



What a Clean Fuel Standard Can Do for Canada

A road to cleaner fuels, more jobs
and less carbon pollution

November 2017

Overview

Though it has flown under the radar of many Canadians, a policy that aims to cut more carbon pollution than any other piece of the Pan-Canadian Framework on Clean Growth and Climate Change was announced last year by the federal government. Canada's Clean Fuel Standard aims to reduce carbon pollution by 30 million tonnes of carbon dioxide equivalent (CO₂eq) by 2030—equal to taking more than seven million cars off the road.

The Clean Fuel Standard targets not only transportation fuels, like gasoline and diesel, but also those used in buildings and industry, like natural gas. It would require fuel suppliers to reduce the carbon intensity (the amount of carbon pollution released for every unit of fuel consumed) of their product, while offering flexibility in how they choose to do it. For instance, a gasoline provider could blend ethanol into their fuel to make it less carbon-intensive—as Canadian fuel providers already do.

The Government of Canada is designing a flexible, performance-based Clean Fuel Standard, but exactly how this standard will work and what implications it will have for Canadians remains under consideration.

Working with Navius Research, Clean Energy Canada designed a version of the Clean Fuel Standard in line with the federal government's plans for the policy. Our goal was to determine what this policy would mean for Canadians. What we found is that a well-designed Clean Fuel Standard—informed by experience with similar policies in California and B.C.—would not only help Canada cut pollution in keeping with our commitment under the Paris Agreement, it would create jobs in Canada's clean fuel sector and grow a new segment of our economy. The Clean Fuel Standard is, in short, a powerful and proven policy.

- **IT WILL DRIVE JOB CREATION AND INVESTMENT IN CLEAN FUELS.** The policy would increase economic activity in clean fuels in Canada by up to \$5.6 billion a year in 2030. It would also create up to 31,000 jobs for the skilled workers needed to build, operate and supply new clean fuel facilities.
- **IT'S AFFORDABLE FOR CANADIAN HOUSEHOLDS.** Canadians will see little if any new costs at the pump or on their utility bills.
- **IT'S ENVIRONMENTALLY EFFECTIVE.** The standard can cut carbon pollution by 30 Mt CO₂eq on top of what other policies in the pan-Canadian framework would achieve.

To get these results, we recommend Environment and Climate Change Canada establish specific requirements:

- For the transportation sector, mandate a 10% reduction in carbon intensity by 2030 from 2015 levels. The transportation sector should be partitioned from buildings and industry.
- For buildings and industry, implement either a 3.5% reduction requirement in carbon intensity over that same period, or a 5% renewable natural gas mandate by 2030.

How did we develop our recommendations?

Clean Energy Canada teamed up with Navius Research, a leading consultancy that evaluates the economic implications of climate policy. Navius used two in-house models to simulate the impact of different Clean Fuel Standard designs on Canada's economy. We worked together for 10 months testing different designs and sharing those results with governments and industry. What you see in this report is the result of that process. Our methods, assumptions and more detailed results are available in the [accompanying technical report](#).



What is the Clean Fuel Standard?

The Clean Fuel Standard is a proposed regulation that would require fuel suppliers to reduce the carbon intensity of the fuels they produce and sell. Suppliers, like refiners and natural gas providers, decide what technologies and fuels will be the cheapest way to comply—whether it’s through biofuels, electricity, natural gas, hydrogen or some other solution. This means that fuel used across Canada will get cleaner year after year.

The federal government is still designing the standard, but here’s what we know: it aims to reduce carbon pollution by 30 Mt CO₂eq by 2030; cover a range of fuels in transportation, industry and buildings (such as gasoline, diesel and natural gas); and focus on results with flexibility around how they’re achieved.



SÉMÉR, a waste-to-energy plant and biomethane refinery in Quebec.
Photo: Joan Sullivan

What is renewable natural gas?

Renewable natural gas is nearly identical to the natural gas that may heat your home or cook your food. Currently, it comes from decomposing organic waste found in landfills, water treatment plants and other industries. It’s a renewable fuel that’s already used in many provinces across Canada.

Why isn’t carbon pricing enough?

The federal government plans to price carbon pollution across the country by 2018.¹ While necessary, federal and provincial carbon pricing plans alone aren’t sufficient—and aren’t designed to operate alone as Canada works to meet its 2030 Paris Agreement target.² Switching to lower carbon fuels is critical to that end,³ and existing carbon pricing plans (as well as other policies in the pan-Canadian framework) are unlikely to move the needle much on fuels. The Clean Fuel Standard is uniquely suited to this task because it provides a gradual but consistent signal to reduce the carbon intensity of fuels specifically over time—which is an important consideration when building long-lived biofuel facilities. The standard would extend to 2030, while current plans for a national price on carbon pollution only see it rise to 2022.

Why It's So Effective

The Clean Fuel Standard is critical to Canada's action on climate change simply because it aims to cut more carbon pollution than any other policy in the pan-Canadian framework. Beyond that, the standard has a number of beneficial features:

1. IT DRIVES GROWTH IN CLEAN FUELS

California's Low Carbon Fuel Standard (a Clean Fuel Standard by another name) has helped drive \$1.6 billion in clean fuel investment⁴ while increasing biofuel production within the state by 75%.⁵

2. IT'S AFFORDABLE FOR HOUSEHOLDS

In B.C., which has had a Low Carbon Fuel Standard since 2010, the cost at the pump has been almost unmeasurable—the policy may have even generated a slight savings.⁶ In California, a package of policies that includes the standard alongside energy efficiency measures will save a typical family up to US\$1,500 a year by 2030.⁷

3. IT BUILDS ON OTHER POLICIES

If designed properly, the standard will reduce emissions beyond what other policies in the pan-Canadian framework accomplish.⁸ It could also be the only policy in the framework that ensures the transportation sector uses cleaner fuels to contribute to meeting Canada's 2030 target—while setting us up to meet our 2050 target.

