of the analysis.

Table 3: Agents in the OILTRANS model

Agents	*Description*
Petroleum refiners	Maximize profits by converting crude oil into gasoline or diesel.
Biofuel/low carbon fuel manufacturers	Maximize profits by converting agricultural products into biofuels. The model accounts for 8 options for biofuels manufacturing, which vary by product (e.g., ethanol, biodiesel and hydrogenation-derived renewable diesel, or "HDRD"); feedstock (e.g., corn, wheat, canola oil, soy oil or palm oil); and fuel used to supply heat (e.g., coal, natural gas or renewable fuel). Each option has a unique GHG intensity based on the GHGenius model version 4.03.
Fuel shippers	Maximize profits by transporting transportation fuels between regions. A fuel will be transported from region *h* to region *hh* if the price in region *h* is greater than price in region *hh* plus the cost of transportation. OILTRTANS accounts for both land (rail, truck, and pipeline) and seaborne transportation (with unique costs for each).
Fuel blenders	Blend fuels for final consumption. Fuel blending is subject to constraints on blending (e.g., maximum blends for biofuels) and policy (e.g., low-carbon fuel standard, renewable fuel standards).
Final consumers	Consume gasoline and diesel. Their consumption is sensitive to price, with lower prices increasing consumption.

[26] Supply may exceed demand if the price for a good or service is zero.

OILTRANS is simulated as a mixed complementarity problem and solved using the PATH solver in GAMS.

Transportation Energy Demand Simulation within OILTRANS

Transportation energy demand in Canada and in other represented regions in OILTRANS is a function mainly of transportation activity and transportation vehicle choice. In this analysis, transportation activity is an external assumption. However, vehicle choice will be a simulated result from a sub-model embedded within the demand module of OILTRANS. We will use a simplified representation of transportation end-uses, focusing on the three that consume the most energy in Canada: light-duty passenger vehicle transportation and heavy duty road freight transportation and off-road transportation.

Within each of these end-uses, we will simulate how vehicle capital stock is acquired, used, and retired at the end of its useful life. New vehicle purchases may vary across efficiency (e.g. high and low-efficiency gasoline engines) and energy source (e.g. electric, gaseous fuel).

The model then simulates how capital stock is acquired, used to provide energy services (e.g. home heating, personal transportation, or electricity consumption), retrofitted and ultimately retired at the end of its useful life. Technology choice decisions are based on financial costs as well as human behaviour. Specifically, our model accounts for how preferences for familiar technologies, perceived risks of new technologies, and heterogeneity of human choices will ultimately investment decisions.

This representation of behaviour is derived from empirical research into how people choose vehicles. For example, to what extent will they trade lower-operating costs for higher upfront costs, or how averse are they to new technology? Our team has conducted primary and applied research in this regard for electric vehicles, for example, Wolinetz and Axsen (2016)[27], and similar research exists for other vehicle choices.

Building and Industrial Heat Energy Demand Simulation

Similar to the representation of transportation energy demand, we will use a CIMS-like model to represent the consumption of fuel for buildings and industry, representing the possible substitutions between fuels that could occur as a result of energy prices, technology costs and policy requirements.

[27] Michael Wolinetz and Jonn Axsen, How policy can build the plug-in electric vehicle market: Insights from the REspondent-based Preference And Constraints (REPAC) model, *Technological Forecasting and Social Change* (2016). http://dx.doi.org/10.1016/j.techfore.2016.11.022