4. IT'S COST-EFFECTIVE

The Clean Fuel Standard lets companies decide what method of lowering their carbon intensity is most cost-effective for them. It also lets them trade credits with other companies. Compared to more prescriptive regulations, the standard can offer lower-cost reductions. If designed properly, it can be almost as cost-effective as carbon pricing while applied to specific sectors.⁹

5. IT'S PROVEN IN THE TRANSPORTATION SECTOR

B.C. and California have versions of a Clean Fuel Standard (focused on the transportation sector), and in both jurisdictions the policy is cutting carbon pollution while expanding the menu of clean fuel options and increasing their use. In short, it's doing exactly what it's supposed to do. And it's not just the Canadian government that's noticed—Oregon implemented a standard in 2016.

How the Clean Fuel Standard Could Work

1 The federal government is developing a Clean Fuel Standard. In short: it will make the fuels that heat our homes and power our cars cleaner. It's also



the single biggest carbon-fighting policy in Canada's national climate plan, aiming to reduce carbon pollution by 30 million tonnes in 2030. That's equal to taking more than seven million cars off the road.



2 As the market for renewable fuels grows more competitive, we'll see more jobs and investment in the sector. There are already 26 biofuel plants across Canada.

The standard could add 30 more plants, 31,000 jobs and \$5.6 billion in economic activity in clean fuels.



3 Fuel suppliers, like refiners and natural gas providers, would meet the Clean Fuel Standard in the way they find most cost-effective.

This **keeps prices competitive while**

also creating more demand for ethanol, biodiesel, clean electricity and renewable natural gas.

4 The standard will apply to gasoline and diesel in cars, as well as natural gas, coal and other fuels used in buildings and industries across Canada. We recommend separating the transportation



sector from the building and industry sectors, so that each can be targeted more effectively.



5 **The Clean Fuel Standard is an affordable way to fight climate change and make Canada's economy cleaner.** Even with the standard in place, with the help of energy efficiency measures, a typical Canadian household would save

\$17 a month on their energy bills in 2030 compared to what they spend today.

How the Clean Fuel Standard Could Work

We investigated several design options for the Clean Fuel Standard, ultimately separating the transportation sector from the building and industry sectors in order to target each more effectively.

In our design, the transportation sector must reduce the carbon intensity of its fuels by 10% from 2015 levels by 2030. Those reductions must occur in the transportation sector, and not from purchasing credits from other sectors. This is known as partitioning the Clean Fuel Standard. Companies in the transportation sector can, however, trade credits with other companies in the transportation sector. If one company isn't able to reduce emissions, it can buy credits from a company that can. This helps keep costs low.

For buildings and industry, we consider either a mandated 3.5% reduction in carbon intensity over that same period, or a requirement to use 5% renewable natural gas by 2030. The first version would be flexible and allow companies to choose how they prefer to reduce emissions—including through trading credits. Either option, combined with the 10% mandate for transportation fuels, would reduce carbon pollution by more than 30 Mt CO₂eq.

How does the standard work for electric cars?

The Clean Fuel Standard could boost electric vehicle sales by 70% beyond what they would otherwise be. Under the standard, carbon pollution reductions are worth money—about \$400 per electric vehicle in some provinces,¹⁰ depending on credit prices and how clean the electricity grid is—which can be returned to EV drivers either through rebates or lower electricity costs. Some California utilities return \$200 a year to EV owners thanks to the state's standard.¹¹

Why this design?

First and foremost, we made sure either version of our design would cut carbon pollution by 30 Mt CO₂eq beyond existing policies in the pan-Canadian framework. We separated the transportation sector because transport accounts for 28% of Canada's emissions,¹² and those emissions must decline for Canada to achieve its 2030 climate target and get us on track for deeper emission reductions afterward. That means switching to cleaner fuels and more electric vehicles, in addition to improving vehicle efficiency and providing alternatives to driving.

Aside from the Clean Fuel Standard, the policies in the pan-Canadian framework have little effect on the fuels we use for transportation. In fact, without the Clean Fuel Standard targeting transportation, we wouldn't see much improvement in transportation sector fuels, even by 2030.¹³ This wouldn't be a problem if Canada was on track to meet its 2030 target, or if other changes like energy efficiency or shutting down coal plants were enough on their own. But study after study has concluded that achieving our 2030 and 2050 targets requires that we switch to cleaner fuels. And because this switch will take time, it's necessary to start now.¹⁴

Other Clean Fuel Standards were initially designed to address just this problem. In California and B.C., the policies have provided a long-term, consistent signal to reduce the carbon intensity of transportation fuels. And since this type of policy already exists in other jurisdictions, Canada can learn from them—and companies in the transportation sector know what to expect.

Canada's Clean Fuel Standard will be new for buildings and industry, so we recommend the government carefully evaluate both options we're presenting. For buildings and industry, the standard would likely apply to natural gas, petcoke, fuel oil and other fuels used for heating. The carbon intensity mandate would in theory cost less, but it is more complex. Conversely, the renewable natural gas mandate would likely cost more but is less complex.

Why It Creates Jobs and Economic Growth in Clean Fuels

In both our modelled designs, the Clean Fuel Standard would create jobs and economic growth in Canada's clean fuel sector. And while slower growth may occur elsewhere, our modelling finds the policy would ultimately add more jobs and economic activity than would be lost—delivering a net benefit.

The policy would increase economic activity in clean fuels by \$4.9 billion to \$5.6 billion a year in 2030. Overall economic activity would increase by \$2.7 billion to \$4.1 billion when accounting for slower growth elsewhere. The renewable natural gas mandate for buildings and industry would increase economic activity more than the flexible option.

The biggest growth sector would be Canada's biofuels industry, with up to \$4.9 billion in new economic activity by 2030. This includes \$200 million to \$1.4 billion in new investment a year out to 2030, largely to build and expand ethanol, biodiesel, renewable diesel and renewable natural gas facilities. The renewable natural gas mandate leads to more investment than the flexible option and is similar in size to the low end of annual investment in renewable electricity.

The remaining economic activity relates to operating expenditures like purchasing feedstocks from farmers and other supplies to keep the facilities running.¹⁵

Thanks to this spending, the standard would increase net employment by 11,000 to 17,000 jobs by 2030 to help build, operate and supply new clean fuel facilities (the renewable natural gas scenario leads to more employment than the flexible option). Other areas, such as electricity and carbon capture, benefit as well, thanks to more demand for electric cars and investments at refineries to reduce carbon pollution.

How are jobs measured?

We include full-time-equivalent direct operating, direct construction and indirect jobs in our analysis. The “net” means we account not only for accelerated job growth but also slower job growth resulting from the policy. Direct jobs include individuals employed directly at facilities, such as a construction worker building a biofuel facility or a plant operator. Indirect jobs include those created to support the direct jobs, like steel manufacturing for the metal used in a biofuel facility or farming to provide the feedstocks.

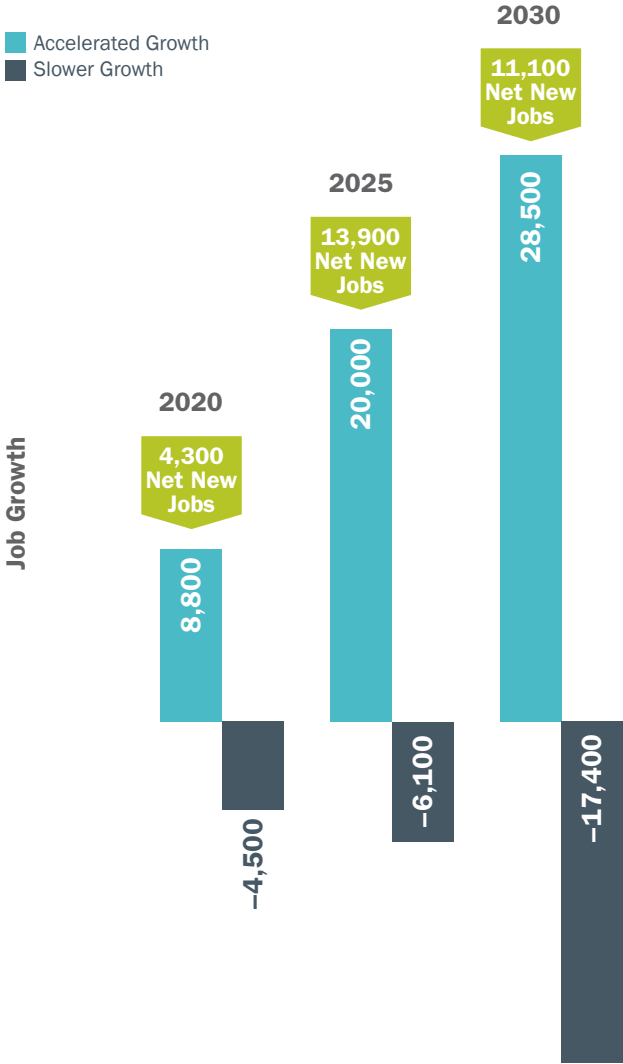
The standard would result in slower growth in vehicle manufacturing, vehicle maintenance and gas station investment and employment, as the policy encourages efficient vehicles. Specifically, growth would be 0.06% slower in these sectors.

Our analysis accounts for changes in economic activity necessary to meet the Clean Fuel Standard, as well as subsequent employment changes. In general, the Clean Fuel Standard shifts investment from conventional refining and transportation to cleaner fuel production. We account for the declines in some segments of the economy as well as the increases. Overall, we find a net increase in employment. Our model does not account for every conceivable impact to the economy, however, such as the relative change in productivity of potential investments, or the cost-savings of avoided climate change damage. We also found that about half of new biofuel production would be in Canada, when accounting for key (though not all) factors that determine where new facilities are built.

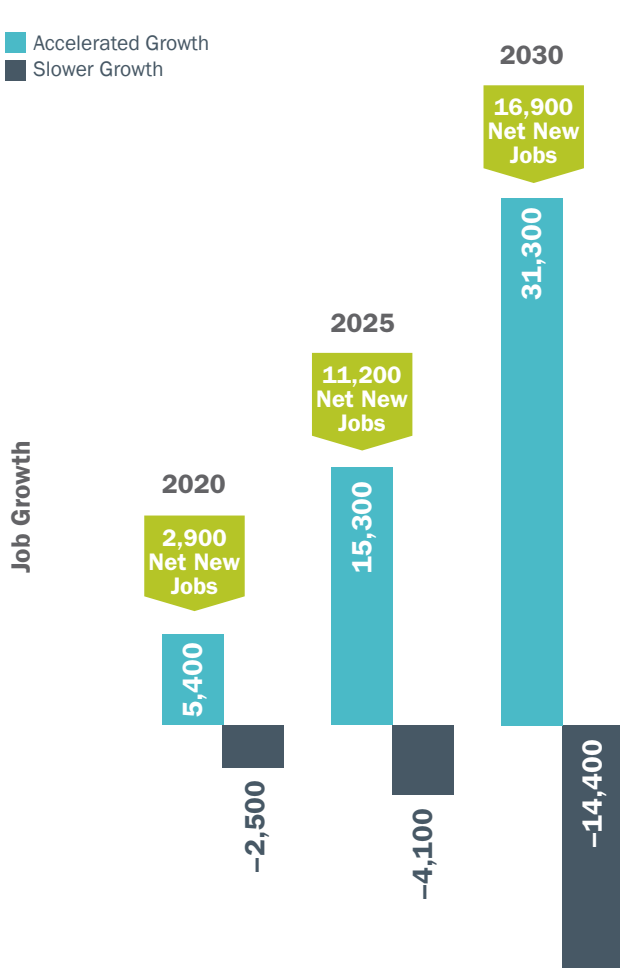
Job Growth in Clean Fuels

Introducing a renewable natural gas mandate for buildings and industry—rather than allowing flexibility in how emission reductions are achieved—would ultimately lead to more job creation and economic growth. Transportation stays the same in both scenarios: flexible.

JOB GROWTH WITH A FLEXIBLE CLEAN FUEL STANDARD

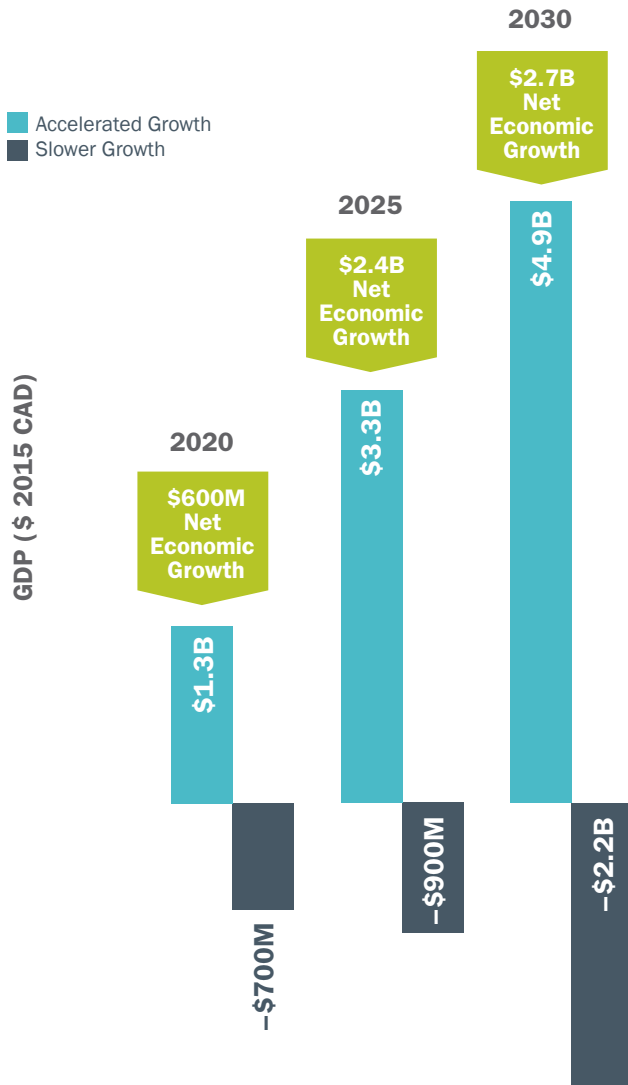


JOB GROWTH WITH A RENEWABLE NATURAL GAS MANDATE

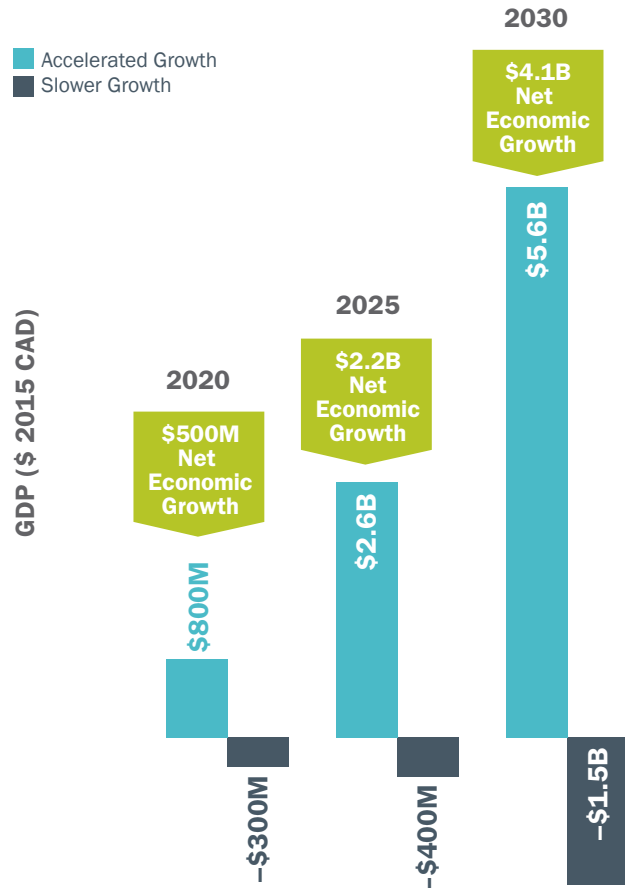


Economic Growth in Clean Fuels

ECONOMIC GROWTH WITH A FLEXIBLE CLEAN FUEL STANDARD



ECONOMIC GROWTH WITH A RENEWABLE NATURAL GAS MANDATE



An example of clean growth



Enerkem is the type of company that could benefit from a Clean Fuel Standard. The Montreal-based firm's Edmonton facility converts a portion of the city's municipal solid waste stream into low-carbon ethanol. The fuel is now sold to B.C. to help refiners meet the province's Clean Fuel Standard¹⁶—it has the lowest carbon intensity of any fuel in B.C. Enerkem employs more than 200 people across Canada and the U.S, including 45 full-time employees at its Edmonton facility.

According to Enerkem's employees



“As a new grad from the University of Alberta, I’m excited to be part of this new cutting-edge field and a more sustainable future.”

— Alvia Shafeeq, mechanical engineer



“After 15 years in the oil and gas industry, I saw a great opportunity to join a home-grown Canadian cleantech company.”

— Pierre St-Laurent, mechanical engineer

An Affordable Solution

Most Canadians won't see a noticeable difference on their energy bills with the Clean Fuel Standard in place—and even those costs are avoidable. We considered two cases: an energy-conscious household and a typical Canadian one.



ENERGY-CONSCIOUS CANADIANS:

These people are purchasing cars, homes and furnaces with an eye for reducing energy costs. In 2020, they are driving a hybrid vehicle like the Toyota Prius, have high-efficiency gas furnaces,

and a house that complies with energy efficiency building codes. By 2030, they're driving a plug-in hybrid like the Chevy Volt and live in very energy-efficient homes. All these technologies are available today, and many people already use them.

OUTCOMES: Energy-conscious Canadians stand to save \$84 a month on their household energy bills by 2030, compared to today.

This is thanks in part to existing and planned federal and provincial policies that mean families can choose more energy-efficient technologies. These Canadians will use less energy compared to today while living similar lifestyles. The Clean Fuel Standard will have virtually no cost impact on these households—at most, it would reduce those savings to \$82 a month, or a \$2 increase.



TYPICAL CANADIANS:

These people are statistically average. The typical Canadian household is based on the average vehicle, house and furnace owned in the given year. As Canadians replace vehicles and furnaces and renovate or buy new homes, the average household becomes more efficient.

OUTCOMES: The typical household will save \$22 a month by 2030 compared to 2015. The Clean Fuel Standard itself will add very little to a household's costs, at worst reducing those savings to \$17 a month by 2030, or a \$5 increase.



What about low-income Canadians?

Regardless of policy, the biggest energy-cost-related threat to the economic wellbeing of low-income families is the likelihood of price increases for natural gas, electricity and gasoline in the future. Energy-saving technology is one of the best ways to buffer against rising fuel prices. Rebates also help shelter low-income Canadians from government penalties on high-carbon fuel use and are common in jurisdictions with carbon pricing. B.C. provides rebates to low-income households and is planning to expand them.¹⁷ Alberta, Ontario and California provide similar support for low-income families.¹⁸ For households unable to make their homes or vehicles more efficient, the monthly cost increase of the Clean Fuel Standard is still small—less than \$4 a month by 2025—and even that can be avoided. How? Through government programs that help low-income Canadians buy energy-saving technologies. For example, Ontario's cap-and-trade reductions are required by law to help support social housing retrofits.¹⁹

The Impact on Carbon Pollution

Transportation

The bottom line: With this policy, the transportation sector can cut 19 million tonnes of CO₂eq by 2030—equal to taking nearly five million cars off Canada’s roads. We recommend setting targets that get more stringent over time, eventually requiring carbon intensity to be 10% lower in 2030 than in 2015.

A target like that would triple the market for cleaner fuels across Canada. Any company with a lower-carbon fuel, Canadian or otherwise, can compete in this newly expanded market. Solutions we’d expect to see: more electric cars in Canada (1.2 million vehicles, specifically) and a doubling of the amount of biofuels produced in the country.

This level of ambition is on par with B.C. and California. B.C. is planning a 15% reduction in the carbon intensity of its transportation fuels by 2030 relative to 2010,²⁰ while California is considering an 18% reduction by 2030 versus 2010.²¹

But this is just one scenario. Any number of technologies can compete for these reductions. We’ve kept our analysis to existing commercial technologies, but a lot can change in 13 years. Case in point: in 2004, Tesla celebrated raising US\$7.5 million—last year it posted \$7 billion in revenues.²²

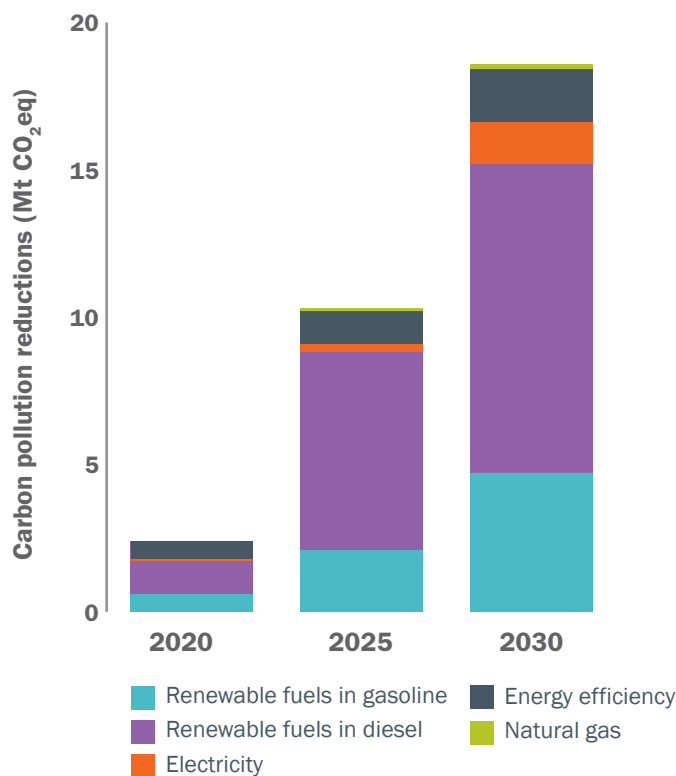
Lastly, you’ll notice the biggest reductions are in diesel. This is because so little diesel today comes from renewable sources—just 2% (compared to over 6% for gasoline).

Will there be enough fuels?

The Clean Fuel Standard would more than triple biofuel use in Canada, but this quantity is still small, representing a 3% increase from today’s levels by 2030 on a North American scale. Electricity increases resulting from the Clean Fuel Standard are low as well—an increase in demand in Canada of 1% by 2030.²³

The standard is also flexible. If a fuel option is unavailable or too expensive, other fuels can fill in. Renewable hydrocarbon diesel can stand in for biodiesel, for example. That said, the policy should guard against unexpected cost increases or fuel shortages—there are many ways to do this.²⁴

TRANSPORTATION EMISSION REDUCTIONS BY FUEL RESULTING FROM THE CLEAN FUEL STANDARD



Buildings and Industry

Combined, buildings and industry can deliver 15 Mt CO₂eq in reductions, either from a mix of technologies or through expanding the use of renewable natural gas.

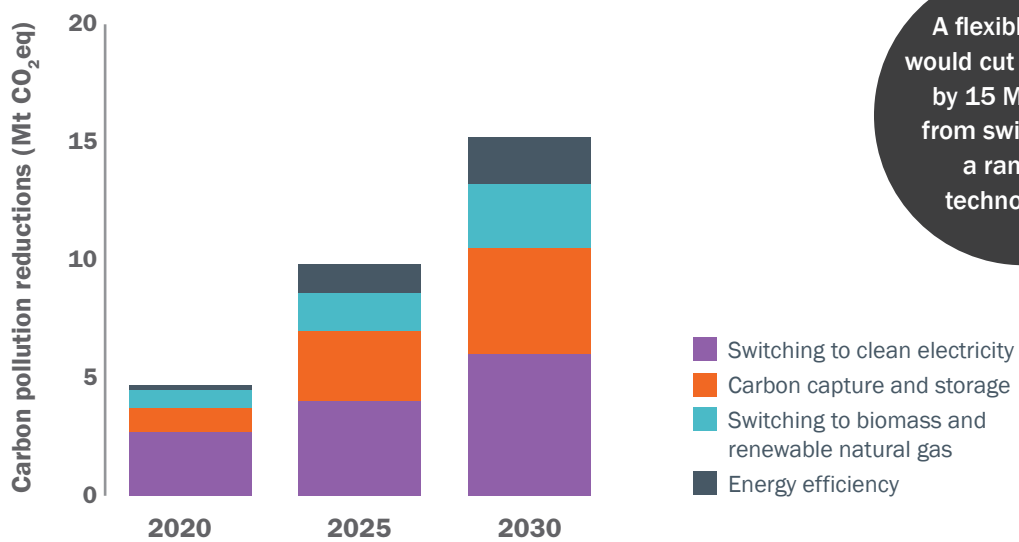
The federal government could apply a Clean Fuel Standard to all buildings and industry. Under this approach, emission reductions come from a mix of sources: carbon capture and storage, energy efficiency, switching to electricity and switching to biofuels. In theory, a flexible, market-based mechanism allows various solutions to compete, resulting in reductions at a lower cost. It also introduces complexity and uncertainty, however. A broad Clean Fuel Standard could require that companies and governments evaluate hundreds of technologies.²⁵

A SECOND OPTION: The federal government could introduce a mandate for renewable natural gas, growing its use in Canada from nearly 0% today to 5% by 2030. Renewable natural gas would mainly replace existing natural gas supplies. This would represent a significant increase from Canada's current use of renewable natural gas, but industry estimates suggest this level of growth is feasible. The Canadian Gas Association estimates that enough renewable natural gas could be developed by 2030 in Canada²⁶ and has proposed a 5% blending target by 2025—five years ahead of our recommended target.²⁷ In short, this option would kick-start a new industry—and make Canada a leader of an important renewable energy technology. It's also likely simpler for companies and the government to focus on a single fuel type, though it would cost more per tonne of carbon pollution reduced.

On a provincial level, the Government of Ontario is considering a renewable natural gas requirement as part of its climate change action plan.²⁸ B.C. is working with Fortis to expand renewable natural gas deployment in the province.²⁹ Enbridge and Union Gas forecasted that 13.5% of Ontario's 2015 natural gas demand could be renewable by 2030.³⁰ And Quebec supports renewable natural gas deployment in its Climate Change Action Plan.³¹

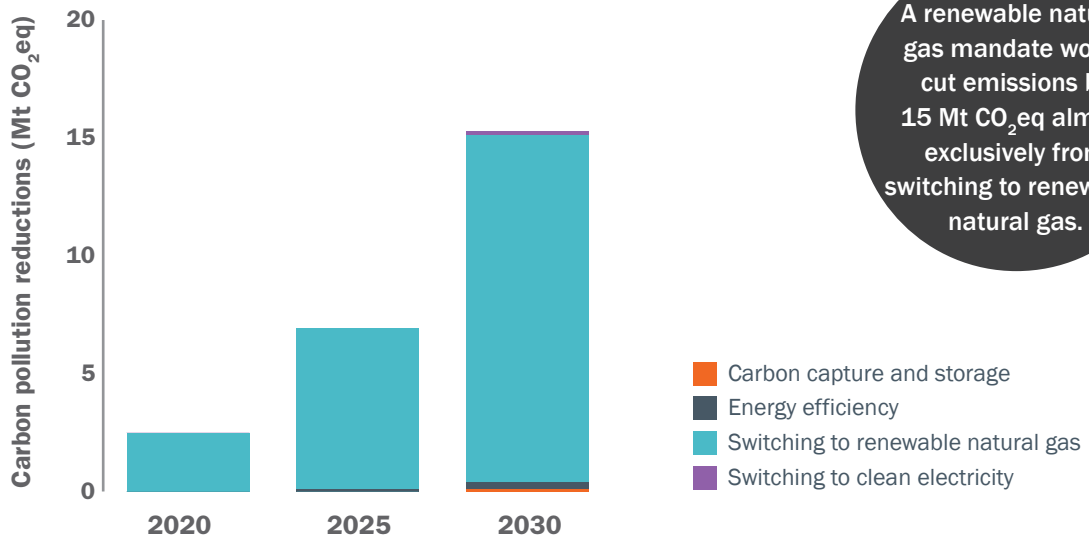
While total emission reductions are similar in both our scenarios for buildings and industry, the way they would be achieved differs greatly.

EMISSION REDUCTIONS IN BUILDINGS AND INDUSTRY WITH A FLEXIBLE POLICY IN PLACE



A flexible policy would cut emissions by 15 Mt CO₂eq from switching to a range of technologies.

EMISSION REDUCTIONS IN BUILDINGS AND INDUSTRY WITH A RENEWABLE NATURAL GAS MANDATE



A renewable natural gas mandate would cut emissions by 15 Mt CO₂eq almost exclusively from switching to renewable natural gas.

What Comes Next

The federal government will continue to design and consult on the Clean Fuel Standard between now and 2019, when it intends to release a final regulation. A draft framework is expected in the fall of 2017, followed by a draft regulation in 2018, publication of the final regulation in 2019 and then implementation.

There are several important design elements and questions to resolve before the Clean Fuel Standard becomes a reality in Canada. Based on our analysis and from engaging with people working on the policy, we think the following six areas require particular attention from government and key stakeholders through stakeholder working groups or other approaches:

- **PARTITIONING.** We've made the case for separating the transportation sector from buildings and industry, giving each its own requirements. This report outlines the rationale and outcomes of this approach. There are trade-offs with partitioning, however, and those implications must be thoroughly discussed and understood.
- **COMPETITIVENESS.** Emission-intensive and trade-exposed industries are concerned about potential competitiveness impacts from the Clean Fuel Standard. As this report went to press, there were no public estimates for what those costs may be and what, if any, impacts they may have on competitiveness.
- **PARTNER POLICIES.** The technical capacity exists to deploy affordable clean fuels in Canada. The results in this report are based on commercial technologies already used in Canada but deployed at a larger scale. As reality can differ from modelling, the actual amount invested in Canada could be higher or lower than we've forecasted. In the latter case, partner policies can help, but they must be chosen carefully. They could include federal investments like the Low-Carbon Economy Fund, the Canada Infrastructure Bank, and the Green Infrastructure Fund.
- **POLICY INTERACTIONS.** There will be different interactions with varying provincial carbon policies, most notably carbon pricing but also renewable fuel mandates and existing low-carbon fuel standards. These policies directly overlap with the Clean Fuel Standard, and there are benefits and drawbacks with both leaving the provincial policies in place as the standard is implemented, and replacing them outright with it.
- **CREDIT MARKET DESIGN.** Keeping costs down and incenting innovation depends on a functioning credit market. This must be designed carefully so that credits are readily accessible, transparent and stable.
- **COST CONTAINMENT.** We expect the Clean Fuel Standard to be affordable for Canadians. This outcome can be guaranteed with the right cost-containment design. Credit markets and price ceilings, for example, can provide more certainty on maximum costs.³²

Recommendations

In designing its Clean Fuel Standard, we urge the federal government to consider the following recommendations:

- **TRANSPORTATION:** Mandate a 10% carbon intensity reduction in the transportation sector by 2030 from 2015 levels. The transportation sector should be partitioned from buildings and industry.
- **BUILDINGS AND INDUSTRY:** Evaluate the options and then implement either a 3.5% carbon intensity reduction by 2030 from 2015 levels or a 5% renewable natural gas mandate by 2030.
- **COMPLEMENTARY:** Ensure the Clean Fuel Standard delivers 30 Mt CO₂eq of pollution reduction on top of existing measures in the pan-Canadian framework.

The Clean Fuel Standard is one of the most important climate policies in Canada. If designed properly, it will not only cut carbon pollution but also create jobs and foster the growth of Canada's clean fuel industry—an industry that countries around the world are competing to establish as the global market for cleaner energy sources keeps growing.



Energem's waste-to-fuel facility in Edmonton

Endnotes

1. Government of Canada (2017) *Technical Paper: federal carbon pricing backstop*. <https://www.canada.ca/en/services/environment/weather/climatechange/technical-paper-federal-carbon-pricing-backstop.html>
2. Government of Canada (2017) *Pan-Canadian Framework on Clean Growth and Climate Change*. <https://www.canada.ca/content/dam/themes/environment/documents/weather1/20170113-1-en.pdf>
3. Bataille, C. et al. (2015) *Pathways to deep decarbonization in Canada*. SDSN – IDDRI, M. Jaccard, M. Hein & T. Vass (2016) *Is Win-Win Possible? Can Canada's Government Achieve Its Paris Commitment . . . and Get Re-Elected?* <http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass%20CdnClimatePol%20EMRG-REM-SFU%20Sep%2020%202016.pdf>. International Energy Agency (2016) *World Energy Outlook*
4. Mui, Simon (2017) *New Progress Report Shows Low Carbon Fuel Standard Working*. <https://www.nrdc.org/experts/new-progress-report-shows-low-carbon-fuel-standard-working>
5. California Air Resources Board (2017) Data Dashboard. <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
6. Navius Research (2017) *Refining Margins in British Columbia*. <http://www.naviusresearch.com/publications/refining-margins-british-columbia/>
7. 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>
8. This based on Clean Energy Canada's analysis with more details in the summary report from a Canada-wide perspective. The level of emission reductions in each province will depend on specific policies in those provinces. As the EcoFiscal commission has noted, a Clean Fuel Standard will interact differently with cap-and-trade and carbon tax jurisdictions. Arnold, Jonathan (2017) *A delicate (im)balance: policy interactions and the federal clean fuel standard*. <https://ecofiscal.ca/2017/09/20/delicate-imbalance-policy-interactions-federal-clean-fuel-standard/>
9. Jaccard, Mark. Vass, Tiffany (2017) *Driving Decarbonization: Pathways and Policies for Canadian Transport*. <http://rem-main.rem.sfu.ca/papers/jaccard/Vass-Jaccard%20Biofuel-CFS%20in%20Canada%20Transport%20June%2029%202017.pdf>
10. Credit price from the B.C. Government (2017) Credit Transfer Activity Dec. 31 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 gCO₂eq/MJ, electricity grid intensity of 80 gCO₂eq/kwh. For an electric vehicle using 3,600 kwh per year, driving 19,200km with an energy efficiency ratio of 3, relative to a gasoline vehicle. The value of a Clean Fuel Standard credit per kwh of electricity is equal to the difference in carbon pollution intensity between gasoline and electricity multiplied by the energy efficiency for an electric vehicle.
11. California Air Resources Board (2017) *2017 Progress Report on the Low Carbon Fuel Standard*.
12. Environment and Climate Change Canada (2017) *National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada*.
13. This based on Clean Energy Canada and Navius Research analysis described in the technical report.
14. Bataille, C. et al. (2015) *Pathways to deep decarbonization in Canada*. SDSN – IDDRI, M. Jaccard, M. Hein & T. Vass (2016) *Is Win-Win Possible? Can Canada's Government Achieve Its Paris Commitment . . . and Get Re-Elected?* <http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass%20CdnClimatePol%20EMRG-REM-SFU%20Sep%2020%202016.pdf>. International Energy Agency (2016) *World Energy Outlook*
15. Investments in renewable electricity have varied between \$2 billion and \$10 billion a year over the past five years. Clean Energy Canada (2015 & 2017) *Tracking the Energy Revolution*. <http://cleanenergycanada.org/work/transition-takes-hold/> and <http://cleanenergycanada.org/trackingtherevolution-canada/2015/>
16. In B.C. the Clean Fuel Standard is called a Renewable and Low Carbon Fuel Requirement Regulation. We refer to this type of policy as a Clean Fuel Standard throughout the report.
17. B.C. Government (2017) *Budget 2017 – September Update* http://bcbudget.gov.bc.ca/2017_Sept_Update/bfp/2017_Sept_Update_Budget_and_Fiscal_Plan.pdf
18. State of California (2017) California Climate Investments Using Cap-and-Trade Auction Proceeds. https://arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2017.pdf. Alberta Government (2017) *Budget 2017*. <http://finance.alberta.ca/publications/budget/budget2017/fiscal-plan-complete.pdf>. Ontario Government (2017) Cap and trade in Ontario & Green Investment Fund. <https://www.ontario.ca/page/cap-and-trade-ontario> & <https://www.ontario.ca/page/green-investment-fund>
19. Ontario Government (2017) Cap and trade in Ontario & Green Investment Fund. <https://www.ontario.ca/page/cap-and-trade-ontario> & <https://www.ontario.ca/page/green-investment-fund>
20. B.C. Government (2016) *B.C.'s Climate Leadership Plan*. <https://climate.gov.bc.ca/>
21. CARB (2017) *The 2017 Climate Change Scoping Plan Update*. https://www.arb.ca.gov/cc/scopingplan/2030sp_pp_final.pdf

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22. Welch, David (2017) “Tesla Just Passed BMW in Market Cap.” <https://www.bloomberg.com/news/articles/2017-06-09/tesla-passes-bmw-in-market-cap-ranks-no-4-automaker-by-value-j3pxj7gc>
 23. State Department of Environmental Quality (2016) Agenda Item D – Assessing Options for Additional Cost Containment in the Clean Fuels Program. <http://www.oregon.gov/deq/Rulemaking%20Docs/AgendaItemD.pdf>
 24. Based on current electricity use of 1,720 PJ, Natural Resources Canada (2017) *Energy Factbook* https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/EnergyFactBook_2016_17_En.pdf
 25. In B.C. there are more than 150 fuel pathways with life-cycle carbon intensity estimates. This same level of detail would need to be developed for fuels used in buildings and industry.
 26. Canadian Gas Association (2016) *Renewable Natural Gas – Affordable for Canadians*. <http://www.cga.ca/wp-content/uploads/2016/05/RNG-publication-FINAL-April-2016-EN.pdf>
 27. Canadian Gas Association (2016) News Release. http://www.cga.ca/news_item/canadas-natural-gas-utilities-propose-target-for-renewable-natural-gas-content/
 28. Government of Ontario (2016) Climate Change Action Plan. <https://www.ontario.ca/page/climate-change-action-plan>
 29. B.C. Government (2017) *Increasing the market for LNG and renewable natural gas*. <https://news.gov.bc.ca/releases/2017MEM0011-000790>
 30. Navigant (2016) *Fuels Technical Report*. <http://www.energy.gov.on.ca/en/files/2016/10/FTRandModules.pdf>
 31. Government of Quebec (2013) http://www.mddelcc.gouv.qc.ca/changements/plan_action/pacc2020.pdf
 32. State Department of Environmental Quality (2016) Agenda Item D – Assessing Options for Additional Cost Containment in the Clean Fuels Program. <http://www.oregon.gov/deq/Rulemaking%20Docs/AgendaItemD.pdf>

